SUA-1341 License Amendment
Ludeman Project
Converse County, Wyoming

Environmental Report
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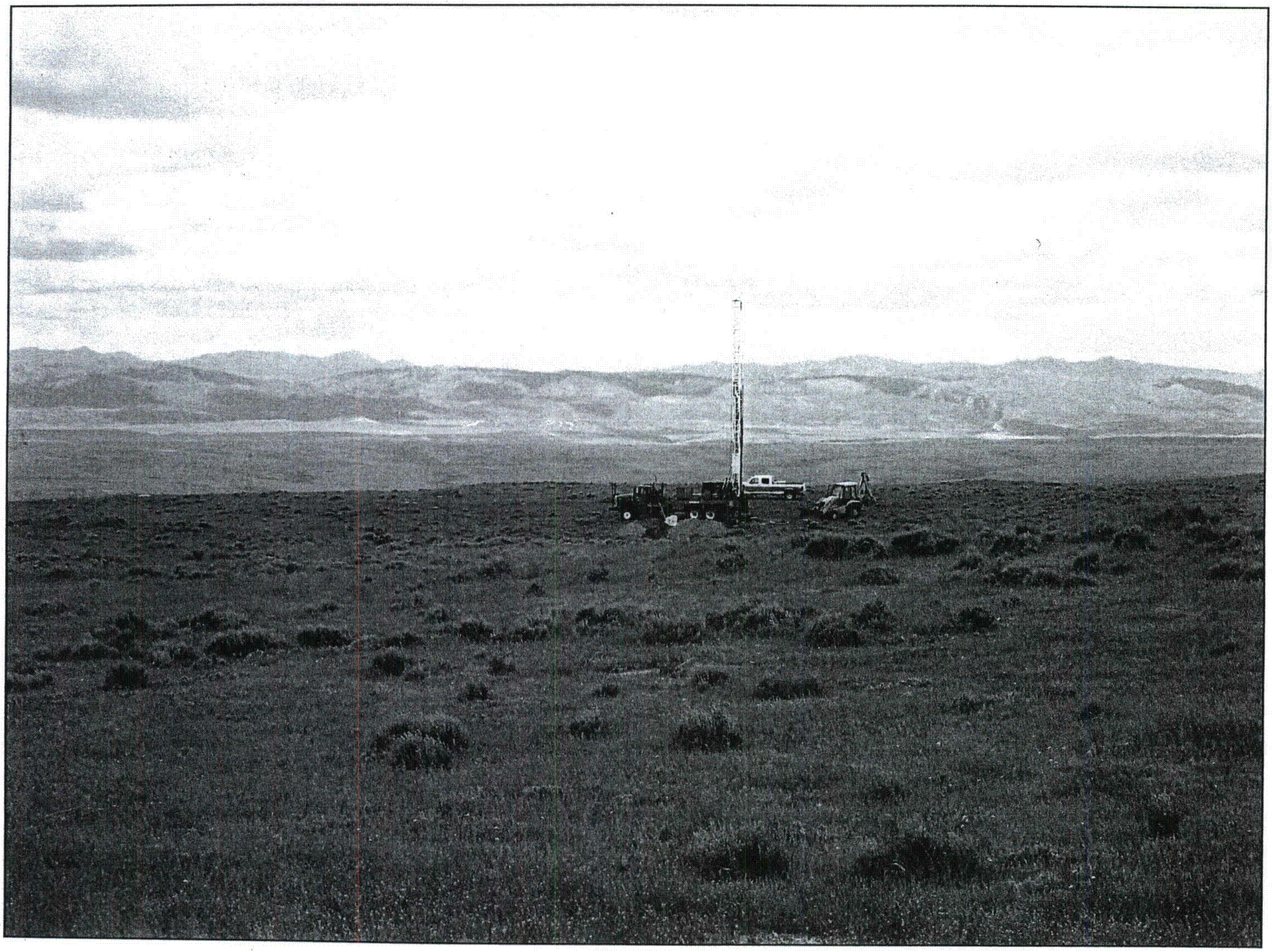

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4 POTENTIAL ENVIRONMENTAL IMPACTS

This section discusses the potential environmental impacts from the construction and operation of the proposed Ludeman Project (proposed project). Mitigation and monitoring are discussed with more detail in Sections 5 and 6 of this Environmental Report. This section is substantially equivalent to sections in the GEIS.

4.1 POTENTIAL LAND USE IMPACTS

As discussed in Section 3.1 of this Environmental Report, rangeland is the primary land use within the proposed project and within the surrounding two-mile review area. Natural gas pipeline facilities and infrastructure are also located on rangeland within the review area. There is one occupied housing unit in the proposed project area. The total surface area of the proposed project to be affected by the proposed operation is estimated to total 815 acres.

The wellfields, three Satellite facilities for ion exchange columns, resin transfer facilities, pumps for injection of lixiviant, six surge ponds and six deep disposal wells are the significant surface features associated with the proposed Ludeman ISR operations. Construction of the three Satellite facilities and associated structures will encompass approximately 15 acres. The Satellite facilities are anticipated to consist of an 80- x 140-foot processing building, associated parking, and other infrastructure within an approximate 1.5 acre area enclosed with security fencing. In addition, two surge ponds (each approximately 1.2 acres) will be separately enclosed in a 3.5 acre area with security fencing.

The road disturbance acreage is approximately 37 acres and is calculated assuming approximately seven miles of 25-foot-wide main road and approximately 18 miles of eight-foot-wide, field roads.

The proposed total wellfield area to be used for the injection and recovery of solution over the twelve-year mine life (not including construction and decommissioning) will be approximately 763 acres. Active wellfields and those in restoration will be fenced to limit access by livestock to wellfield areas and will be slightly greater than that encompassed by the areas to be mined. Natural gas pipeline facilities will not be affected. Considering the relatively small size of the area impacted by operations, the exclusion of grazing from this area over the course of the proposed project will have an insignificant impact on local livestock production.

4.2 POTENTIAL TRANSPORTATION IMPACTS

4.2.1 Potential Access Road Construction Impacts

State Highways 95 and 93 pass through the northern end of the proposed project. Delivery of construction materials will access the site on these highways. Existing gravel road accesses the general locations selected for construction of the Satellite facilities. This existing road may require minor improvements and completion of a short spur road to accommodate access by trucks and heavy equipment during construction and operation. The road disturbance acreage is approximately 37 acres and is calculated assuming approximately seven miles of 25-foot-wide main road and approximately 18 miles of eight-foot-wide, field roads. The environmental impacts of these minor improvements will be insignificant. Access road construction activities will primarily have minor air quality impacts, which are discussed in detail in Section 4.6.

4.2.2 Potential Traffic Impacts

The primary transportation route to the proposed project from nearby communities is on State Highway 95, which connects the license area to the community of Glenrock along Interstate 25 to the west and State Highway 93, which connects to Douglas to the east. The City of Casper is located approximately 36 miles west of the project area on State Highways 95 and Interstate 25. The Town of Douglas is approximately 18 miles southeast on State Highway 93, and also lies along the Interstate 25 corridor. In 2007 the Annual Average Daily Traffic counts along the 18-mile segment of State Highway 95 between Glenrock and the State Highway 93 junction was approximately 50 vehicles (WYDOT, personal communication, October 23, 2008). Several private access roads extend south from State Highway 95 to access existing agricultural, residential, and oil and gas facilities in the project area. The Annual Average Daily Traffic counts at the intersection of State Highway 95 and County Road 26 (Leuenberger Lane, used to access residential and ranch facilities) is 260.

The highest levels of project-related traffic would be from the operations workforce, and assuming there would be an average of one employee per vehicle, per one-way vehicle trip, there could be an increase of 5.4 percent in daily traffic along the highway. This 5.4 percent (10.8 percent for two trips per day) increase is well below the 25 percent threshold generally used for predicting significant effects to a transportation system.

Equipment needed for construction and installation of the proposed facility would include heavy equipment (cranes, bulldozers, graders, trackhoes, trenchers, and front-end loaders), and heavy-and light-duty trucks. It is anticipated that heavy equipment will be transported primarily to the site during off-peak traffic hours.

Transportation of IX resin would be made in exclusive use transport vehicles to the Willow Creek central plant for further processing. Loaded ion exchange resin will be transported from the proposed project in a tanker truck/trailer. It is currently anticipated that up to four loads of uranium-laden resin may be transported for elution and up to four loads of barren eluted resin may be returned on a daily basis, resulting in approximately 2,920 shipments of IX resin per year. This level of traffic would not significantly affect the project-related traffic compared to the commuting traffic associated with the project workforce.

Transportation of 11(e).2 byproduct material will be made in exclusive-use transport vehicles off-site to a licensed disposal facility. In accordance with NRC License SUA1341 a disposal agreement is in place with the Pathfinder Mines Corp. (PMC) Shirley Basin facility. The Shirley Basin facility is located approximately 100 highway miles from the proposed project. The expected transport route to the PMC facility will be west on State Highway 95, north on State Highway 93, south on Interstate 25, west on State Highway 220, and south on State Highway 487 to the PMC facility access road. The expected annual byproduct material production rate for the proposed project is approximately 250 cubic yards. Based on the use of covered roll-off containers with a nominal capacity of 20 cubic yards, Uranium One expects 12 to 13 byproduct material shipments per year. This level of traffic would not significantly increase the project related traffic compared to the estimated commuting and truck traffic associated with the project.

Transportation of nonradioactive solid waste will be made using a contract waste hauling company to a licensed disposal facility. The preferred alternative disposal site is the Glenrock disposal facility located in Glenrock, Wyoming due to proximity to the proposed project site. The Glenrock facility is located approximately 3 highway miles from the proposed project. The expected transport route to the Glenrock disposal facility will be west on State Highway 95 to Rolling Hills where it is located. The expected annual nonradioactive solid waste production rate for the proposed project is 2,000 cubic yards. Typical contract waste haulage vehicles range in capacity from 20 to 40 cubic yards. Based on a conservative assumption of the use of haulage vehicles with a nominal capacity of 20 cubic yards, Uranium One expects 100 nonradioactive solid waste shipments per year, or an average of approximately 2 shipments per week. This level of traffic would not significantly increase the project-related traffic compared to the estimated commuting and truck traffic associated with the project.

On-site road maintenance will include periodic grading of the primary access roads, snow plowing, applying water or other agent(s) for dust control, and regular inspections to ensure erosion control measures are adequate.

4.2.3 Potential Transportation Accident Impacts

Transportation of hazardous materials to and from the proposed project can be classified as follows:

- Shipments of uranium-laden resin from the proposed Satellite facilities to the Willow Creek central processing plant for further processing and return shipments of barren, eluted resin. Resin will be transported in tank trucks/trailers to the Willow Creek Central Plant for elution, precipitation and drying;
- Shipments of process chemicals or fuel from suppliers to the site; and
- Shipment of radioactive waste from the site to a licensed disposal facility.

Accident risks involving potential transportation occurrences and mitigating measures are discussed in the following sections. Mitigation and control measures to eliminate or minimize transportation accident environmental impacts are discussed in Section 5.2.

4.2.3.1 Potential Accidents Involving Ion Exchange Resin Shipments

A potential transportation risk associated with operation of the proposed project is the transfer of the ion exchange resin to and from an offsite central processing plant. Loaded ion exchange resin would be transported in a tanker truck/trailer. It is currently anticipated that up to four loads of uranium-laden resin may be transported for elution and up to four loads of barren eluted resin may be returned on a daily basis. The transfer of resin will occur on a combination of private, county and State roads. For shipments of ion exchange resin to an offsite central processing facility, NRC determined that the probability of an accident involving such a truck was 0.009 in any year.

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium-laden and barren resin. General shipping procedures are outlined as follows:

- The resin, either loaded or eluted, will be shipped as "Exclusive Use Only". This will require the outside of each container or tank to be marked "Radioactive LSA" and placarded on four sides of the transport vehicle with "Radioactive" diamond signs;
- A bill of lading will be included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified shall be the shipping name, id number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number;
- Before each shipment of loaded or barren eluted resin, the exterior surfaces of the tanker will be surveyed for contamination. In addition, gamma exposure rates will be obtained from the surface of the tanker and inside the cab of the tractor. All of the survey results will appear on the bill of lading; and
- Properly licensed and trained drivers will transport the resin between the proposed Ludeman Project Satellite and offsite central processing facilities.

Uranium One will develop an emergency response plan for transportation accidents to or from the proposed project. Uranium One personnel will receive training for responding to a transportation accident.

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck 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 and environmental impact of a similar accident with barren, eluted resin would be less significant. 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.

Mitigation for traffic impacts are discussed in Section 5.2

4.2.3.2 Accidents Involving Shipments of Process Chemicals and Fuel

It is estimated that approximately four bulk chemical, fuel, and supply deliveries will be made per working day throughout the operational life of the project. Types of deliveries will include carbon dioxide, oxygen, salt, soda ash, and fuel. All shipment will be made in accordance with the applicable DOT hazardous materials shipping provisions.

4.2.3.3 Potential Accidents Involving Radioactive Wastes

Low level radioactive 11e.(2) by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential environmental impact in the event of an accident. Shipments are generally made bulk in sealed roll off containers in accordance with the applicable DOT hazardous materials shipping provisions.

4.3 POTENTIAL GEOLOGY AND SOILS IMPACTS

4.3.1 Potential Geologic Impacts

Potential geological impacts from operations are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the target sandstone will be on the order of one percent or less. Further, once

production and restoration operations are completed, groundwater levels will return to near-original conditions under a natural gradient.

4.3.2 Potential Soil Impacts

Based on the soil mapping unit descriptions in Section 3.3, the hazard for water erosion within the proposed project area varies from slight to severe and the hazard from wind erosion varies from moderate to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. General topography of the area ranges from nearly level uplands to very steep hills, ridges and breaks of dissected shale plains. The soils occurring on the proposed project were generally a sandy or coarse texture throughout upland areas and fine, clay textured soils occurring in or near drainages. The proposed project area contained deep soils on level upland areas with shallow and very shallow soils located on hills, ridges and breaks. Given the texture of the surface horizons throughout the majority of the proposed project area and the semi-arid climate, the soils are more susceptible to erosion from wind than water. See Table 3.3-8 in Section 3.3 for a summary of wind and water erosion hazards within the proposed project.

The three Satellite facility locations are underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. The soils underlying the proposed wellfields are at a moderate to severe risk of erosion from both wind and water. Though no topsoil will be stripped from the wellfields, construction may result in an increase in the erosion hazard from both wind and water due to the removal of vegetation and the physical disturbance from heavy equipment.

Soil erosion mitigation will be implemented in accordance with WDEQ-LQD Rules and Regulations, Chapter 3, Environmental Protection Performance Standards. Typical erosion protection measures that may be implemented at the proposed project include the following:

- Temporary diversion of surface runoff from undisturbed areas around the disturbed areas and the use of water velocity dissipation structures;
- Retaining sediment within the disturbed areas through the use of best management practices such as silt fencing, retention ponds, or other effective means; and
- Salvage and stockpiling of topsoil from the proposed project Satellite facility areas and from secondary wellfield access roads in a manner to avoid wind and/or water erosion.

4.4 POTENTIAL WATER RESOURCES IMPACTS

4.4.1 Potential Surface Water Impacts

4.4.1.1 Potential Impacts on Surface Waters and Wetlands

Uranium One plans to construct three Satellite facilities and associated well fields at the proposed project. No perennial streams or other permanent water bodies exist within the proposed project area. The majority of the area is drained to the east by Sage Creek and its tributaries. Little Sand Creek drains the western portion of the site. All natural flow in the region is categorized as intermittent or ephemeral and all, if not impounded, eventually drains to the North Platte River to the south. A number of stock tanks and reservoirs were scattered throughout the area, though the reservoirs rarely contained water. A wetland survey was conducted within the entire proposed project site area in accordance with the Interim Regional Supplement to the 2008 U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual: Great Plains Region. Identification of potential wetlands was based on visual assessment of vegetation and hydrology indicators, as well as intrusive soil sampling to determine the presence of wetland criteria indicators. Hydrology and soils were evaluated whenever a plant community type met hydrophytic vegetation parameters based on the Dominance Test and Prevalence Index (as defined by the USACE Great Plains Regional Supplement), or whenever indicators suggested the potential presence of a seasonal wetland area under normal circumstances. Per the Great Plains Interim Regional Supplement, for wetland delineation purposes, an area is considered to be vegetated if it has five percent or more total plant cover at the peak of the growing season.

Construction, operation, or reclamation activities, which cause disturbance or impacts to jurisdictional wetlands on the proposed project, will be performed in accordance with appropriate Nationwide Permits (NWP), if applicable:

- NWP 44 non-coal mining activities, which requires Pre-construction Notification (PCN) for all activities;
- NWP 12 utility line activities, which requires a PCN for an area where a Section 10 permit is required (utility installation in navigable waters), when a utility line in waters of the U.S. exceeds 500 feet, when a utility line is placed within a jurisdictional area and it runs parallel to a stream bed that is within that jurisdictional area, when more than 0.1 acre will be impacted, or when permanent access roads are constructed in waters of the U.S. with impervious materials; and
- NWP 14 linear transportation projects, which requires a PCN when more than 0.1 acre will be impacted or if there is a discharge in a special aquatic site, including wetlands.

NWP 44, NWP 12, and NWP 14 have an acreage impact limit of one-half acre for waters of the United States (e.g. jurisdictional). Impacts to Other Waters of the United States (OWUS) are not considered under the acreage limit. Wetlands will not be impacted by the construction of the Satellite facilities. Wetlands or surface water channels may be impacted by the construction of wellfields. Approximately 6.6 acres of wetlands or water bodies fall within the boundaries of the ore bodies. Of those, approximately 1.8 acres are potentially jurisdictional. The actual acreage of impacted wetlands and water bodies will be determined when the final design for the wellfields is complete.

Wetlands and water bodies within the 19,888 acre site were delineated June 2 through the 12 and August 5 through 10, 2008. The majority of the wetlands and water bodies identified were small, disconnected depressions within ephemeral drainages. Wetlands identified included groundwater slope wetlands, depressions within ephemeral and intermittent drainages, diked ephemeral drainages, or isolated depressions. All of the wetlands within the site are classified as Palustrine Emergent according to the Cowardin classification system (Cowardin, et al, 1979). Many of the wetlands also have an open water component and are therefore also classified as Palustrine Unconsolidated Bottom. As a general rule, one data collection point was used for a series of small disconnected wetlands within the same drainage. Approximately 59.6 acres of wetland were identified (233 individual wetlands).

Water bodies identified were either depressions within ephemeral drainages, behind dikes in ephemeral drainages, or isolated depressions. None of the water bodies contained flowing water. Approximately 29.3 acres of water bodies were identified (195 individual water bodies).

The investigation identified approximately 59.64 acres of wetlands which represents emergent depressional wetlands associated with surface water drainage features, or emergent isolated depressions. Approximately 0.3 percent of the 19,888-acre proposed project area meets the wetland criteria. The investigation identified approximately 29.3 acres of water bodies within the 19,888 acre site which is approximately 0.15 percent of the site.

Based upon published guidance, those wetlands and water bodies within intermittent waterways are likely jurisdictional and those wetlands and water bodies within ephemeral drainages are likely non-jurisdictional. Isolated features are also likely non-jurisdictional. Those features which are likely jurisdictional include 43 wetlands and four water bodies which represent 29.046 acres of the proposed project area.

Description of the three major drainages (Little Sand Creek, Running Dutchman Ditch, Sage Creek) is provided in Section 3.5.5.2.

4.4.1.2 Potential Surface Water Impacts from Sedimentation

Normal construction activities within the wellfields, Satellite facilities locations and along the pipeline alignments and roads have the potential to increase the sediment yield of the disturbed areas. However, the relative size of these disturbances is small when compared to the size of the overall areas and to the size of the watersheds, and also have a short-term impact. Since wellfield decommissioning and reclamation activities will be on-going throughout the life of the proposed project, the area to be reclaimed at the conclusion of operations will be reduced, although a slight increase in sediment yields and total runoff can still be expected. Since all natural flow within the proposed project boundaries is ephemeral with no intermittent or perennial streams, potential impacts to surface water from construction, operations, and decommissioning activities are also limited to uncommon precipitation or runoff events.

The physical presence of the surface facilities including wellfields and associated structures, access roads, office buildings, pipelines, facilities and other structures associated with ISR mining and processing of uranium are not expected to significantly change peak surface water flows because of the topography of the drainages at the site, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage within and adjacent to the proposed Ludeman Project. In areas where these structures may affect surface water drainage patterns, diversion ditches and culverts will be used to prevent excessive erosion and control runoff. In areas where runoff is concentrated, energy dissipaters are used to slow the flow of runoff to minimize erosion and sediment loading in the runoff.

No drainages or bodies of water will be significantly modified or altered within the proposed project area during project construction or operations. The potential for erosion is present due to the construction of the wells near the drainage. However, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

Construction and industrial stormwater National Pollutant Discharge Elimination System (NPDES) permits will be obtained in accordance with WDEQ - Water Quality Division regulations. Best management practices will be implemented to reduce impacts according to storm water management plans developed for those permits.

4.4.1.3 Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as excessive rainwater or runoff in impacted soil areas or failure or an uncontrolled release of process liquids due to a wellfield leak. Section 5.4.2 presents a discussion of the measures to be used to prevent and control wellfield spills. Process buildings and chemical storage areas will be constructed with

sumps or secondary containments, and a regular program of inspections and preventive maintenance will be implemented.

4.4.2 Potential Groundwater Impacts

The potential groundwater impacts of ISR mining are related to the consumption of groundwater and short- and long-term changes to groundwater quality. Impacts of groundwater consumption are described in Section 4.4.2.1. Perhaps the most significant environmental impact that can occur as a result of ISR mining is the degradation of water quality in the ore-bearing aquifer. These potential impacts are discussed in Section 4.4.2.2. Potential groundwater impacts resulting from accidents and spills are described in Sections 4.4.2.3.

4.4.2.1 Groundwater Consumption

Based on a bleed of 0.5 percent to 1.5 percent which has been successfully applied at other ISR operations, the potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99 percent) of groundwater used in the mining process will be treated and re-injected. Potential impacts on groundwater due to consumptive use outside the proposed project are expected to be negligible.

To assess the impacts from mining and restoration operations on local groundwater, the following monitoring will be performed:

- Measure background water levels in the private domestic or livestock water wells surrounding the proposed project area before mining and every three months during operation; and
- Measure background water levels in regional monitoring wells installed by Uranium One before mining and every three months during operations.

If significant impacts to either the adjacent domestic wells or to stock wells in the vicinity of the proposed project are observed (e.g., water levels drop to a point that impairs the usefulness of the wells), the following mitigation measures would be considered:

- Lowering the pump level in the wells, if possible;
- Deepening the wells, if possible; or
- Replacing the wells with new wells completed in deeper sands that are not impacted by ISR operations.

4.4.2.2 Potential Impacts on Production Zone Groundwater Quality

During ISR mining operations, water quality impacts are usually of greater concern than water consumption impacts because water consumption during mining is relatively small. Impacts to groundwater from the proposed lixiviant is caused by (1) the addition of sodium bicarbonate and or carbon dioxide and oxygen to the groundwater, (2) the addition of chloride to the groundwater by the processing plant, and (3) the interaction of these chemicals with the mineral and chemical constituents of the aquifer being mined. The result is that during mining, the concentration of most of the naturally occurring dissolved constituents in the mining zone will be appreciably higher than their concentrations in the original groundwater.

Uranium One has estimated the post-mining water quality based on the experience of COGEMA Mining, Inc. (Cogema, 2004) in Production Units 1 through 9 at the Irigaray ISR project located in the Powder River Basin near the proposed Ludeman Project as described in Section 5.4.2.2. The Irigaray data was selected because of the availability of extensive quantities of relevant data, its general proximity to and similar geologic conditions to the proposed project. COGEMA employed ammonium bicarbonate with hydrogen peroxide as the oxidant during early mining operations. In May 1980, the lixiviant system for the entire site was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database is extensive because it represents nine Production Units located in a 30-acre site.

The water quality of the Irigaray Production Zone after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Production Units 1 through 9 is presented in Section 5, Table 5-2. The chemical alteration of the ore zone aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations. Uranium One expects similar baseline and post-mining water quality at the proposed project site.

While it is likely that the wells within and surrounding the proposed project area may provide stock water for private or public (BLM) leases, none are located in currently proposed mining areas. If future development includes an area(s) where a stock well is located in an aquifer to be produced, the following mitigation measures would be considered:

- Replacing the wells with new wells completed in either shallower or deeper sands that are not impacted by ISR operations, or
- Providing another source of stockwater.

4.4.2.2.1 Negley Subdivision Water Wells

The Negley development is an unplatted subdivision consisting of approximately 30 individual land owners located in Section 11, T34N, R74W (shown in Figure 4.4-1). The Negley Subdivision is located within two miles of the proposed project boundary. Twenty water wells have been identified in Section 11 of the subdivision, and three nearby wells, one located in each of Section 1 (Well N-9), Section 2 (Well N-11) and Section 9 (Well N-8, off-map), T34N, R74W, all of which have been grouped into the Negley well category. Table 7-3 provides the Negley well information and Figure 4.4-1 shows the locations of the wells. The Negley wells have been sampled for baseline water quality and the data summaries are found in Section 3.4, Addendum 3.4-F.

Available information indicates that the water wells in the Negley Subdivision are in aquifers that lie above the proposed project Production Zones and that the proposed in-situ mining activities will not occur in the same zones in which the Negley wells are completed. Additionally, the proposed project Production Zone aquifers are separated from the Negley wells aquifers by approximately 100 feet of claystone that has shown to be a hydrologic confining layer through historic and modern pumping tests conducted in the Leuenberger area (described in Section 3.4.3). As a result, mining activities at the proposed project are not anticipated to have an impact on the water quality of the Negley wells, based on the available information that is summarized below.

Historical Backround

In-situ recovery related mining activities occurred in the late 1970's and early 1980's on the Leuenberger Ranch, located south of the Negley Subdivision in Section 14. Figure 4.4-1 shows the location of the Leuenberger pilot project site, which was licensed by the NRC (Source Material License No. SUA-1371, Docket No. 40-8728) and permitted by the WDEQ-LQD to Teton Exploration Drilling Co., Inc. (Teton) for License to Explore (LE103), which was replaced by a Research and Development License (2RD), and subsequently replaced by commercial scale Mine Permit 552. A review of the operator history, project activities and permitting history of the Leuenberger pilot project is outlined in a WYDEQ-LQD memorandum (WYDEQ-LQD, 2000).

The Production Zones tested (including well designs, operations, restoration) at the Leuenberger site were in the "M" (80) Sand and the "N" (90) Sand, both of which are considered Production Zone targets of the proposed Ludeman Project in the area of the former Leuenberger site. The underlying aquifer was considered the "L" (70) Sand. (Uranium One geologic nomenclature and a stratigraphic column describing the geologic units at the proposed Ludeman Project is seen in Section 3.3). The 80 Sand is about 320 to 390 feet below surface and is separated from the overlying 90 Sand by about 50 to 75 feet of claystone and siltstone. The 80 Sand ranges from about 50 to 65 feet in thickness. The 90 Sand, which was the shallowest sand mined at this site, occurs about 220 to 270 feet below

surface and is about 50 feet thick. The overlying aquifer, referred to as the "Idaho Sand" or "O" (interpreted as the 100 Sand in the region, and as the 110 Sand in the immediate vicinity of the Leuenberger test site where the 100 Sand is absent), was noted as the uppermost ground water aquifer and the common domestic water source. This shallow aquifer is separated from the 90 Sand by about 100 feet of claystone.

During the Leuenberger pilot project, baseline monitoring of ground water quality from monitor wells in the overlying, production zone and underlying aquifers was conducted in the pilot project area. Two off-site monitor wells were completed in the overlying aquifer. Based on available site information, data interpretation, and the limited duration and magnitude of mining activities at the Leuenberger pilot plant, it was concluded that there were no impacts to the shallow aquifer in which most domestic wells in the area were completed. (WYDEQ-LQD, 2000).

Figure 4.4-1: Negley Subdivision Water Well Locations

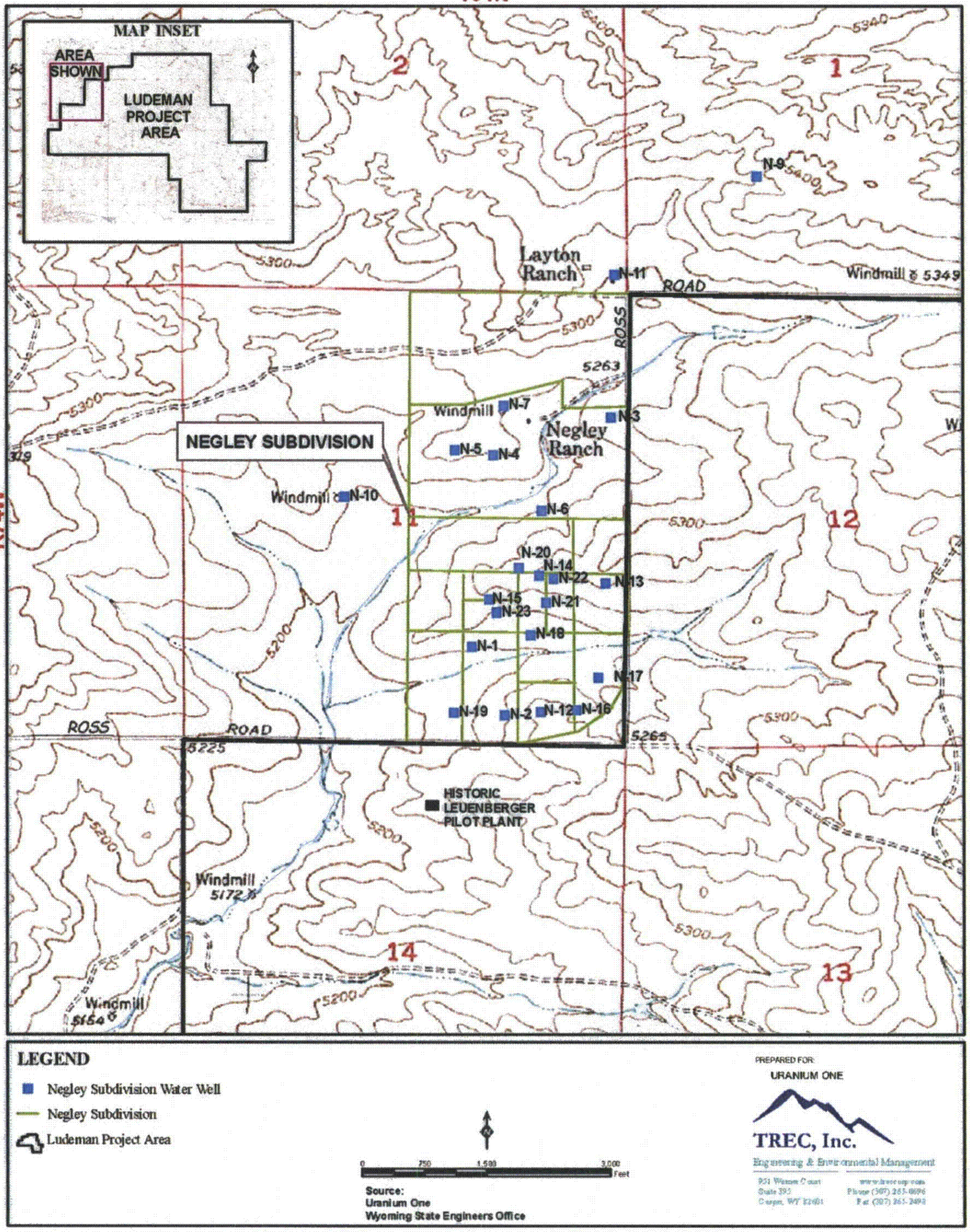


Table 4-1
Negley Subdivision
Well Information

Well No.	Elevation (ft)	Latitude North	Longitude West	Casing ID	TD (ft)
N-1	5262	42°55.674	105°41.904	5"	129
N-2	5255	42°55.543	105°41.812	5"	80
N-3	5277	42°56.116	105°41.529	5"	120
N-4	5269	42°56.042	105°41.849	5"	200
N-5	5307	42°56.051	105°41.952	5"	200
N-6	5260	42°55.936	105°41.717	5"	180
N-7	5290	42°56.138	105°41.821	6"	300
N-8	5215	42°55.541	105°43.994	10"	300
N-9	5371	42°56.581	105°41.137	5"	135
N-10	5237	42°55.959	105°42.251	5"	60
N-11	5310	42°56.392	105°41.524	5"	n.a.
N-12	5288	42°55.550	105°41.717	5"	n.a.
N-13	5293	42°55.798	105°41.542	5"	210
N-14	5272	42°55.812	105°41.722	6"	172
N-15	5258	42°55.766	105°41.857	5"	n.a.
N-16	5281	42°55.555	105°41.617	6"	175
N-17	5261	42°55.618	105°41.559	5"	n.a.
N-18	5252	42°55.698	105°41.745	5"	200
N-19	5214	42°55.548	105°41.951	5"	n.a.
N-20	5289	42°55.827	105°41.777	5"	n.a.
N-21	5285	42°55.760	105°41.702	5"	n.a.
N-22	5265	42°55.806	105°41.682	5"	210
N-23	5260	42°55.741	105°41.836	5"	165

n.a. = Information not available from WSEO

Current Analysis

Water quality data summaries for the Negley wells are located in Section 3.4, Addendum 3.4-F. A summary of an evaluation of water quality data of 22 of the Negley wells indicate that, based on similar water quality, water tables, and well completion data, it is probable that the following wells are completed in and produce from the same aquifer, probably the 110 Sand: N-19, N-13, N-20, N-6, N-22, N-1, N-13, N-2, N-4, N-21, N-12, N-5 and N-16. The N-8 (Section 9, T34N, R74W-off map) well was probably completed in the 80 Sand,

however probably not in or near ore based on the Uranium and ^{226}Radium results. Wells that are anomalous and appear to be affected by surface contamination (in order of greatest infiltration of nitrate, chloride and sulfate) include N-18, N-3, N-10, N-23, N-9, N-7 and N-10. N-16 was noted to not be contaminated by surface related sources, based on a lack of elevated nitrate or chloride.

Geologic computer modeling that utilizes the total depth (TDs) of the Negley wells, geophysical logs from exploratory drill holes, local structural and stratigraphic data indicates that two Negley wells (N-7 and N-17) located in Section 11, T34N, R74W penetrate as deep as the 100 Sand aquifer. As previously discussed, the 100 Sand is present in the region but is absent in the immediate vicinity of the Leuenberger test site. The 100 Sand is separated by approximately 100 feet of claystone from the production sand (90 Sand). The remainder of the Negley wells with known TDs are estimated to be completed in shallower aquifer sands (110 Sand).

Based on available well data, geologic information and historic pilot plant operations, the in-situ mining activities at the proposed Ludeman Project are not anticipated to have an impact on the water quality of the wells in Negley Subdivision. Although it is possible that N-8 is completed in a production zone aquifer, it is located approximately 1.1 miles from the proposed project boundary. Uranium One will continue to perform baseline operational monitoring as required by the NRC.

4.4.2.3 Potential Groundwater Quality Impacts from Accidents

4.4.2.3.1 Lixiviant Excursions

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

Water quality impacts in adjacent aquifers from ISR mining activities are related to the identification, control, and clean-up of excursions. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of impacted groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, or hydrofracturing of the ore zone or surrounding units. Past experience from other commercial scale ISR projects in the Powder River Basin has shown that when proper steps are taken in

monitoring and operating a wellfield, excursions, if they do occur, can be controlled and recovered such that serious impacts to groundwater quality are prevented.

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

Accident Prevention

Uranium One will control the lateral movement of lixiviant by maintaining well field 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 will either be recycled in the facility or sent to the liquid waste disposal system. When process bleed is properly distributed among the many mining patterns within the wellfield, mining solutions are contained within the monitor well ring.

Uranium One will monitor 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. Monitor wells will be installed as discussed in Section 6.2. Monitor wells will be sampled semiweekly for approved excursion indicators. Corrective actions will be taken if early signs of lixiviant migration are detected prior to reaching excursion status.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers. Uranium One will prevent 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 WDEQ for review and approval before wellfield operation may proceed. Well construction and integrity testing will be conducted in accordance with WDEQ regulations and methods approved by NRC and WDEQ. Construction and integrity testing methods were discussed in detail in Section 2.2.6. Well abandonment is conducted in accordance with methods approved and monitored by the WDEQ and discussed in detail in Section 5.1.1.

Uranium One will monitor for vertical excursions in the overlying and underlying aquifers using shallow monitor wells. These wells will be located within the wellfield boundary at a density of one well per four acres. Shallow monitor wells will be sampled semi-monthly for approved excursion indicators.

4.4.2.3.2 Wellfield Spills

Potential impacts to groundwater and surface water may occur during operations as a result of an uncontrolled release of process liquids due to a wellfield leak. Should an uncontrolled wellfield release occur, there would be a potential impact of the shallow aquifer as well as surrounding soil. With a slow leak that remains undiscovered or a catastrophic failure, a shallow excursion is one potential impact. In this unlikely event, wells could be installed in the effected shallow aquifer and pumps used to capture and eliminate the impacted water.

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the facility, would result in a release of injection or production solution which would impact the ground in the area of the break.

Occasionally, small leaks at pipe joints and fittings in the header houses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. These leaks seldom result in soil contamination. Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination. Following repair of a leak, Uranium One will 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. Impacted soils may be removed as appropriate.

4.5 POTENTIAL ECOLOGICAL RESOURCES IMPACTS

4.5.1 Vegetation

Wellfield and production facilities will be constructed within four of the vegetation communities in the proposed project. Those vegetation communities are Big Sagebrush Shrubland, Lowland Grassland, Upland Grassland, and Upland Grassland Rough Breaks Complex. Potential direct impacts include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types). Potential indirect impacts would include the short-term and long-term invasion, establishment, and expansion of non-native species, exposure of soils to accelerated erosion, shifts in species composition or changes in vegetative density, reduction of wildlife habitat, reduction in livestock forage and changes in visual aesthetics. The total surface area of the proposed project to be affected by the proposed operation is within the proposed project area and is estimated to total 815 acres.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species within the

proposed project area. Non-native species invasion and establishment has become an increasingly important result of previous and current disturbance in Wyoming. 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 the surrounding undisturbed vegetation. The Converse County Weed and Pest District Supervisor will be consulted when weed concerns arise to help determine the best management practices for the specific weed infestation.

There were no federally listed threatened or endangered species were observed in the proposed project area found during sampling; therefore, no impacts are anticipated. The Converse County designated noxious weeds wavyleaf thistle (*Cirsium undulatum*) and cheatgrass (*Bromus tectorum*) were encountered in the area during recent sampling.

Mitigation of vegetation impact will consist of temporary and permanent surface revegetation of disturbed areas. Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. Disturbed areas will be seeded to establish a vegetative cover to minimize wind and water erosion and the invasion of undesired plant species. A long-term temporary seed mix may be used in wellfield and other areas where the vegetation will be disturbed again prior to final decommissioning and final revegetation. This long-term seed mix typically consists of one or more of the native wheatgrasses (e.g., western wheatgrass, and thickspike wheatgrass). Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD. The permanent seed mix typically contains native wheatgrasses, fescues and clovers. Wellfield areas may be fenced as necessary to prevent livestock access, which will enhance the establishment of temporary vegetation.

4.5.2 Wildlife and Fisheries

ISR uranium mining differs from conventional surface mining by using less intrusive extraction methods that are more efficient and, thus, have less impact on the surrounding area. ISR operation use a series of injection and production wells that extract the uranium from the ore body without physically removing the ore or overburden from the ground. The production area consists of a series of wells within a systematic pattern with a single Satellite facility to remove the uranium from the lixiviant. ISR mining has a much smaller impact footprint than conventional surface mining because topsoil stripping and habitat destruction are restricted to relatively small areas needed for the processing facilities and the access roads. The total surface area of the proposed project to be affected by the proposed operation is within the license area and is estimated to total 815 acres. Construction of the three Satellite facilities and associated structures will encompass approximately 15 acres. The Satellite facilities are anticipated to consist of an 80- x 140-foot processing building, associated parking, and other infrastructure within an approximate 1.5 acre area enclosed with security fencing. In addition, two surge ponds (each approximately 1.2 acres) will be separately enclosed in a 3.5 acre area

with security fencing. The road disturbance acreage is approximately 37 acres and is calculated assuming approximately seven miles of 25-foot-wide main road and approximately 18 miles of eight-foot-wide, field roads.

The proposed total wellfield area to be used for the injection and recovery of solution over the twelve-year mine life (not including construction and decommissioning) will be approximately 763 acres. As indicated, most of that habitat disturbance will consist of scattered, confined drill sites for wells that will not result in large expanses of habitat being dramatically transformed from its original character as in other surface mining operations. Therefore, most indirect impacts would relate to the displacement of wildlife due to increased noise, traffic, or other disturbances associated with the development and operation of the proposed project, as well as from small reductions in existing or potential cover and forage due to habitat alteration, fragmentation, or loss. Indirect impacts typically persist longer than direct impacts. However, the nature of ISR decreases the occurrence of large-scale habitat alterations and, thus, the need for reclamation efforts that can result in dramatic differences between pre-construction and post-construction vegetative communities.

In-situ recovery of uranium could potentially have direct and indirect impacts on local wildlife populations. These impacts may be both short-term (lasting until successful reclamation is achieved) and long-term (persisting beyond successful completion of reclamation). However, long-term impacts are not expected to be substantial due to the relatively limited habitat disturbance associated with this mining method. The direct impacts of ISR production on wildlife include injuries and mortalities caused by collisions with project-related traffic or habitat removal actions such as topsoil stripping, particularly for smaller species with limited mobility such as some rodents and reptiles and restrictions on wildlife movement due to construction of fences. The likelihood for the impacts resulting in injury or mortality is greatest during the construction phase due to increased levels of traffic and physical disturbance during that period. Traffic will persist during production, but should occur at a reduced, and possibly more predictable level. Speed limits will be enforced during all construction and maintenance operations to reduce impacts to wildlife throughout the year, but particularly during the breeding season.

Repeated surveys over multiple, consecutive years in the proposed project area have documented that two wildlife species of particular concern do not occur in the proposed project area: the bald eagle and the mountain plover. Suitable habitat for the two species (trees, sagebrush, and sparse, low-growth vegetation, respectively) is extremely limited, further minimizing the potential for both direct and indirect impacts for those species, and others that require similar habitats. Other wildlife species of concern, such as ferruginous hawks (*Buteo regalis*), that do occur in the area may experience indirect impacts from increased travel and noise in the area during project construction and operation. However, the combination of documented nesting, the presence of potential alternate nesting and foraging habitat in the immediate vicinity, and the mobility of this species reduces impacts to

ferruginous hawks and other such species. Sage grouse occur in small numbers in the proposed project area but there are no active or inactive leks present.

4.5.3 Medium-Sized and Small Mammals

A variety of small and medium-sized mammal species occur in the vicinity of the general analysis area, although not all have been observed on the proposed project itself. These include predators and furbearers. Observed species include: the coyote (*Canis latrans*), swift fox (*Vulpes velox*), badger (*Taxidea taxus*), White-tailed Jackrabbit (*Lepus townsendii*), cottontails (*Sylvilagus* spp.), Thirteen-lined ground squirrel (*Tamias minimus*), Black-tailed prairie dog (*Cynomys ludovicianus*), and the Deer mouse (*Peromyscus maniculatus*).

Medium-sized mammals (such as lagomorphs, coyotes, and foxes) may be temporarily displaced to other habitats during the initial uranium mining activities. Direct losses of some small mammal species (e.g., voles, ground squirrels, mice) may be higher than for other wildlife due to their more limited mobility and likelihood that they would retreat into burrows when disturbed, and thus be impacted by topsoil scraping or staging activities. However, given the limited area expected to be disturbed by the proposed project, such impacts would not be expected to result in major changes or reductions in mammalian populations for small or medium-sized animals. The species known to be, or potentially, present in the proposed project area have shown an ability to adapt to human disturbance in varying degrees, as evidenced by their presence in CBM developments and residential areas of similar, or greater, disturbance. Additionally, small mammal species in the area have a high reproductive potential and tend to re-occupy and adapt to altered and/or reclaimed areas quickly.

4.5.4 Big Game Mammals

Pronghorn (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) are the only two big game species that regularly occur in the general analysis area for the proposed project. No crucial big game habitat or migration corridors are recognized by the WGFD in this area. Crucial range is defined as any particular seasonal range or habitat component that has been documented as the determining factor in a population's ability to maintain and reproduce itself at a certain level.

Pronghorn are more abundant than mule deer in the proposed project area, but neither species is prevalent. Upland grasslands dominate the proposed project area and immediate perimeter. Although grassland habitats do provide adequate forage during much of the year, they are not considered as preferred by wintering pronghorn (Sundstrom et al. 1973). The home range for pronghorn can vary between 400 to 5,600 acres, depending on several factors including season, habitat quantity and quality, population characteristics, physical movement barriers, and local livestock occurrence. In northeast Wyoming, daily movement typically does not

exceed six miles. Pronghorn may make seasonal migrations between summer and winter habitats, but migrations are often triggered by availability of specific plants and not local weather conditions (Fitzgerald et al. 1994).

The WGFD has classified the general analysis area as yearlong pronghorn range, which means that a population or a portion of a population of animals makes general use of this habitat on a year-round basis. The proposed project site spans two WGFD pronghorn Herd Units: the Pumpkin Buttes area to the north of Wyoming Highway 387, and the North Converse Unit south of the highway. The WGFD estimated the 2006 post-season pronghorn populations in those two hunt areas to be approximately 36,500 and 32,300, respectively; both considerably above objective (Pumpkin Buttes and North Converse Pronghorn JCR Reports, WGFD, 2006).

Mule deer use nearly all habitats, but prefer sagebrush-grassland, rough breaks, and riparian bottomland. Browse is an important component of the mule deer's diet throughout the year, comprising as much as 60 percent of total intake during autumn, while forbs and grasses typically make up the rest of their diet (Fitzgerald et al. 1994). Mule deer are not abundant in the general analysis area, with most individuals recorded in eroded draws and small tree windbreaks in that vicinity. In certain areas of the state, this species tends to be more migratory than white-tailed deer, traveling from higher elevations in the summer to winter ranges that provide more food and cover. However, monitoring indicates that mule deer are not very migratory in the vicinity of the proposed project. The WGFD has classified the majority of the general analysis area as yearlong mule deer range, with a portion of the proposed project area south of the highway classified as "out". That range delineation is considered inadequate to support mule deer. As with pronghorn, the proposed project spans the Pumpkin Buttes and North Converse mule deer Herd Units. The WGFD estimated the 2006 post-season pronghorn population to be approximately 12,350 and 9,700 animals, respectively whereas the herd objectives were 11,000 and 9,100, respectively (Pumpkin Buttes and North Converse Pronghorn JCR Reports, WGFD, 2006). No crucial or critical mule deer ranges or migration corridors occur on or within several miles of the proposed project.

Under the proposed action, big game could be displaced from portions of the proposed Ludeman Project to adjacent areas, particularly during construction of the wellfield and facilities, when disturbance activities would be greatest. Disturbance levels would decrease during actual production and restoration operations and would consist primarily of vehicular traffic on improved and unimproved (two-track) roads throughout the proposed project area. Pronghorn would be most affected, as they are more prevalent in the area. However, no areas classified as crucial pronghorn habitat occur on or within several miles of the proposed project area and this species is not as common in the general analysis area as elsewhere within the region due to the limited presence of sagebrush in the area. Mule deer would not be substantially impacted given their infrequent use of these lands, the paucity of winter forage and security cover, and the availability of suitable habitat in adjacent areas. The

WGFD does not consider the general area to be within the "use range" of any other big game species. Sightings of those species in that vicinity are rare, if they occur at all.

4.5.5 Upland Game Birds

No known greater sage-grouse (*Centrocercus urophasianus*) or sharp-tailed grouse (*Tympanuchus phasianellus*) leks were documented within the proposed project survey area (License area and one-mile perimeter, defined by the WGFD) prior to baseline surveys in 2008. Few sage-grouse and no sharp-tailed grouse were observed in the proposed project survey area.

The mourning dove (*Zenaida macroura*) was the only other upland game bird that was observed in or near the proposed project area during 2008. Mourning doves were most often recorded along the North Platte River as it passes through the extreme southern portion of the one-mile perimeter. Doves were also documented in tree windbreaks at occupied ranches or in individual trees located throughout the proposed project area. This species is a relatively common breeder in Converse County, and is the most prevalent upland game bird in the general analysis area. Doves are often seen in the area during migration, with fewer observations during the nesting season.

Given the limited area expected to be disturbed by the proposed project, such impacts would not be expected to result in major changes of potential foraging and nesting habitat for mourning doves. Additionally, doves are not restricted to treed habitats, nor are they subject to any special mitigation measures for habitat loss.

Baseline monitoring studies have repeatedly demonstrated that sage-grouse do not inhabit the proposed project area. As described previously in Section 3.5, those surveys encompassed most of the proposed project area and its one-mile perimeter for much of that period. No sage-grouse leks were observed in that region during any survey year. WGFD records and USDA-FS records also failed to document any sage-grouse leks within the area that encompasses the general analysis area (i.e., proposed Ludeman Project boundary and a one-mile perimeter). Given the lack of sage-grouse observations in the area, and the minimal quantity and marginal quality of potential sage-grouse habitat, Uranium One does not plan to conduct operational monitoring for sage-grouse.

4.5.6 Other Birds

Eleven USFWS avian species of concern were recorded within the proposed project Survey Area during 2008. Six of those 11 species are categorized as Level I, which indicates a need for conservation action (i.e., having a monitoring and mitigation plan): the greater sage-grouse (*Centrocercus urophasianus*), ferruginous hawk *(Buteo regalis)*, burrowing owl (Athene cunicularia), bald eagle *(Haliaeetus leucocephalus)*, Swainson's hawk (*Buteo*

swainsoni), and short-eared owl (*Asio flammeus*). The remaining five species are considered Level II, for which continued monitoring is recommended: the lark bunting (*Calamospiza melanocorys*), grasshopper sparrow (*Ammodramus savannarum*), loggerhead shrike (*Lanius ludovicianus*), vesper sparrow (Pooecetes gramineus), and lark sparrow (Chondestes grammacus).

Direct impacts to these 11 avian species could include injury or mortality due to encounters with vehicles or heavy equipment during construction or maintenance operations. Indirect impacts could include habitat loss or fragmentation and increased noise and activity that may deter use of the area by some species. Surface disturbance would be relatively minimal and would be greatest during construction. Enforced speed limits during all phases of the proposed project would reduce impacts to wildlife throughout the year, particularly during the breeding season.

4.5.7 Raptors

Raptor species that are known to nest in the proposed project area (Proposed Project Area and one-mile perimeter) are the ferruginous hawk, red-tailed hawk, and great horned owl. Seven additional raptor species were recorded in the proposed project survey area during 2008: the bald eagle, golden eagles turkey vulture, Swainson's hawk, northern harrier, short-eared owl, and burrowing owl.

The final rule delisting the bald eagle was published in the Federal Register on July 9, 2007 (Federal Register: Vol. 72, No. 130, pg. 37345-37372 July 9, 2007). Delisting became effective 30 days after publication of this rule, on August 8, 2007. However, this species will continue to be protected under both the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The bald eagle is considered a breeder in portions of Converse County, Wyoming (Cerovski et al. 2004). In the proposed Ludeman Project Survey Area, nesting and winter roosting habitat for this species is primarily limited to the cottonwood corridor in the southeastern portion of the one-mile perimeter along the North Platte River.

In accordance with WDEQ LQD requirements, a raptor nest survey is conducted in late April or early May each year to identify any new nests and assess whether known nests are being utilized. The survey covers all areas of planned activity for the life of mine (i.e., wellfields and Satellite facilities) and a one mile area around the activity. Status and production at known nests will be determined, if possible. This survey program is primarily intended to protect against unforeseen conditions such as the construction of a new nest in an area where operations may take place. Wildlife studies on the proposed project will include annual raptor surveys.

ISR uranium mining in the proposed project area would not impact regional raptor populations, though individual birds or pairs may be affected. Mining activity could cause

raptors to abandon nests proximate to disturbance, particularly if mining encroaches on active nests during a given breeding season. Construction activities associated with the proposed project that occur within or near active raptor territories would temporarily impact the availability of foraging habitat for nesting birds. However, equipment yards associated with mining provide additional habitat for prey species such as cottontails and raptors have been documented voluntarily nesting quite near those areas. Other potential direct impacts to these species are limited to injury or mortality due to collisions with mine-related vehicular traffic. As at other surface mines throughout the region, including nearby uranium projects, nesting raptors in the proposed project area have likely been influenced primarily by natural factors such as prey abundance and availability of nesting substrates. Due to the paucity of woody vegetation and river cliffs, raptors that nest in trees or on high cliffs are not as abundant as those that either nest on the ground or are adaptable to nesting on mine facilities or other man-made structures (platform nests, etc.). During active mining, new nesting habitat can be created through enhancement efforts (nest platforms, nest boxes, and tree plantings) to mitigate any negative impacts associated with the proposed project. Additionally, mining related activities are limited to relatively small areas for limited periods of time. It is not anticipated that mining related activities will adversely affect a raptor nest, or disturb a nesting raptor as there is a lack of nesting raptors on and near the facility and wellfield areas due to the lack of trees and other nesting sites.

4.5.8 Fish and Macroinvertebrates

Potential habitat for reptiles, amphibians, and aquatic species is quite limited within the proposed project area and occurs primarily in Gilbert Lake, and as ephemeral or intermittent habitat associated with small, scattered stock ponds or drainages in the area. Under natural conditions, aquatic habitat on and near the proposed project is limited by the ephemeral nature of surface waters in the general analysis area. The lack of deep-water habitat, and extensive and persistent water sources precludes the presence of fish, and limits the abundance and diversity of other aquatic species. The largest water body is Gilbert Lake, located at the extreme eastern extent of the proposed project area. The lake held water throughout the 2008 baseline study period. No quantitative surveys for fish were required or conducted specifically for the proposed Ludeman Project.

4.5.9 Threatened and Endangered Species

No Threatened or Endangered vertebrate species have been documented in the proposed project survey area, and none were observed there during baseline wildlife surveys conducted in 2008. Likewise, no current (as of September 2008) candidate, petitioned, or proposed vertebrate species were recorded during recent or previous surveys.

4.5.9.1 Bald Eagle (Federal Threatened)

Bald eagles were observed within the one-mile perimeter of the Survey Area in 2008. No bald eagle nests or consistent winter roost sites were identified in the proposed project. As bald eagle nests and winter roost sites are absent in the study area, potential hazards for this species would be limited to foraging individuals during winter.

Direct impacts to bald eagles would include the potential for injury or mortality to individual birds foraging in the proposed project area due to collisions with mine-related equipment during construction or operation of the proposed project. The increased human presence and noise associated with construction activities, if conducted while eagles are wintering within the area, could displace individual eagles from using the area during that period. As bald eagles have not been documented in the proposed project area, impacts of the proposed action would be limited to occasional foraging individuals rather than a large segment of the population. If necessary, the majority of direct impacts could be mitigated if construction activities were conducted outside the winter and early spring months, or outside the daily roosting period, should eagles be present in the proposed project area during construction. Any bald eagles that might roost or nest in the area once the mine is operational would be doing so in spite of continuous and on-going human disturbance, indicating a tolerance for such activities.

Indirect impacts such as area avoidance could result from increased noise and human presence associated with mining related operations. Potential winter foraging habitat could be further fragmented by linear disturbances such as fences and new roads associated with the proposed project. Given the size of the proposed project, those disturbances would occur within narrow corridors over relatively short distances.

ISR mining at the proposed project may affect, but is not likely to adversely affect, bald eagles. As bald eagle nests and winter roost sites are absent in the study area, potential hazards for this species would be limited to foraging individuals during winter. Due to the lack of potential nesting or roosting sites and the lack of concentrated sources of prey, both the direct and indirect effects of the proposed action to bald eagles are expected to be minimal.

4.5.9.2 Reptiles, Amphibians

Potential habitat for reptiles, amphibians, and aquatic species is quite limited within the proposed project area and occurs primarily in Gilbert Lake, or as ephemeral or intermittent habitat associated with small, scattered stock ponds or drainages in the area. The only amphibian that was encountered in the proposed Ludeman Project Area, in the 2008 ICF Jones & Stokes survey, was the boreal chorus frog (*Pseudacris triseriata*). One bullsnake (*Pituophis melanoleucas*) was observed in the western portion of the proposed Ludeman

Project Area in early August. No fish were sampled or observed incidentally in the North Platte River during baseline studies for this project.

Activities associated with the proposed project are not expected to disturb existing surface water or alter the topography in the area. Furthermore, under natural conditions, such habitat is limited in the proposed project area and few observations of aquatic species have been recorded there over time. Impacts to surface water flow and channels are expected to be minimal, as no significant alterations to these features would result from construction and operations. Additionally, any primary channels and surface water flow affected during mining would be restored during reclamation.

4.5.10 Waterfowl and Shorebirds

Avian species recorded in the proposed project area included several common waterfowl, wading bird, and shorebird species, such as the mallard (*Anas platyrhynchos*), gadwall (*A. strepera*), green-winged teal (*A.* crecca), American wigeon (*A. Americana*), great blue heron (*Ardea herodias*), killdeer (*Charadrius vociferous*), and Wilson's phalarope (*Phalaropus tricolor*). The majority of these wetland birds were observed at Gilbert Lake in the extreme eastern portion of the proposed project area. The western kingbird (*Tyrannus verticalis*), Say's phoebe (*Sayornis saya*), common nighthawk (*Chordeiles minor*), and rock wren (*Salpinctes obsoletus*) were also seen within the proposed project area, as were other common species (Appendix 3.5-K). The nighthawk, eastern kingbird (*Tyrannus tyrannus*), and other species were also documented in the surrounding perimeter.

Under natural conditions, the proposed Ludeman Project area provides extremely limited and marginal habitat for waterfowl and shorebirds. As described for other aquatics-related species, above, natural aquatic habitats are mainly present during spring migration. Many of those water features are reduced to small, isolated pools or are completely dry during summer.

Construction and operation of the proposed project would have a negligible effect on migrating and breeding waterfowl and shorebirds. Little existing habitat is present in the area, so it does not currently support large groups or populations of these species. Ponding of water from fluid releases during operations will be immediately removed, minimizing any contact of released fluids with waterfowl or shorebirds. Any new treated water sources would enhance current habitat conditions for these species, though such effects may be ephemeral and temporary in nature. Habitat disturbance in drainages or other potential water sources would be reclaimed once productive operations have ceased. Replacement of any impacted jurisdictional wetlands would be required in accordance with Section 404 of the Clean Water Act.

4.6 POTENTIAL AIR QUALITY IMPACTS

The only gaseous effluent from the proposed project is radon-222 gas. The impacts from this effluent are discussed in detail in Section 4.12.2.

Construction activities at the proposed project will cause minimal short-term effects on local air quality. Increased suspended particulates from vehicular traffic on unpaved roads, fugitive dust caused by wind erosion of areas cleared of vegetation, and diesel emissions from construction equipment would be the primary air quality impacts. The application of water to unpaved roads will reduce the amount of fugitive dust to levels equal to or less than the existing condition. Diesel emissions from construction equipment are expected to be short term only, ceasing once the operational phase begins.

Uranium One estimated fugitive dust emissions from operation of the proposed project area based on projected activity levels and using emission factors supplied by the WDEQ. Projected activities impacting dust emissions included ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Based on these activities, the projected total PM_{10} emissions is 15.5 tons per year. This level of emissions is small relative to surface mines and other industrial operations that generate dust from vehicles and disturbed areas. The larger surface mines in the Powder River Basin show PM_{10} emissions inventories in the thousands of tons per year. Sections of unpaved county roads can also exceed 15 tons per year emission rate by an order of magnitude or more. Viewed another way, atmospheric dispersion modeling generally shows that fugitive PM_{10} emissions on the order of 15 tons per year result is an insignificant impact to ambient air beyond a distance of a few hundred yards from the sources. 40 CFR 51.165(b)(2) defines the Significant Impact Level (SIL) for PM_{10} as 1.0 $\mu g/m^3$ or more. For reference purposes, 40 CFR 50.6(a) defines the national ambient standard for annual average PM_{10} as 150 $\mu g/m^3$.

It is important to note that no control factors were assumed for the emission calculations. This is a conservative effect resulting in overestimation of dust generation as periodic watering or chemical treatment of the unpaved roads will reduce emission factors by half or more. Mitigation measures for potential air quality impacts from dust are discussed in Section 5.6.

4.7 POTENTIAL NOISE IMPACTS

There a small cluster of occupied housing units in the vicinity of and one residence in the proposed Ludeman Project area. The proposed North Platte facility site is approximately 1.2 miles from the property boundary and Highway 93. The existing ambient noise in the vicinity

of the proposed project is dominated by the traffic noise from State Highways 95 and 93 and surrounding oil and gas operations.

The proposed Leuenberger Satellite facility site is approximately one half mile from the property boundary of the small residential subdivision and approximately one mile from the Leuenberger Ranch house. Assuming that the noise level produced by unshielded machinery at the facility site is 85dB at 50 feet, the sound pressure level attained at the property boundary will be below the level identified by the USEPA as suitable for outdoor areas where human activity takes place (approximately 55 dB[1]). A level of 85 dB is the OSHA threshold at which a hearing conservation program at the facility would be required. Experience at operating ISR facilities verifies that this assumption is conservative and that the average sound pressure levels during construction will be less than 85 dB. After appropriate engineered controls (i.e. the protective enclosure for the equipment) are installed, noise levels will not impact the residences, and are unlikely to approach the levels attained by State Highway 95. Therefore, impact to noise or congestion above ambient background noise within the proposed project area or in the surrounding two-mile area is not anticipated.

As a result of the remote location of the proposed project and the relatively low population density of the surrounding area, impact to noise or congestion above ambient background noise within the proposed project area or in the surrounding two-mile area are not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Glenrock, Rolling Hills or other neighboring towns or counties.

4.8 POTENTIAL HISTORIC AND CULTURAL RESOURCES IMPACTS

As discusseg in Section 3.8, a Class III cultural resource inventory of the proposed project was conducted in 2008 by Ethnoscience, Inc. of Billings Montana. The inventory incorporated 19,888 acres, of which 398 acres are under Bureau of Land Management jurisdiction, 1,485 acres are owned by the State of Wyoming, and remaining 18,005 acres are privately owned. The investigation identified 47 sites and 59 isolated finds. Three previously recorded prehistoric sites within the proposed project area were not found. It is assumed they no longer exist. Historic documents also note the possible presence of an historic telegraph line, but the inventory identified no evidence of this site.

Twenty-four of the sites are prehistoric. All of the existing sites are archaeological. Eighteen of the prehistoric sites contain stone features. Two sites are culture material scatters and six are lithic scatters. No other class of artifacts was found.

Twenty-three sites are historic. The historic sites consist of a historic trail (Bozeman Trail), five windmills, five farmsteads, three foundations, three depressions, four culture material

scatters, and two stone features. The stone feature consists of a historically formed rock pile. Its function is unknown.

The Bozeman Trail is listed on the National Register. The ruts associated with this trail in the proposed project area are shallow and difficult to see. The setting associated with the Bozeman trail within the proposed project area is impacted by the construction of Highway 93, located between 0.5 to 0.25 mile to the east and northeast, a fence line along the highway, and the construction of a dam and stock pond immediately to the east of the trail. As such, the portion of the trail located within the proposed project area is no longer able to convey its original character as a frontier trail. Because of the lack of setting and feeling, the segments of the trail within the proposed project area are recommended as not contributing to the site's eligibility for listing on the National Register.

The remaining sites were examined to ascertain their eligibility for listing on the National Register. The method used to provide recommendations regarding National Register eligibility closely follows the guidelines established by the Department of the Interior. Of particular importance are National Register Bulletins 15 and 16 (National Park Service [NPS] 1991a and 1991b). According to these bulletins, a property must possess historic significance and integrity to be listed on the National Register. With the exception of windmills, sites identified in the proposed project area consist of archaeological remains. This limits the potential eligibility of sites. Isolated Finds are rarely, if ever, recommended National Register eligible.

Based on the site's historic significance, and surface observations of integrity and soil deposition, 37 of the sites are recommended ineligible for listing on the National Register of Historic Places (National Register). Three additional sites are recommended ineligible based on the results of subsurface testing. The National Register status of the remaining six sites cannot be determined without further investigation.

As concluded in the Class III Inventory Report, provided in Appendix B, the currently proposed Ludeman Project will not affect any known significant cultural resources and additional archaeological work is not considered necessary.

Mitigation measures that will be implemented if future development expands near these eligible sites are discussed in Section 5.8.

4.9 POTENTIAL VISUAL/SCENIC RESOURCES IMPACTS

The visible surface structures proposed for the proposed project include wellhead covers, header houses, electrical distribution lines, booster pump houses, and three Satellite facilities. The proposed project will use existing and limited new roads to access the Satellite facilities and each header house.

Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately three feet high and two feet in diameter. Each header house is a small metal building. A disturbance area around each header house is necessary to provide an adequate area for operations and maintenance vehicles to turn around. Each Satellite facility is anticipated to consist of an 80- x 140-foot processing building, associated parking, and other infrastructure within an approximate 1.5 acre area enclosed with security fencing. In addition, two surge ponds (each approximately 1.2 acres) will be separately enclosed in a 3.5 acre area with security fencing. Electric distribution lines will connect header houses and Satellite facilities to existing electric distribution lines and will be buried when possible. The distribution poles will be approximately 20 feet high and will be wooden so that their natural color harmonizes with the landscape. Road disturbance acreage is calculated assuming approximately seven miles of 25-foot-wide main road and approximately 18 miles of eight-foot-wide, field roads.

Temporary and short-term visual effects during the construction period in each wellfield will result from header house construction, well drilling, and construction of access roads and electric distribution lines. Following completion of wellfield installation, temporarily disturbed areas will be reclaimed. Only long-term effects associated with operations and maintenance will remain following post-construction reclamation.

Long-term effects will result from the addition of structures to the landscape, such as the Satellite facilities and associated structures, header houses, wellhead covers, access roads, and electric distribution lines. Effects from long-term activities will occur over the life of the project. Current photographs of the site and a map of the photograph locations are provided in Addendum 2.4-A of the Technical Report.

The most important visual resource areas include:

- Public views from Highways 93 and 95 and from Country Roads 26 and 27 (Leuenberger Road and Tank Farm Road);
- Views from the subdivision adjacent to the northwest project boundary;
- Views from the Leuenberger ranch house;
- Views from the North Platte River; and
- Portions of the Bozeman Trail accessible to the general public.

The most important visual resource areas include:

- Public views from Highways 93 and 95 and from Country Roads 26 and 27 (Leuenberger Road and Tank Farm Road);
- Views from the subdivision adjacent to the northwest project boundary;
- Views from the Leuenberger ranch house;

- Views from the North Platte River; and
- Portions of the Bozeman Trail accessible to the general public.

Wellfields with associated wellheads and header houses will be visible from public roadways, the subdivision, and will be adjacent to the Bozeman Trail. Wellhead covers will be approximately 3-feet tall and header houses will be approximately 10-feet high at the eave; both will be painted to blend with the surrounding environment. Within the proposed project area, there are currently three industrial sites visible from the public roadways (Photos 1, 8 & 12 provided in Addendum 2.4-A of the TR). The portions of the industrial sites that are painted to blend with the surrounding environment are not as easily discerned as those painted white or dark brown.

The locations for the three proposed Satellite facilities were chosen to minimize visibility of those facilities as a result of existing topography. The Leuenberger Satellite facility site will be the site most visible to the public. Its proposed location in Section 14 (T34N R74W) at an elevation of 5,260 feet and approximately one-half mile south of Highway 95 will be partially visible from the highway and from the subdivision adjacent to Highway 95. A small bluff at an elevation of 5,260 is located between the subdivision and the proposed facility site which will partially block the view from the subdivision. A line-of-sight diagram from the subdivision to the proposed facility is shown in Figure 3.9-1 of this ER. There is currently an industrial building with two outlying tanks within the same section of land (Leuenberger Pilot Plant Building) which are located closer, and are more visible to the subdivision than the proposed Satellite facility.

The proposed North Platte Satellite facility site is located in Section 10 (T34N R73W) at an elevation of 5,320 feet. There is a hill to the east of the North Platte facility site with an approximate top elevation of 5,372 feet. The hill will partially block the view of the facilityfrom Highway 93 and the Bozeman Trail which is approximately one mile northeast of the facility site. There are hills to the northwest of the North Platte facility site with a maximum elevation of approximately 5,340 feet which will limit the view of the facility from sections of Highway 95. Line-of-sight diagram from Highway 95 to the proposed North Platte facility site is shown in Figure 3.9-2 of this ER.

The proposed North Platte Satellite facility site is located in Section 10 (T34N R73W) at an elevation of 5,320 feet. There is a hill to the east of the North Platte facility site with an approximate top elevation of 5,372 feet. The hill will block the view of the facility from Highway 93 and the Bozeman Trail which is approximately 1 mile northeast of the facility site. There are hills to the northwest of the North Platte Satellite facility site with a maximum elevation of approximately 5,340 feet which will limit, if not completely block, the view of the facility from Highway 95. A line-of-sight diagram from Highway 93 to the proposed facility is shown in Figure 3.9-3 of this ER.

The proposed Peterson Satellite facility is located in Section 26 (T34N R73W) at an elevation of approximately 5,110 feet. The facility site will be on top of a bluff and approximately two miles north of the North Platte River which is at an elevation of approximately 4,900 feet. The distance combined with the elevation difference should effectively limit views of the facility from the river. The facility is approximately 1.25 miles north of Tank Farm Road. Tank Farm Road is at an elevation of approximately 4,910-feet. As with the river, the distance and the difference in elevation should effectively shield the facility from view. A line-of-sight diagram from the North Platte River to the proposed facility is shown in Figure 3.9-4 of this ER.

The views from the Leuenberger ranch house should not be affected. The closest wellfield will be just over one-half mile west of the ranch house. A hill exists between the ranch house and the proposed wellfield which will shield the view of the wellfield. The next closest wellfield is approximately 1.5 miles to the southeast. The rolling topography between the wellfield and the ranch house will shield the view of the wellfield.

As discussed above, if the visual resource evaluation rating of a proposed project area is 19 or less, no further evaluation is required by NUREG-1569 (NRC, 2003). Based on field reconnaissance conducted in June and August 2008, the total score of the scenic quality inventory for the proposed project is 11. Therefore, no further evaluation of existing scenic resources and any changes to scenic resources from proposed project facilities are required. However, Uranium One intends to continue to adopt measures to lessen the visual impact of the proposed project.

Mitigation measures are meant to minimize adverse contrasts of proposed 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.

Uranium One's additional measures are meant to minimize adverse contrasts of project facilities with the existing landscape. All installed above-ground wellheads and structures will be painted with low reflectivity paint in colors that harmonize with the surrounding landscape. In addition, several design techniques will be implemented to minimize the visual contrasts. Those methods include reducing unnecessary disturbance by using the same trench for multiple utilities, reducing the area of temporary disturbance by designating equipment parking areas during construction, and following areas of existing disturbance when considering utility placement. To the extent possible, topographic features will be used to screen Satellite facilities and roads from public view. Roads may be aligned with the contours of the topography, although this measure may result in a greater area of disturbance. Construction debris will be removed from new construction areas as soon as possible and temporarily disturbed areas will be reclaimed as soon as possible following construction.

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

4.10 POTENTIAL SOCIOECONOMIC IMPACTS

4.10.1 Construction

The construction and decommissioning phases of the proposed project will cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities and increased demand for housing and other services. Impacts to community services such as roads, housing, schools and energy costs would be minor in the nearby towns of Rolling Hills (a small town located west of the proposed project on State Highway 95), Glenrock (west on State Highway 95), Douglas (southeast on State Highway 93), and Casper (the nearest regional economic hub).

In the first year, project development will be construction only and will create approximately 65 jobs directly related to construction activities. Based on local experience, an estimated 50 percent of the peak year construction/decommissioning workforce would be persons already living in Converse County and Natrona County. Other workers may come from outside the local area and will either re-locate for the term of the proposed project or will be long-distance commuters working for extended shifts.

Most construction work available to the local construction labor pool consists of temporary contract work that varies in duration, depending on the scope of each construction project. Further, the number of unemployed construction workers does not represent the number of workers that would be available to the proposed project from the local construction labor pool. The number is an annual average that does not take into account monthly variations in the available construction labor pool from construction start-ups and completions. Contractors for projects located in central Wyoming typically hire the local construction labor pool. The actual number of construction workers available for the proposed project would potentially draw from the Converse County and Natrona County construction combined labor pool of 3,142 (January, 2009 Wyoming Department of Employment).

4.10.2 Operations Workforce

The directly employed operations workforce will grow from approximately 14 persons in the second year of operations to approximately 48 during the peak work years. The peak includes a period when all three Satellite facilities and multiple wellfields would be actively operating. The peak operations period is transient and not permanent (lasting approximately three years with average annual direct employment at 44-48 jobs). It is assumed that the majority of operations personnel would be generated from the Casper, Glenrock, Douglas area or would be temporary personnel from outside the area. It is not known how many of the permanent

required operations workforce would be hired from outside of Converse and Natrona Counties. In the event that the entire operations workforce and their families relocated to the counties, the population increase would be a maximum of 113, based on the 2006-2008 average household size of 2.46 in Wyoming (U.S. Census Bureau). This increase would account for 0.1 percent of the population of Converse and Natrona Counties, and is smaller than the projected annual growth rate. Therefore, there would be little to no effect to the vacancy rates of any type of housing in Converse or Natrona County area.

4.10.3 Potential Effects to Housing

At its peak levels of employment, the proposed project is estimated to produce approximately 164 total jobs in Wyoming. This includes jobs created directly or indirectly by the proposed project or induced by related household expenditures. Many of the jobs will be ongoing over the life of the proposed project (such as the number of persons directly employed by the operator or its contractors for ongoing construction). Others will be tied to specific phases, such as construction or decommissioning, and will be shorter-term rather than on-going. As a result, the total number of jobs is estimated to fluctuate from year to year.

Compared to the rest of the nation, unemployment rates are low in Converse and Natrona Counties, the area most likely to be affected by the increased number of jobs and associated housing demand. These counties are however beginning to feel the effects of the national recession. In June 2009, the unemployment rate in Converse County was 5.2 percent (compared to 2.8 percent in June 2008) and 6.1 percent in Natrona County (compared to 3.0 percent in June 2008). In June 2009, the national unemployment rate was 9.5 percent. The average unemployment rate between July 2008 and June 2009 was 7.6 percent in the nation, but it remained below 4 percent in Converse and Natrona Counties. It is anticipated that Converse and Natrona Counties will continue to have lower unemployment rates than the state and the nation. In part due to the relatively lower unemployment in the local area and the small population base, it is assumed that the supply of available workers is limited locally and that many (and possibly most) of the employees needed to fill the projected new local jobs will come from outside Converse and Natrona Counties.

At the peak of direct employment numbers (in 2016), the proposed project would account for approximately 96 new jobs. Assuming each new job resulted in a separate demand for housing, 96 housing units would be needed. Homeowner vacancy rates were 2.3 percent in Converse County and 1.5 percent in Natrona County, according to the 2000 census (the most recent for which such census data are available at the county level). In a multiple listing service (MLS) internet web search on March 26, 2009, there were 420 listings for houses priced at $300,000 or less in Glenrock (27), Douglas (36), and Casper (357). In July 2007, Converse County had an estimated two vacant units out of 424 total rental units (.47 percent rental vacancy rate) and Natrona County had 44 vacant rental units (1.07 percent rental vacancy rate). The lack of available rental units in Converse County was reported in the

Douglas Budget on November 26, 2008. Many people who desire rental units have been staying in hotels/motels for weeks and months at a time.

Based on these data, there would be adequate supply of houses available for sale for needs associated with direct employment from the proposed project and a very limited supply of rental units. It is assumed that the supply of houses for sale that are in good "move-in" condition and in desirable areas may be less than the total number of houses for sale, but with more than 400 available (as of March 2009), there would be sufficient numbers for the estimated 96 new homes needed for direct employment numbers. Some of the employees will likely be hired from the existing local labor pool and therefore 96 homes may overestimate housing demand from direct employment. Based on current trends, it is anticipated that at least some workers will continue to have a residence outside of Converse and Natrona Counties and will be commuting long distance for shift work. While on site they would likely be staying in rentals or hotels/motels. Unless additional rental units are created, this will exacerbate the existing tight rental market.

The total of all new direct, indirect, and induced jobs estimated by the IMPLAN analysis (refer to Section 9.0) are for the state of Wyoming, not just Converse and Natrona Counties. If all 164 new direct, indirect, and induced jobs (at the peak of total employment in 2016) were in Converse and Natrona Counties, there would be adequate housing stock to purchase (based on the March 2009 homes for sale), but rental housing would be inadequate and put additional strains on hotels and motels.

4.10.4 Potential Effects to Services

The estimated total of 164 direct, indirect, and induced jobs of the peak employment year for the proposed project would result in a total population increase of 397 persons, based on average household size in Wyoming of 2.42 in 2006 (U.S. Census estimate) and assuming that all of the jobs are filled with persons not already living in Wyoming..

Although the IMPLAN analysis (described in Section 7) study area was for the entire state of Wyoming, for purposes of analyzing the impacts to schools and other public services, all 164 jobs were projected to result in population increases to Converse and Natrona Counties. This overestimates the likely potential for impacts for those two counties. The addition of 397 persons would be an increase of less than one percent to the total combined 2007 estimated population of 84,618 for Converse and Natrona Counties.

Children between the ages of five and 19 constituted approximately 20 percent of total estimated population in Converse and Natrona Counties in 2007. Using 20 percent as the ratio for school age children, there would be approximately 79 school age children anticipated from the projected increase in employment.

Converse School District No. 1 in Douglas was adding new facilities in 2008-2009 and was anticipating it could handle 350 additional students in grades K-5 and 250 additional students in Middle and High School. Converse School District #2 in Glenrock was under capacity in 2008 and would be able to increase enrollment by another 200 students without additional expansion (other than what has already been planned or recently completed). The Natrona County School District (primarily in the Casper area) has approximately 11,500 students.

A total increase of less than one percent to the total population of Converse and Natrona County is not likely to create a significant impact on other public services such as fire, police, water, and utilities.

4.10.5 Economic Impact Summary

It is anticipated that the overall effect of the proposed facility operations on the local and regional economy would be beneficial. Purchases of goods and services by the mine and mine employees would contribute directly to the economy. Local, state, and the federal governments would benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, would also be beneficial. These economic effects would further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economy provided by the proposed Ludeman Project operation would continue for the life of the facility, estimated to be 13 years for the facility and wellfield construction, operation and decommissioning. Economic impacts of the proposed operation are discussed in detail in Section 7.

4.11 ENVIRONMENTAL JUSTICE

In compliance with Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, ethnicity and poverty status in the vicinity of the proposed actions have been examined and compared to city, regional, state, and national data to determine if any minority or low-income communities could potentially be disproportionately affected by implementation of the proposed action. Similarly, in compliance with Executive Order 13045 – *Protection of Children from Environmental Health Risks and Safety Risks,* the distribution of children and locations where numbers of children may be disproportionately high in the vicinity of the proposed actions was determined to ensure that environmental risks and safety risks to children are addressed.

Three criteria must be met for impacts to minority/low income communities to be considered significant. First, there must be one or more populations within the region of influence. Second, there must be adverse (or significant) impacts from the proposed action. Finally, the population under investigation must bear a disproportionate burden of those adverse impacts.

If any of these criteria are not met, then impacts with respect to environmental justice or protection of children are not significant.

According to the environmental justice guidance provided by the Nuclear Regulatory Commission, *"percentage differences greater than 20 percentage points may be considered significant, and if either the minority or low-income population percentage in the radius of influence exceeds 50 percent, environmental justice should be considered in greater detail"* (Nuclear Regulatory Commission 2008:6.3). An examination of census blocks indicates there are several areas within the proposed project study area that contain a concentration of minority populations over 40 percent. However, these localities are scattered throughout the study area, and generally consist of only one or a few households. The proposed project study area will not disproportionately affect minorities or low-income communities.

4.12 POTENTIAL PUBLIC AND OCCUPATIONAL HEALTH IMPACTS

4.12.1 Potential Non-radiological Impacts

4.12.1.1 Potential Public Health Impacts

The area within an 80-kilometer (km) (50-mile) radius of the proposed project area includes portions of eight counties in northeastern Wyoming (Albany, Campbell, Carbon, Converse, Johnson, Natrona, Niobrara, and Platte Counties). The proposed Ludeman Project is located in central Converse County. The nearest communities are Glenrock located southwest on State Highway 95, Douglas which is to the southeast on State Highway 93, and Casper located in Natrona County southwest of the proposed project on Interstate 25.

Section 3.10 discussed the population distribution for the 80 km radius around the proposed project. Figure 3.10-1 provides the sectorial population for the 16 compass sectors in concentric rings of 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70 and 80 km from the center of the proposed project. The population within two-miles of the proposed project area boundary was estimated by locating occupied residences within two-miles using 2006 aerial photos and field reconnaissance in 2008. The nearest resident is approximately 0.8 km from the Leuenberger Satellite facility location. The nearest sensitive receptors (e.g., schools) are in the Town of Glenrock, located approximately 15.8 km from the nearest Satellite facility location.

NUREG-1569 requires that applicants provide estimates of concentrations of nonradioactive constituents in effluents at the points of discharge and provide a comparison with natural ambient concentrations and applicable discharge standards. There are two effluents expected from the proposed project.

- A gaseous and airborne effluent will consist of air ventilated from the facility ventilation system and vented from process vessels and tanks. This gaseous effluent will contain radon gas as previously discussed in Sections 4 and 4.12.3. The gaseous and airborne effluent will not contain any non-radiological effluents. Nonradioactive airborne effluents at the proposed project will be limited to fugitive dust from access roads and wellfield activities. Fugitive dust emissions will be minimal and dust suppressants will be used if conditions warrant their use. Air quality impacts of operation of the proposed project were discussed in detail in Section 4.6.

- The liquid effluent will be managed in the deep disposal wells. The deep disposal wells will permanently dispose of liquid wastes and will be permitted under a Class I UIC Permit issued by the WDEQ. No routine liquid environmental discharges, other than waste disposal via deep well injection, are planned and as such, no definable water related pathways for routine operations exist. There are no non-radiological impacts to public health expected due to the liquid effluents from the proposed project.

4.12.1.2 Potential Occupational Health Impacts

Accidents involving human safety associated with the ISR uranium mining technology typically have far less severe consequences that accidents associated with underground and open pit mining methods. *In situ* mining provides a higher level of safety for employees and neighboring communities when compared to conventional mining methods or other energy related industries. Accidents that may occur would generally be considered minor when compared to other industries. Radiological accidents that might occur would typically manifest themselves slowly and are therefore easily detected and mitigated. The remote location of the proposed project and the low level of radioactivity associated with the process combine to decrease the potential hazard of an accident to the general public.

NRC has previously evaluated the effects of accidents at conventional uranium milling facilities in NUREG-0706 (USNRC, 1980) and specifically at ISR uranium facilities in NUREG/CR6733. These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures and properly trained personnel are used. The proposed Ludeman Project facilities are consistent with the operating assumptions, site features, and designs examined in the NRC analyses in NUREG/CR-6733 (USNRC, 2001). Uranium One will develop emergency management procedures to implement the recommendations contained in the NRC analyses. Training programs will be developed to ensure that Uranium One personnel are adequately trained to respond to all potential emergencies. These training programs are discussed in detail in Section 5 of the Technical Report.

NUREG-0706 considered the environmental effects of accidents at single and multiple uranium milling facilities. Analyses were performed on incidents involving radioactivity and classified these incidents as trivial, small, and large. NUREG-0706 also considered transportation accidents. Some of the analyses in NUREG-0706 are applicable to ISR facilities, such as transportation accidents. NUREG/CR-6733 specifically addressed risks at ISR facilities and identified the "risk insights" that are discussed in the following sections.

4.12.2 Chemical Risk

NUREG/CR-6733 noted that the scope of the NRC mission includes hazardous chemicals to the extent that mishaps with these chemicals could affect releases of radioactive materials. Industrial safety aspects associated with the use of hazardous chemicals at Ludeman Project is regulated by the Wyoming Occupational Safety and Health Administration (OSHA).

4.12.2.1 Oxygen

Oxygen presents a substantial fire and explosion hazard. The design and installation of the oxygen storage facility is typically performed by the oxygen supplier and meets applicable industry standards. The oxygen will be delivered to the proposed Ludeman Project by truck and stored on site under pressure in a cryogenic tank in liquid form. The oxygen will be allowed to evaporate and will be added to the barren lixiviant upstream of the injection manifold.

<u>Accident Prevention</u>

The design and installation of underground and above-ground gaseous oxygen piping at the proposed project including material specifications, velocity restrictions, location and specifications for valves, and design specifications for metering stations and filters will be in accordance with industry standards contained in CGA G-4.4. Headerhouses will be equipped with an exhaust ventilation system. Oxygen monitoring will be conducted prior to entry into confined spaces where oxygen buildup could occur.

Combustibles such as oil and grease will burn in oxygen if ignited. Uranium One will ensure that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1.

<u>Mitigation/Accident Response</u>

Uranium One will develop procedures that implement emergency response instructions for a spill or fire involving oxygen systems. Emergency response procedures will include instructions in the following:

- Immediate notifications;
- Evacuation procedures;
- Perimeter establishment;
- Personal Protective Equipment requirements;and
- Reporting

4.12.2.2 Carbon Dioxide

The primary hazard associated with the use of carbon dioxide is concentration in confined spaces, presenting an asphyxiation hazard. Bulk carbon dioxide facilities are typically located outdoors and are subject to industry design standards. Floor level ventilation and carbon dioxide monitoring at low points will be performed to protect workers from undetected leaks of carbon dioxide within the Satellite facility.

The carbon dioxide storage system will consist of one 50-ton bulk liquid carbon dioxide pressure vessel tank at each Satellite supplied and maintained by the carbon dioxide supplier. The tank will be located outdoors and outside the Satellite facilities. All carbon dioxide deliveries and tank fillings will be performed by the supplier. Gaseous carbon dioxide is routed via carbon steel piping from the bulk storage tank to both the production and injection main lines.

Uranium One will incorporate recommendations concerning materials of construction for tanks and piping systems and the use of ventilation to control vapors in the event of a leak of carbon dioxide. The building HVAC system is designed for 3 air changes per hour with the capacity to expand to 6 air exchanges per hour. In addition, local exhaust fans will be installed along the outer facility wall to sweep vapors and gases near the floor level.

4.12.2.3 Sodium Sulfide

Sodium sulfide may be used as a reductant during groundwater restoration. Sodium sulfide is corrosive and will cause severe eye and skin burns. Routes of entry into the body include inhalation, ingestion, and contact with the skin. Under low pH conditions, sodium sulfide can react with water to liberate hydrogen sulfide gas.

<u>Accident Prevention</u>

Prevention methods utilized to minimize potential impacts to human health and the environment from a release of sodium sulfide include the following:

- Sodium sulfide can be flammable and contact with heat, flame, or other sources of ignition will be avoided;
- Sodium sulfide will be stored separately from incompatible chemicals such as hydrogen peroxide and sulfuric acid;
- Construction of all storage tanks, piping, and associated appurtenances will be in accordance with current industry standards;
- All tanks are enclosed limiting the amount of vapors that can escape to the atmosphere;
- Daily shift inspections of facility and chemical storage facilities are conducted for early detection of potential deficiencies;
- Containment will be provided for 110 percent of the total storage capacity constructed of chemically compatible materials; and
- Offloading procedures will be developed and implemented to ensure proper steps and precautions are followed during offloading into bulk storage areas.

Mitigation/Accident Response

Upon detection of a release of sodium sulfide, steps will be taken to stop or limit the extent of the release that can be performed without endangering the health of the responders. Uranium One will develop emergency response procedures for an accidental release of sulfuric acid and employees will be trained on those procedures. Emergency response procedures will include instructions in the following:

- Immediate notifications;
- Evacuation procedures;
- Perimeter establishment
- Personal Protective Equipment requirements;
- Site mitigation, neutralization, and cleanup; and
- Reporting

4.12.3 Potential Radiological Impacts

Uranium One is proposing to develop a uranium in-situ recovery facility (facility) with a production and restoration flow of approximately 9,000 and 3,000 gallons per minute (gpm) respectively (ie, 3,000 and 1,000 per Satellite.) An assessment of the radiological effects from the facility must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The facility will use fixed bed pressurized down flow ion exchange columns to separate uranium from the pregnant production fluid and to treat restoration solutions. The uranium contained in the loaded resin from the ion exchange columns will be precipitated and subsequently vacuum dried off site.

In addition to ion exchange treatment, the groundwater restoration process will also use reverse osmosis to remove the dissolved solids. Liquid waste disposal will be via a direct deep well injection. Each satellite facility will be accompanied by surge ponds to be utilized during maintenance or when disposal wells are temporarily inoperable.

The proposed project will consist of three Satellite facilities with processing flow rates of 3,000 gpm each and 1,000 gpm each restoration capacity. Each satellite facility will generate uranium loaded ion exchange resin. An average of 1 resin transfer per day at each satellite facility is anticipated.

Since the drying and packaging operation will be conducted off-site, the only expected routine emission at the facility will be radon-222 gas. Radon-222, a decay product of radium-226, is dissolved in the lixiviant as it travels through the ore to a production well where it is brought to the surface. The concentration of radon-222 in the production solution and estimated releases are calculated using the methods found in USNRC Regulatory Guide 3.59, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (NRC, 1987). The details of and assumptions used in these calculations are found later in this section.

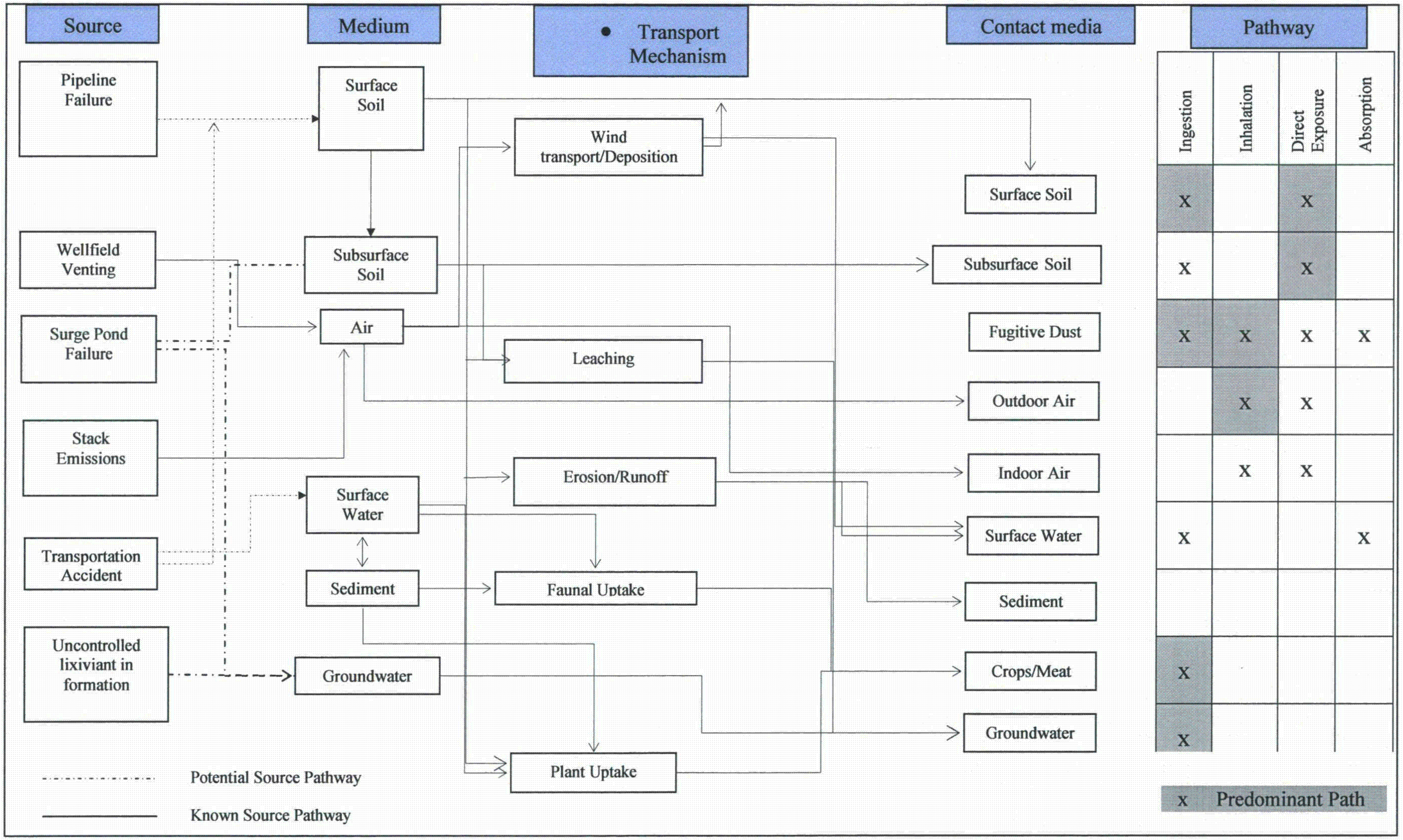
MILDOS-AREA is used to model radiological impacts on human and environmental receptors (e.g. air and soil) using site-specific radon-222 release estimates, meteorological and population data, and other parameters. The estimated radiological impacts resulting from routine site activities will be compared to applicable public dose limits as well as naturally occurring background levels.

4.12.3.1 Potential Exposure Pathways

Figure 4.12-1 presents exposure pathways from all potential sources at the facility. The predominant pathways for planned and unplanned releases are identified. As mentioned earlier, atmospheric radon-222 is expected to be the predominant pathway for impacts on human and environmental media. Impacts of radon-222 releases can be expected in all quadrants surrounding the facility, the magnitude of which is driven predominantly by wind direction and atmospheric stability. As a noble gas, radon-222 itself has very little radiological impact on human health or the environment. Radon-222 has a relatively short half-life (3.2 days) and its decay products are short lived, alpha emitting, nongaseous radionuclides. These decay products have the potential for radiological impacts to human health and the environment. As Figure 4.12-1 shows, all exposure pathways, with the

possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon-222 are evaluated by MILDOS-AREA. MILDOS-AREA modeling output is in contained in Appendix C.

Figure 4.12-1: Human Exposure Pathways for Known and Potential Sources from the Proposed Project Area



4.12.3.2 Potential Exposures from Water Pathways

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

The primary method of waste disposal at the facility will be by deep well injection. The deep well will be completed at a depth sufficiently deep enough to geologically isolate waste from underground sources of drinking water. The well will be constructed under a permit from the Wyoming Department of Environment Quality (WDEQ) and all requirements of the Underground Injection Control (UIC) program will be met.

No routine liquid environmental discharges, other than waste disposal via deep well injection, are planned and as such, no definable water related pathways for routine operations exist.

4.12.3.3 Potential Exposures from Air Pathways

The only source of radionuclide emissions is radon-222 released into the atmosphere through a vent system in the satellite facilities or from the wellfields. As shown in Figure Figure 4.12-1, atmospheric releases of radon-222 can result in radiation exposure via three pathways; inhalation, ingestion, and external exposure. The Total Effective Dose Equivalent (TEDE) to nearby residents in the region around the facility was estimated using MILDOS-AREA.

4.12.3.3.1 Source Term Estimates

The source terms used to estimate radon-222 releases from the facility include three well fields in production, three restoration well fields, new well field development, and three Satellite facilities. The wellfields were chosen based on their proximity to the nearest facility and site boundary. The parameters used to characterize and estimate releases are provided in Table 4-2.

Table 4-2: Parameters used to estimate and characterized source terms at the Ludeman *In situ* Recovery facility.

Parameter	Value	Unit	Source
Average ore grade	0.1	%	Application
Ore radium-226 concentration	282	pCi g-1	Reg. Guide 3.59
Average lixiviant flow per facility	1.14E+04	L m-1	Application
Average restoration flow per facility	3.79E+03	L m-1	Application
Operating days per year	365	days	
Ore formation thickness	3	meters	Application
Ore formation porosity	0.25	NA	Application
Ore formation rock density	1.83	g cm-3	Application
Average residence time for lixiviant	7	days	Application
Average residence time for restoration solutions	35	days	Application
Average mass of ore material in mud pit	5.44E+05	g	Estimate based on planned activities
Number of mud pits generated per year (entire site)	600	NA	Estimate based on planned activities
Storage time in mud pits	30	days	Estimate based on planned activities
Radon-222 emanating power	0.25	NA	NUREG 1569
Resin porosity	0.3	NA	NUREG 1569
Volume of ion exchange resin	1.42E+04	L	Estimate based on planned activities
Number of resin transfers per day (at each facility)	1	NA	Estimate based on planned activities

<u>Production Releases</u>

The current plans are to have up to three production areas (one per Satellite facility) operating concurrently. The potential radon-222 releases from the production well fields were estimated using methods described in U.S. Nuclear Regulatory Commission (USNRC) Regulatory Guide (RG) 3.59, *Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations* as follows (NRC, 1987):

Radon released (equilibrium condition) to production fluid from leaching is calculated using Equation 1:

$$G = R\rho E\frac{(1-p)}{p}x10^{-6} \qquad \text{(Equation 1)}$$

Where:

G	=	radon released (Ci/m^3)
R	=	radium content of ore (pCi/g)
E	=	radon-222 emanating power
ρ	=	rock density ($g\ cm^{-3}$)
p	=	formation porosity

The yearly radon released to the production fluid is calculated using Equation 2:

$$Y = 1.44GMD(1-e^{-\lambda t}) \qquad \text{(Equation 2)}$$

Where:

Y	=	yearly radon released to production fluid ($Ci\ yr^{-1}$)
G	=	radon released at equilibrium ($Ci\ m^{-3}$)
M	=	lixiviant flow rate ($L\ min^{-1}$)
D	=	production days per year (d)
λ	=	radon-222 decay constant ($0.181\ d^{-1}$)
t	=	lixiviant residence time
1.44	=	unit conversion factor

Using Equations 1 and 2 and the parameters in Table 4-2, the yearly radon released to production fluid is 1655 Ci yr^{-1}. USNRC RG 3.56 assumes all the radon-222 that is released to the production fluid is ultimately released to the atmosphere which in the case of ion exchange columns operating at atmospheric pressure in an open system is an appropriate conservative assumption (NRC, 1987). In cases where pressurized downflow ion exchange columns are used, and wellfields are operated under pressure, the majority of radon released to the production fluid stays in solution and is not released. The radon which is released is from occasional well field venting for sampling events, small unavoidable leaks in well field and ion exchange equipment, and maintenance of well field and ion change equipment. For this reason, estimated annual releases of 10 percent of the radon-222 in the production fluid would occur in the well fields and an additional 10 percent in the ion exchange circuit was assumed. Given this assumption, the annual radon-222 released from production in a mining unit and at the associated satellite facility is 166 and 149 Ci yr^{-1} respectively.

<u>Restoration Releases</u>

Radon-222 releases resulting from wellfield restoration activities were estimated in the same manner as the production activities above (i.e. using Equation 2) but modified for the lower restoration flow rate and the longer restoration fluid residence time, both of which are listed

in Table 4-2. The assumption of a 10 percent release at the mining unit and associated satellite facility results in releases of 76.9 and 69.2 Ci yr^{-1} respectively.

New Well Field Releases

Radon-222 releases resulting from new wellfield development activities were estimated using methods described in NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* as follows (NRC, 2003):

$$Rn_{nw} = EL[Ra]TmNx10^{-12} \qquad \text{(Equation 3)}$$

Where:

Rn_{nw} = Radon-222 release rate from new well field (Ci yr^{-1})
E = emanating power
[Ra] = concentration of radium-226 in ore (pCi g^{-1})
L = decay constant of radon-222
T = storage time in mud pit (d)
m = average mass of ore material in the pit (g)
N = number of mud pits generated per year
10^{-12} = unit conversion factor (Ci pCi^{-1})

Since development of new wellfields are planned to occur throughout the site, the number of mud pits generated per year for the entire site were assumed to be equally distributed among the three facilities. Therefore, the number of mud pits generated per year at each facility was assumed to be 200. Using Equation 3 and the parameters in Table 4-2, the yearly radon released from new well field development for each facility is 0.041 Ci yr^{-1}. For purposes of the MILDOS-AREA model simulations, the new wellfield release was assumed to occur at each mining unit.

Resin Transfer Releases

Radon-222 releases resulting from resin transfers at the satellite facilities were estimated using methods described in NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* as follows (NRC, 2003):

$$Rn_x = 3.65x10^{-10} F_i C_{Rn} \qquad \text{(Equation 4)}$$

Where:

Rn_x = Radon release rate from resin transfers (Ci yr^{-1})
F_i = water discharge rate from resin unloading (L d^{-1})

C_{Rn}	=	Steady state radon-222 concentration in process water (pCi L^{-1})
3.65×10^{-10}	=	unit conversion factor (Ci pCi^{-1})(d yr^{-1})

The steady state radon-222 concentration in process water (C_{Rn}) can be estimated from the following expression:

$$C_{Rn} = \frac{Y * 1.9E6}{M} \qquad \text{(Equation 5)}$$

Where:

C_{Rn}	=	Steady state radon-222 concentration in process water (pCi L^{-1})
Y	=	yearly radon released to production fluid (Ci yr-^{1})
M	=	lixiviant flow rate (L min^{-1})
1.9E6	=	unit conversion factor (pCi Ci^{-1})(yr min^{1})

The water discharge rate from resin unloading (Fi) can be estimated from the following expression:

$$F_i = N_i * V_i * P_i \qquad \text{(Equation 6)}$$

Where:

F_i	=	water discharge rate from resin unloading (L d^{-1})
N_i	=	Number of resin transfers per day
V_i	=	volume of resin in transfer (L)
P_i	=	porosity of resin

Using Equations 4-6 and the parameters in Table 4-2, the yearly radon released from resin transfers from satellite facilities development is 0.430 Ci yr^{-1}. For purposes of the MILDOS-AREA model simulations, the resin transfer release was assumed to occur at each satellite facility.

Radon-222 Release Summary

A summary of estimated radon-222 releases from the facility is presented in Table 4-3. The source coordinates in Table 4-3 are relative to the approximate center of the permit boundary.

Table 4-3: Estimated Radon-222 Releases (Ci yr^{-1}) from the proposed project Site

Location	X (km)	Y (km)	Production	Restoration	Drilling	Resin Transfer	Total
Leuenberger Satellite	-6.86	-1.65	149	69.2	-	0.43	218.6
North Platte Satellite	0	0	149	69.2	-	0.43	218.6
Peterson Satellite	1.79	-5.51	149	69.2	-	0.43	218.6
Wellfield 1	-7.36	-1.41	166	76.9	0.04	-	242.9
Wellfield 2	-6.63	-2.11	146	76.9	0.04	-	242.9
Wellfield 3	-8.02	-1.14	146	76.9	0.04	-	242.9
Wellfield 4	0.02	-1.44	146	76.9	0.04	-	242.9
Wellfield 5	-2.47	-3.56	146	76.9	0.04	-	242.9
Wellfield 6	-0.09	-5.27	146	76.9	0.04	-	242.9
Wellfield 7	2.53	-6.77	146	76.9	0.04	-	242.9

4.12.3.3.2 Receptors

Two types of receptors were used in the MILDOS-AREA simulation. First, arbitrary receptors were identified based on a 0.5 km grid system across the site. The grid system was established using a random starting point. A total of 1189 arbitrary receptors were modeled to develop iso-dose curves within the permit boundary using the kriging method described in ArcMap GIS software. The arbitrary receptor are intended to represent worse case dose potentials for members of the public within the permit boundary. This conservative estimate would account for the rancher or hunter scenario. Second, potential receptor locations were identified and modeled. Data regarding the arbitraty receptors is shown in Appendix E of the Technical report, Appendix A (Table A.1). Potential resident receptors used in the MILDOS-AREA model are presented in Table 4-4 and are anticipated to be the highest public dose recipients. The receptor coordinates in Table 4-4 are relative to the North Platte satellite processing area. Annual dose estimates for residential receptors are based on 24 hours per day for one year.

4.12.3.3.3 Miscellaneous Parameters

The metrological data used in the MILDOS-AREA model is from the Joint Frequency Distribution data presented in Section 3.6 of this application.

The population distribution used in the MILDOS-AREA model to estimate population doses is from the demographic information presented in Section 3.10 of this ER.

4.12.3.3.4 Total Effective Dose Equivalent (TEDE) to Individual Receptors

In order to show compliance with the annual dose limit found in 10 CFR 20.1301, Uranium One has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the facility is less than 100 mrem per year. The results of the MILDOS-AREA simulation for each receptor are presented in Table 4-4.

An evaluation of the TEDE follows:

1) The maximum TEDE of 1.56 mrem/yr, located at nearest resident (Resident 3) within the property boundary, is 1.6 percent of the public dose limit of 100 mrem as shown in Table 7-4. Resident 3 TEDE is from the projected 3rd year of operations;
2) The effect of the proposed Ludeman operation on any potential resident is less than 2 percent of the public dose limit;
3) Since radon-222 and its products are the only radionuclides emitted, public dose requirements in 40 CFR part 190 and the 10 mrem/y constraint rule in 10 CFR part 20.1101 do not apply; and
4) Even if 100 percent of the radon-222 contained in restoration and production fluids were released to the atmosphere (i.e. 100 percent released instead of 10 percent), the impacts to potential residents surrounding the facility would be less than the 100 mrem public dose limit;

Table 4-4: Proposed Ludeman Project Site Receptor Names, Locations and TDE

Receptor	X (km)	Y (km)	TEDE (mrem yr^{-1})
Resident 1	-5.17	-2.17	0.70
Resident 2	3.5	-11.5	0.27
Resident 3	5.3	-9.8	1.56
Resident 4	7.9	-9.2	0.20
Resident 5	8.5	-9.3	0.21
Resident 6	8.3	-10.0	0.21
Resident 4	7.9	-9.2	0.20
Resident 5	8.5	-9.3	0.21

4.12.3.3.5 Population Dose

The annual population dose commitment to the population in the region within 80 km of the facility is also predicted by the MILDOS-AREA code. The results are contained in Table 4-5 where TEDE is expressed in terms of person-rems. For comparison, the dose to

the population within 80 km of the facility due to background radiation has been included in the table. Background radiation doses are based on a North American population of 346 million and an average TEDE of 360 mrem.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming, during the year 1978. The results of these calculations are included in Table 4-5 and also combined with dose to the region within 80 km (50 mi) of the facility to arrive at the total radiological effects of one year of operation at the proposed project.

The maximum radiological effect from the operations at the facility would be to increase the TEDE of continental population by 0.000098 percent.

Table 4-5: Total Effective Dose Equivalent to the Population from One Year's Operation at the Ludeman Facility

Criteria	TEDE (person rem/yr)
Dose received by population within 80 km of the facility	0.31
Dose received by population beyond 80 km of the facility	11.1
Total Continental Dose	11.4
Background North American Dose	1.0E+08
Fractional increase to background dose	1.1E-07

4.12.3.3.6 Potential Exposure to Flora and Fauna

To estimate the potential radiological impacts to flora and fauna, the primary pathway for exposure should be identified. Since the only planned emissions from the facility is radon-222 to the atmosphere, the dominant pathway for exposure to flora and fauna is deposition of radon-222 decay products on surface water, surface soils, and vegetation. MILDOS-AREA estimates surface deposition rate as a function of distance from the source for the radon-222 decay products and calculates surface concentrations. Table 4-6 presents the highest surface soil concentrations of radon-222 decay products predicted by MILDOS-AREA over a 100 year period. Soil concentrations were calculated based on a conservative assumption of 1.5 g cm^{-3} bulk soil density.

Table 4-6: Highest Surface Concentrations of Radon-222 Decay Products Resulting from the Proposed Ludeman ISR Operations

Radionuclide	Distance from site (km)	Direction	Surface Concentration (pCi/m2)	Soil Concentration in upper 0.5 cm (pCi/g)
Polonium-218	1.5	S	33.7	0.004
Lead-214	1.5	S	33.7	0.004
Bismuth-214	1.5	S	33.7	0.004
Lead-210	65	E	14.1	0.002

Lead-210 represents the radionuclide with the highest concentration (2.0E-3 pCi/g) which is at least an order of magnitude below most analytical laboratories detection limits. Recent site specific surface soil (0-5 cm) data taken from nearby Moore Ranch show that concentrations of lead-210 in the geographical area have a mean of 0.5 pCi g^{-1} and a standard deviation of 0.4 pCi g^{-1} (EMC, 2007). The increase in soil radioactivity at the proposed project from operations is insignificant compared to site specific background concentrations.

It is likely that soil re-suspension from background soils would be the predominant source of lead-210 concentration in vegetation surrounding the site since lead-210 concentrations in vegetation would be similar to that of soil.

From this evaluation, the impact of operations at the proposed Ludeman Uranium In-Situ Recovery Facility would be minimal and indistinguishable from current conditions.

4.12.3.4 Potential Radiological Accidents

The following sections discuss potential accident scenarios that could have radiological impacts. Mitigation measures to reduce or eliminate these impacts are discussed in Section 5.12.2.

4.12.3.4.1 Potential Tank Failure

A spill of the materials contained in the process tanks at the proposed project will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the Satellite facilities. The tanks at the proposed project will contain injection and production solutions, ion exchange resin and liquid waste.

NUREG/CR-6733 also assessed the potential dose from a catastrophic spill from an ion exchange column resulting in the release of the entire contents of the vessel and the

resultant release of radon gas. Based on a number of assumptions, the predicted dose was 1.3 rem in a 30-minute period to a worker in the area. Any change to the Rn-222 concentration or exposure time has a linear affect on dose. For example, if the room size is doubled or the exposure time is halved, then the dose will be halved. NUREG/CR-6733 recommended that the use of ventilation or atmosphere-supplying respirators designed to protect against gases would be sufficient to mitigate doses that unprotected personnel should evacuate spill areas near ion exchange columns, and that ISR facilities maintain proper equipment, training, and procedures to respond to large lixiviant spills or ion exchange column failure.

Accident Prevention

The facility will be designed to control and confine liquid spills from tanks should they occur. The Satellite 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, and/or double-walled tanks will perform a similar function for any process chemical vessels located outside the Satellite facility building.

All tanks will be constructed of fiberglass or steel. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary. Other prevention methods include shift inspections of facility areas including tanks.

Mitigation/Accident Response

The proposed Ludeman Satellite facilities will be designed in accordance with standard industry building codes and will incorporate containment adequate to contain the contents of the largest tank in the facility at a minimum. As discussed in Section 5.12.2.1, area ventilation will be provided to control concentrations of airborne radioactive material in the Satellite facilities. Finally, Uranium One will prepare spill response procedures, provide spill response equipment and materials, require the use of protective equipment, and will train employees in proper spill response methods. Emergency response procedures will include instructions in the following:

- Immediate notifications;
- Evacuation procedures;
- Perimeter establishment;
- Personal Protective Equipment requirements;
- Site mitigation, neutralization, and cleanup; and

- Reporting

4.12.3.4.2 Potential Facility Pipe Failure

The rupture of a pipe within the Satellite facilities will be easily detected by operating staff and can be quickly controlled. Spilled solution will be contained and managed in the same fashion as for a tank failure.

4.12.3.4.3 Wellfield Spill

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the Satellite facilities, would result in a release of injection or production solution which would contaminate the ground in the area of the break. All piping from the proposed project Satellite facilities, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Mitigation for wellfield spills is discussed in Section 5.4.2.3.2

4.12.4 Gaseous and Airborne Particulates

The primary radioactive airborne effluent at the proposed project will be radon-222 gas. Radon-222 is found in the pregnant lixiviant that comes from the wellfield into the ion exchange facility. The uranium is separated from the groundwater by passing the solution through fixed bed ion exchange units operated in a pressurized downflow mode. Vessel vents from the individual ion exchange vessels will be directed to a manifold that is exhausted to atmosphere. Venting any released radon-222 gas to atmosphere outside the facility will minimize employee exposure. Small amounts of radon-222 may be released via solution spills, filter changes, ion exchange resin transfer, from the reverse osmosis (RO) system operation during groundwater restoration, and from maintenance activities. These situations result in minimal radon gas releases on an infrequent basis. The exhaust system in the proposed project Satellite facilities will further reduce employee exposure. The air in the facility will be sampled for radon daughters (see Section 5.1.6) to assure that concentration levels of radon and radon daughters are maintained as low as reasonably achievable (ALARA).

4.13 POTENTIAL WASTE MANAGEMENT IMPACTS

ISR uranium facilities produce airborne effluents, liquid wastes, and solid wastes that must be handled and disposed of properly. Potential impacts resulting from airborne effluents are described in Section 4.6. This section describes the anticipated quantities, proposed waste management systems, and potential impacts resulting from the management of liquid and solid waste generated under the Proposed Action.

4.13.1 Proposed Waste Management Systems

This section describes the types and quantities of waste anticipated during construction, operation, groundwater restoration, and decommissioning of the proposed project. Liquid and solid wastes are divided into two general categories: 11e.(2) liquid waste and 11e.(2) solid waste and non-11e.(2) liquid waste and non-11e.(2) solid waste.

11e.(2) waste includes liquids and solids meeting the definition of 11e.(2) byproduct material as defined by 10 CFR Part 40.4: "The tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content." 11e.(2) liquid wastes include brine, excess permeate, decontamination wastewater, spent eluant and other process liquids. 11e.(2) solid wastes include process solids (e.g., filter media), contaminated soil, parts, equipment, debris, and PPE that cannot be decontaminated for unrestricted release including, but not limited to, pipe, fittings, and hardware (NMA 2007). Non-11e.(2) liquid waste include storm water runoff and domestic sewage. Non-11e.(2) solid waste include hazardous waste such as oily rags and equipment and uncontaminated solid waste such as office refuse.

The following subsections describe the management of each waste stream anticipated under the proposed action. For each waste stream, the following information is provided, as required by NUREG-1748:

- The expected quantity of waste generated during construction, operation, groundwater restoration and decommissioning;
- Waste management systems designed for waste collection, storage, and disposal;
- Waste disposal plan;
- Waste minimization plan; and
- Assessment of potential impacts, including potential cumulative impacts.

4.13.1.1 11e.(2) Liquid Waste

4.13.1.1.1 Brine

Brine Quantity

Brine will be generated from RO treatment of the production bleed and from RO treatment of the groundwater restoration water.

Brine Management

Brine will be routed from the wellfield and restoration RO units in the Satellite facilities to a wastewater collection system. RO brine will be discharged into the deep disposal wells unless maintenance activities are occurring then the brine will be routed to the surge ponds.for temporary storage. The DDW and lined surge ponds are described in Section 4.2.4 of the TR. Up to six lined surge ponds are planned for the proposed Satellite facilities. Surge ponds will include dual liners and leak detection systems.

Brine Disposal

All brine generated by the proposed action will be disposed in Class I deep disposal wells. Deep well disposal is selected as the preferred method of brine disposal due to minimal potential impacts to human health and the environment compared to large evaporation ponds or off-site brine transport. A comparison between the maximum anticipated disposal well capacity and the maximum brine and spent eluant disposal rate shows that adequate disposal well capacity will be available.

The target zones will be the Lance Formation through the Parkman Formation (depths ranging from 4,500 to 10,000 feet). Deep disposal wells will be constructed according to WDEQ/WQD Class I disposal well construction standards, including surface casing from the ground surface to a distance of at least 100 feet below the base of the lowermost potential USDW. The location, depth, and construction methods for deep disposal wells will be designed to isolate liquid waste from any USDW. In order to permit the wells, AUC will demonstrate that there will be no migration of injected fluids into nearby wells or USDWs. Uranium One will also perform routine monitoring consisting of quantity and pressure recordation and perform internal and external MIT every 5 years.

Brine will be pumped to the deep disposal wells using buried pipelines. Lined surge ponds will provide surge capacity for the disposal wells.

Multiple deep disposal wells will provide operational flexibility in case one of the disposal wells becomes inoperable either for the short or long term. Additional capacity

also will be available in the lined surge ponds to completely contain an entire pond cell in the remaining cells without exceeding the freeboard capacity limits, which include space for rainfall and wave surges. In the event that a leak should develop in a pond cell, the contents of that pond will be quickly pumped to another pond or shipped by truck to another operating DDW. The anticipated water chemistry of the waste stream that will be disposed of in the deep disposal well is presented in Table 4-7. Minor concentrations of corrosion inhibitors, scale inhibitors, and/or biocides may be used as needed to maintain the deep disposal well in optimum condition.

Table 4-7: Summary of Anticipated Waste Stream Water Quality

	Estimated Range of Waste Stream Water Quality	
Chemical Species	**Minimum**	**Maximum (mg/l)**
pH (std. units)	6	9
Sodium (mg/l)	150	3,000
Calcium (mg/l)	200	1,000
Potassium (mg/l)	10	1,000
Bicarbonate as HCO3 (mg/l)	1,500	4,000
Carbonate as CO3 (mg/l)	0	500
Sulfate (mg/l)	80	2,000
Chloride (mg/l)	200	4,000
Uranium as U3O8 (mg/l)	1	15
Ra-226 (pCi/l)	300	3,000
TDS (mg/l)	4,000	15,000

Brine Minimization

Uranium One will further reduce the brine quantity by employing limited groundwater sweep. A limited volume of groundwater sweep is proposed to minimize consumptive use of groundwater from outside of the exempted aquifer. Uranium One may also selectively apply groundwater sweep to specific portions of an affected wellfield in order to maximize benefits with a minimal volume of water withdrawal and subsequent brine production.

Brine Waste Management Potential Impacts

Potential impacts from brine management include potential leaking pipes in the wastewater collection system, potential leaks from the lined surge ponds, potential spills from transportation of wellfield wastewater (e.g., resulting from well work over) to the ponds, and potential deep disposal well impacts, including potential pipeline leaks and potential groundwater impacts. These potential impacts are described as potential water resource impacts (Section 4.4) and potential soil impacts (Section 4.3). Section 4.12 also addresses potential radiological impacts from the use of deep well injection for disposal of 11e.(2) liquid wastes.

4.13.1.1.2 Excess Permeate

Excess Permeate Quantity

Uranium One proposes to withdraw excess bleed during production, treat this production bleed through RO treatment, and inject most of the permeate into producing wellfields to help reduce salt buildup. Permeate that is recycled to the wellfield is not considered a waste product and is not included in the analysis of potential waste management impacts. During operation and groundwater restoration, all permeate generated from production and restoration RO units is expected to be injected into wellfields for recovery or restoration. Additional information is presented in TR Section 6.1.

Excess Permeate Management

Excess permeate is not anticipated. However, if present it will be routed from the wellfield and restoration RO units in the Satellite facility to the lined surge ponds via buried pipelines. Note that the lined surge ponds may be used to store either permeate, brine, or other 11e.(2) liquid waste at various stages. All permeate will generally be injected into wellfields for recovery or restoration

Excess Permeate Disposal

Permeate is nearly pure, treated effluent, and as such, excess permeate will generally be put to beneficial use. Most permeate will be injected into wellfields undergoing groundwater restoration without being routed through the lined surge ponds. Excess permeate temporarily stored in the lined surge ponds will be disposed through one of the following methods:

- Recycle for Satellite facility make-up water and lixiviant make-up water;
- Injection into wellfields undergoing groundwater restoration to control bleed; and
- Class I deep disposal wells.

Most excess permeate temporarily stored in the lined surge ponds will be recycled to the Satellite facilities for use as make-up watert. Excess permeate also may be used to make up fresh elution brine.

A second method of disposing of excess permeate stored in the lined surge ponds will be injection into wellfields undergoing RO treatment with permeate injection. The lined surge ponds will provide a surplus capacity to allow Uranium One to supplement the permeate that circumvents the ponds during groundwater restoration.

Excess Permeate Waste Management Potential Impacts

Potential waste management impacts resulting from excess permeate recycled to the Satellite facility are addressed with brine impacts, since most of this water ultimately will be discharged to the deep disposal wells.

Following mining operations, restoration of the affected aquifer commences which results in the production of wastewater. The current groundwater restoration plan, discussed in detail in Section 6, consists of two activities:

1. Groundwater Sweep; and
2. Groundwater Treatment.

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. Groundwater sweep may not be extensively utilized due to the large consumption of groundwater with limited success.

Groundwater treatment activities involve the use of process equipment to lower the ion concentration of the groundwater in the affected mining area. A reverse osmosis (RO) unit will be used to reduce the total dissolved solids (TDS) of the groundwater. The RO unit produces clean water (permeate) and brine. The permeate is injected back into the formation and the brine is sent to the deep disposal well(s). Chemical reducing agents such as sodium sulfide or hydrogen sulfide may also be employed during the groundwater treatment phase. These groundwater treatment activities have proven effective in reaching restoration targets at other ISR facilities.

4.13.1.2 Other 11e.(2) Liquid Waste

Other 11e.(2) liquid waste includes spent eluant, liquid from process drains in the Satellite facilities, fluids generated from work over operations on injection and recovery wells, contaminated reagents, resin transfer wash water, filter backwash water, plant

wash down water, and decontamination water (e.g., employee showers). Liquid wastes generated in the Satellite facilities will be discharged into the to the deep disposal well. Water collected from swabbing or other work over activities on injection and recovery wells will be collected in dedicated tanks and transported to the lined surge ponds. Any water captured from leaking pipelines or equipment will also be transported to lined surge ponds in dedicated portable tanks or tanker trucks. Any water released in the wellfield would consist of either injection lixiviant or recovery fluids and would occur only in areas where a liquid release has occurred from a well or pipeline. The water would be collected and be placed into the surge ponds for eventual injection in the deep disposal well(s).

Other 11e.(2) liquid wastes will be managed with brine and disposed primarily through deep well injection.

4.13.1.3 Liquid Waste Disposal

Uranium One expects that the liquid waste stream generated at the proposed project facility will be chemically and radiologically similar to the waste disposed in the current disposal wells in operation at existing ISR sites in the Powder River Basin. Management of the wastewater from the proposed project will be via deep injection wells, and Uranium One plans to install up to six deep disposal Underground Injection Control (UIC) wells at the proposed project area as the primary liquid waste disposal method. Each facility will have up two deep disposal wells and up two surge ponds. The surge ponds will be used as a backup if one of the deep disposal wells is to become non-operational. The number of disposal wells proposed should provide enough capacity for peak flow conditions.

Uranium One believes that permanent deep disposal is preferable to evaporation in evaporation ponds or land application methods for the following reasons: (1) Liquid waste disposed of through deep wells is secluded from human contact eliminating risk to human health; (2) large evaporation ponds have the potential for leaks and impacts to the environment and much larger volume of 11e.(2) byproduct is created through use of evaporation ponds; (3) land application methods have the potential to impact surface media from prolonged discharge and would require extensive treatment to meet land application standards. All compatible liquid wastes at the proposed Ludeman Facilities will be disposed in the planned deep wells. Uranium One anticipates submittal of a Class I or Class V injection well permit during the third quarter of 2012.

4.13.1.4 Solid 11e.(2) Byproduct Material

Solid 11e.(2) Byproduct Material Quantity

Solid 11e.(2) byproduct material will be generated during all project phases except construction. During operation and groundwater restoration, Uranium One estimates that approximately 250 cubic yards of solid 11e.(2) byproduct material will be generated annually. This equates to about 12-13 20-cubic yard shipments annually from the following sources, which is within the typical range of 2.5 to 15 annual shipments provided in NRC NUREG 1910 Vol. 1 (Table 2.8-1, pg. 2-39).

- Filtrate and spent filter media from production and restoration circuits;
- General sludge, scale, etc. from maintenance operations;
- Affected soil collected from spill areas;
- Spent/damaged ion exchange resin;
- Well solids from injection/recovery well work over operations; and
- Contaminated PPE

Estimated quantities generated during decommissioning are provided in the financial assurance calculations in Appendix E of this ER. During decommissioning, up to an estimated 4,000 cubic yards of solid 11e.(2) byproduct material will be generated from the following areas.

Wellfield decommissioning, including:

- Injection, recovery, and restoration fluid trunklines;
- Injection and recovery well feeder pipelines;
- Downhole well piping (drop pipe) ;
- Manholes and sumps ;
- Valves, pumps, and instrumentation and control equipment ;
- Impacted soil ;
- Affected concrete floors, sumps, and berms in the Satellite facilities ;
- Equipment and piping in the Satellites facilities:
- Pond sludge, pond liners, and leak detection systems; and
- Disposal well piping and equipment

Solid 11e.(2) Byproduct Material Management

During production and groundwater restoration, solid 11e.(2) byproduct material will be stored inside the restricted area of the Satellite facility.

Solid 11e.(2) byproduct material will be placed inside of 55-gallon lined drums. When the drums are full they will be sealed and moved into a 20-cubic yard roll-off container. The roll-off containers will be shipped off-site to a licensed disposal facility. Adequate storage will be provided for at least two roll-off containers in each of the Satellite facilities. One or more additional 11e.(2) byproduct material storage areas may be designated outside of the facilities. These areas will be fenced, locked and posted with signs indicating they are restricted access 11e.(2) byproduct material storage areas. Large items such as contaminated equipment that cannot be stored in a roll-off container will be stored in one of the designated 11e.(2) byproduct material storage areas and covered/sealed in a manner that will prevent the spread of contamination in the 11e.(2) byproduct material storage area.

Solid 11e.(2) Byproduct Material Disposal

Sealed 20-cubic yard roll-off containers containing 11e.(2) byproduct material will be transported by an appropriately licensed transporter to a disposal facility licensed by NRC or an agreement state. In accordance with SUA-1341 Uranium One will dispose of solid 11e.(2) waste at Pathfinder Mine Corporation, Shirley Basin Facility in Shirley Basin, Wyoming. Uranium One will notify NRC within 7 days if the 11e.(2) byproduct material disposal agreement is terminated and will submit a new agreement for NRC approval within 90 days of expiration or termination.

Based on the anticipated solid 11e.(2) byproduct material generation rate of 250 cubic yards per year during operation and groundwater restoration, about 12 to 13 annual shipments of 11e.(2) byproduct material are anticipated during these project phases. During decommissioning, which is estimated to last 12-18 months, 100 to 200 shipments per year are expected.

Solid 11e.(2) Byproduct Material Minimization

The quantity of solid 11e.(2) byproduct material will be minimized through process design, decontamination, and volume reduction during decommissioning. Filter media for the production and restoration circuits will be selected based on filtration efficiency and on minimizing waste material. Where possible, equipment and building surfaces will be decontaminated and reclassified for unrestricted release. Decontamination procedures are discussed in TR Section 6 and may include high pressure washing, sand blasting, and acid rinsing.

Solid 11e.(2) Byproduct Material Management Potential Impacts

Potential impacts resulting from the management and disposal of solid 11e.(2) byproduct material include potential spills, addressed in Section 4.4, and potential transportation impacts, addressed in Section 4.2.3. In addition, Uranium One assessed the potential

impacts on solid 11e.(2) byproduct material disposal on the capacity of the facilities potentially receiving the byproduct material. This assessment is provided below:

- Pathfinder Mines Corporation, Shirley Basin Facility: According to NRC materials license SUA-442, Amendment No. 59 (Adams Accession No. ML063480527), the Shirley Basin Facility is authorized to dispose of byproduct from ISR facilities without specific authorization from the NRC. There is a disposal limit of 10,000 cubic yards of byproduct material from generators other than ISR facilities. While there is potentially sufficient capacity to accept all of the solid 11e.(2) byproduct material from the Proposed Action at the Shirley Basin Facility, AUC might be required to find an alternate disposal facility in the event that the Shirley Basin Facility stops accepting 11e.(2) byproduct material and completes reclamation.

4.13.1.5 Non-11e.(2) Solid Waste

4.13.1.5.1 Uncontaminated Solid Waste

Solid Waste Quantity

Waste which is not contaminated with radioactive material or which can be decontaminated and re-classified as uncontaminated waste includes solid waste (containers and construction debris), piping, valves, instrumentation, equipment and any other items that are not contaminated or which may be successfully decontaminated. If decontamination of waste material is possible, surveys for residual surface contamination will be made before releasing the material. Decontaminated materials must have activity levels lower than those specified in NRC guidance (USNRC 1987). Methods for decontamination and release of contaminated equipment are discussed in further detail in Section 5 of the TR.

The proposed project will produce 2,000 cubic yards of uncontaminated solid waste each year. Uncontaminated solid waste will be collected at the facility sites on a regular basis and disposed of in the nearest sanitary landfill.

Solid Waste Management

During construction and decommissioning, non-11e.(2) solid waste will be stored in roll-off containers in designated areas prior to shipment off-site to a nearby landfill. During operation and groundwater restoration, solid waste will be collected daily from work areas and disposed in trash receptacles located within the restricted area but near a primary access road for convenient access for a contract waste disposal contractor.

Solid Waste Disposal

Non 11e.(2) non-hazardous solid waste will be disposed off-site in a municipal landfill permitted by WDEQ/SHWD. The nearest municipal landfill is the Glenrock Area Solid Waste Disposal Facility (approximately 3 road miles west).

Solid Waste Minimization

The quantity of non-hazardous solid waste will be minimized by recycling and decontaminating materials and process equipment during decommissioning. Recyclable materials currently accepted at the Glenrock Area Solid Waste Disposal Facility include newspaper, magazines, phone books, cardboard, aluminum and steel cans, and plastic.

Solid Waste Potential Impacts

The potential impact to area municipal landfills from disposing the nonhazardous solid waste generated by the proposed action will be small.

Potential transportation impacts resulting from disposing solid waste are addressed in Section 4.2.3.

4.13.1.5.2 Hazardous Waste

Hazardous Waste Quantity

Hazardous waste generated by the proposed action may include small quantities of used oil from Satellite facility equipment and wellfield vehicles, oil-contaminated soil, oily rags, used batteries, expired laboratory reagents, fluorescent lightbulbs, solvents, cleaners, and degreasers. Small amounts of hazardous waste are expected to be generated during all four project phases in similar quantities. Uranium One anticipates that the proposed project will be classified as a conditionally exempt small quantity generator (CESQG) by WDEQ/SHWD. As such, the project will be required to generate less than 220 pounds (100 kg) of hazardous waste and less than 2.2 pounds (1 kg) of acute hazardous waste in any calendar month and store less than 2,200 pounds (1,000 kg) of hazardous waste at any one time. If the facility does not meet the requirements for a CESQG, it will lose its CESQG status and be fully regulated as either a small-quantity generator (more than 100 but less than 1,000 kg hazardous waste per calendar month) or a large quantity generator (more than 1,000 kg per calendar month) (NRC 2010).

Hazardous Waste Management

Hazardous waste will be stored in secure containers inside the maintenance shop. The containers will be compatible with the materials stored, visually inspected for leaks, rust, etc. and will be labeled with contents. The maintenance shop will have a specific area that is bermed and adequately vented for hazardous waste temporary storage.

Hazardous Waste Disposal

Hazardous waste will be transported to an off-site treatment, storage and disposal facility that is licensed by WDEQ/SHWD or a nearby state to manage hazardous waste. The Glenrock Area Solid Waste Disposal Facility, located just north of Glenrock, accepts used oil and batteries for recycling and certain other hazardous waste by contract If needed, small quantities of used reagents or other types of hazardous waste may occasionally be transported to more distant licensed disposal facilities by a licensed hazardous waste contractor.

Hazardous Waste Minimization

Uranium One will minimize the quantity of hazardous waste generated by the proposed action by generally servicing vehicles and equipment at off-site facilities and by limiting laboratory reagent orders to quantities that can be consumed within the reagent shelf lives. The quantity of hazardous waste generated and stored in the proposed project area will be kept small in order to comply with CESQG requirements.

Hazardous Waste Potential Waste Management Impacts

Potential waste management impacts from hazardous waste management, storage and disposal include potential releases to surface and groundwater, addressed in Section 4.4, and potential transportation impacts, addressed in Section 4.2.

4.13.1.5.3 Domestic Sewage

Domestic Sewage Quantity

The quantity of domestic sewage generated by the proposed action will vary according to the number of workers during each project phase. During construction portable toilets will be used. The average daily wastewater generation rate during operations will likely approach 800 gpd, based on the EPA (2002) domestic wastewater generation rate of 13 gpd for industrial building employees.

Domestic Sewage Management

Domestic wastewater will be collected in a gravity sewer collection system serving the Satellite facility, and any other buildings with restrooms. Raw wastewater will be routed in gravity fed sewer pipes to one or more septic tanks for primary treatment.

Domestic Sewage Disposal

Domestic waste will be disposed in an on-site disposal system. The system will be designed according to WDEQ/WQD standards and will likely include one or more septic tanks for primary treatment. Septic tank effluent will either be disposed in a gravity or pressure-dosed drainfield. The anticipated peak daily flow rate is not anticipated to exceed 2,000 gpd. Therefore, permitting as a Class V UIC facility through WDEQ/WQD will not be required nor will the installation of monitor wells around the drainfield.

Every 1 to 5 years, the septic tank(s) will require sludge removal. This will be performed by a waste disposal contractor, who will pump the solids from the septic tanks into a tanker truck and transport the sludge to a nearby municipal wastewater treatment system for disposal.

Domestic Sewage Minimization

Domestic waste will also be minimized by using modern, low-flow restroom fixtures. As required by the 1992 U.S. Energy Policy Act, fixtures installed after January 1994 must meet modern low-flow requirements (e.g., toilets with flush capacities equal or less than 1.6 gallons per flush).

Domestic Sewage Potential Impacts

Construction of the domestic wastewater system will result in soil disturbance, although the system will be constructed inside or adjacent to the central plant area, in areas likely disturbed by facility construction and utility installation. The size of the drainfield will depend on the design capacity, the drainfield configuration, and the site-specific percolation rate of the receiving soils. Effluent may be pumped from the septic tank(s) to the drainfield if needed; the drainfield will not need to be located downgradient from the septic tank(s).

Potential groundwater impacts resulting from effluent disposal will be small and are addressed in Section 4.4. The small quantity of effluent (about 2 gpm on average) spread over a large area will have very limited potential to impact groundwater quality, considering that a properly sized and maintained septic tank will remove most of the solids and significantly reduce total suspended solids, organic carbon, and ammonia, and a drainfield will provide further treatment, including a high level of bacteria reduction.

4.14 POTENTIAL CUMULATIVE IMPACTS

4.14.1 Potential Cumulative Impacts of Other Uranium Development Projects

The Powder River Basin has been historically developed for the recovery of uranium using ISR and conventional (underground and pit) mining. The only existing licensed uranium projects currently located in the Powder River Basin are the Smith Ranch/Highland Uranium Project (operated by Power Resources, Inc.) and the Willow Creek Project operated by Uranium One USA These ISR projects are located approximately ten miles north-northeast and 70 miles north-northwest of the proposed project, respectively. For the purposes of this discussion potential cumulative impacts will be addressed for the Smith/Highland Uranium Project and the proposed Ludeman Project due to the proximity of these facilities. Considering the distance between the existing projects and the proposed Ludeman Project, potential cumulative environmental impacts are not expected.

4.14.1.1 Potential Cumulative Land Use Impacts

As discussed in Section 2.2 of this Technical Report, rangeland is the primary land use within the proposed project and within the surrounding two-mile review area with the exception of the rural Negley subdivision and the Top of the World wind farm. There is one occupied housing unit in the proposed project area. To the north of the proposed project lies the Smith Ranch/Highland Uranium Project. Due to the minimal amount of surface disturbance (815 acres) potential land use impacts are anticipated to be small.

The potential cumulative impacts of the proposed project operations and the Smith Ranch/Highland Uranium Project include the restriction of wildlife and agricultural activities from the production areas and the removal of grazing lands through the construction of facilities, roads, and wellfields, however; due to the minimal surface disturbance associated with ISR operations potential land use conflicts are expected to be small.

4.14.1.2 Potential Cumulative Transportation Impacts

State Highways 95 and 93 pass through the northern end of the proposed project. As discussed in Section 3.2 of the ER, primary access to the proposed project will be through the use of these roadways. Delivery of construction materials to the proposed project and the Smith Ranch/Highland Uranium Project along with disposal of waste, resin transport, and maintenance vehicles would not significantly increase the quantity of traffic.

It is anticipated that heavy equipment will be transported primarily to the site during off-peak traffic hours minimizing the potential transportation impacts.

4.14.1.3 Potential Cumulative Geology and Soils Impacts

Potential geological impacts from the proposed project are expected to be minimal, if any, as with the nearby Smith Ranch/Highland Uranium Project. As such, no potential cumulative impacts to geology are anticipated. However, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

As discussed in Section 2.6 of this document, the three Satellite facility locations are underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. As with any soil disturbance the potential exists for increased erosion hazards. Mitigation measures are provided in Section 5 of the ER to minimize this potential.

4.14.1.4 Potential Cumulative Water Resources Impacts

Potential impacts to surface water resources at the proposed project are anticipated to be minimal as no drainages or bodies of water will be significantly modified or altered within the proposed project area during project construction or operations. All streams within the proposed project two mile buffer area and the Smith Ranch/Highland Uranium Project are ephemeral with the exception of the North Platte River. As such, potential cumulative impacts to surface water resources will be minimal. Mitigation measures are discussed in detail in Section 5 of the ER.

Potential cumulative impacts to groundwater resources are expected to be minimal as due to the distance from the Smith/Highland Uranium project to the proposed project. The instrumentation and control system and excursion monitoring system proposed to be used at the proposed project are designed to quickly detect any leaks, spills, or potential excursions, so any area of impact would be small. Thus, there is an extremely small likelihood of any groundwater impacts extending off-site to create cumulative impacts.

4.14.1.5 Potential Cumulative Ecological Resources Impacts

Potential cumulative impacts on wildlife habitat could potentially occur from the proposed project in conjunction with other ISR facilities in the region. Environmental stressors to include the proposed project and other existing ISR uranium facilities on wildlife habitat consist of roads, transmission lines, pipelines, increased traffic, and agricultural activities. While the proposed project and other projects requiring state and federal approvals would be located and built in a manner that would avoid and minimize potential impacts, there may still be residual impacts such as temporary and permanent

removal of habitat and subsequent removal of wildlife. Neither the proposed project nor the Smith/Highland Uranium Project are located inside the core sage grouse areas and crucial big-game ranges.

4.14.1.6 Potential Cumulative Air Quality Impacts

Projected activities at the proposed project impacting dust emissions include ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Fugitive dust and exhaust from construction activities are potential causes of decreases in air quality related to wind farm installation. Construction emissions would occur during potential road and pad construction and transmission line installation. Cumulative air quality impacts would occur during construction, operation, restoration, and decommissioning of ISR facilities. The amount of air pollutant emissions during construction is controlled by watering disturbed soils, and by air pollutant emission limitations. Cumulative impacts to air quality as a result of the proposed project and the Smith/Highland Uranium Project are anticipated to be small due to the distance between the projects.

It is not anticipated that there will be any significant potential impacts regarding radiological particulate or gaseous emissions from the Satellite facilities operations. Radiological gaseous emissions anticipated during operation are described in Section 7.3.

4.14.1.7 Potential Cumulative Noise Impacts

As a result of the remote location of the proposed project and the Smith/Highland Uranium Project and the relatively low population density of the surrounding area, impact to noise or congestion above ambient background noise within the proposed project area or in the surrounding two-mile area are not anticipated. ISR facilities create little noise during operation. Consequently, no adverse potential cumulative impacts are anticipated.

4.14.1.8 Potential Cumulative Cultural Resources Impacts

A Class III cultural resource inventory of the proposed project was conducted in 2008 by Ethnoscience, Inc. of Billings Montana. As concluded in the Class III Inventory Report, provided in Appendix B, the currently proposed project will not affect any known significant cultural resources and additional archaeological work is not considered necessary.

Construction of the proposed project is designed to avoid potential impacts to pre-historic and historic properties and to minimize disturbance to such by implementing a stop-work procedure. As a result of the minimal land disturbance of ISR operations and mitigation measures provided in Section 5 of the ER, the risk of potential cumulative impacts to cultural resources is small.

4.14.1.9 Potential Cumulative Visual Impacts

The visible surface structures proposed for the proposed project and the Smith/Highland Uranium Project include wellhead covers, header houses, electrical distribution lines, booster pump houses, and Satellite/CPP facilities. The proposed project will use existing and limited new roads to access the Satellite facilities and each header house. Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately three feet high and two feet in diameter. Each header house is a small metal building.

As a result of blending structures with the landscape, siting facilities in locations to minimize public view, and the distance between the Smith/Highland Uranium Project and proposed project potential cumulative visual impacts will be small.

4.14.1.10 Potential Cumulative Socioeconomic Impacts

As mentioned in Section 4.10 of the ER, the construction and decommissioning phases of the proposed project will cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities and increased demand for housing and other services. As the Smith/Highland Uranium Project is currently operating and requires minimal additional resources to continue operating no cumulative impacts are anticipated except for increased tax revenue as a result of income for both projects.

4.14.1.11 Potential Cumulative Health Impacts

Potential impacts to health as a result of the proposed project are discussed in Section 7.4 below. With proper mitigation measures in place as discussed in Section 5 of the ER, there are no anticipated cumulative impacts for ISR

4.14.2 Potential Cumulative Impacts of Coal Bed Methane Development Projects

The PRB has been developed since the mid-1980's for the recovery of CBM. With advancements in technology, development and production of CBM has been increasing

substantially since the mid-1990s. Development has been centered in all or parts of Campbell, Converse, Johnson, and Sheridan counties. The target coal zones are contained in the Fort Union formation.

Licensing and permitting applications have not been submitted to the regulatory agencies at the time of this application. As such, it is not possible for Uranium One to accurately predict the potential cumulative environmental impacts should CBM projects be developed.

4.14.3 Potential Cumulative Impacts of Wind Farm Projects

In recent years the PRB has seen growth in the wind energy. Within the vicinity of the proposed project area exists the Top of the World wind farm owned by Duke Energy and the PacificCorp wind farm. Several wind turbines from the Top of the World wind farm are within the two mile buffer west of the project boundary. The wind farm operated by PacificCorp is outside of the two mile buffer and is located approximately 6.5 miles northwest of the property boundary. The two wind farms combined have a total of 268 windmills stretched over 16 miles long and 3.5 miles wide..

Potential cumulative impacts include land use impacts by restricting access to portions of the area, geology and soils through pad and access road construction, ecological impacts on wildlife habitat through environmental stressors such as access roads and pad construction, air quality degradation through dust emissions during construction and operations, noise by increased traffic and construction, cultural resources disturbance during construction, visual impacts from dominant features such as the 400 feet high wind turbines found 1.5 miles west of the proposed project, socioeconomic implications include potential increased employment and increased tax revenue.

4.14.3.1 Potential Cumulative Land Use Impacts

As discussed in Section 2.2 of this Technical Report, rangeland is the primary land use within the proposed project and within the surrounding two-mile review area with the exception of the rural Negley subdivision and the Top of the World wind farm operated by Duke Energy. There is one occupied housing unit in the proposed project area. The total surface area of the proposed project to be affected by the proposed operation is estimated to total 815 acres.

The potential cumulative impacts of the proposed project operations and the wind farm include the restriction of wildlife and agricultural activities from the production areas and the removal of grazing lands through the construction of facilities, roads, and windmill pads.

4.14.3.2 Potential Cumulative Transportation Impacts

State Highways 95 and 93 pass through the northern end of the proposed project. Primary access to the proposed project will be through the use of these roadways. Delivery of construction materials to the proposed project and the Top of the World wind farm along with disposal of waste, resin transport, and wind farm maintenance vehicles would not significantly increase the quantity of traffic.

It is anticipated that heavy equipment will be transported primarily to the site during off-peak traffic hours minimizing the potential transportation impacts.

4.14.3.3 Potential Cumulative Geology and Soils Impacts

Potential geological impacts from the proposed project are expected to be minimal, if any, as with the nearby wind farm. As such, no potential cumulative impacts to geology are anticipated. However, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

As discussed in Section 2.6 of this document, the three proposed Satellite facility locations are underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. As with any soil disturbance the potential exists for increased erosion hazards. Mitigation measures are provided in Section 5 of the ER to minimize this potential.

4.14.3.4 Potential Cumulative Water Resources Impacts

Potential impacts to surface water resources at the proposed project are anticipated to be minimal as no drainages or bodies of water will be significantly modified or altered within the proposed project area during project construction or operations. All streams within the proposed project two mile buffer area and the Top of the World wind farm are ephemeral with the exception of the North Platte River. As such, potential cumulative impacts to surface water resources will be minimal. Mitigation measures are discussed in detail in Section 5 of the ER.

Potential cumulative impacts to groundwater resources are expected to be minimal as wind farms have no impact to groundwater.

4.14.3.5 Potential Cumulative Ecological Resources Impacts

Potential cumulative impacts on wildlife habitat could potentially occur from the proposed project in conjunction with other action in the proposed project buffer area.

Environmental stressors to include the proposed project on wildlife habitat consist of roads, transmission lines, pipelines, windfarms, and agricultural activities. While the proposed project and other projects requiring state and federal approvals would be located and built in a manner that would avoid and minimize potential impacts, there may still be residual impacts such as temporary and permanent removal of habitat and subsequent removal of wildlife. Neither the proposed project nor the Top of the World wind farm are inside the core sage grouse areas and crucial big-game ranges.

4.14.3.6 Potential Cumulative Air Quality Impacts

Projected activities at the proposed project impacting dust emissions include ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Fugitive dust and exhaust from construction activities are potential causes of decreases in air quality related to wind farm installation. Construction emissions would occur during potential road and pad construction and transmission line installation. Maximum air pollutant emissions from each windmill would be temporary (i.e., occurring during a short construction period) and would occur in isolation as with the development and operation of the proposed project. Air quality impacts would occur during production for maintenance on the windmills and associated structures (i.e., transmission lines and transformers). The amount of air pollutant emissions during construction is controlled by watering disturbed soils, and by air pollutant emission limitations.

4.14.3.7 Potential Cumulative Noise Impacts

As a result of the remote location of the proposed project and the Top of the World wind farm and the relatively low population density of the surrounding area, impact to noise or congestion above ambient background noise within the proposed project area or in the surrounding two-mile area are not anticipated. Wind turbines create little noise usually masked by the wind itself. Consequently, mo adverse potential cumulative impacts are anticipated.

4.14.3.8 Potential Cumulative Cultural Resources Impacts

A Class III cultural resource inventory of the proposed project was conducted in 2008 by Ethnoscience, Inc. of Billings Montana. As concluded in the Class III Inventory Report, provided in Appendix B, the currently proposed project will not affect any known significant cultural resources and additional archaeological work is not considered necessary.

Construction of the proposed project is designed to avoid potential impacts to pre-historic and historic properties and to minimize disturbance to such by implementing a stop-work procedure.

4.14.3.9 Potential Cumulative Visual Impacts

The visible surface structures proposed for the proposed project include wellhead covers, header houses, electrical distribution lines, booster pump houses, and three Satellite facilities. The project will use existing and limited new roads to access the Satellite facilities and each header house. Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately three feet high and two feet in diameter. Each header house is a small metal building.

The dominant feature of the landscape of the wind farm 1.5 miles to the west of the proposed project are the 268 wind turbines. The wind turbines are approximately 400 feet in height and are spaced approximately 750 feet apart in multiple rows over 15 miles. These structures are visible at night due to the lighting requirements by the Federal Aviation Administration (FAA) on all structures over 200 feet high. These requirements can range from white strobes to red flashing lights.

4.14.3.10 Potential Cumulative Socioeconomic Impacts

As mentioned in Section 4.10 of the ER, the construction and decommissioning phases of the proposed project will cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities and increased demand for housing and other services. As the wind farm is currently operating and requires little additional resources to continue operating no cumulative impacts are anticipated except for increased tax revenue as a result of income for both projects.

4.14.3.11 Potential Cumulative Health Impacts

Potential impacts to health as a result of the proposed project are discussed in Section 7.4 below. Wind farms only have a slight potential impact to health generally only occurring in the immediate vicinity of the individual windmill. As there are no overlapping health effects between the two projects, potential cumulative impacts are not anticipated to occur.

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5 MITIGATION MEASURES

The following sections describe mitigation measures that are proposed to minimize the potential impacts described in Section 4 of this Environmental Report (ER). These mitigation measures are described for the Proposed Action, while no mitigation measures will be implemented for the No Action Alternative since the proposed Ludeman Project (proposed project) will not be constructed. Where possible, tangible and specific mitigation measures are provided as required by Section 5.5 of NUREG-1748.

5.1 MITIGATION MEASURES FOR LAND USE IMPACTS

All lands disturbed within the proposed project area will be returned to their pre-existing land use (ER Section 3.1) and released for unrestricted use following decommissioning. As discussed in Section 3.1 of this ER, rangeland is the primary land use within the proposed project and the surrounding 2.0-mile review area. Based on site reconnaissance conducted in June and August 2008, there is one occupied housing unit in the proposed project area. Figure 3.1-2 depicts land use in the review area.

The visible surface structures proposed for the proposed project include wellhead covers, headerhouses, electrical distribution lines, and three Satellite facilities. The proposed project will use existing and new roads to access each headerhouse and the Satellite facilities.

Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately 3 feet high and 2 feet in diameter. Each headerhouse is a small metal building. A disturbance area around each headerhouse is necessary to provide an adequate area for operations and maintenance vehicles to turn around. Each ion exchange Satellite facility is anticipated to consist of an 80- x 160-foot processing building and a 60- x 150-foot shop and laboratory complex with associated parking and other infrastructure within an approximate 1.5 acre area enclosed with security fencing. Electric distribution lines would connect headerhouses and Satellite facilities to existing electric distribution lines. The distribution poles are approximately 20 feet high and are wooden so that their natural color harmonizes with the landscape. Road disturbance acreage is calculated assuming approximately 6 miles of 25-foot-wide main road and approximately 26 miles of 8-foot-wide, two-tracks for field roads.

Use of the land as rangeland will be excluded from the wellfield and Satellite facility areas during the life of the project. Considering the relatively small size of the area impacted by construction and operation, the exclusion of grazing from this area over the course of the proposed project will have an insignificant impact on local livestock production. These impacts are considered temporary and reversible by returning the land

to its former grazing use through post-recovery surface reclamation. Mitigation measures for the temporary loss of agricultural production over the course of the project include site reclamation and decommissioning efforts to return the land to its beneficial use(s) before the proposed project and are discussed in this section.

All lands disturbed by the proposed project will be returned to their pre-operational land use of livestock grazing and wildlife habitat unless an alternative use is justified and is approved by the landowner, e.g., the rancher desires to retain roads and/or buildings. The objectives of the surface reclamation effort is to return the disturbed lands to production capacity of equal to or better than that existing prior to recovery. The soils, vegetation and radiological baseline data will be used as a guide in evaluating final reclamation. This section provides a general description of the proposed facility decommissioning and surface reclamation plans for the proposed project. The following is a list of general decommissioning activities:

- Plug and abandon all wells as detailed in Section 5.1.1;
- Determination of appropriate cleanup criteria for structures (Section 5.1.6) and soils (Section 5.1.7);
- Radiological surveys and sampling of all facilities, process related equipment and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning;
- Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the recovery operation as discussed in Section 5.1.6;
- Decontamination of items to be released for unrestricted use to levels consistent with the requirements of NRC;
- Survey excavated areas for contamination and remove contaminated materials to a licensed disposal facility;
- Perform final site soil radiation surveys;
- Backfill and recontour all disturbed areas; and
- Establish permanent revegetation on all disturbed areas.

The following sections describe in general terms the planned decommissioning activities and procedures for the proposed project facilities. Uranium One will, prior to final decommissioning of an area, submit to the NRC a detailed Decommissioning Plan for their review and approval at least 12 months before planned commencement of final decommissioning as per NUREG-1569.

5.1.1 Well Plugging and Abandonment

Wellfield plugging and surface reclamation will be initiated once the regulatory agencies concur that the groundwater has been adequately restored and that groundwater quality is stable. All production, injection and monitor wells will be abandoned in accordance with Chapter 11, Section 8 of the WDEQ-LQD Rules and Regulations to prevent adverse impacts to groundwater quality or quantity.

Wells will be plugged and abandoned in accordance with the following program:

- All pumps and tubing will be removed from the well;
- All wells will be plugged from total depth to within 2 feet of the collar with a nonorganic well abandonment plugging fluid of neat cement or bentonite-based grout mixed in the recommended proportion of 20 pounds (lbs) per barrel of water, to yield an abandonment fluid with a 10-minute gel strength of at least 20 lbs/100 square feet (sq ft) and a filtrate volume not to exceed 13.5 cubic centimeters (cc);
- The casing will be cut off at least three feet below the ground surface. Abandonment fluid will be topped off to the top of the cut-off casing. A steel plate will be placed atop the sealing mixture showing the permit number, well identification, and date of plugging; and
- A cement plug will be placed at the top of the casing (if cement is not within two feet of the surface), and the area will be backfilled, smoothed, and leveled to blend with the natural terrain.

5.1.2 Surface Disturbance

The primary surface disturbances associated with ISR operations are the sites containing the Satellite facilities. Surface disturbances also occur during the well drilling program, pipeline and well installations, and road construction. These more superficial disturbances involve relatively small areas or have very short-term impacts.

Disturbances associated with the Satellite facilities, pipeline installations, and wellfield header houses will be for the life of those activities and topsoil will be stripped from the areas prior to construction. Disturbance associated with drilling and pipeline installation is limited, and is reclaimed and reseeded no later than the first fall or spring seeding season. Vegetation will normally be re-established over these areas within two years. Surface disturbance associated with development of access roads will occur at the proposed project site and topsoil will be stripped from the road areas prior to construction and stockpiled.

Surface reclamation in the wellfield production units will vary in accordance with the development sequence and the recovery/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. Surface preparation will be accomplished as needed so as to blend any disturbed areas into the contour of the surrounding landscape.

Wellfield decommissioning will consist of the following steps:

- The first step of the wellfield decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, header houses, electrical and control distribution systems, well boxes, and wellhead equipment. Wellhead equipment such as valves, meters or control fixtures will be salvaged to the extent possible;
- Removal of buried wellfield trunk line piping and surface power lines;
- 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 in section 5.1.5; and
- 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 solid waste landfill or unrestricted use. Other materials that are contaminated will be decontaminated until they meet release limits. If the equipment cannot be decontaminated to meet release limits, it will be disposed of at a licensed disposal facility.

Wellfield decommissioning will be an independent ongoing operation throughout the recovery sequence. 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 Topsoil Handling and Replacement

In accordance with WDEQ-LQD requirements, topsoil is salvaged from building sites, permanent storage areas, main access roads, graveled wellfield access roads and chemical storage sites. Conventional rubber-tired, scraper-type earth moving equipment is typically used to accomplish such topsoil salvage operations. The exact location of topsoil salvage

operations is determined by wellfield pattern placement and the final locations of access roads within the wellfields, determined during wellfield construction activities.

As described in Section 3.3, salvage depth varies within the proposed project area from non-existent to several feet in depth. However, typical topsoil stripping depths are expected to range from 3 to 6 inches.

Salvaged topsoil is stored in designated topsoil stockpiles. These stockpiles will be generally located on the leeward side of hills to minimize wind erosion. Stockpiles will not be located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles will be seeded as soon as possible after construction with the permanent seed mix. In accordance with WDEQ-LQD requirements, all topsoil stockpiles will be identified with a highly visible sign with the designation "Topsoil."

During mud pit excavation associated with well construction, exploration drilling and delineation drilling activities, topsoil will be separated from subsoil with a backhoe. When use of the mud pit is complete, all subsoil will be replaced and topsoil applied. Mud pits only remain open a short time, usually less than 30 days. Similarly, during pipeline construction, topsoil is stored separate from subsoil and is replaced on top of the subsoil after the pipeline ditch is backfilled.

5.1.4 Final Contouring

Recontouring of land where surface disturbance has taken place will restore it to a surface configuration that will blend in with the natural terrain and will be consistent with the post-operational land use. Since no major changes in the topography will result from the proposed project, a final contour map is not required. As a result, the pre-operations contour shown on Figure 2.1-1 will generally show post-operation contour.

5.1.5 Revegetation Practices

Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. During project operations the topsoil stockpiles, and as much as practical of the disturbed wellfield areas will be seeded to establish a vegetative cover to minimize wind and water erosion. After topsoiling prior to final reclamation, an area will normally be seeded with a nurse crop to establish a standing vegetative cover along with the permanent seed mix. A long-term temporary seed mix may be used in the wellfields and other areas where the vegetation will be disturbed again prior to final decommissioning and final revegetation. This long-term seed mix typically consists of one or more of the native wheat grasses (i.e. Western Wheatgrass, Thickspike Wheatgrass).

Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD. The permanent mix typically contains native wheat grasses, fescues, and clovers. Typical seeding rates will be 12 to14 lbs of pure live seed per acre.

The success of permanent revegetation in meeting land use and reclamation success standards will be assessed prior to application for bond release by utilizing the "Extended Reference Area" method as detailed in WDEQ-LQD Guideline No. 2 - Vegetation (March 1986). This method compares, on a statistical basis, the reclaimed area with adjacent undisturbed areas of the same vegetation type.

The Extended Reference Areas will be located adjacent to the reclaimed area being assessed for bond release and will be sized such that it is at least half as large as the area being assessed. In no case will the Extended Reference Area be less than 25 acres in size.

The WDEQ-LQD will be consulted prior to selection of Extended Reference Areas to ensure agreement that the undisturbed areas chosen adequately represent the reclaimed areas being assessed. The success of permanent revegetation and final bond release will be assessed by the WDEQ-LQD.

5.1.6 Procedures for Removing and Disposing of Structures and Equipment

5.1.6.1 Preliminary Radiological Surveys and Contamination Control

Prior to process plant decommissioning, a preliminary radiological survey will be conducted to characterize the levels of contamination on structures and equipment and to identify any potential hazards. The survey will support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities. In general, the contamination control program used during recovery operations (as discussed in Section 5.7 of the TR) will be appropriate for use during decommissioning of structures.

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

5.1.6.2 Removal of Process Buildings and Equipment

The majority of the process equipment in the process buildings will be reusable, as well as the buildings. 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 facilities including tanks, filters, pumps, piping, etc., will be inventoried, listed and designated for one of the following removal alternatives:

- Removal to a new licensed location for future use;
- Removal to a licensed facility for permanent disposal; or
- Decontamination to meet unrestricted use criteria for release, sale or other unrestricted use by others.

Uranium One believes that process buildings will be decontaminated, dismantled and released for use at another location. If decontamination efforts are unsuccessful, the material will be sent to a permanent licensed disposal facility. Cement foundation pads and footings will be broken up and trucked to a solid waste disposal site or to a licensed disposal facility, if contaminated.

All waste that could pose a threat to human health and the environment will be disposed of offsite. This will effectively control, minimize, or eliminate post-closure escape of non-radiological hazardous constituents, leachate, contaminated rainwater or waste composition products to the ground or surface waters, or to the atmosphere.

5.1.6.2.1 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 NRC guidance. Release limits for alpha radiation are as follows:

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

Decontamination of surfaces will be guided by the ALARA principle to reduce surface contamination to levels as far below the limits as practical. Particular attention will be given to equipment and structures in which radiological materials could accumulate in

inaccessible locations including piping, traps, junctions, and access points. Contamination of these materials will be determined by surveys at accessible locations. Items that cannot be adequately characterized will be considered contaminated in excess of the limits and will be disposed at a properly licensed facility.

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

5.1.6.2.2 Preparation for Disposal at a Licensed Facility

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

- Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce interior contamination, as necessary, for safe handling;
- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be contaminated the equipment will be washed down and decontaminated to permit safe handling;
- The equipment will be disassembled only to the degree necessary for transportation. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the plant 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 disposal facility; or
- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.

5.1.6.3 Waste Transportation and Disposal

Materials, equipment, and structures that cannot be decontaminated to meet the appropriate release criteria will be disposed at a disposal site licensed by the NRC or an Agreement State to receive 11e.(2) byproduct material. Uranium One is investigating alternatives for disposal at existing sites licensed to receive 11e.(2) byproduct material including Pathfinder Mines, Kennecott Uranium Company, and Denison Mines. An agreement for disposal of 11e.(2) byproduct material will be in place before operation of the Proposed project commences. A current disposal agreement will be maintained at a minimum of one licensed disposal facility throughout licensed operations.

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

5.1.7 Methodologies for Conducting Post-Reclamation and Decommissioning Radiological Surveys

5.1.7.1 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 5-2. The process employed by Uranium One for deterrecovery cleanup criteria follows.

5.1.7.2 Determination of Radium Benchmark Dose

On April 12, 1999, the NRC issued a Final Rule (64 FR 17506) that requires the use of the existing soil radium standard to derive a dose criterion for the cleanup of byproduct material. The amendment to Criterion 6(6) of 10 CFR Part 40, Appendix A was effective on June 11, 1999. This "benchmark approach" requires that NRC licensees model the site-specific dose from the existing radium soil standard and then use that dose to determine the allowable quantity of other radionuclides that would result in a similar dose to the average member of the critical group. These determinations must then be submitted to NRC with the site reclamation plan or included in license applications. This section documents the modeling and assumptions made by Uranium One to derive a standard for natural uranium in soil for the proposed project.

Concurrent with publication of the Final Rule, NRC published draft guidance (64 FR 17690) for performing the benchmark dose modeling required to implement the final rule. Final guidance (NRC, 2003) was published as Appendix E to the Standard Review Plan for *In Situ* Leach License Applications (NUREG-1569). This guidance discusses acceptable models and input parameters. This guidance, guidance from the RESRAD Users Manual (ANL, 2001), the Data Collection Handbook (ANL, 1993) and site-specific parameters were used in the modeling as discussed in the following sections.

RESRAD Version 6.4 computer code (RESRAD) was used to model the proposed project site and calculate the maximum annual dose rate from the current radium cleanup standard.

The following supporting documentation for determination of the radium benchmark dose and the natural uranium soil standard (explained in Section 5.1.7.3) is attached:

- The RESRAD Data Input Basis (Appendix D-1) provides a summary of the modeling performed with RESRAD and the values that were used for the input parameters. A sensitivity analysis was performed for parameters which are important to the major component dose pathways and for which no site specific data was available:
- Selected graphs produced with RESRAD that present the results of the sensitivity analysis performed on the input parameters are attached (Appendix D-2):
- A full printout of the final RESRAD modeling results for the resident farmer scenario with the chosen input values is attached (Appendix D-3 and Appendix D-4). The printout provides the modeled maximum annual dose for calculated times for the 1,000-year time span and provides a breakdown of the fraction of dose due to each pathway:
- Graphs produced with RESRAD that present the modeling results for the maximum dose during the 1,000 year time span for radium-226 and natural uranium. A series of graphs depicting the summed dose for all pathways and the component pathways that contributes to the total dose are attached (Appendix D-5).

The maximum dose from Ra-226 contaminated soil at the 5 pCi/g-above-background cleanup standard, as determined by RESRAD, for the residential farmer scenario was 39.6 mrem/year. This dose was based upon the 5 pCi/g surface (0 to 6-inch) Ra-226 standard and was noted at time, t = 0 years. The two major dose pathways were external exposure and plant ingestion (water independent). For these two pathways, a sensitivity analysis was performed for important parameters for which no site specific information was available. The 39.6 mrem/year dose from radium is the level at which the natural uranium radiological end point soil standard will be based as described in the following section.

5.1.7.3 Determination of Natural Uranium Soil Standard

RESRAD was used to determine the concentration of natural uranium (U-nat) in soil distinguishable from background that would result in a maximum dose of 39.6 mrem/year. The method involved modeling the dose from a set concentration of natural uranium in soil. This dose was then compared to the radium benchmark dose and scaled to arrive at the maximum allowable natural uranium concentration in soil.

For ease of calculations, a preset concentration of 100 pCi/g U-nat was used for modeling the dose. The fractions used were 49.2 percent (or pCi/g) U-234, 48.6 percent (or pCi/g)

U-238 and 2.2 percent (or pCi/g) U-235. The distribution coefficients that were selected for each radionuclide were RESRAD default values. A sensitivity analysis was performed using a range of distribution coefficients to evaluate potential effects of not using site specific data. All other input parameters were the same as those used in the Ra-226 benchmark modeling.

Using a natural uranium concentration in soil of 100 pCi/g, RESRAD determined a maximum dose of 6.9 mrem/yr. at time, t = 0 years. The printout of the RESRAD data summary is provided in Appendix D-4 and the dose figures generated with RESRAD are provided in Appendix D-5.

To determine the uranium soil standard, the following formula was used:

$$\text{Uranium Limit} = \left(\frac{100 \text{ pCi/g U - nat}}{6.9 \text{ mrem/yr U - nat dose}} \right) \text{x } 39.6 \text{ mrem/yr radium benchmark dose}$$

$$\text{Uranium Limit} = 574 \text{ pCi/g U - nat}$$

The natural uranium limit is applied to soil cleanup with the Ra-226 limit using the unity rule. To determine whether an area exceeds the cleanup standards, the standards are applied according to the following formula:

$$\left(\frac{\text{Soil Uranium Concentration}}{\text{Soil Uranium Limit}} \right) + \left(\frac{\text{Soil Radium Concentration}}{\text{Soil Radium Limit}} \right) < 1$$

This approach will be used at the proposed project site to determine the radiological impact on the environment from releases of source and byproduct materials.

5.1.7.4 Uranium Chemical Toxicity Assessment

The chemical toxicity effects from uranium exposure are evaluated by assuming the same exposure scenario as that used for the radiation dose assessment. In the benchmark dose assessment for the resident farmer scenario, it was assumed that the diet consisted of 25 percent of the meat, fruits, and vegetables grown at the site. No intake of contaminated food through the aquatic or milk pathways was considered probable since it is unlikely the proposed project area could support this activity with local vegetation. Also, the model showed that the contamination would not affect the groundwater quality. Therefore, the same model will be used in assessing the chemical toxicity. The intake from eating meat was shown to be negligible compared to the plant pathway and therefore is not shown here. This is confirmed by the results of the RESRAD calculations

shown in Appendix D-4d and the figures generated with RESRAD shown in Appendix D-5.

The method and parameters for estimating the human intake of uranium from ingestion are taken from NUREG/CR-5512 Vol. 1 (NRC, 1992). The uptake of uranium in food is a product of the uranium concentration in soil and the soil-to-plant conversion factor. The annual intake in humans is then calculated by multiplying the annual consumption by the uranium concentration in the food. Since the soil-plant conversion factor is based on a dry weight, the annual consumption must be adjusted to a dry-weight basis by multiplying by the dry-weight to wet-weight ratio. Parameters for these calculations are given in Section 6.5.9 of the NUREG/CR-5512 Vol. 1 (NRC, 1992). Table 5-1 provides the parameters used in these calculation and results for leafy vegetables, other vegetables, and fruit. Annual intakes of 14 kg/year and 97 kg/year were assumed for leafy vegetables and other vegetables and fruit, respectively. Consistent with Appendix A-3 dose calculations, it was assumed that 25 percent of the food was grown on the site. It was also assumed that the uranium concentration in the garden or orchard was 574 pCi/g. This corresponds to the uranium benchmark concentration for surface soils. Using a conversion factor for natural uranium of 1 mg = 677 pCi, then 574 pCi/g is equivalent to 848 mg/kg. The human intake shown in the first column of Table 5-1 is equal to the product of the parameters given in the subsequent columns. Table 5-1 shows that the total annual uranium intake from all food sources from the site is 56 mg/yr.

The two-compartment model of uranium toxicity in the kidney from oral ingestion was used (ICRP, 1995) to predict the burden of uranium in the kidney following chronic uranium ingestion. This model allows for the distribution of the two forms of uranium in the blood, and consists of a kidney with two compartments, as well as several other compartments for uranium distribution, storage and elimination including the skeleton, liver, red blood cells and other soft tissues.

Table 5-1: Annual Intake of Uranium from Ingestion

Human Intake (mg/yr)	Soil Concentration (mg/kg)	Soil to Plant Ratio (mg/kg plant to mg/kg soil)	Annual Consumption (kg)	Dry Weight Wet Weight Ratio	Food Source
10.1	848	1.7E-2	3.5	0.2	Leafy Vegetables
38.6	848	1.4E-2	13	0.25	Other Vegetables
7.3	848	4.0E-3	12	0.18	Fruit
56.0					Total

The total burden to the kidney is the sum of the two compartments. The mathematical representation for the kidney burden of uranium at steady state can be derived as follows (ICRP, 1995):

$$Q_P = \frac{IR \times f_1}{\lambda_P \left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pk} - f_{pk1}\right)}$$

Where:

Q_P = uranium burden in the plasma, μg
IR = dietary consumption rate, mg U/d
f_1 = fractional transfer of uranium from GI tract to blood, unit less
f_{ps} = fractional transfer of uranium from plasma to skeleton, unit less
f_{pr} = fractional transfer of uranium from plasma to red blood cells, unit less
f_{pl} = fractional transfer of uranium from plasma to liver, unit less
f_{pt} = fractional transfer of uranium from plasma to soft tissue, unit less
f_{pk1} = fractional transfer of uranium from plasma to kidney, compartment 1, unit less
λ_p = biological retention constant in the plasma, d^{-1}

The burden in kidney compartment 1 is:

$$Q_{k1} = \lambda_P \times Q_P \times \frac{f_{pk1}}{\lambda_{k1}}$$

Where:

Q_{k1} = uranium burden in kidney compartment 1, mg
λ_{k1} = biological retention constant of uranium in kidney compartment 1, d^{-1}

Similarly, for compartment 2 in the kidney, the burden is:

$$Q_{k2} = \lambda_P \times Q_P \times \frac{f_{pk2}}{\lambda_{k2}}$$

Where:

Q_{k2} = uranium burden in kidney compartment 2, µg;
λ_{k2} = biological retention constant of uranium in kidney compartment 2, d^{-1};
f_{pk2} = fractional transfer of uranium from plasma to kidney compartment 2, unitless.

The total burden to the kidney is then the sum of the two compartments is:

$$Q_{k1} + Q_{k2} = \frac{IR \times f_1}{\left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pt} - f_{pk1}\right)} \times \left(\frac{f_{pk1}}{\lambda_{k1}} + \frac{f_{pk2}}{\lambda_{k2}}\right)$$

The parameter input values for the two-compartment kidney model include the daily intake of uranium estimated for residents at this site, and the ICRP69 values recommended by the ICRP as listed below (ICRP, 1995). The daily uranium intake rate was estimated to be 0.15 mg/day (56.0 mg/year) from ingestion while residing at this site.

IR = 0.15 mg/day
f_1 = 0.02
f_{ps} = 0.105
f_{pr} = 0.007

f_{pl} = 0.0105
f_{pt} = 0.347
f_{pk1} = 0.00035
f_{pk2} = 0.084
λ_{k1} = ln(2)/(5 yrs*365 days/yr)
λ_{k2} = ln(2)/7 days

Where, ln(2) = 0.693…

Given a daily uranium intake of 0.15 mg/day at this site and the above equation, the calculated uranium in the kidneys is 0.010 mg U, or a concentration of 0.034 μg U/g kidney. This is 3.4 percent of the 1.0 μg U/g value that has generally been understood to protect the kidney from the toxic effects of uranium. Some researchers have suggested that mild effects may be observable at levels as low as 0.1 μg U/g of kidney tissue. Using 0.1 μg U/g as a criterion, then the intake is 34 percent of the level where mild effects may be observable.

The EPA evaluated the chemical toxicity data and found that mild proteinuria has been observed at drinking water levels between 20 and 100 μg/liter. Assuming water intake of two liters/day, this corresponds to an intake of 0.04 to 0.2 mg/day. Using animal data and a conservative factor of 100, the EPA arrived at a 30 μg/liter limit for use as a National Primary Drinking Water Standard (Federal Register/Vol.65, No.236/ December 7, 2000). This is equivalent to an intake of 0.06 mg/day for the average individual. Naturally, since large diverse populations are potentially exposed to drinking water sources regulated using these standards, the EPA is very conservative in developing limits.

This analysis indicates that a soil limit of 574 pCi/g of U-nat would result in an intake of approximately 0.15 mg/day. 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. Therefore exposure to soils containing 230 pCi/g of natural uranium should not result in chemical toxicity effects. Since the roots of a fruit tree would penetrate to a considerable depth, limiting subsurface uranium concentrations to 230 pCi/g will be considered appropriate as well.

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

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

Uranium One proposes an ALARA goal of limiting the natural uranium concentration in the top 15 cm soil layer to 150 pCi/g, averaged over 100 m^2. The uranium concentration should be limited to 225 pCi/g for all soil depths because of chemical toxicity concerns

Table 5-2: Soil Cleanup Criteria and Goals

	Radium-226 (pCi/gm)		**Natural Uranium (pCi/gm)**	
Layer Depth	*Limit*	*Goal*	*Limit*	*Goal*
Surface (0-15 cm)	5	5	225	150
Subsurface (15 cm layers)	15	15	225	225

5.1.7.5 Excavation Control Monitoring

Pre-reclamation radiological surveys will be conducted in a manner consistent with the baseline radiological surveys, described in Section 6.1, so that the data can be directly compared for identification of potentially contaminated areas. For example, a comprehensive gamma scan of the site will be performed, including conversion of raw scan data to three-foot HPIC-equivalent gamma exposure rate readings and/or to estimates of soil Ra-226 concentration. These data sets will be used to develop continuous estimates across the site. This will allow direct spatial comparisons with baseline survey maps for any area at the site. Both qualitative assessments and quantitative statistical comparisons between data sets can be made to assess significant differences, taking into account potential magnitudes of estimation uncertainty. In cases of identified contamination at the soil surface, subsurface soil sampling will also be conducted to determine the vertical extent of contamination that would require remediation under applicable soil cleanup criteria.

Uranium One will use hand-held and GPS-based gamma surveys to guide soil remediation efforts. Field personnel will monitor excavations with hand-held detection

systems to guide the removal of contaminated material to the point where there is high probability that an area meets the cleanup criteria. Support will be provided by GPS-based gamma surveys periodically to more accurately assess the progress of excavation.

5.1.7.6 Surface Soil Cleanup Verification and Sampling Plan

Cleanup of surface soils will be restricted to a few areas where there are known spills and, potentially, small spills near wellheads. Final GPS-based gamma surveys will be conducted in potentially contaminated areas. Areas will be divided into 100 m^2 grid blocks. Soil samples will be obtained from grid blocks with gamma count rates exceeding the gamma action level. The samples will be five-point composites and will be analyzed at an offsite laboratory for radium-226 and natural uranium.

Final status surveys after any remediation has occurred will also be conducted such that results can be directly compared to pre-operational baseline survey data. As with pre-reclamation surveys, final status gamma scan data will be converted to three-foot HPIC-equivalent gamma exposure rates and/or to estimates of soil Ra-226 concentrations. For aspects of the final status survey, pre-operational baseline data may be used instead of a physically separated reference area to provide information on background conditions for statistical comparative testing. Subsurface sampling will be conducted as part of the final status survey only if residual subsurface contamination is known to remain after any remediation has been completed. Other post-operational environmental monitoring data such as sediments, surface waters, groundwater, air particulates, radon, and vegetation may also be compared quantitatively and/or qualitatively against pre-operational baseline data.

Pre-reclamation surveys will also be conducted as described in Section 5.1.6.1 in areas where known contamination has occurred or the potential for unknown soil contamination exists.

5.1.7.7 Quality Assurance

Verification soil samples will be sent to a commercial laboratory for analysis of radium-226 and natural uranium. The commercial laboratory will be required to have a well-defined quality assurance program that addresses the laboratory's organization and management, personal qualifications, physical facilities, equipment and instrumentation, reference materials, measurement traceability and calibration, analytical method validation, standard operating procedures (SOPs), sample receipt, handing, storage, records, and appropriate licenses. Uranium One will maintain a laboratory QA file that will include, at a minimum, the laboratory's Quality Assurance Manual (QAM) and audit reports.

5.2 MITIGATION MEASURES FOR TRANSPORTATION IMPACTS

5.2.1 Access Road Construction Impacts

The impacts associated with upgrading and extending the existing gravel roads to provide access to the Satellite facilities are minor, consisting primarily of air quality impacts from equipment exhaust and dust. Mitigation measures for air quality impacts are discussed in detail in Section 5.6.

5.2.2 Transportation Accident Risk

Transportation of hazardous materials to and from the proposed project can be classified as follows:

- Shipments of uranium-laden resin from the Satellite facilities to the offsite central plant for elution, precipitation and drying of uranium and return shipments of barren eluted resin;
- Shipments of process chemicals or fuel from suppliers to the site; and
- Shipment of 11e.(2) waste from the site to a licensed disposal facility. Accident risks involving potential transportation occurrences and mitigating measures are discussed in the following sections.

5.2.2.1 Accidents Involving Ion Exchange Resin Shipments

A potential transportation risk associated with operation of the proposed project, is the transfer of the ion exchange resin to and from the offsite central plant. Loaded ion exchange resin would be transported in a tanker truck. It is currently anticipated that up to four loads of uranium-laden resin may be transported for elution and up to four loads of barren eluted resin may be returned on a daily basis. The transfer of resin will occur on a combination of private, county and State roads. For shipments of ion exchange resin to a central processing facility, NRC determined that the probability of an accident involving such a truck was 0.009 in any year.

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium-laden and barren resin. General shipping procedures are outlined as follows:

- The resin, either loaded or eluted, will be shipped as "Exclusive Use Only". This will require the outside of each container or tank to be marked "Radioactive LSA"

and placarded on four sides of the transport vehicle with "Radioactive" diamond signs;

- A bill of lading will be included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified shall be the shipping name, ID number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number;
- Before each shipment of loaded or barren eluted resin, the exterior surfaces of the tanker truck will be surveyed for contamination. In addition, gamma exposure rates will be obtained from the surface of the tanker truck and inside the cab of the tractor. All of the survey results will appear on the bill of lading; and
- Properly licensed and trained drivers will transport the resin between the proposed project satellite facilities and offsite central processing facilities.

Accident Prevention

Actions taken to prevent accidents involving shipments of ion exchange resins include the following:

- Properly licensed and trained drivers will transport the resin between the proposed project and the toll "milling" facility;
- Tanker trucks used to transport ion exchange resins will be maintained in good operating condition;
- Inspections will be conducted of the tanker truck prior to shipment of ion exchange resins. Transportation equipment will be taken out of service if any significant deficiencies are identified that could affect safe operation and transport and will not be place back into service until the deficiencies are corrected; and
- Transport of ion exchange resin will only occur on maintained gravel or paved roads and will not occur during extreme or unsafe weather conditions.

Mitigation/Accident Response

Uranium One will develop an emergency response plan for transportation accidents to or from the Proposed project. Uranium One personnel will receive training for responding to a transportation accident. The emergency response plan will include descriptions of the following provisions:

- DOT Regulations;
- Carrier Emergency Response Procedures;
- Spill Kits;

- Immediate response and notification;
- Accident scene response;
- Spill cleanup;
- Concluding activities;
- Review of accident documentation;
- Review of monitoring and sampling data;
- Site abandonment: and
- Reporting

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport tanker truck when carrying uranium-laden resin where all of the tanker truck 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 and environmental impact of a similar accident with barren, eluted resin would be less significant. 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, Uranium One will institute its emergency response plan for transportation accidents. To minimize the impacts from such an accident, the following procedures will be followed:

- Each truck will be equipped with a communication device that will allow the driver to communicate with either the shipper or receiver. In the event of an accident and spill, the driver will be able to communicate with either site to obtain help;
- A check-in and check-out procedure will be instituted where the driver will notify the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, an emergency response team will respond and search for the vehicle. This system will assure 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 which the driver can use to begin containment of any spilled material. The kit will include plastic sheeting to cover spilled material until cleanup operations can begin;
- Both the shipping and receiving facilities will be equipped with emergency response kits to quickly respond to a transportation accident; and
- Personnel and truck drivers will have specialized training to handle an emergency response to a transportation accident.

5.2.2.2 Accidents Involving Shipments of Process Chemicals

It is estimated that approximately four bulk chemical, fuel, and supply deliveries will be made per working day throughout the operational life of the project. Types of deliveries will include carbon dioxide, oxygen, and fuel. All shipment will be made in accordance with the applicable DOT hazardous materials shipping provisions.

5.2.2.3 Accidents Involving 11e.(2) Wastes

Low level radioactive 11e.(2) by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential environmental impact in the event of an accident. Shipments are generally made bulk in sealed roll off containers in accordance with the applicable DOT hazardous materials shipping provisions.

5.2.3 Fires and Explosions

The fire and explosion hazard of the Satellite facilities will be minimal because the facilities do not use flammable liquids in the recovery process and building, and equipment materials are largely made up of non-flammable materials such as steel or concrete. Natural gas used for building heat would be the primary source for a potential fire or explosion. In the Satellite facilities the uranium will be adsorbed on ion exchange resins. An explosion, therefore, would not appreciably disperse the uranium to the environment.

In the wellfields, injection and recovery well piping systems are manifolded for ease of operational control. Piping manifolds, submersible pump motor starters/controllers, and gaseous oxygen delivery systems are situated within electrically-heated, all-weather buildings. These are commonly referred to as "headerhouses". An accumulation of gaseous oxygen would be the primary source for a potential fire or explosion. Such an event could result in the rupture of a leaching solution pipeline within the building and a spill of leaching solution.

<u>Fire Prevention</u>

Prevention methods utilized to minimize potential impacts to human health and the environment from fire or explosion scenarios discussed above include the following:

- Spilled liquids or slurries would be confined to the building sump or to the runoff control system.

- Both the gaseous oxygen and primary leaching solution lines entering each headerhouse are equipped with automatic low pressure shut off valves to minimize the delivery of oxygen to a fire or of liquids to a spill.
- Additionally, each headerhouse is equipped with a continuously operating exhaust fan that would assist in preventing the build-up of oxygen in the building.
- Procedures will be in place for confined space work or hot work for monitoring of oxygen build-up prior to start of work.

Mitigation/Emergency Response

Automatic detection and alarm systems along with sprinkler systems will be installed in the facilities at the proposed project. Fire extinguishers will be placed at accessible locations in all buildings and vehicles for quick response. Appropriate training will be provided for appropriate personnel in use of fire extinguishers. Uranium One personnel will receive training for responding to a fire or explosion. The emergency response plan will include descriptions of the following provisions:

- Notification and evacuation procedures
- Personal protective equipment
- General fire fighting safety rules
- Reporting procedures
- Electrical and gas emergencies

5.2.4 Natural Disaster Risk

NUREG/CR-6733 considered the potential risks to an ISR facility from natural disasters. Specifically, the risk from an earthquake and a tornado strike were analyzed. NRC determined that the primary hazard from these natural events was from dispersal of yellowcake from a tornado strike and failure of chemical storage facilities, resulting in the possible reaction of process chemicals. There will be no processing of uranium to yellow cake at the proposed project and the only chemicals in use will be oxygen and carbon dioxide. NUREG/CR-6733 recommended that licensees follow industry best practices during design and construction of chemical facilities.

The proposed project is located in Converse County Wyoming, in which 37 tornado touch downs were recorded in a period from 1950 through 2003 (WSCO, 2007). Of those, 34 tornadoes were classified as FO (with wind speeds of 40-72 miles per hour and described as a gale tornado) or F1 tornadoes (described as moderate with wind speeds of 73-112 miles per hour). Three of the 37 tornadoes were classified as F2 with wind speeds of 113 to 157 miles per hour and described as significant tornadoes. Based on the Fujita

Scale, the type of damage that can be expected from an F2 tornado is roof damage, unsecured mobile homes pushed off foundations, and light structures severely damaged or destroyed. Based on the maximum Fujita Scale wind speed probability, the eastern third of the state can expect a tornado between 10,000 and 100,000 years,

NUREG-0706 estimated the probability of occurrence of a tornado in the area in which the project is located is about 3 x 10^{10} per year. The area was categorized as Region 3 in relative tornado intensity. For this category, the wind speed of the design tornado was 240 mph (F4 tornado), of which 190 mph is rotational and 50 mph is translational. The proposed project structures are not designed to withstand a tornado of this intensity.

Mitigation and Emergency Response

NUREG/CR-6733 concluded that tornado risk is very low at uranium ISR facilities and that no design or operational changes were required to mitigate the risk. One recommendation was that chemical storage tanks be located sufficiently far apart that leaks caused by tornado damage would not result in chemical reactions. Uranium One will institute procedures and provide instructions to operating personnel for response and mitigation of natural disasters and any associated spills of radioactive materials. Emergency response procedures will include:

- Notification to personnel of potential severe weather;
- Evacuation procedures;
- Damage inspection and reporting; and
- Cleanup and mitigation of spills of radioactive materials or chemicals

5.3 MITIGATION MEASURES FOR GEOLOGIC AND SOILS IMPACTS

5.3.1 Geologic Impacts

Geological impacts from operations are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the target sandstone will be on the order of one percent or less. Further, once recovery and restoration operations are completed, groundwater levels will return to near-original conditions under a natural gradient.

5.3.2 Soil Impacts

Based on the soil mapping unit descriptions in Section 3.3, the hazard for water erosion within the proposed project area varies from slight to severe and the hazard from wind

erosion varies from moderate to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. General topography of the area ranges from nearly level uplands to very steep hills, ridges and breaks of dissected shale plains. The soils occurring on the proposed project were generally a sandy or coarse texture throughout upland areas and fine, clay textured soils occurring in or near drainages. The project area contained deep soils on level upland areas with shallow and very shallow soils located on hills, ridges and breaks. Given the texture of the surface horizons throughout the majority of the proposed project area and the semi-arid climate, the soils are more susceptible to erosion from wind than water. See Table 3.3-8 in Section 3.3 for a summary of wind and water erosion hazards within the proposed project.

The three Satellite facilities locations are underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. The soils underlying the proposed wellfields are at a moderate to severe risk of erosion from both wind and water. Though no topsoil will be stripped from the wellfields, construction may result in an increase in the erosion hazard from both wind and water due to the removal of vegetation and the physical disturbance from heavy equipment.

Soil erosion mitigation will be implemented in accordance with WDEQ-LQD Rules and Regulations, Chapter 3, Environmental Protection Performance Standards. Typical erosion protection measures that may be implemented at the proposed project include the following:

- Temporary diversion of surface runoff from undisturbed areas around the disturbed areas and the use of water velocity dissipation structures;
- Retaining sediment within the disturbed areas through the use of best management practices such as silt fencing, retention ponds, or other effective means; and
- Salvage and stockpiling of topsoil from the Proposed project plant facility areas and from secondary wellfield access roads in a manner to avoid wind and/or water erosion.

5.4 MITIGATION MEASURES FOR WATER RESOURCES IMPACTS

5.4.1 Surface Water Impacts

5.4.1.1 Surface Water Impacts from Sedimentation

Normal construction activities within the wellfields, satellite process locations, and along the pipeline alignments and roads have the potential to increase the sediment yield of the disturbed areas. However, the relative size of these disturbances is small when compared to the size of the overall areas and to the size of the watersheds, hence will also have a short-term impact. Since wellfield decommissioning and reclamation activities will be on-going throughout the life of the project, the area to be reclaimed at the conclusion of operations will be reduced, although a slight increase in sediment yields and total runoff can still be expected. Since all natural flow within the project boundaries is ephemeral with no intermittent or perennial streams, potential impacts to surface water from construction, operations, and decommissioning activities are also limited to uncommon precipitation or runoff events.

The physical presence of the surface facilities including wellfields and associated structures, access roads, satellite facilities, pipelines, facilities and other structures associated with ISR operations and processing of uranium are not expected to significantly change peak surface water flows. This is due to the topography of the drainages at the site, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage within and adjacent to the proposed project. In areas where these structures may affect surface water drainage patterns, diversion ditches and culverts will be used to prevent excessive erosion and control runoff. In areas where runoff is concentrated, energy dissipaters are used to slow the flow of runoff to minimize erosion and sediment loading in the runoff.

No drainages or bodies of water will be significantly modified or altered within the proposed project area during project construction or operations. The potential for erosion is present due to the construction of the wells near the drainage. However, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

Construction and/or industrial stormwater National Pollutant Discharge Elimination System (NPDES) permits will be obtained in accordance with WDEQ - Water Quality Division regulations. Best management practices will be implemented to reduce impacts according to storm water management plans developed for those permits.

5.4.2 Groundwater Impacts

The potential groundwater impacts of ISR operations are related to the consumption of groundwater and short- and long-term changes to groundwater quality within the ore body. Impacts of groundwater consumption are described in Section 5.4.2.1. Perhaps the most significant environmental impact that could occur as a result of ISR operations is the degradation of water quality in the ore-bearing aquifer. These potential impacts are discussed in Section 5.4.2.2. Potential groundwater impacts resulting from accidents and spills are described in Sections 5.4.2.3.

5.4.2.1 Groundwater Consumption

Based on a bleed of 0.5 percent to 1.5 percent which has been successfully applied during recovery at other ISR operations, the potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99 percent) of groundwater used in the recovery process will be treated and re-injected. Potential impacts on groundwater due to consumptive use outside the proposed project area are expected to be negligible.

5.4.2.1.1 Monitoring

To assess the impacts from recovery and restoration operations on local groundwater, the following monitoring will be performed:

- Measure background water levels in the private domestic or livestock water wells surrounding the project area before recovery and every three months during operation; and
- Measure background water levels in regional monitoring wells installed by Uranium One before ISR operations begin and every three months during operations.

5.4.2.1.2 Mitigation

If significant impacts to either the adjacent domestic wells or to stock wells in the vicinity of the proposed project are observed (e.g., water levels drop to a point that impairs the usefulness of the wells), the following mitigation measures would be considered:

- Lowering the pump level in the wells, if possible;
- Deepening the wells, if possible; or

- Replacing the wells with new wells completed in deeper sands that are not impacted by ISR operations.

5.4.2.2 Impacts on Groundwater Quality

Uranium One has estimated the post-operation water quality at the proposed project based on the experience of Cogema, Inc., in Production Units 1 through 9 at the Irigaray ISR project (Cogema, 2004), and Units (MU) 2 through 5 at the Christensen Ranch ISR Project located in the Powder River Basin near the proposed proposed project. The Willow Creek Project (Irigaray and Christensen) data was selected because of the proximity and similar geologic conditions to those at the proposed project. Cogema employed ammonium bicarbonate lixiviant with hydrogen peroxide as the oxidant during early ISR operations at the Irigaray Project and a sodium bicarbonate lixiviant with gaseous oxygen at Christensen Ranch. In May 1980, the lixiviant system for Irigaray was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database for the Irigaray ISR Projects is extensive because it represents 5 wellfields located in a 200-acre site.

The water quality of the Irigaray and Christensen Production Zones after ISR operations was established by sampling each of the designated restoration wells. The post-operations mean of the analytical results from Irigaray Production Units 1 through 9 and Christensen Production Units 2 through 5 are presented in Table 5-3.

As discussed in previous sections, past pilot-scale operations were conducted on the west side (Leuenberger Project) and east side (North Platte Project) of the proposed project area. Three five-spot patterns in the "M" Sand (80 Sand) and one pattern in the "N" Sand (70 Sand) were mined at the Leuenberger site utilizing a sodium bicarbonate lixiviant solution in combination with carbon dioxide and oxygen. Pilot operations at the North Platte Project site utilized a similar lixiviant makeup, except hydrogen peroxide was used as the oxidant instead of oxygen. Post-operations mean concentrations of baseline water quality parameters for ore zone water quality at the Leuenberger site are also shown on Table 5-3 along with a range of parameter concentrations for the Leuenberger, Irigaray and Christensen Ranch sites. Uranium One does possess some restoration information for the North Platte Project. However, no information on post-operation water quality for the North Platte Project has been located. Uranium One expects the post-operations water quality at the proposed project will be similar to the ranges shown on Table 5-3. Since ammonia will not be used at the proposed project, ammonia results will be most similar to Leuenberger. The success of groundwater restoration at the Christensen Ranch site, Irigaray site and Leuenberger site is discussed in Section 5.4.2.2.4.

Table 5-3: Post-Operations Water Quality

Parameter (units)	Christensen Ranch Post-Recovery Mean (MUs 2-5)	Irigaray Post-Recovery Mean (MUs 1-9)	Leuenberger "M" Sand (80-Sand) Post-Recovery Mean Concentration	Range of Post Recovery Mean Concentrations For All Projects
Dissolved Aluminum (mg/l)	≤0.1	<1.037	0.06	0.06-1.037
Ammonia as N (mg/l)	0.70	23	NA	0.7-23
Dissolved Arsenic (mg/l)	0.04	<0.601	0.011	0.011-0.601
Dissolved Barium (mg/l)	≤0.1	<1.067	<0.10	<0.1-1.067
Boron (mg/l)	≤0.1	<0.442	<0.25	0.1-0.442
Dissolved Cadmium (mg/l)	≤0.01	<0.979	<0.01	0.01-0.979
Dissolved Chloride (mg/l)	146	277	78.2	78-277
Dissolved Chromium (mg/l)	≤0.05	<1.018	<0.05	<0.05-1.018
Dissolved Copper (mg/l)	≤0.01	<0.828	<0.05	<0.01-0.828
Fluoride (mg/l)	0.11	<1	0.27	0.11-0.27
Total and Dissolved Iron (mg/l)	0.93	<1.098	0.05	0.05-1.098
Dissolved Mercury (mg/l)	≤0.001	<0.971	<0.001	<0.001-0.971
Dissolved Magnesium (mg/l)	56.4	45.7	NA	45.7-56.4
Total Manganese (mg/l)	0.64	1.249	0.18	0.18-1.249
Dissolved Molybdenum (mg/l)	≤0.1	<1.067	<0.10	<0.1-1.067
Dissolved Nickel (mg/l)	0.07	<1.018	<0.05	<0.05-1.018
Nitrate + Nitrite as N (mg/l)	0.25	<3	0.31	0.25-3
Dissolved Lead (mg/l)	≤0.05	<1.018	<0.05	<0.05-1.018
Radium-226 (pCi/L)	384	200.5	1,463	200-1,463
Dissolved Selenium (mg/l)	3.57	0.247	0.022	0.022-3.57
Dissolved Sodium (mg/l)	712	827	440	440-827
Sulfate (mg/l)	890	639	394	394-890
Uranium (mg/l)	14.37	7.411	21.8	7.4-21.8
Vanadium (mg/l)	0.34	<1.067	0.22	0.22-1.067
Dissolved Zinc (mg/l)	0.02	<0.065	0.05	0.02-0.065
Dissolved Calcium (mg/l)	300	199.2	209	199-300
Bicarbonate (mg/l)	1,864	1343	1,418	1,343-1,864

Parameter (units)	Christensen Ranch Post-Recovery Mean (MUs 2-5)	Irigaray Post-Recovery Mean (MUs 1-9)	Leuenberger "M" Sand (80-Sand) Post-Recovery Mean Concentration	Range of Post Recovery Mean Concentrations For All Projects
Carbonate (mg/l)	0.88	<2	15	0.88-15
Dissolved Potassium (mg/l)	11	9	20.2	9-20
Total Dissolved Solids (TDS) @ 180°F (mg/l)	3,282	2451	1,807	1,807-3,282

5.4.2.2.1 Groundwater Restoration Criteria

The purpose of groundwater restoration is to protect groundwater adjacent to the ISR extraction zone. Approval of an aquifer exemption by the WDEQ and the EPA is required before recovery operations can begin. The aquifer exemption removes the recovery zone from protection under the Safe Drinking Water Act (SDWA). Agency approval of an exemption of a portion of an aquifer is based on existing water quality, the ability of the geologic formation hosting the aquifer to commercially produce minerals, and the inability to use (as a result of natural groundwater quality) or the lack of use of an aquifer as an underground source of drinking water (USDW). Groundwater restoration helps ensure that any mobilized constituents do not affect aquifers adjacent to the ore zone.

The primary goal of the groundwater restoration efforts will be to return the groundwater quality of the production zone, on a wellfield average, to the preoperational (baseline) water quality conditions using Best Practicable Technology (BPT). Recognizing that restoration activities are not likely to return groundwater to the exact water quality that existed prior to *in situ* operations (as discussed in Section 5.4.2.2), the WDEQ restoration standard of class of use may be applied. The secondary standard of class of use will be only after restoration, using BPT, no longer shows significant improvement in groundwater quality and continuing restoration activities would not be beneficial. The pre-operation baseline water quality and class of use will be determined by the baseline water quality sampling program which will be performed for each wellfield, as compared to the groundwater use categories defined by the WDEQ, Water Quality Division (WQD). Baseline, as defined for this project, will be the mean of the pre-operation baseline data for each wellfield, after removal of outliers or anomalous data. Restoration will be demonstrated in accordance with Chapter 11, Section 5(a)(ii) of the WDEQ, Land Quality Division Rules and Regulations and NUREG-1569 Section 6.

Baseline water quality will be collected for each wellfield from the wells completed in the planned Production Zone (i.e., MP-Wells). The evaluation of restoration will be

conducted on a parameter by parameter basis. Restoration Target Values (RTVs) will be established for the list of baseline water quality parameters. The RTVs for the wellfields will be the average of the pre-operation values. Table 5-4 entitled Baseline Water Quality Parameters lists the parameters included in the RTVs.

Baseline values will not be changed unless the operational monitoring program indicates that baseline water quality has changed significantly due to accelerated movement of groundwater, and that such change justifies redetermination of baseline water quality. Such a change would require resampling of monitor wells and review and approval by the WDEQ.

Table 5-4: Baseline Water Quality Parameters

Parameter (units)
Dissolved Aluminum (mg/l)
Ammonia Nitrogen as N (mg/l)
Dissolved Arsenic (mg/l)
Dissolved Barium (mg/l)
Boron (mg/l)
Dissolved Cadmium (mg/l)
Dissolved Chloride (mg/l)
Dissolved Chromium (mg/l)
Dissolved Copper (mg/l)
Fluoride (mg/l)
Gross Alpha (pCi/l)
Gross Beta (pCi/l)
Total and Dissolved Iron (mg/l)
Dissolved Mercury (mg/l)
Dissolved Magnesium (mg/l)
Total Manganese (mg/l)
Dissolved Molybdenum (mg/l)
Dissolved Nickel (mg/l)
Nitrate + Nitrite as N (mg/l)
Dissolved Lead (mg/l)
Radium-226 (pCi/L)
Radium-228 (pCi/L)
Dissolved Selenium (mg/l)
Dissolved Sodium (mg/l)
Sulfate (mg/l)
Uranium (mg/l)
Vanadium (mg/l)
Dissolved Zinc (mg/l)
Dissolved Calcium (mg/l)
Bicarbonate (mg/l)
Carbonate (mg/l)
Dissolved Potassium (mg/l)
Total Dissolved Solids (TDS) @ 180°F (mg/l)

Source: WDEQ LQD Guideline 8, Hydrology, March 2005

5.4.2.2.2 Ground Water Restoration Method

The groundwater restoration program consists of two stages, the restoration stage and the stability monitoring stage. The restoration stage typically consists of two phases:

1) Groundwater sweep, and
2) Groundwater treatment.

These phases are designed to optimize restoration equipment used in treating groundwater and to minimize the volume of groundwater consumed during the restoration stage. Uranium One will monitor the quality of groundwater in selected wells, as needed, during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary. Online production wells used during restoration will be sampled for uranium concentration and for conductivity to determine restoration progress on a pattern-by-pattern basis.

The sequence of the activities will be determined by Uranium One based on operating experience, hydraulic characteristics of the aquifer at the time of restoration and waste water disposal capacity.

A reductant may be added at any time during the restoration stage to lower the oxidation potential of the Production Zone. Either a sulfide or sulfite compound may be added to the injection stream in concentrations sufficient to establish reducing conditions within the recovery zone.

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

Ground Water Sweep

Groundwater sweep may be used as a stand-alone process where groundwater is pumped from a wellfield without reinjection. This causes an influx of baseline quality water from the perimeter of the recovery unit, which sweeps the affected portion of the aquifer. The cleaner baseline water has a lower ion concentration that acts to strip the cations that have attached to the clays during recovery. Additionally, oxidized production water located near the perimeter of the wellfield is also drawn inside the boundaries of the wellfield. Groundwater sweep may also be used in conjunction with the groundwater treatment phase of restoration. The water produced during groundwater sweep is disposed of in the deep disposal wells.

Due to the limited success and excessive consumption removal of groundwater sweep at other operations, Uranium One anticipates that use of groundwater sweep will be very limited or not used at all at the proposed project.

Ground Water Treatment

Either following, or in conjunction with, the groundwater sweep phase, if used, water will be pumped from the recovery zone to treatment equipment at the surface. Ion exchange, reverse osmosis (RO) treatment equipment will be utilized during this phase of restoration.

Groundwater recovered from the restoration wellfield will first be passed through an ion exchange system prior to RO treatment and disposed in the deep disposal wells or it will be re-injected into the wellfield. The ion exchange columns exchange the majority of the contained soluble uranium for chloride. Additionally, prior to or following ion exchange treatment, the groundwater may be passed through a decarbonation unit to remove residual carbon dioxide that remains in the groundwater after recovery.

All or some portion of the restoration recovery water can be sent to the RO unit. The purposes of the RO unit are as follows:

1. To reduce the total dissolved solids in the affected groundwater;
2. To reduce the quantity of water that must be removed from the aquifer to meet restoration limits;
3. To concentrate the dissolved compounds from the restoration flow in a smaller volume of brine to facilitate waste disposal; and
4. To enhance the exchange of ions from the formation due to the large difference in ion concentration in the recirculated restoration flow.

The RO passes a high percentage of the water through the membranes, leaving 60 to 90 percent of the dissolved salts in the brine water or concentrate. The clean water, called permeate, will be re-injected or stored for use in the recovery process. The permeate may also be de-carbonated prior to re-injection into the wellfield. The brine water that is rejected contains the majority of dissolved salts in the affected groundwater and is sent for disposal in the deep disposal wells. Make-up water, derived from water produced from a wellfield that is in a more advanced state of restoration, water from the raw water system, water purged from an operating wellfield, or a combination of these sources, may be added prior to the RO or wellfield injection stream to control the amount of "bleed" in the restoration area.

As described previously, at any time during the process, a chemical reductant, which will be used to create reducing conditions in the recovery zone, may be metered into the restoration wellfield injection stream. The concentration of reductant injected into the formation is determined by how the recovery zone groundwater reacts with the reductant. The goal of reductant addition is to decrease the concentrations of redox sensitive elements.

The chemical reductant added to the injection stream during this stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During recovery operations, certain trace elements are oxidized. By adding the reductant, the Eh of the groundwater in the aquifer is lowered, thereby decreasing the solubility of these elements. If necessary, sodium hydroxide may be used during the groundwater treatment phase to return the groundwater to baseline pH levels. This will assist in immobilizing certain parameters such as trace metals.

5.4.2.2.3 Estimate of Treated Pore Volumes

The number of pore volumes treated and re-injected during the groundwater treatment phase will depend on the efficiency of the RO in removing total dissolved solids (TDS) and the success of the reductant in lowering the uranium and trace element concentrations in the aquifer. The following subsections provide an evaluation with respect to the number of pore volumes (PVs) of treatment that are currently anticipated to achieve restoration of the production zone aquifer. This includes evaluation of similar ISR projects, both in the Powder River Basin and at the proposed project site.

<u>Christensen Ranch and Irigaray ISR Projects Pore Volumes</u>

As previously described, previous ISR operations at the Willow Creek Project are similar to those that will be performed at the proposed project and evaluation of restoration efforts at these other sites provides valuable information with respect to anticipated methods, durations and pore volumes requirements. Table 5-5 presents a summary of the restoration volumes for Willow Creek. As shown on the table, the average number of PVs extracted and treated/re-injected/or disposed was 13.7 for Irigaray and 12.6 for Christensen. However, several points are presented that suggest that the number PVs required to restore the aquifer at the proposed project will be less than what was required at the Willow Creek Project. Circumstances at Willow Creek resulted in increased PVs to achieve restoration goals including the following:

- Groundwater sweep, the initial phase of restoration performed, was often largely ineffective and in some cases may have exacerbated the problem; and

- RO was continued in some wellfields after it was apparent that little improvement in water quality was occurring.

Table 5-5: Restoration Volumes for Willow Creek Project (Christensen and Irigaray)

SCHEDULE OF PORE VOLUMES				
CHRISTENSEN			**IRIGARAY**	
UNIT	**PVD**		**UNIT**	**PVD**
MU2	14.4		PU 1-3	18.4
MU3	19.8		PU 4-5	13.9
MU4	12.8		PU 6	9.5
MU5	10.1		PU 7	14.3
MU6	6.0		PU 8	12.5
			PU 9	13.0
Average	**12.6**		**Average**	**13.7**

Results of the effectiveness of groundwater sweep (or lack of it) were clearly demonstrated in the Christensen Ranch Wellfield Restoration report (CRWR) (COGEMA 2008). Example plots, from that report, of mean wellfield water quality at the end of recovery, groundwater sweep, RO and stabilization monitoring are attached as Addendum 5-A. Plots of total dissolved solids for MU3, MU5 and MU6 (Figures 5-A-1, 5-A-2 and 5-A-3, from the respective MU Data Packages of the Christensen Ranch Wellfield Restoration report), indicate minimal improvement following groundwater sweep at MU3 and MU5 and an actual increase in concentrations of indicator parameters at MU6. Following application of RO, the TDS values at MU5 and MU6 decreased to levels below the target Restoration Goal. Uranium concentrations increased in MU5 and MU6 following groundwater sweep (Figures 5-A-4 and 5-A-5 from the respective Mine Unit Data Packages of the CRWR), and then was significantly lowered during RO. Approximately 1.8, 4.8, and 1.5 PVs of groundwater were removed from MU3, MU5 and MU6, respectively, during groundwater sweep. This water removal was consumptive by design, in that none of it was returned to the aquifer. Based on the results, minimal benefit, if any, was derived from this phase of restoration. Minimizing or eliminating groundwater sweep in the restoration process, will reduce the number of PVs required to reach restoration goals.

Based on a review of the uranium and conductivity concentration trend plots from the Irigaray recovery wells during restoration (included in the Irigaray Mine Wellfield Restoration Report (Cogema 2004)), in some cases, RO treatment was continued longer than necessary, or at least longer than any improvements to water quality were occurring. Figures 5-A-1 through 5-A-5 from the Irigaray report show that RO was often continued for several PVs beyond the point that water quality had stabilized. The additional PVs of

RO treatment resulted in no direct benefit to aquifer water quality and resulted in consumptive use of the groundwater resources. RO treatment typically results in disposal of approximately 20 percent of the recovered groundwater with reinjection of the remaining 80 percent following treatment. Terminating RO once water quality has stabilized will minimize the consumptive use of groundwater and reduce the number of PVs of treatment.

The net result of each of these strategies -- immediate restoration following production, elimination of groundwater sweep, and terminating RO once restoration is achieved or water quality has stabilized and should reduce the number of PVs required to achieve aquifer restoration. It is difficult to quantify how effective each of these strategies will be until actual field measured data become available. Substantial justification of the number of PVs estimated for restoration of the proposed project wellfields following ISR recovery using analytical methods or numerical modeling, given the degree of uncertainty that exists in many of the parameters that would be used in such a demonstration, is not appropriate at this time. The preferred approach is to use existing analogs to the site, and to adjust the PV approximation based on "lessons learned" from those sites.

Leuenberger ISR Pilot Project Pore Volumes

Restoration results from the ISR pilot project performed by UNC-Teton in 1980 (Catchpole) at the Leuenberger Site, located in the northwest portion of the Proposed project area, have been evaluated as an on-site analog. This information is directly applicable to expectations for the proposed project since the Leuenberger pilot project was performed in the same formation and aquifer that will be recovered at the proposed project. Three, five-spot patterns were installed and operated utilizing a bicarbonate leach solution in the 80 Sand at the Leuenberger ISR pilot project. The total affected wellfield pore volume from recovery was determined to be 5,089,136 gallons considering flare. Restoration of the 80 Sand was initiated on February 25, 1981 and terminated December 20, 1981. Phase 1 of restoration consisted of water treatment using ion exchange and EDR. Approximately 6,456,750 gallons were recovered from the production wells and treated through ion exchange with approximately 93 percent of the treated water re-injected into the recovery zone. Phase 1 resulted in the reduction of TDS by an average of 57 percent and rapid cleanup of all other most internal wellfield parameters.

Phases 2 and 3 of the 80 Sand restoration consisted of a directional sweep and treatment from injection and production wells on the far upgradient and downgradient areas of the wellfield and reinjection of treated water into the center portions of the wellfield. A total of 8,721,453 gallons were recovered and treated with ion exchange during these phases, including 4,902,333 gallons which were treated through the EDR unit.

The restoration was completed during Phase 4, which consisted of withdrawing water from the downgradient area of the wellfield and reinjecting treated water to upgradient

areas. A total of 7,413,145 gallons were recovered and treated with ion exchange during this phase, including 3,549,215 gallons which were treated through the EDR.

In total, approximately 22,591,350 gallons were recovered during the 10 months of restoration of the 80 Sand pilot wellfield and treated using ion exchange and EDR. This represents approximately 4.4 pore volumes of the affected wellfield area. After a one-year stabilization period, all parameters remained either below restoration goals or within the range of acceptable baseline values.

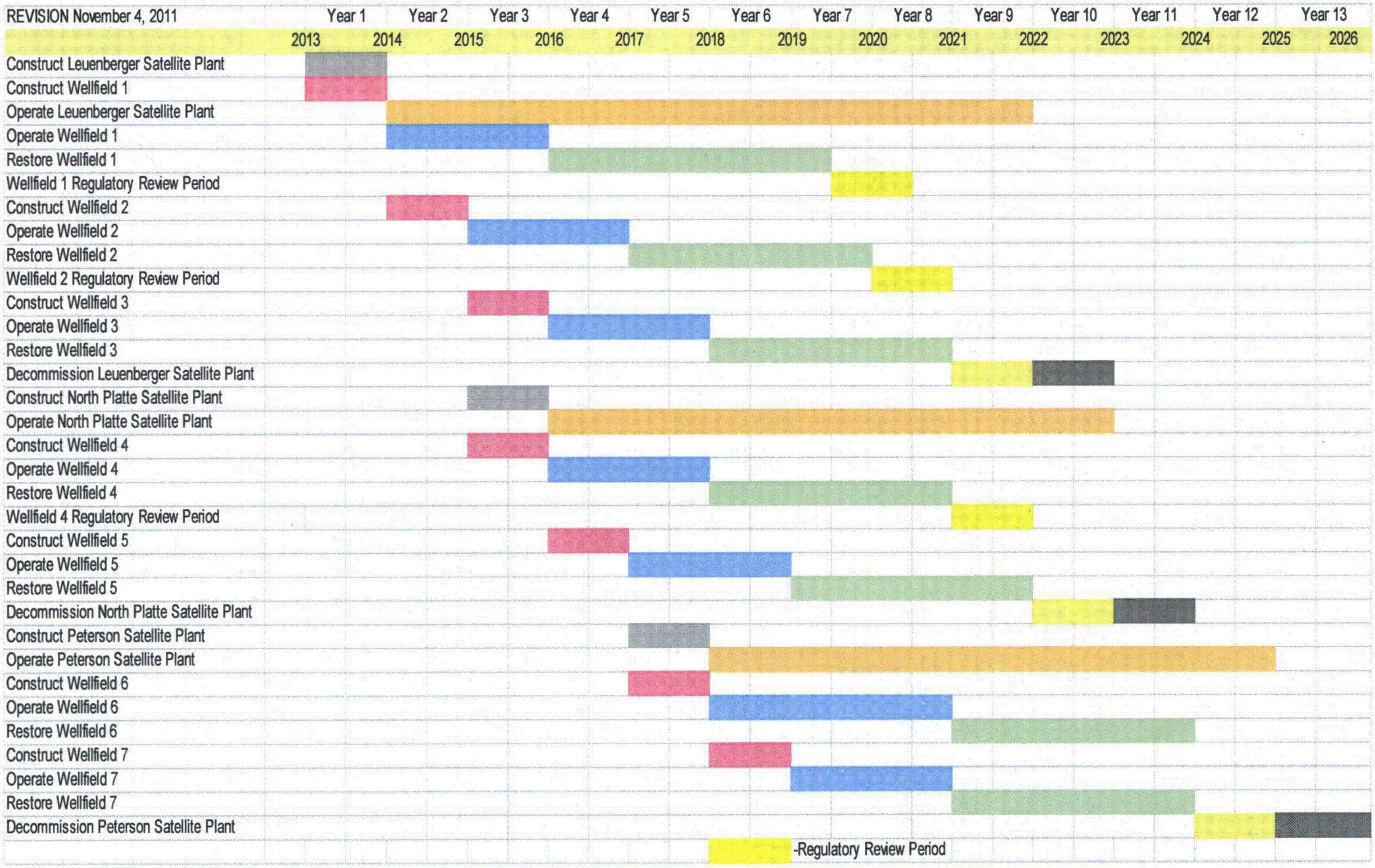
In addition to pilot operations in the 80 Sand, a single, five-spot pattern was installed in the 70 Sand and operated utilizing a bicarbonate leach solution from January 1980 to May of 1981. Restoration of this pattern began in June of 1981. The total affected pore volume of the 70 Sand pilot operations was determined to be 2,626,786 gallons. A five-phase restoration sequence was used to complete the 70 Sand restoration. The phases included recirculation of recovery zone water through the ion exchange circuit (Phase 1), water blending and partial transfer of recovery zone water to the 80 Sand wellfield operations (Phase 2), and induced groundwater sweep (Phases 3 through 5). No EDR treatment was utilized. A total of 6,321,079 gallons were recovered through all five phases of restoration, or approximately 2.4 pore volumes of treatment.

Based on these data from the Leuenberger Pilot Project, it is reasonable to anticipate restoration at the proposed project will require significantly less pore volumes than was performed for the Irigaray and Christensen Ranch Projects. Uranium One anticipates that on the order of four to six pore volumes may be required for restoration.

5.4.2.2.4 Restoration Schedule

The proposed project mine schedule is shown in Figure 5-1 and includes the estimated schedule for restoration. Based on current information the estimated time of restoration for Wellfields 1 and 2 is three-and-a-half years and two-and-a-half years, respectively. The estimated time of restoration for Wellfield 1 is based on six pore volumes (approximately 360,000,000 gallons) through reverse osmosis (RO) at a rate of 300 gallons per minute (gpm) treatment rate, equaling 2.3 years, plus one year of stability monitoring. The Wellfield 2 restoration schedule is based on 6 pore volumes (approximately 150,000,000 gallons) through RO treatment at a rate of 300 gpm equaling approximately 0.9 years, plus one year of stability monitoring. Restoration of Wellfields 3 through 7 is estimated to be three years each, more or less, depending on the size of each wellfield. The restoration schedule includes a period of time for regulatory review following the restoration of the final wellfield at each Satellite facility. As the proposed project is further developed, the restoration schedule will be refined.

Figure 5-1: Proposed Ludeman Operations and Restoration Schedule



5.4.2.2.5 Effectiveness of Ground Water Restoration Techniques

The groundwater restoration methods described in this application have been successfully applied at other uranium ISR facilities in the Powder River Basin, as well as in Nebraska and Texas. A number of uranium ISR projects in Wyoming, Nebraska, and Texas have successfully restored groundwater and obtained regulatory approval of restoration using these techniques. The two ISR facilities described in the following paragraphs are located in the Powder River Basin near the proposed project.

Smith Ranch/Highland Uranium Project

Groundwater restoration activities at the Smith Ranch-Highland Uranium Project currently operated by Power Resources, Inc. (PRI) have been approved by the NRC and the WDEQ for the R&D operations and for the A Wellfield during commercial operations. In 1987, the NRC confirmed successful restoration of the Q Sand project. Although one well exhibited uranium and nitrate levels above the target restoration values, the wellfield averages on a whole were below the targets.

In 2004, the NRC concurred with the WDEQ's determination that the A-wellfield at Highland had been restored in accordance with the applicable regulatory requirements (USNRC, 2004). Not all of the parameters were returned to baseline conditions, but the groundwater quality was consistent with the pre-recovery class of use.

Willow Creek (Irigaray) Uranium Project

Groundwater restoration activities at the Willow Creek Uranium Project operated by Cogema Recovery, Inc. have been approved by the NRC and the WDEQ for Production Units 1 through 9. Post-recovery water quality in the nine production units was described in Section 5.4.2.2. The WDEQ determined that 27 of 29 constituents were restored below the restoration target values. Only bicarbonate and manganese did not meet the baseline range. However, WDEQ determined that these two constituents met the criteria of pre-recovery class of use. Based on this, the WDEQ determined that the groundwater, as a whole, had been returned to its pre-recovery class of use and that the post-restoration groundwater conditions did not significantly differ from the background water quality.

In 2006, the NRC concurred with the WDEQ's determination that Wellfields 1 through 9 at Irigaray had been restored in accordance with the applicable regulatory requirements (USNRC, 2006). NRC determined that Cogema used BPTs and concurred that the WDEQ class-of-use standards were met.

5.4.2.2.6 Groundwater Restoration Monitoring

Monitoring During Active Restoration

During restoration, lixiviant injection is discontinued and the quality of the groundwater is constantly being improved, thereby greatly diminishing the possibility and relative impact of an excursion. Therefore, the monitor ring wells (M-Wells), overlying aquifer wells (MO or MS Wells), and underlying aquifer wells (MU or MD Wells) will be sampled once every 60 days and analyzed for the excursion parameters, chloride, total alkalinity and conductivity during active restoration. Water levels will also be obtained at these wells prior to sampling.

In the event that unforeseen conditions (such as snowstorms, flooding, and/or equipment malfunction) occur, the WDEQ will be contacted if any of the wells cannot be monitored within 65 days of the last sampling event.

The recovery zone will be monitored on a frequency adequate to determine success of restoration, optimize efficiency of restoration techniques, and determine any areas of the wellfield that need additional attention. Samples will be monitored for all of the parameters shown in Table 5-4 at the start of restoration and all or selected parameters through restoration, as needed.

Restoration Stability Monitoring

As specified in WDEQ-LQD Guideline 4, a minimum six-month groundwater stability monitoring period is required to show that the restoration goal has been adequately maintained. WYDEQ has recently requested that this period be extended to 12 months. The following restoration stability monitoring program will be performed during the stability period:

- The monitor ring wells will be sampled quarterly and analyzed for the UCL parameters, chloride, total alkalinity (or bicarbonate) and conductivity; and
- At the beginning, middle and end of the stability period, the MP-Wells will be sampled and analyzed for the parameters in Table 5-4.

In the event that unforeseen conditions (such as snowstorms, flooding, and/or equipment malfunction) occur, the WDEQ will be contacted if any of the M-Wells or MP-Wells cannot be monitored within 65 days of the last sampling event.

The criteria to establish restoration stability will be based on wellfield averages for water quality. A determination of aquifer stablility should be based made upon the "trends" in the data; i.e., a stable aquifer should not exhibit rapid upward or downward trends or be

oscillating back and forth over a wide range of values. The data is evaluated against baseline quality and variability to determine if the restoration goal is met and if the ground water is restored. If increasing trends are confirmed during the stability period for all or part of a wellfield, then an evaluation of the potential cause of the increasing trends will be conducted and corrective actions will be taken, including continued restoration using Best Practical Technology if needed.

5.4.2.2.7 Restoration Wastewater Disposal

Uranium One plans to install deep disposal wells (EPA UIC Class I non-hazardous wells) at the proposed project as the primary liquid waste disposal method. Each Satellite facility will have two surge ponds in case the well becomes non-operational or when routine maintenance is required. One pond is designed to support well operations and the second is a redundant back up. Uranium One believes that permanent deep disposal is preferable to evaporation in evaporation ponds. Disposal in a Class I well permanently isolates the waste water from the public and the environment. Alternatives assessed by Uranium One for waste water disposal are discussed in Section 2.

Based on the expected post-recovery concentrations of groundwater quality constituents discussed in Section 5.4.2.2 and the proposed groundwater restoration techniques discussed in Section 5.4.2.2.2, Uranium One projects that the restoration wastewater disposal stream for injection will exhibit the range of characteristics shown in Table 5-6.

All liquid wastes generated during groundwater restoration at the proposed project will be disposed in the planned deep wells. An application is currently being prepared for submittal to the WDEQ for a Class I UIC Permit for the deep disposal wells at the proposed project.

Table 5-6: Projected Ludeman Restoration Injection Stream Water Quality

Parameter	Units	Minimum Concentration	Maximum Concentration
Calcium	mg/l	350	700
Magnesium	mg/l	50	150
Sodium	mg/l	400	950
Potassium	mg/l	40	90
Carbonate	mg/l	0	0.3
Bicarbonate	mg/l	200	1250
Sulfate	mg/l	900	2500
Chloride	mg/l	300	1000
Nitrate	mg/l	0.01	0.5
Fluoride	mg/l	0.01	2
Silica	mg/l	10	65
Total Dissolved Solids	mg/l	1000	6500
Conductivity	µmho/cm	1000	5500
Alkalinity	mg/l	165	1025
pH	Std. Units	6	12
Arsenic	mg/l	0.01	1
Cadmium	mg/l	0.0001	0.001
Iron	mg/l	0.5	15
Lead	mg/l	0.01	0.04
Manganese	mg/l	0.01	1.5
Mercury	mg/l	0.0001	0.001
Molybdenum	mg/l	0.1	1.5
Selenium	mg/l	0.01	0.5
Uranium	mg/l	0.05	15
Ammonia	mg/l	0.1	0.5
Radium-226	pCi/l	500	5000

5.4.2.3 Potential Groundwater Impacts from Accidents

5.4.2.3.1 Lixiviant Excursions

During any operation where injection fluids are utilized, excursions can be a concern. As stated in NUREG-1910 (GEIS Sec. 2.4.1.3), the unintended movement of the injected lixiviant out of the wellfield results in an excursion A horizontal excursion is a lateral movement of production solution outside the production zone of the orebody aquifer. A vertical excursion is a movement of production solution into overlying or underlying aquifers.

The historical experience at other ISR uranium operations indicates that the selected excursion 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. According to NUREG-1910 (SEIS, Supplement 3, Sec. 4.5.2.1.2.2), excursions have occurred at ISR operating facilities. Following analysis of 60 excursion events by NRC staff, most excursions were controlled through pumping and extraction of nearby wells. In all cases, however, none of these excursions resulted in environmental impacts.

<u>Accident Prevention</u>

Uranium One will control the lateral movement of lixiviant by maintaining well field 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 will either be recycled in the plant or sent to the liquid waste disposal system. When process bleed is properly distributed among the many recovery patterns within the wellfield, recovery solutions are contained within the monitor well ring.

Uranium One will monitor 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. Monitor wells will be sampled semiweekly for approved excursion indicators. Corrective actions will be taken if early signs of lixiviant migration are detected prior to reaching excursion status.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers. Uranium One will prevent vertical excursions through aquifer testing programs and rigorous well construction, abandonment, and testing requirements. Aquifer testing is conducted before recovery wells are installed to detect any leaks in the confining layers. Aquifer test reports are submitted to the WDEQ for review and approval before wellfield operation may proceed. Well construction and integrity testing will be conducted in

accordance with WDEQ regulations and methods approved by NRC and WDEQ. Construction and integrity testing methods were discussed in detail in Section 2.2.6. Well abandonment is conducted in accordance with methods approved and monitored by the WDEQ and discussed in detail in Section 5.1.1.

Uranium One will monitor for vertical excursions in the overlying and underlying aquifers using shallow monitor wells. These wells will be located within the wellfield boundary at a density of one well per four acres. Shallow monitor wells will be sampled semimonthly for approved excursion indicators.

5.4.2.3.2 Wellfield Spills

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the plant, would result in a release of injection or production solution which would impact the ground in the area of the break. All piping from the proposed project facilities, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Spill Prevention

Each wellfield will have a number of header houses where injection and production wells will be continuously monitored for pressure and flow. Individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each header house 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 in detection of significant piping failures.

Occasionally, small leaks at pipe joints and fittings in the header houses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service.

Mitigation/Spill Response

Following repair of a leak, Uranium One will 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. Impacted soil may be removed as appropriate.

Uranium One will develop a response plan for wellfield spills that will include:

- Notification procedures;
- Spill containment and recovery procedures;
- Post spill sampling and cleanup procedures; and
- Reporting procedures

5.5 MITIGATION MEASURES FOR ECOLOGICAL RESOURCES IMPACTS

5.5.1 Vegetation

No State-designated weeds were observed within the proposed project area. The Converse County designated noxious weed cheatgrass was present in all vegetation communities except the Crested Wheatgrass Field vegetation community. The Converse County designated noxious weed curlycup gumweed was present in the Crested Wheatgrass Field vegetation community. The Converse County designated noxious weed wavyleaf thistle was present in the Upland Grassland Rough Breaks Complex vegetation community. Uranium One will conduct weed control as needed to limit the spread of undesirable and invasive, non-native species on disturbed areas. The Converse County Weed and Pest District Supervisor will be consulted when weed concerns arise to help determine the best management practices for the specific weed infestation.

Mitigation of vegetation impact will consist of temporary and permanent surface revegetation of disturbed areas. Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the recovery permit. Disturbed areas will be seeded to establish a vegetative cover to minimize wind and water erosion and the invasion of undesired plant species. A long-term temporary seed mix may be used in wellfield and other areas where the vegetation will be disturbed again prior to final decommissioning and final revegetation. This long-term seed mix typically consists of one or more of the native wheatgrasses (e.g., western wheatgrass, and thickspike wheatgrass). Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD. The permanent seed mix typically contains native wheatgrasses, fescues and clovers. Wellfield areas may be fenced as necessary to prevent livestock access, which will enhance the establishment of temporary vegetation.

5.5.2 Wildlife and Fisheries

The likelihood for the impacts resulting in injury or mortality for wildlife is greatest during the construction phase due to increased levels of traffic and physical disturbance during that period. Traffic will persist during production, but should occur at a reduced,

and possibly more predictable level. Speed limits will be enforced during all construction and maintenance operations to reduce impacts to wildlife throughout the year, but particularly during the breeding season.

5.5.3 Birds

Enforced speed limits during all phases of the proposed project would reduce impacts to wildlife throughout the year, particularly during the breeding season.

5.5.4 Raptors

Wildlife studies on the proposed project will include annual raptor surveys. It is not anticipated that recovery related activities will adversely affect a raptor nest, or disturb a nesting raptor as there is a lack of nesting raptors on and near the facilities and wellfield areas due to the lack of trees and other nesting sites. Additionally, recovery related activities are limited to relatively small areas for limited periods of time. A search of the BLM raptor database revealed nine previously existing nests within the proposed project Survey Area (Project Area and one-mile perimeter) (Table 3.5-24, Figure 3.5-35); all nine were in cottonwood (*Populus* spp.) trees. Two BLM nests have identical numbers (337310), and are further distinguished in Table 3.5-24 with "E" (east) or "W" (west). Thirty-one additional nests were documented and 3 potential nests were recorded during ground and aerial searches of the survey area in 2008 (Figure 3.5-35). The potential nests were located during the final flight over the survey area in September 2008, with no additional time for ground-truthing. Those sites will be verified prior to actual surface disturbance in the project area. Based on their proximity to one another, it is likely that some nests are within the same territory.

One of the previously identified BLM nests (337310-E, unknown species) was destroyed by natural causes prior to 2008 (Table 3.5-24, Figure 3.5-35). Another BLM nest (337311, unknown species) was not accessible as it was on an island within the North Platte River. A third BLM nest (5138) has a new, unnumbered nest in the same tree (Figure 3.5-35). Therefore, 38 of the 40 confirmed nests were known to be intact as of September 2008; the potential nests were not included in that tally. Thirty-two of the 38 intact nests were within the proposed project and 6 were in the one-mile perimeter. Existing nests included:

- 30 ferruginous hawk (*Buteo regalis*) nests;
- 2 great horned owl (*Bubo virginianus*) nests;
- 1 red-tailed hawk (*Buteo jamaicensis)* nest;
- 2 golden eagle (*Aquila chrysaetos*)/red-tailed hawk nests;

- 1 great horned owl/red-tailed hawk nest; and
- 2 unknown raptor species nests.

In accordance with WDEQ-LQD requirements, a raptor nest survey is conducted in late April or early May each year to identify any new nests and assess whether known nests are being utilized. The survey covers all areas of planned activity for the life of the proposed project (i.e., wellfields and Satellite facilities) and a one mile area around the activity. Status and production at known nests will be determined, if possible. This survey program is primarily intended to protect against unforeseen conditions such as the construction of a new nest in an area where operations may take place.

In the event that it is necessary to disturb a raptor nest, a mitigation plan and appropriate permit will be acquired from the U.S. Fish and Wildlife Service, Wyoming Field Office, in Cheyenne, Wyoming.

5.5.5 Threatened and Endangered Species

No Threatened or Endangered vertebrate species have been documented in the proposed project Survey Area, and none were observed there during baseline wildlife surveys conducted in 2008. Likewise, no current (as of September 2008) candidate, petitioned, or proposed vertebrate species were recorded during recent or previous surveys. No T&E plant species were encountered during the baseline vegetation assessment.

5.5.5.1 Bald Eagle (Federal Threatened)

Bald eagles have not been documented in the project area and impacts of the proposed action would be limited to occasional foraging individuals rather than a large segment of the population. If necessary, the majority of direct impacts could be mitigated if construction activities were conducted outside the winter and early spring months, or outside the daily roosting period, should eagles be present during construction. Any bald eagles that might roost or nest in the area once the mine is operational would be doing so in spite of continuous and on-going human disturbance, indicating a tolerance for such activities.

5.5.6 Waterfowl and Shorebirds

Construction and operation of the proposed project would have a negligible effect on migrating and breeding waterfowl and shorebirds. Habitat disturbance in drainages or other potential water sources would be reclaimed once productive operations have

ceased. Replacement of any impacted jurisdictional wetlands would be required in accordance with Section 404 of the Clean Water Act.

5.6 MITIGATION MEASURES FOR AIR QUALITY IMPACTS

Air quality impacts are primarily related to fugitive dust from construction activities and vehicular traffic. As discussed in Section 4.6, these impacts are negligible. Enforcement of site speed limits and the application of water to unpaved roads would reduce the amount of fugitive dust to levels equal to or less than the existing condition.

5.7 MITIGATION MEASURES FOR NOISE IMPACTS

As a result of the remote location of the project and the low population density of the surrounding area, impact to noise or congestion within the proposed project area or in the surrounding two-mile area are not anticipated. Noise impacts will be mitigated through enforcement of site speed limits.

5.8 MITIGATION MEASURES FOR HISTORIC AND CULTURAL RESOURCES IMPACTS

None of the sites eligible for nomination are located within areas currently planned for *in situ* mine development, and in fact, are located well over a mile away from any planned development. If exploration and development plans are subsequently expanded near those areas, then all associated ground-disturbing activities will avoid impacting sites 48CA6694 and 48CA6696. If avoidance is not feasible, then a testing/data recovery plan will need to be implemented and completed prior to commencement of any ground disturbing activities to mitigate the adverse affects to the eligible sites.

5.9 MITIGATION MEASURES FOR VISUAL/SCENIC RESOURCES IMPACTS

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.

As discussed above, if the visual resource evaluation rating of a proposed project area is 19 or less, no further evaluation is required by NUREG-1569 (NRC 2003). Based on field reconnaissance conducted in June and August 2008, the total score of the scenic quality inventory for the proposed project is 11. Therefore, no further evaluation of existing

scenic resources and any changes to scenic resources from proposed project facilities are required. However, Uranium One intends to continue to adopt measures to lessen the visual impact of the project.

Uranium One's additional measures are meant to minimize adverse contrasts of project facilities with the existing landscape. All installed above-ground wellheads and structures will be painted with low reflectivity paint in colors that harmonize with the surrounding landscape. In addition, several design techniques will be implemented to minimize the visual contrasts. Those methods include reducing unnecessary disturbance by using the same trench for multiple utilities, reducing the area of temporary disturbance by designating equipment parking areas during construction, and following areas of existing disturbance when considering utility placement. To the extent possible, topographic features will be used to screen wellheads, plant facilities and roads from public view. Roads may be aligned with the contours of the topography, although this measure may result in a greater area of disturbance. Construction debris will be removed from new construction areas as soon as possible and temporarily disturbed areas will be reclaimed as soon as possible following construction.

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

5.10 MITIGATION MEASURES FOR SOCIOECONOMIC IMPACTS

As discussed in Section 7, it is anticipated that the overall effect of the proposed project on the local and regional economy would be beneficial. Purchases of goods and services by the Uranium One and supplier employees would contribute directly to the economy. Local, state, and the federal governments would benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, would also be beneficial. Assuming that the entire projected work force of 44 to 48 workers relocated to the area, this increase would account for 0.1 percent of the population of Converse County, and is smaller than the projected annual growth rate. Therefore, there would be little to no effect to the vacancy rates of any type of housing in Douglas area or Converse County. Families moving into the Converse County school districts would not stress the current school system because it is presently under capacity.

No mitigative measures are identified.

5.11 MITIGATION MEASURES FOR ENVIRONMENTAL JUSTICE

Section 4.11 determined that there would be no disproportionate environmental impacts to minority populations or populations living below the poverty level from the proposed project activities. No mitigative measures are identified.

5.12 MITIGATION MEASURES FOR PUBLIC AND OCCUPATIONAL HEALTH IMPACTS

5.12.1 Non-Radiological Impacts

NUREG-1569 requires that applicants provide estimates of concentrations of nonradioactive constituents in effluents at the points of discharge and provide a comparison with natural ambient concentrations and applicable discharge standards. There are two effluents expected from the proposed project.

- A gaseous and airborne effluent will consist of air ventilated from the plant building ventilation system and vented from process vessels and tanks. This gaseous effluent will contain radon gas as previously discussed in Sections 2.4 and 4.6. The gaseous and airborne effluent will not contain any non-radiological effluents. Nonradioactive airborne effluents at the proposed project will be limited to fugitive dust from access roads and wellfield activities. Fugitive dust emissions will be minimal and dust suppressants will be used if conditions warrant their use. Air quality impacts of construction and operation of the proposed project were discussed in detail in Sections 4.1.1 and 4.2.1, respectively; and
- The liquid effluent will be managed in the deep disposal wells. The deep disposal wells will permanently dispose of liquid wastes and will be permitted under a Class I UIC Permit issued by the WDEQ. No routine liquid environmental discharges, other than waste disposal via deep well injection, are planned and as such, no definable water related pathways for routine operations exist. There are no non-radiological impacts to public health expected due to the liquid effluents from the proposed project.

Uranium One will develop emergency management procedures to implement the non-radiological risk control recommendations contained in NUREG/CR-6733 analyses. Training programs will be developed to ensure that Uranium One personnel are adequately trained to respond to all potential emergencies. These training programs were discussed in detail in Section 5 of the Technical Report for this License Amendment Application.

5.12.2 Radiological Impacts

5.12.2.1 Radiological Impacts from Routine Operations

As discussed in Section 4.12.2, the maximum Total Effective Dose Equivalent (TEDE) estimated by MILDOS-AREA is 1.56 mrem/yr. to a receptor located at the nearest residence located within the project area. This dose is 1.6 percent of the public annual dose limit from licensed operations of 100 mrem.

The dose estimates developed by MILDOS-AREA are based on the Satellite facility system design, which includes pressurized downflow ion exchange columns to reduce the release of radon-222 to a minimum and the use of vacuum dryers, which have no airborne radioactive emissions. The Uranium One design applies state-of-the-art ISR technology to reduce radiological doses to the public and employees to a minimum.

A separate ventilation system will be installed for the ion exchange vessels or other vessels where radon-222 or process fumes would be expected. The system will consist of an air duct or piping system connected to the top of each of the vessel. The venting system from all tanks and sumps consists of four- to six-inch polyvinyl chloride (PVC) piping and function to vent radon gas to the outside atmosphere. The design of the ventilation system will ensure that the system will be capable of limiting employee exposures with the failure of any single fan. Discharge stacks will be located away from building ventilation intakes to prevent introducing exhausted radon into the facility as recommended in Regulatory Guide 8.31 (USNRC, 2002). Airflow through any openings in the vessels will be from the process area into the vessel and into the ventilation system, controlling any releases that occur inside the vessel. Separate ventilation systems may be used as needed for the functional areas within the facility. Tank ventilation systems of this type have been successfully utilized at other ISR facilities and have proven to be an effective method for minimizing employee exposure.

The work area ventilation systems will be designed to force air to circulate within the proposed project Satellite facilities. The ventilation system exhausts will be located on the leeward side of the buildings and will exhaust outside the building, drawing fresh air in from the upwind side of the building. During favorable weather conditions, open doorways and convection vents in the roof will provide satisfactory work area ventilation. The design of the ventilation system will be adequate to ensure that radon daughter concentrations in the facility are maintained below 25 percent of the derived air concentration (DAC) from 10 CFR Part 20 as follows:

- For the proposed Ludeman Satellite facilities, a minimum of two exhaust fans will operate at a minimum rate of 10,000 cubic feet per minute (cfm), at zero inches of water, each. Increased operation of these systems will provide adequate

ventilation during unfavorable weather conditions. The system will have a design rate of three air exchanges per hour with a redundant system as a backup of three air exchanges per hour.

Radon effluent monitoring will be conducted in the Satellite facilities as described in Section 6

Other emissions to the air are limited to exhaust and dust from limited vehicular traffic. Impacts from potential emissions from process chemicals that will be used at the plant are described in Section 4.12.1. There are no significant combustion-related emissions from the Satellite facility, as commercial electrical power is available at the site.

5.12.3 Air Particulate Effluents

The proposed project consists of only ion exchange operations and no yellowcake processing occurs where airborne particles could be present. There is no potential hazard for air particulate effluents at the proposed project site.

No other mitigation measures to control radiological impacts from routine operations have been identified.

5.12.3.1 Radiological Impacts from Accidents

The proposed Ludeman Satellite facilities will be designed in accordance with standard industry building codes and will incorporate containment adequate to contain the contents of the largest tank in the facility at a minimum. The Satellite facilities building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, and/or double-walled tanks will perform a similar function for any process chemical vessels located outside the central facility.

All piping from the plant, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be 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 wellfield will have a number of headerhouses where injection and production wells will be continuously monitored for pressure and flow. Individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the 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 in detection of significant piping failures (e.g., failed fusion weld). Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service.

Uranium One will prepare spill response procedures, provide spill response equipment and materials, require the use of protective equipment, and will train employees in proper spill response methods.

5.13 MITIGATION MEASURES FOR WASTE MANAGEMENT IMPACTS

This section describes mitigation measures for the waste management impacts from the proposed project. The estimated waste streams and management programs were described in Section 4.13.

5.13.1 Gaseous Effluents-Tank and Process Vessel, and Work Area Ventilation Systems

The radiological effluents of concern at ISR operations include the release or potential release of radon gas (radon-222), radionuclides in liquid process streams, and dried yellowcake.

Section 5.12.2.1 discussed the mitigation measures included in the Uranium One design to control gaseous and airborne impacts.

5.13.2 Air Particulate Effluents

Section 5.12.3 discussed the mitigation measures included in the Uranium One design to control gaseous and airborne impacts.

5.13.3 Liquid Waste

5.13.3.1 Aquifer Restoration

Following recovery operations, restoration of the affected aquifer commences which results in the production of wastewater. The current groundwater restoration plan, discussed in detail in Section 6, consists of two activities:

1. Groundwater Sweep; and

2. Groundwater Treatment.

During groundwater sweep, water is extracted from the recovery zone without injection, causing an influx of baseline quality water to sweep the affected recovery area. The extracted water must be sent to the wastewater disposal system during this activity. As described in Section 5.4.2.2.2, groundwater sweep may not be extensively utilized due to the large consumption of groundwater with limited success.

Groundwater treatment activities involve the use of process equipment to lower the ion concentration of the groundwater in the affected recovery area. Detailed discussion of the groundwater treatment phase of aquifer restoration is presented in Section 5.4.2.2.2. A reverse osmosis (RO) unit will be used to reduce the total dissolved solids (TDS) of the groundwater. The RO unit produces clean water (permeate) and brine. The permeate is injected back into the formation and the brine is sent to the deep disposal weel(s). Chemical reducing agents such as sodium or hydrogen sulfide may also be employed during the groundwater treatment phase. These groundwater treatment activities have proven effective in reaching restoration targets at other ISR facilities.

5.13.3.2 Water Collected from Wellfield Releases

Any water released in the wellfield would consist of either injection lixiviant or recovery fluids and would occur only in areas where a liquid release has occurred from a well or pipeline. The water would be collected and be placed into the surge ponds for eventual injection in the deep disposal well(s).

5.13.3.3 Stormwater Runoff

Stormwater management is controlled under National Pollutant Discharge Elimination System (NPDES) permits issued by the WDEQ-WQD. Facility drainage will be designed to route storm runoff water away from or around the plant, ancillary buildings and parking areas, and chemical storage. The design and controls of the proposed project facilities will be implemented such that runoff is not considered to be a potential source of pollution.

5.13.3.4 Domestic Liquid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in aseptic system that meets the requirements of the WYDEQ-WQD. These systems are in common use throughout the United States and the effect of the system on the environment is known to be minimal.

5.13.4 Liquid Waste Disposal

Uranium One expects that the liquid waste stream generated at the proposed project facility will be chemically and radiologically similar to the waste disposed in the current disposal wells in operation at existing ISR sites in the Powder River Basin. Management of the wastewater from the proposed project will be via deep injection wells and Uranium One plans to install six deep disposal Underground Injection Control (UIC) wells at the proposed project area as the primary liquid waste disposal method. The preliminary deep disposal well locations are shown in Figure 2.1-1 of the TR. Each Satellite facility will have two deep disposal wells and two surge ponds. The surge ponds will be used as a backup if one of the deep disposal wells is to become non-operational. The number of disposal wells proposed should provide enough capacity for peak flow conditions however wastewater disposal well requirements are expected to vary, as described below.

Deep Disposal Well Permitting

Because the Wyoming DEQ is in the process of reviewing how it will implement the Class I and Class V UIC regulations related to ISR operations, the permitting path for deep disposal wells is not entirely clear at this time. However, it is clear that an approach similar to that used by other ISR operations in the Powder River Basin is warranted. In this regard, Uranium One anticipates submittal of a Class I or Class V injection wells permit during the second quarter of 2010. The target zones will be the Lance Formation through the Parkman Formation (depths ranging from 4,500 to 10,000 feet).

The Lance Formation has a total thickness in the area of approximately 2,500 feet. The Lance Formation includes approximately 900 feet of net sand with porosity greater than 8 percent and an average permeability of about 12 millidarcies. Individual sandstone lenses within the Lance Formation commonly have porosities around 20 percent. The Teckla-Parkman section in the area of the proposed project has a total thickness of about 2,000 feet. The section has on the order of 340 feet of net sand above 8 percent porosity with a permeability of approximately 3 millidarcies. Individual Sands within the Teckla-Parkman seldom exceed porosity of 12 percent. Based on superior porosity-thickness, the primary target of Class I wells at Ludeman will be the Lance Formation.

The proposed project wastewater disposal requirements are expected to vary from 100 to 300 gpm, the total number of deep injection wells required may also vary from the proposed six wells, depending on whether injection to the Lance formation is approved. If the Lance formation is not approved and all the injection occurs only in the Teckla-Parkman section, additional deep disposal wells may be necessary.

Although water quality in the Lance Formation is not anticipated to exceed TDS levels of 10,000 mg/l, it is likely that this unit will contain elevated concentrations of various

constituents that exceed Wyoming Class I, II or III groundwater standards, such as TDS, chloride, ammonia, trace metals, organic compounds, or oil and grease. The Lance Formation is an established oil and gas producing section in the Powder River Basin. Additionally, the great depth of this unit makes it unlikely to ever be a source of drinking water supply.

Data from wells in the area indicate that the Teckla Parkman water quality either exceeds the TDS level of 10,000 mg/l or contains levels of BTEX compounds that exceed drinking water standards. Oil and gas production occurs throughout the region in the Teckla-Parkman section and in deeper geologic units.

Uranium One believes that permanent deep disposal is preferable to evaporation in evaporation ponds or land application methods for the following reasons: (1) Liquid waste disposed through deep wells is secluded from human contact eliminating risk to human health; (2) large evaporation ponds have the potential for leaks and impacts to the environment and much larger volume of 11e.(2) byproduct is created through use of evaporation ponds; (3) land application methods have the potential to impact surface media from prolonged discharge and would require extensive treatment to meet land application standards. All compatible liquid wastes at the proposed Ludeman satellite facilities will be disposed in the planned deep wells.

Surge Ponds

Two surge ponds are planned for installation at each of the Satellite facilities. As described previously, the surge ponds will be used as a backup if one of the deep disposal wells is to become non-operational during maintenance or periods of shutdown of operational wells. Details of preliminary pond designs are provided in Addendum 4-A in the TR. In summary, the ponds will have two layers of low permeable liner with geotextile fabric and a leak detection system between the two liners. The second pond is redundant to the first in case the first pond becomes unusable due to a leak in the liner or other unforeseen reason. Each pond will be equipped with a leak detection system which consists of a perforated collection pipe system with sumps (see TR Addendum 4-A). The leak detection taps will be monitored every two weeks for the presence of moisture when the ponds are in use. The design of the leak detection system will enable the identification of leak locations if water is detected in the system as the ponds have been divided into six zones, with detection taps in each zone. The leak detection system can also be used to remove water (if a leak is present) from between the primary and secondary liners, and to estimate the size of a leak based on the recovered volume from the leak detection system. The leak detection system will help to maintain low to zero head pressure on the secondary liner. Liquid recorded in the leak detections system does not necessarily constitute a release of pond water to the environment but serves as an active tool to monitor the integrity of the total liner system.

Each surge pond is designed to contain the maximum wastewater flow anticipated for a seven-day period. This volume is based on the maximum wastewater flow that will occur when all wellfields are being restored at each Satellite facility. The maximum volume of waste water also accounts for any wastewater collected from well swabbing and also includes the volume of water contained in the curbing within the facility. The ponds will be located approximately 125 feet from each of the Satellite facilities, the ponds will be approximately 140 feet by 240 feet with a maximum depth of 9.5 feet. Pond designs will be updated as wastewater disposal requirements become more defined for the proposed project.

During operations, wastewater generated at the facility can be directly pumped to the surge ponds. Wastewater in the surge ponds will then be pumped back to the facility and first passed through a bag filter prior to being pumped to the disposal well pump house. At the pump house, the solutions will again be filtered with bag filters prior to injection. The system will also be set up to pump wastewater directly from the plant to the disposal well pump house, bypassing the surge ponds. A fiberglass wastewater tank will be located in the facility to store water prior to transfer directly to the disposal well.

The surge ponds are incorporated to act as the primary method of surge capacity between the facility and the disposal well(s). The surge capacity in the form of a tank will be used when wastewater is transferred directly to the disposal well from the plant, bypassing the surge ponds. During the times a deep disposal well could be down for maintenance, annual testing, or failure, wastewater will be stored in the surge ponds

5.13.4.1 Liquid Waste Monitoring and Reporting

A composite sample of the waste stream will be collected quarterly, or when process change occurs that could significantly alter the chemical composition of the waste stream. Samples will be collected upstream of the high-pressure injection pump on the deep disposal wells. Analyses will be performed using approved methods and in accordance with WDEQ Rules and Regulations. The proposed parameter list follows:

- Ra-226 (pCi/l);
- Uranium (mg/l);
- TDS (mg/l);
- PH (units); and
- Total Alkalinity (mg/l)

Uranium One understands that WDEQ recently has been requesting an EPA 624 Analysis for waste streams at similar facilities. If this standard should be required by the WDEQ, Uranium One will also monitor for these parameters.

Monitoring records of the disposal well injection will be submitted to WDEQ quarterly (within 30 days after the end of the quarter) and will include:

1) Date, location and time of sampling;
2) Name(s) of sampling personnel;
3) Date(s) of analysis;
4) Analytical laboratory and name(s) of analytical technician(s);
5) Analytical procedures or methods used; and
6). Analytical results

Reporting will include injection and annulus pressures. Further, the average reservoir pressure will be determined once per year by conducting a pressure falloff test as required by the WDEQ-WQD permit.

5.13.4.2 Disposal Well Mechanical Integrity

After completion of deep disposal well construction, a Part I Mechanical Integrity Test (MIT) will be demonstrated for each well before injection commences, in accordance with the procedures specified by WDEQ.

Part II integrity will be demonstrated prior to injection by either: (1) a Radioactive Tracer Log and Temperature Survey coupled with a casing pressure check, or (2) an oxygen activation log. Part II MIT will also be demonstrated as necessary and as follows:

1) If any abnormal annulus pressures are observed,
2) Every five years at a minimum, and
3) Any time the tubing and packer are removed from the well.

5.13.5 Potential Pollution Events Involving Liquid Waste

Although there are a number of potential sources of liquid release present at the proposed project, existing regulatory requirements from the NRC and WDEQ and provisions of Uranium One's Safety, Health, and Environment Programs have established a framework that significantly reduces the possibility of an occurrence. Extensive training of all personnel is standard policy for Uranium One operations and will be implemented at the proposed project. Frequent inspections of waste management facilities and systems will be conducted. Detailed procedures will be included in Uranium One's Safety, Health, and Environment Programs.

Potential sources of liquid releases are described in the following subsections.

5.13.5.1 Potential Spills from Wellfield Buildings, Pipelines, and Well Heads

Wellfield buildings or pipelines are not considered to be a potential source of pollutants during normal operations, as there will be no process chemicals or effluents stored within them. The only instance in which these wellfield features could contribute to pollution would be in the event of a release of injection or recovery solutions due to pipe or well failure. The possibility of such an occurrence is considered to be minimal as the piping will be pressure tested to verify integrity before being backfilled underground and placed into operation. In addition, the flows through the pipe will be at a relatively low pressure and can quickly be stopped. Thus, any release would be controlled and would likely not migrate far. Wellfield header houses will also be equipped with wet alarms for early detection of leaks. Piping from the wellfields will generally be buried, minimizing the possibility of an accident. Large leaks in the pipe would quickly become apparent to the

plant operators due to a decrease or increase in flow and pressure and associated alarm systems. Thus, any release could be mitigated rapidly.

In general, piping from the facility, to and within the wellfield, will be constructed of PVC or high density polyethylene pipe (HDPE) with butt-welded joints, or the equivalent. All pipelines will be pressure tested to verify pipe and joint integrity before final operation. It is unlikely that a break would occur in a buried section of line because no additional stress is placed on the pipes. In addition, burying the pipelines underground will protect them from a major cause of potential failure -- vehicles driving over the lines causing breaks. Typically, the only exposed pipes will be at the Satellite facilities, at the wellheads, and in the header houses in the wellfield. Trunkline flows and manifold pressures will be monitored for process control.

Engineering and administrative controls will be in place at the proposed Ludeman Satellite facilities to prevent both surface and subsurface releases to the environment, and to mitigate the effects should an accident occur.

5.13.5.2 Potential Spills from the Proposed Ludeman Satellite facilities

The proposed Ludeman Satellite facilities will serve as a central hub for the recovery operations. Therefore, those facility areas will have the greatest potential for spills or accidents resulting in the release of potential pollutants. Spills could result from a release of process chemicals from bulk storage tanks, piping failure, or a process storage tank failure.

The design of the proposed Ludeman Satellite facility buildings will be such that any release of liquid waste would be contained within the structure. A concrete curb will be built around each process building. These pads will be designed to contain the contents of the largest tank within the building in the event of a rupture. In the event of a piping failure, the pump system will immediately shut down, limiting any release. Liquid inside the buildings, either from a spill or from washdown water, will be drained through a sump and sent to the deep disposal well or surge ponds.

5.13.5.3 Potential Spills from Deep Well Pump Houses and Wellheads

The design of the deep well pump houses and wellheads will be such that any release of liquids will be contained within the building or in a bermed containment area surrounding the building. In this manner, any spills will be contained and will be managed, as appropriate.

The disposal wells will be equipped with a high-level shutoff switch on the injection tubing to prevent operation of the pumps at pressures greater than the Limiting Surface Injection

Pressure. In addition, the wells will be equipped with a low-pressure shut-down switch on the surface injection line that will deactivate the injection pump in the event of a surface leak. Finally, the wells will include a high/low pressure shutdown switch with a pressure sensor on the tubing/casing annulus. This switch will stop the injection pump in the event of either a tubing leak or a casing, packer, or wellhead leak.

5.13.6 Solid Waste

Solid waste generated at the site is expected to include spent resin, resin fines, empty reagent containers, miscellaneous pipe, pumps and fittings, and domestic trash, construction debris, and is separated into the following two categories.

5.13.7 Non-11e.(2) Solid Waste

Waste which is not contaminated with radioactive material or which can be decontaminated and re-classified as uncontaminated waste includes solid waste (containers and construction debris), piping, valves, instrumentation, equipment and any other items that are not contaminated or which may be successfully decontaminated. If decontamination of waste material is possible, surveys for residual surface contamination will be made before releasing the material. Decontaminated materials must have activity levels lower than those specified in NRC guidance (USNRC, 1987). Methods for decontamination and release of contaminated equipment are discussed in further detail in Section 6 in the TR.

The proposed project will produce 2,000 cubic yards (yd^3) of uncontaminated solid waste combined per year. Uncontaminated solid waste will be collected at the plant sites on a regular basis and disposed of in the nearest sanitary landfill.

5.13.8 11e.(2) Byproduct Material

All contaminated items that cannot be decontaminated to meet release criteria are considered 11e.(2) byproduct materials and will be properly packaged, transported, and disposed at a disposal site licensed to accept 11e.(2) byproduct material. Solid wastes generated by this project that may become contaminated with radioactive materials consist of items such as rags, trash, packing material, worn or replaced parts from equipment, piping, filters, protective clothing, and solids removed from process pumps and vessels. Radioactive solid waste that has a contamination level requiring controlled disposal will be isolated in drums or other suitable containers. Uranium One estimates that the proposed project will produce approximately 250 yd^3 of 11e.(2) byproduct material combined per year. These materials will be stored on site inside the restricted

area until such time that a full shipment can be shipped to a licensed waste disposal site or mill tailings facility.

5.13.9 Septic System Solid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in septic system that meets the requirements of the WDEQ-WQD. Disposal of solid materials collected in septic systems must be performed in accordance with WDEQ Solid Waste Management rules and regulations.

5.13.10 Hazardous Waste

The potential exists for any industrial facility to generate hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). In the State of Wyoming, hazardous waste is governed by WDEQ Hazardous Waste Rules and Regulations. Based on preliminary waste determinations conducted by Uranium One in consideration of the processes and materials that will be used on the proposed project, Uranium One will likely be classified as a Conditionally Exempt Small Quantity Generator (CESQG), defined as a generator that generates less than 100 kg of hazardous waste in a calendar month and that complies with all applicable hazardous waste program requirements. Uranium One expects that the proposed project will generate light universal hazardous wastes such as batteries and oil (part/equipment lubrication and general vehicle use).

5.13.11 Soil Contaminated as a Result of Wellfield Releases

All piping from the proposed project plant facilities, to and within the wellfield, will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt-welded joints, or equivalent. All pipelines will be 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 wellfield will have a number of header houses where injection and production wells will be continuously monitored for pressure and flow. Individual wells, along with main trunk lines, may have high- and low-flow alarm limits set in the header houses. All monitored parameters and alarms will be observed in the 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 in detection of significant piping failures (e.g., failed fusion weld).

Occasionally, leaks (typically small) at pipe joints and fittings in the header houses or at the wellheads may occur. Reporting of site releases is discussed below. Until remedied,

these leaks may drip process solutions onto the underlying soil. Although the specific concentration of radio nuclides in these process solutions is relatively low, the concentration of contamination in the soil may exceed regulatory limits if the solution is confined to a small area or if there are multiple spills in the same location. Uranium One will implement a program of wellfield monitoring by roving wellfield operators and will require periodic (at a minimum of daily) inspections of each wellfield that is in service or in restoration. Small leaks in wellfield piping, if present, would typically occur in the injection system as a result of the higher system pressures. These leaks seldom result in soil contamination above cleanup standards because the injection fluid lacks any significant concentrations of pollutants. Following repair of a leak, the affected soil will be surveyed for contamination and the area of the spill documented as required by the NRC. The soils potentially impacted by a spill of injection or production fluid are typically scanned for gamma radiation. The surface extent of any spill will be delineated horizontally by use of a field GPS system. If contamination is detected by gamma surveys, the soil is sampled and analyzed for the appropriate radio nuclides. Contamination may be removed immediately if concentrations exceed regulatory requirements or left in-place and documented for future clean up (if necessary) during the decommissioning phase of site closure.

In the event of a minor spill where the amount of fluid is limited with minimal chance of significant infiltration of the fluid, samples may be obtained at only the first 15 cm of depth. In the case of significant pooling of fluid, soil samples may be necessary at the surface and subsurface 15 cm intervals. The first steps after a release is discovered will be to immediately stop the source of the leak and limit the horizontal migration of released fluid and then initiate the process of recovering any free standing fluids.

All site release information and survey results will be maintained as a component of the decommissioning records as required by 10 CFR §20.2103. Documentation of annual releases from the site will be provided with a map to the NRC.

5.14 TRANSPORTATION VEHICLES

The release of pollutants to the environment could occur due to accidents involving transportation vehicles. This could involve vehicles delivering bulk chemical products, transporting resin to an offsite central processing plant from a Satellite facility, or transporting radioactive contaminated waste from the proposed project area to an approved disposal site.

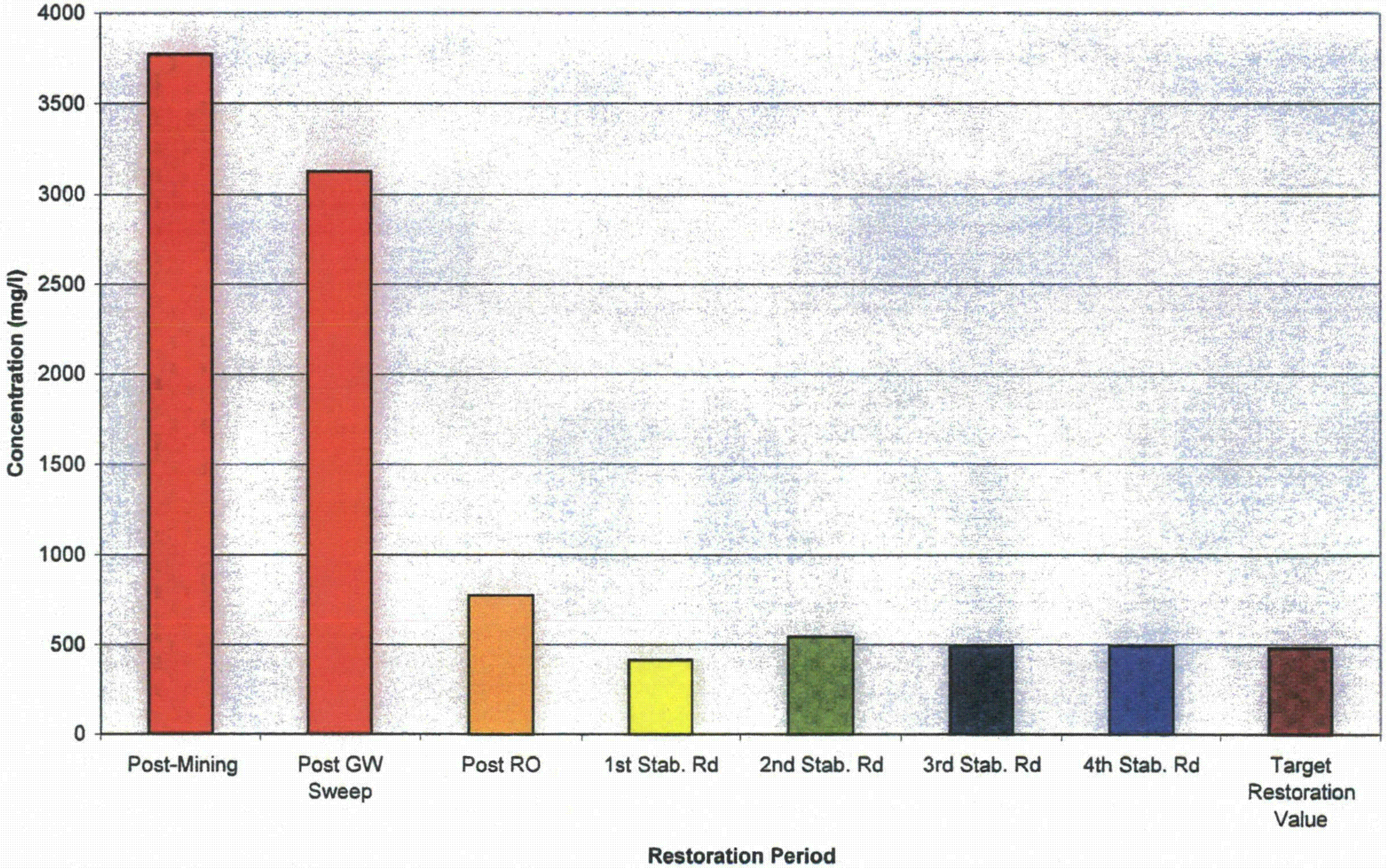
All chemicals and products delivered to or transported from the site will be transported in accordance with DOT regulations. Emergency response procedures will be developed and implemented as part of Uranium One's Safety, Health, and Environment programs to insure a rapid response to the situation. All appropriate personnel will be trained to the

level required in the emergency response procedures to facilitate proper response from Uranium One employees.

ADDENDUM 5-A

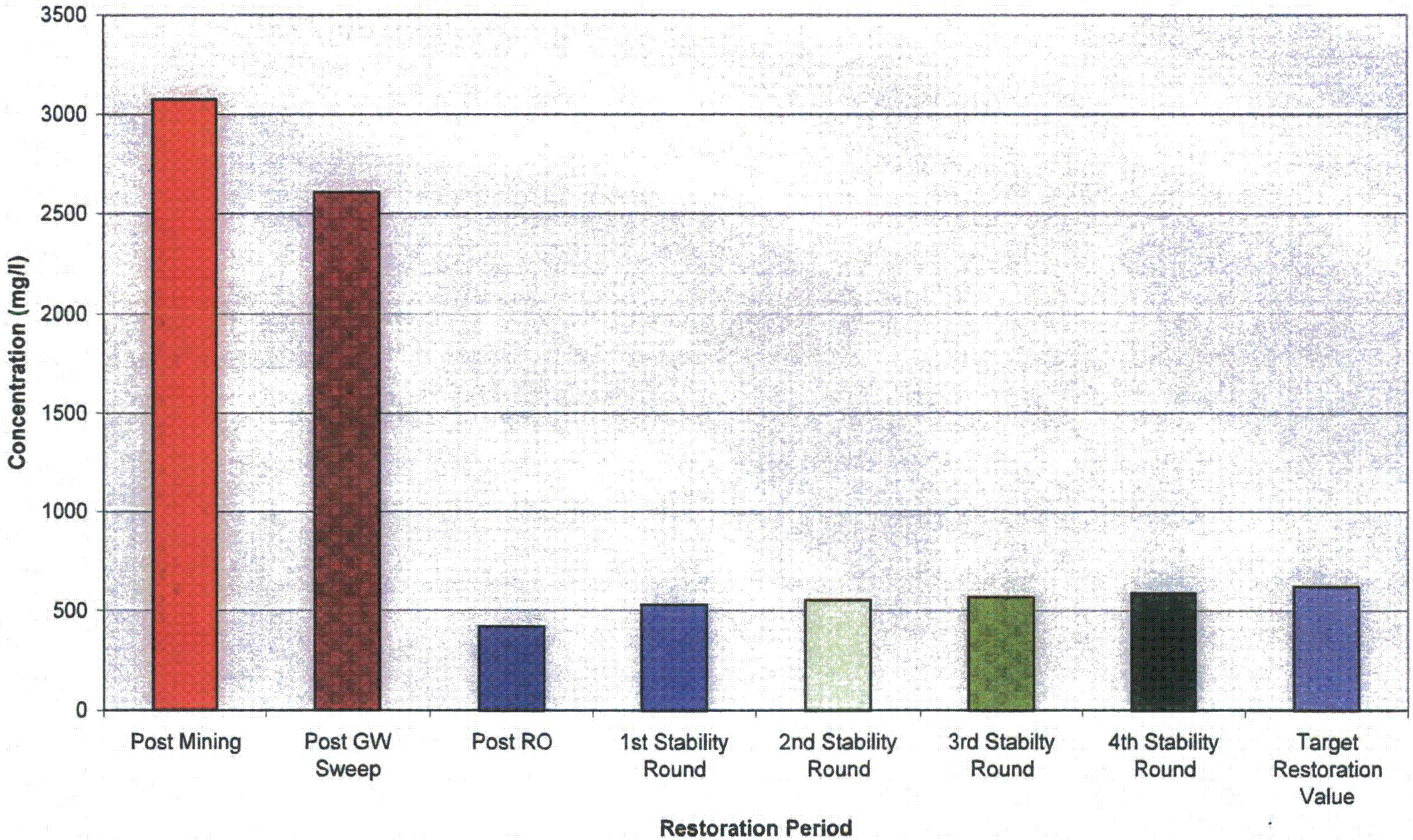
WILLOW CREEK WELLFIELD RESTORATION REPORT FIGURES

Figure 5-7. Mean TDS Concentration-Post Mining Through 4th Stability Round
Mine Unit 3, Christensen Ranch, Wyoming, Cogema Mining, Inc.



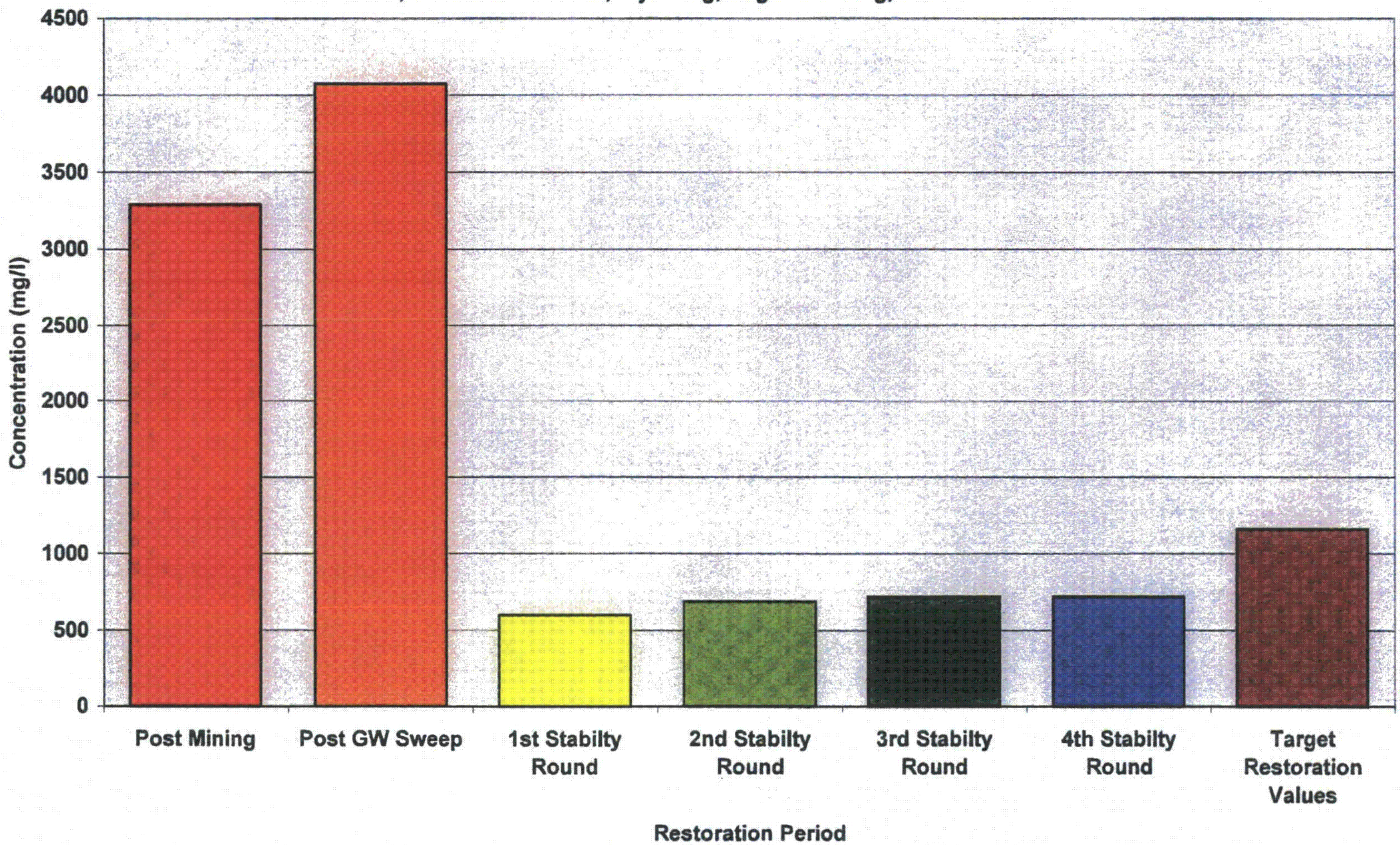
Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.

Figure 5-8. Mean TDS Concentration-Post Mining Through 4th Stability Round
Mine Unit 5, Christensen Ranch, Wyoming, Cogema Mining, Inc.



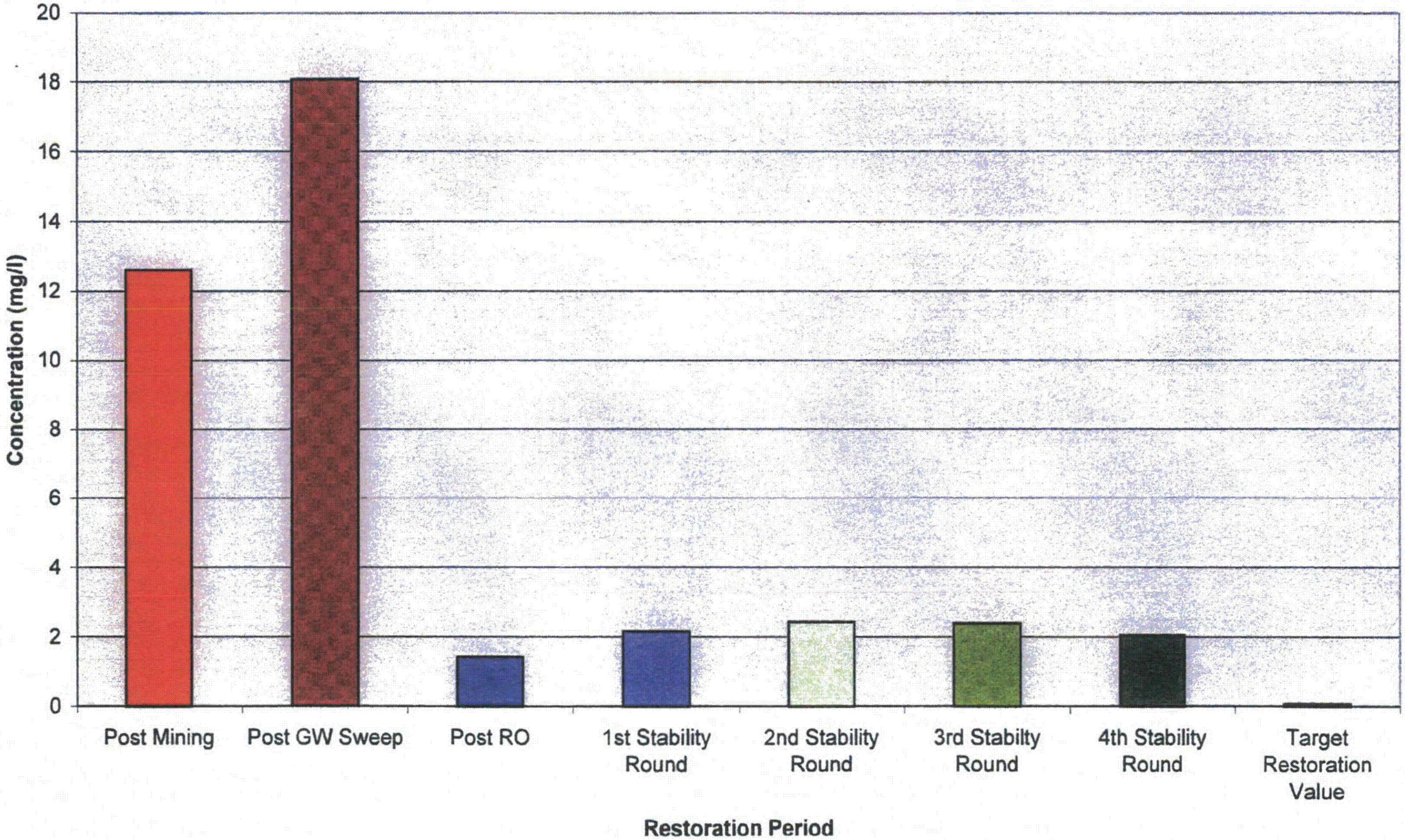
Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.

Figure 5-7 Mean Total Dissolved Solids Concentration-Post Mining Through 4th Stability Round
Mine Unit 6, Christensen Ranch, Wyoming, Cogema Mining, Inc.



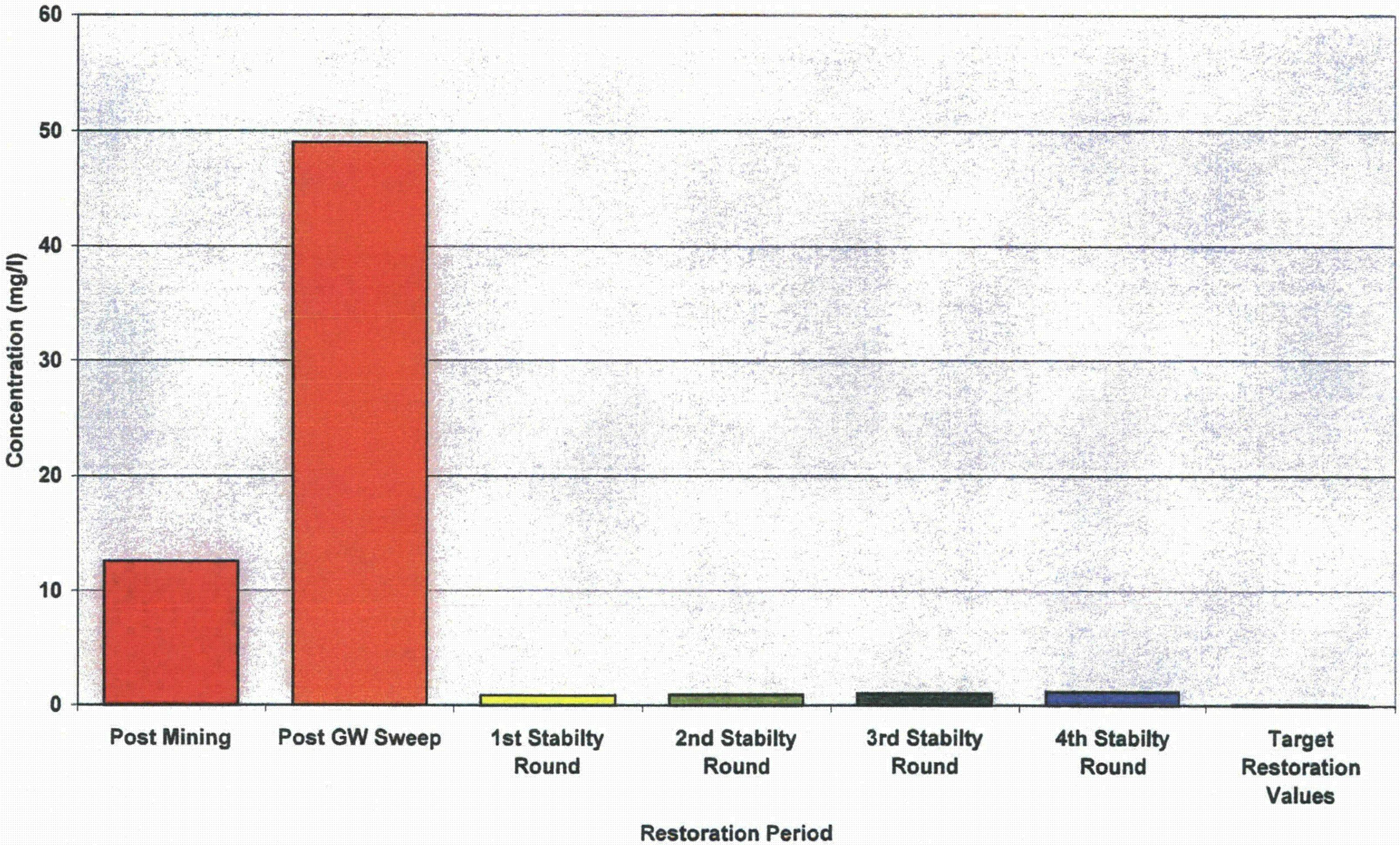
Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.

Figuire 5-12. Mean Uranium Concentration-Post Mining Through 4th Stability Round
Mine Unit 5, Christensen Ranch, Wyoming, Cogema Mining, Inc..



Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.

Figure 5-13 Mean Uranium Concentration-Post Mining Through 4th Stability Round
Mine Unit 6, Christensen Ranch, Wyoming, Cogema Mining, Inc.



Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.