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40-9079

October 17, 2008

Attn: Document Control Desk
Myron Fliegel, Senior Project Manager
Uranium Recovery Licensing Branch
Division of Waste Management
and Environmental Protection,
Office of Federal and State Materials
and Environmental Management Programs,
US Nuclear Regulatory Commission
Two White Flint North, MS T8F5
11545 Rockville Pike
Rockville, MD 20852

RE: ADDITIONAL COPIES OF THE ANTELOPE AND JAB URANIUM PROJECT TECHNICAL REPORT

Dear Mr. Fliegel:

Please find the enclosed additional 3 copies of the Antelope and JAB Uranium Project Technical Report as requested. Also enclosed is electronic copies of the Antelope and JAB Uranium Project Technical Report and Environmental Report.

Section 6 has been revised to reflect the primary goal of restoration as baseline. Three copies of revised Section 6 have also been enclosed for replacement into the 3 copies of the Technical Report submitted previously (these revised pages are currently in the additional copies submitted herein).

FSME08

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If you should have any questions, please contact me by phone at (307) 234-8235 ext. 330 or by email at ken.milmine@uranium1.com.

Sincerely,

Ken Milmine

Ken Milmine
Manager of Environmental and Regulatory Affairs

Enclosures:	Additional 3 copies of the Antelope and JAB Uranium Project Technical Report
	Electronic copies of the Antelope and JAB Uranium Project Technical Report and Environmental Report
	Revised pages 6-1 through 6-4

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6 GROUNDWATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

The objective of groundwater restoration, surface reclamation, and facility decommissioning is to return the affected environment (groundwater and land surface) to conditions such that they are suitable for uses for which they were suitable prior to mining. The methods to achieve this objective for both the affected groundwater and the land surface are described in the following sections.

6.1 PLANS AND SCHEDULES FOR GROUNDWATER QUALITY RESTORATION

6.1.1 Groundwater Restoration Criteria

The purpose of groundwater restoration following mining operations is to protect groundwater adjacent to the mining zone. Approval of an aquifer exemption by the WDEQ and the EPA is required before mining operations can begin. The aquifer exemption removes the mining zone from protection under the Safe Drinking Water Act (SDWA). Approval is based on existing water quality, the ability to commercially produce minerals, and the lack of use as an underground source of drinking water (USDW). Groundwater restoration prevents any mobilized constituents from affecting 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. 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 6.5.1), a secondary restoration standard of class of use will be applied. The secondary standard of class of use will be applied only after restoration using BPT no longer shows significant improvement in groundwater quality and continuing restoration activities would not provide a significant benefit. The pre-mining baseline water quality and class of use will be determined by the baseline water quality sampling program which is performed for each wellfield, as compared to the use categories defined by the WDEQ, Water Quality Division (WQD). Baseline, as defined for this project, shall be the mean of the pre-mining baseline data after outlier removals. Restoration shall be demonstrated in accordance with Chapter 11, Section 5(a)(ii) of the WDEQ, Land Quality Division Rules and Regulations, NUREG-1569 Section 6, and Criterion 5B(5)(b) of Appendix A to 10 CFR Part 40.

The evaluation of the effectiveness of restoration of the groundwater within the production zone shall be based on the average baseline quality over the production zone. 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) are established for the list of baseline water quality parameters. The RTVs for the wellfields will be the average of the pre-mining values. Restoration success will be evaluated by comparing restoration results to the RTVs to determine if pre-mining class of use has been met. Table 6-1 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 6-1 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)

Table 6-1 Baseline Water Quality Parameters

Parameter (units)
Fluoride (mg/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)

Table 6-1 Baseline Water Quality Parameters

Parameter (units)
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

6.1.2 Estimate of Post-Mining Groundwater Quality

Uranium One has estimated the post-mining water quality based on the experience of COGEMA Mining, Inc. in Production Units 1 through 9 at the Irigaray ISR project located in the Powder River Basin[1]. The Irigaray data was selected because of the similar operating chemistry as proposed at the Antelope and JAB Uranium 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 ore 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 Table 6-2. The chemical alteration of the ore zone aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations.

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Table 6-2 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Aluminum (mg/l)	<0.05 – 4.25	<1.037
Ammonia Nitrogen as N (mg/l)*	<0.05 – 1.88	23
Dissolved Arsenic (mg/l)	<0.001 – 0.105	<0.601
Dissolved Barium (mg/l)	<0.01 – 0.12	<1.067
Boron (mg/l)	<0.01 – 0.225	<0.442
Dissolved Cadmium (mg/l)	<0.002 – 0.013	<0.979
Dissolved Chloride (mg/l)*	5.3 – 15.1	277
Dissolved Chromium (mg/l)	<0.002 – 0.063	<1.018
Dissolved Copper (mg/l)	<0.002 – 0.04	<0.828
Fluoride (mg/l)	0.11 – 0.66	<1
Total and Dissolved Iron (mg/l)	0.02 – 11.8	<1.098
Dissolved Mercury (mg/l)	<0.0002 - <0.001	<0.971
Dissolved Magnesium (mg/l)	0.02 – 9.0	45.7
Total Manganese (mg/l)	<0.005 – 0.190	1.249
Dissolved Molybdenum (mg/l)	<0.02 - <0.1	<1.067
Dissolved Nickel (mg/l)	<0.01 - <0.2	<1.018
Nitrate + Nitrite as N (mg/l)	<0.2 – 1.0	<3
Dissolved Lead (mg/l)	<0.002 - <0.050	<1.018

Table 6-2 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Radium-226 (pCi/L)	0 – 247.7	200.5
Dissolved Selenium (mg/l)	<0.001 – 0.416	0.247
Dissolved Sodium (mg/l)	95 - 280	827
Sulfate (mg/l)	136 - 824	639
Uranium (mg/l)	<0.0003 – 18.8	7.411
Vanadium (mg/l)	<0.05 – 0.55	<1.067
Dissolved Zinc (mg/l)	<0.01 – 0.200	<0.065
Dissolved Calcium (mg/l)*	1.6 – 33.5	199.2
Bicarbonate (mg/l)*	5 - 144	1343
Carbonate (mg/l)	0 - 96	<2
Dissolved Potassium (mg/l)	0.4 – 17.5	9
Total Dissolved Solids (TDS) @ 180°F (mg/l)	308 - 1054	2451

* Parameters with RTV other than baseline

Uranium One expects similar baseline and post-mining water quality at the Antelope and JAB site. The success of groundwater restoration at the Irigaray site is discussed in Section 6.1.5.

6.1.3 Groundwater Restoration Method

The commercial groundwater restoration program consists of two stages, the restoration stage and the stability monitoring stage. The restoration stage may consist of any or all of the following three phases:

1) Groundwater transfer;

2) Groundwater sweep;
3) Groundwater treatment, including reductants.

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 in 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 and waste water system capacity. Not all phases of the restoration stage will be used if deemed unnecessary by Uranium One.

A reductant may be added at any time during the restoration stage to lower the oxidation potential of the mining zone. Either a sulfide or sulfite compound may be added to the injection stream in concentrations sufficient to establish reducing conditions within the production zone. Uranium One may also employ bioremediation as a reduction process.

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

6.1.3.1 Groundwater Transfer

During the groundwater transfer phase, water may be transferred between a wellfield commencing restoration and a wellfield commencing mining operations. Also, a groundwater transfer may occur within the same wellfield, if one area is in a more advanced state of restoration than another.

Baseline quality water from the wellfield commencing mining will be pumped and injected into the wellfield in restoration. The higher TDS water from the wellfield in restoration will be recovered and injected into the wellfield commencing mining. The direct transfer of water will act to lower the TDS in the wellfield being restored by displacing affected groundwater with baseline quality water.

The goal of the groundwater transfer phase is to blend the water in the two wellfields until they become similar in conductivity. The water recovered from the restoration wellfield may be passed through ion exchange (IX) columns and/or filtered during this phase if suspended solids are sufficient in concentration to present a problem with blocking the injection well screens.

For the groundwater transfer between wellfields to occur, a newly constructed wellfield must be ready to commence mining. Therefore this phase may be initiated at any time during the restoration process.

The advantage of using the groundwater transfer technique is that it reduces the amount of water that must ultimately be sent to the waste water disposal system during restoration activities.

6.1.3.2 Groundwater Sweep

Groundwater sweep may be used as a stand-alone process where groundwater is pumped from the wellfield without injection causing an influx of baseline quality water from the perimeter of the mining unit, which sweeps the affected portion of the aquifer. The cleaner baseline water has lower ion concentrations that act to strip off the cations that have attached to the clays during mining. The plume of affected water near the perimeter of the wellfield may 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 an approved manner.

The rate of groundwater sweep will be dependent upon the capacity of the waste water disposal system and the ability of the wellfield to sustain the rate of withdrawal. Many

hydrologic systems are not able to sustain the one hundred percent consumptive removal of groundwater for a prolonged basis. Uranium One may choose to reduce the amount of groundwater sweep, or omit the step entirely for groundwater treatment if it is determined that restoration progress would be limited during this step.

6.1.3.3 Groundwater Treatment

Either following or in conjunction with, or instead of the groundwater sweep phase, groundwater will be pumped from the mining zone to treatment equipment at the surface. Ion exchange (IX), reverse osmosis (RO) or Electro Dialysis Reversal (EDR) treatment equipment will be utilized during this phase of restoration.

Groundwater recovered from the restoration wellfield will first be passed through an IX system prior to RO/EDR treatment. Additionally, prior to or following IX treatment, the groundwater may be passed through a de-carbonation unit to remove residual carbon dioxide that remains in the groundwater after mining.

At any time during the process, a reductant (either biological or chemical), which will be used to create reducing conditions in the mining zone, may be metered into the restoration wellfield injection stream. The concentration of reductant injected into the formation is determined by how the mining zone groundwater reacts with the reductant. The goal of reductant addition is to decrease the concentrations of redox sensitive elements. The reductant added to the injection stream during this stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During mining operations, certain trace elements are oxidized. By adding the reductant, the Eh of the aquifer is lowered thereby decreasing the solubility of these elements. Regardless of the reductant used, a comprehensive safety plan regarding reductant use will be implemented.

All or some portion of the restoration recovery water can be sent to the RO unit. The use of an RO unit 1) reduces the total dissolved solids (TDS) in the affected groundwater, 2) reduces the quantity of water that must be removed from the aquifer to meet restoration limits, 3) concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal, and 4) enhances the exchange of ions from the formation due to the large difference in ion concentration. 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 mining 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 waste system. Make-up water, which may come from water produced from a wellfield that is in a more advanced state of restoration, water being exchanged with a new mining unit, water being pumped from a different aquifer, the over-production 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.

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.

The number of pore volumes treated and re-injected during the groundwater treatment phase will depend on the efficiency of the RO in removing TDS and the success of the reductant in lowering the uranium and trace element concentrations. Estimates of the number of pore volumes required for each restoration phase are discussed in Section 6.6.

6.1.4 Restoration Schedule

The proposed Antelope and JAB mine schedule is shown in Figure 6-1 and 6-2 respectively, showing the estimated schedule for restoration. The restoration schedule is preliminary based on Uranium One's current knowledge of the area, and are based on the completion of mining activities for the proposed wellfields. As the Antelope and JAB Project is developed, the restoration schedule will be defined further.

Figure 6-1 Proposed Antelope Project Operations and Restoration Schedule

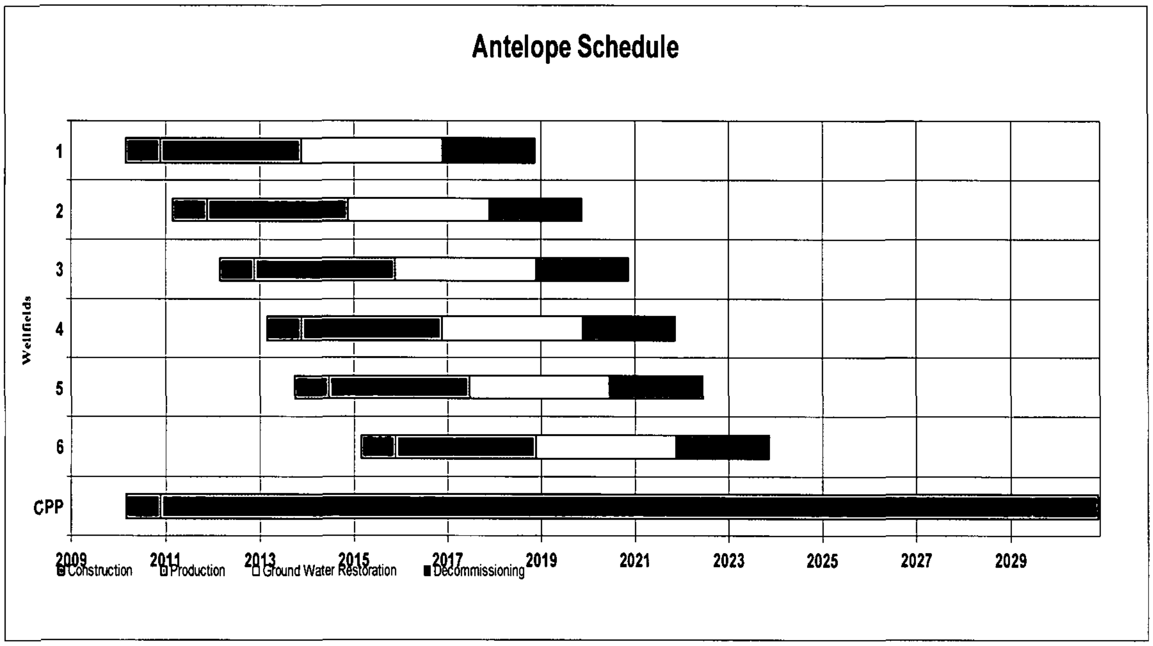
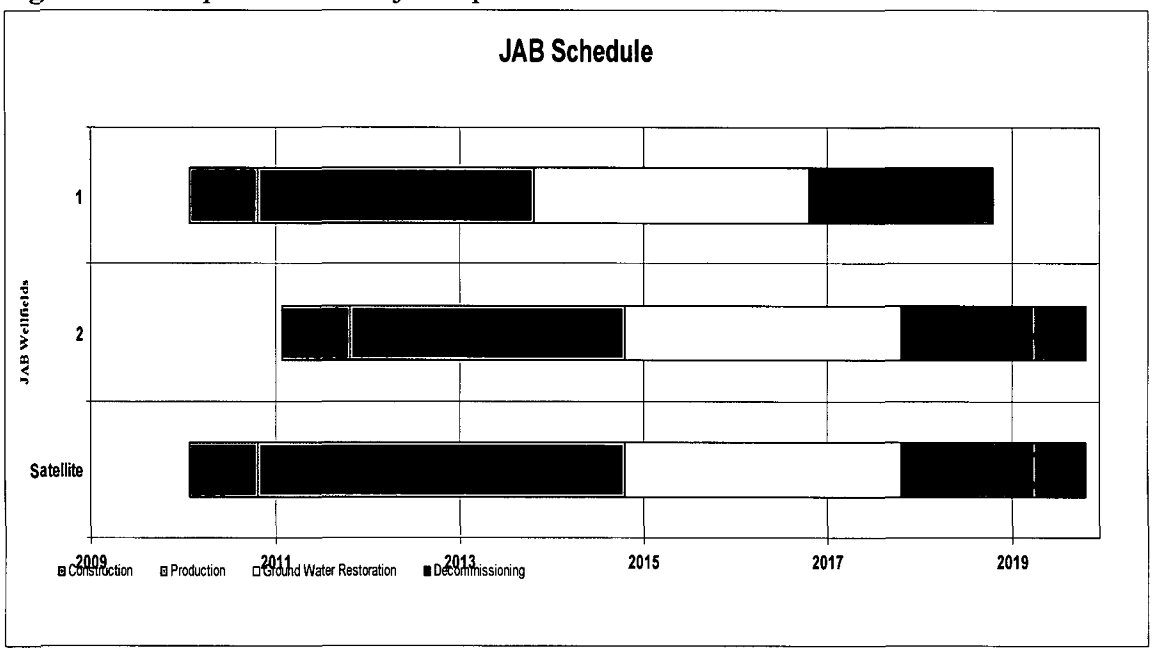


Figure 6-2 Proposed JAB Project Operations and Restoration Schedule



6.1.5 Effectiveness of Groundwater 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 mines in Wyoming, Nebraska, and Texas have successfully restored groundwater and obtained regulatory approval of restoration using these techniques. The following two ISR facilities with restoration history and regulatory approvals are located in the Powder River Basin in central Wyoming.

- 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[2]. Not all of the parameters were returned to baseline conditions, but the groundwater quality was consistent with the pre-mining class of use.

- Irigaray/Christensen Ranch Uranium Project

Groundwater restoration activities at the Irigaray/Christensen Ranch Uranium Project operated by COGEMA Mining, Inc. have been approved by the NRC and the WDEQ for Wellfields 1 through 9 following commercial operations and groundwater restoration. Post-mining water quality in the nine production units was described in Section 6.1.2. The WDEQ determined that twenty-seven of twenty-nine constituents were restored below the restoration target values. Only bicarbonate and manganese did not meet the baseline range. WDEQ determined that these two constituents met the criteria of pre-mining class of use. Based on this, the WDEQ determined that the groundwater, as a whole, had been returned to its pre-mining 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[3]. NRC determined that COGEMA used best practicable technology and agreed that the WDEQ class-of-use standards were met.

6.1.6 Environmental Effects of Groundwater Restoration

Based on the effectiveness of groundwater restoration at other ISR mines in the Powder River Basin, Uranium One expects that the proposed groundwater restoration techniques will successfully return the mining zones at the Antelope and JAB Project to the restoration target values. As discussed in Section 6.1.1, the purpose of restoring the groundwater to these restoration target values is to protect adjacent groundwater that is outside the production zone. If a constituent cannot technically or economically be restored to its restoration target value within the exploited production zone, WDEQ and NRC will require that Uranium One demonstrate that leaving the constituent at a higher concentration will not be a threat to public health and safety or the environment or produce an unacceptable impact to the use of adjacent groundwater resources. Uranium One believes that the application of proven best practicable technology for groundwater restoration and the regulatory requirements that are in place at the State and federal level will ensure that there is no adverse impact on the water quality of groundwater outside the production zone.

The proposed restoration methods consume groundwater. Groundwater recovered during groundwater sweep is generally directly disposed in the waste water system. Approximately 20 percent of the groundwater treatment flow through the RO system is disposed as RO brine. This consumption of groundwater is an unavoidable consequence of groundwater treatment. Impacts and water usage during operations and restoration are discussed in more detail in Section 7.2.5.1.

6.1.7 Groundwater Restoration Monitoring

6.1.7.1 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) are sampled once every 60 days and analyzed for the excursion parameters, chloride, total alkalinity and conductivity. Water levels are also obtained at these wells prior to sampling.

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

6.1.7.2 Restoration Stability Monitoring

A minimum six month groundwater stability monitoring period will be implemented to show that the restoration goal has been adequately maintained. The following restoration stability monitoring program will be performed during the stability period:

- The monitor ring wells will be sampled once every two months 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 6-1.

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

6.1.8 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 and drillholes will be abandoned in accordance with WS-35-11-404 and Chapter VIII, 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.

- When practicable, all pumps and tubing will be removed from the well.
- All wells will be plugged from total depth to within three 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 lbs per barrel of water, to yield an abandonment fluid with a 10 minute gel strength of at least 20 lbs/100 sq ft and a filtrate volume not to exceed 13.5 cc.
- The casing is cut off at least three feet below the ground surface. Abandonment fluid is topped off to the top of the cut-off casing. A steel plate is placed atop the sealing mixture showing the permit number, well identification, and date of plugging.

- A cement plug is placed at the top of the casing (if cement is not within three feet of the surface), and the area is backfilled, smoothed, and leveled to blend with the natural terrain.

As an alternative method of well plugging, a dual plug procedure may be used where a cement plug will be set using slurry of a weight of no less than 12 lbs/gallon into the bottom of the well. The plug will extend from the bottom of the well upwards across the first overlying aquitard. The remaining portion of the well will be plugged using a bentonite/water slurry with a mud weight of no less than 9.5 lbs/gallon. A 10-foot cement top plug will be set to seal the well at the surface.

6.1.9 Restoration Wastewater Disposal

Uranium One plans to install deep disposal wells (EPA UIC Class I or Class V non-hazardous wells) at the Antelope and JAB Project areas as the primary liquid waste disposal method. Uranium One believes that permanent deep disposal is preferable to evaporation in evaporation ponds. Disposal in a Class I or Class V 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 8.

Based on the expected post mining concentrations of groundwater quality constituents discussed in Section 6.1.2 and the proposed groundwater restoration techniques discussed in Section 6.1.3, Uranium One projects that the restoration wastewater injection stream will exhibit the range of characteristics shown in Table 6-3.

Table 6-3 Projected Antelope and JAB Restoration Wastewater Injection Stream Water Quality

Parameter	Units	Min	Max
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

Table 6-3 Projected Antelope and JAB Restoration Wastewater Injection Stream Water Quality

Parameter	Units	Min	Max
Radium-226	pCi/l	500	5000

All compatible liquid wastes generated during groundwater restoration at the Antelope and JAB Project will be disposed in the planned deep wells. A feasibility study for both areas was initiated in the spring of 2007 and potential target sands have been identified. Data collection is continuing to further refine potential receivers and an application is under preparation for submittal to the WDEQ for a Class I (or Class V) UIC Permit for the Antelope and JAB Uranium Project. Uranium One plans to submit this application to the WDEQ in the third quarter of 2008.

6.2 PLANS AND SCHEDULES FOR RECLAIMING DISTURBED LANDS

6.2.1 Introduction

All lands disturbed by the mining project will be returned to their pre-mining land use of livestock grazing and wildlife habitat unless an alternative use is justified and is approved by the state and the BLM. 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 mining. 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 Antelope and JAB Project. The following is a list of general decommissioning activities:

- Plug and abandon all wells as detailed in Section 6.1.8.
- Determination of appropriate cleanup criteria for structures (Section 6.3) and soils (Section 6.4).
- Perform radiological surveys and sampling of all facilities, process related equipment and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.

- Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation as discussed in Section 6.3.

- 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 roads.

- Establish permanent revegetation on all disturbed areas.

Pre-reclamation radiological surveys will be conducted in a manner consistent with the baseline radiological surveys 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 3-foot HPIC equivalent gamma exposure rate readings and/or to estimates of soil Ra-226 concentration. These data sets will be kriged in GIS to develop continuous estimates across the site, making direct spatial comparisons with baseline survey maps possible for any given area at the site. Both qualitative assessments and quantitative statistical comparisons between kriged 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.

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 3-foot HPIC equivalent gamma exposure rates and/or to estimates of soil Ra-226 concentrations, then kriged using GIS for comparative assessments against pre-operational baseline data. 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.

The following sections describe in general terms the planned decommissioning activities and procedures for the Antelope and JAB 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.

6.2.2 New Drill Hole Site Preparation, Hole Abandonment and Site Reclamation

Prior to drilling a hole, topsoil will be removed from the mud pit location and stockpiled on native ground at a sufficient distance to avoid impacts by drilling activities. Subsoil excavated from the mud pit will be stockpiled on native ground separate from the stockpiled topsoil and near the mud pit.

Drill sites located on steep slopes will require excavation of a pad, and access route as well as the mud pit. Topsoil will be stripped from the pad, mud pit and access road and windrowed to the uphill side of the drill hole location. Subsoil excavated from the mud pit will be stockpiled next to the pit and downhill from the topsoil stockpile. The drill rig and water truck will then move onto the site and drill the hole.

After the hole has been drilled to total depth (TD) and prior to geophysical logging, abandonment fluid will be mixed to the specifications described below and circulated through the drill pipe to the bottom of the hole and back to the surface. The drill pipe will then be removed from the hole, the rig removed from location and the hole geophysically probed.

To minimize topsoil and vegetation disturbance, access routes to drill locations will be designated by marking with stakes or similar types of markers with survey ribbons attached. Vehicles will be required to stay within the designated access routes and on existing roads and two-tracks.

All drill holes will be abandoned in accordance with W.S. 35-11-404 and WDEQ-LQD Regulations Chapter VIII using Plug Gel or an equivalent abandonment material. The abandonment material will be mixed with water and circulated through the drill pipe filling the drill hole from bottom to top. The mixed abandonment fluid will have the following characteristics:

1. Ten minute gel strength of at least 20 lbs/100 sq. ft.; and

2. Filtrate volume not to exceed 13.5 cc.

Any open hole between the top of the abandonment mud column and the collar of the hole will be filled with bentonite chips, pellets or similar material. A concrete plug will be placed in the hole a minimum of two feet below the ground surface. The ground surface affected by the drilling will then be reclaimed. If the hole cannot be plugged immediately after probing, it will be securely covered until plugging is possible.

Following abandonment of the drill hole, the mud pit will be allowed to dry out for several days prior to backfilling. Other techniques, such as squeezing the mud from the

pit back into the drill hole or removing excess water from the pit for use at other drill sites, will be utilized to expedite mud pit reclamation. After backfilling the pits with subsoil, the pits will be allowed to settle before applying the topsoil and performing final grading. Steep slope sites and access routes will be reclaimed using a dozer or track hoe to minimize the surface disturbance.

Those drill sites that will become part of a production wellfield within one year of drilling the hole will not be seeded until wellfield construction is complete. Those sites that will not become part of a production wellfield within one year will be seeded after mud pit reclamation is complete. In either case, seeding will take place during the next available seeding window, spring or fall. All seeding will be completed using the approved permanent seed mixture described in Table 6-4 of Section 6.2..

Abandonment of delineation holes will be reported to the WDEQ with each Annual Report. A copy of the abandonment report will be sent to the WSEO pursuant to W.S. 35-11-404(d) and (e).

Drilling contractors will be instructed that chronic leaks of oil from their equipment onto the ground surface will not be allowed. Drip pans, absorbent pads or other means of preventing oil leaks onto the ground will be required. Uranium One will have spill control and containment materials on-site to control and contain any unanticipated spill events. Any spills of oil that may occur will be controlled and contained, and will be cleaned up as soon as practicable. Any contaminated soil resulting from spills of oil will be removed and properly disposed.

6.2.3 Surface Disturbance

The primary surface disturbances associated with ISR mining are the sites containing the central processing and satellite plants, maintenance buildings and office areas. 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 Antelope central processing plant, the JAB satellite plant, office and maintenance buildings, and field header buildings, 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 as soon as weather conditions permit. Vegetation will normally be reestablished over these areas within two years. Surface disturbance associated with development of access roads will occur at the Antelope and JAB sites and topsoil will be stripped from the road areas prior to construction and stockpiled as described in Section 3.

Surface reclamation in the wellfield production units will vary in accordance with the development sequence and the mining/reclamation timetable. Final surface reclamation of each wellfield production unit will be completed after approval of groundwater restoration stability and the completion of well abandonment activities. Surface preparation will be accomplished as needed so as to blend any disturbed areas into the contour of the surrounding landscape.

Wellfield decommissioning will consist of the following steps:

- The first step of the wellfield decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, wellhouses, electrical and control distribution systems, well boxes, and wellhead equipment. Wellhead equipment such as valves, meters or control fixtures will be salvaged to the extent possible.

- Removal of buried wellfield piping.

- The wellfield area may be recontoured, if necessary, and a final background gamma survey conducted over the entire wellfield area to identify any contaminated earthen materials requiring removal to disposal.

- Removal of gravel surface on access roads, recontour and replace topsoil from stockpiles.

- Final revegetation of the wellfield areas and roads will be conducted according to the revegetation plan.

- All piping, equipment, buildings, and wellhead equipment will be surveyed for contamination prior to release in accordance with the NRC guidelines for decommissioning.

It is estimated that a significant portion of the equipment will meet release limits, which will allow disposal at an unrestricted area landfill. Other materials that are contaminated will be decontaminated until they are releasable. If the equipment cannot be decontaminated to meet release limits, it will be disposed of at a licensed byproduct material disposal facility.

Wellfield decommissioning will be an independent ongoing operation throughout the mining 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.

6.2.4 Topsoil Handling and Replacement

In accordance with WDEQ-LQD requirements, topsoil will be 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 will typically be used to accomplish such topsoil salvage operations. The exact location of topsoil salvage operations will be determined by wellfield pattern emplacement and designated wellfield access roads within the wellfields, which will be determined during final wellfield construction activities.

As described in Section 2.6, topsoil thickness varies within the license area from non-existent to several feet in depth. However, typical topsoil stripping depths are expected to range from 3 to 12 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 at the next available window of opportunity in the fall or spring seeding season 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 is separated from subsoil with a backhoe. Drill hole site topsoil management procedures was discussed in section 6.2.2.

6.2.5 Erosion Control Practices

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 Antelope and JAB 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;
- Salvage and stockpiling of topsoil from the central plant and satellite facility areas and from secondary wellfield access roads in a manner to avoid wind and/or water erosion. This is accomplished by grading stockpiles to the appropriate slopes, avoiding excessive compaction, establishing a temporary vegetative cover, using appropriate fencing and signs, and installation of sedimentation catchments;
- Reestablishment of temporary or permanent native vegetation as soon as possible after disturbance; and
- Constructing roads to minimize erosion through practices such as surfacing with a gravel road base, constructing stream crossings at right angles with adequate embankment protection and culvert installation, and providing adequate road drainage with runoff control structures and revegetation.

Implementation of Best Management Practices (BMPs) will minimize the effects to soils associated with the construction and operation of the Antelope and JAB Project.

No drainages or bodies of water will be significantly modified or altered within the Antelope and JAB Project areas during project construction or operations. If significant changes or alterations were to occur, the impact to the second tributary to Simmons Draw wetlands would be minimal as the disturbance is short-term and the draw is ephemeral. 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.

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 relatively flat 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 Permit area. 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.

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

6.2.6 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 mining land use. Since no major changes in the topography will result from the proposed mining operation, a final contour map is not required.

6.2.7 Revegetation Practices

Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. During mining 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 permanent seed mix which will often contain a nurse crop (sterile wheat or oats) to establish a standing vegetative cover along with the permanent seed mix. This long term permanent seed mix typically consists of one or more of the native wheat grasses (i.e. Western Wheatgrass, Thickspike Wheatgrass). Listed below is the proposed permanent seed mix to be used at the Antelope and JAB site.

Table 6-4 Proposed Seed Mix for Use at the Antelope and JAB Project

SPECIES	LBS/ACRE	SEEDS/LB	SEEDS/FT SQ	% SEEDS
Bluebunch Wheatgrass	6.00	191,000.00	17.54	23.14
Slender Wheatgrass	4.00	110,000.00	10.10	13.33
Streambank Wheatgrass	6.00	97,000.00	4.45	5.88
Bottlebrush Squirreltail	4.00	926,000.00	21.26	28.04
Indian Ricegrass	4.00	181,000.00	8.31	10.96
American Vetch	4.00	154,000.00	14.14	18.66
Showy Evening Primrose	0.20		**75.80**	**100.00**
TOTAL POUNDS PLS/ACRE	28.20			

Larger disturbance areas will typically utilize drill seeding methods done with typical farming equipment. All seed will be drilled to the appropriate depths. Smaller disturbance areas may utilize broadcast seeding and raking methods. All seeding will be completed as soon as practical during the next available seasonal seeding window. At the minimum, all sites will be seeded within one month with a cover or nurse crop species if not in the optimal seasonal seeding window. An example of this situation would be if a construction of a site was completed on July 1. In this example, the site would be seeded within 30 days with a cover or nurse crop and then seeded with the permanent seed mix at a more optimal fall seeding date.

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 Area 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.

Reclaimed wellfield and process facility areas will remain fenced until successful reclamation is achieved to protect newly seeded areas from livestock grazing.

6.2.8 Road Removal and Reclamation

Those portions of roads constructed and utilized for access to the facilities and wellfields will be reclaimed unless landowners and lessees request that the roads be left for future access and accept the responsibility for their long term maintenance and ultimate reclamation.

Prior to reclamation, any contamination which resulted from the ISR operation would be cleaned to appropriate NRC standards and the contaminated material disposed at a licensed byproduct disposal facility. Following clean up, the roads will be ripped and/or disked to relieve compaction. Excess imported gravel will be removed. Culverts will be removed and pre-mine drainages reestablished. All roads and ditches to be reclaimed will be graded and recontoured to blend with the surrounding terrain.

Topsoil will salvaged and stockpiled during construction of all newly constructed primary and secondary access roads. Available topsoil will be replaced in a uniform manner prior to revegetation.

6.3 PROCEDURES FOR REMOVING AND DISPOSING OF STRUCTURES AND EQUIPMENT

6.3.1 Preliminary Radiological Surveys and Contamination Control

Prior to central process and satellite 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 mining operations (as discussed in Section 5.7) 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.

6.3.2 Removal of Process Buildings and Equipment

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

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

- Removal to a new location for future use;
- Removal to another licensed facility for either use or 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 byproduct material disposal facility if contaminated.

6.3.2.1 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
- 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. Non-salvageable contaminated equipment, materials, and dismantled structural sections will be sent to an licensed byproduct material disposal facility. In most cases, the byproduct material will be shipped as Low Specific Activity (LSA-I) material, UN2912, pursuant to 49 CFR 173.427. 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 or that are too large to be scanned will be considered contaminated in excess of the limits and will be disposed at a properly licensed facility.

6.3.2.2 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 excessive interior contamination as necessary for safe handling by workers during dismantling.

- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be excessively contaminated, the equipment may be washed down as necessary and decontaminated to permit safe handling by workers during dismantling.

- The equipment will be disassembled only to the degree necessary for transportation or as required by the licensed disposal facility. 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 receiving facility.

- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.

6.3.3 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, Denison Mines, and Waste Control Specialists (Texas). An agreement for disposal of 11e.(2) byproduct material will be in place before operation of the Antelope and JAB 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).

6.4 METHODOLOGIES FOR CONDUCTING POST-RECLAMATION AND DECOMMISSIONING RADIOLOGICAL SURVEYS

6.4.1 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 6.4-2.

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 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 Antelope and JAB 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 was published as Appendix E to NUREG-1569[4]. This guidance discusses acceptable models and input parameters. This guidance, guidance from the RESRAD Users Manual[5], the Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil[6] and site-specific parameters were used in the modeling as discussed in the following sections.

6.4.1.1 Determination of Radium Benchmark Dose

RESRAD Version 6.3 computer code was used to model the Antelope-JAB Project site and calculate the annual dose from the current radium cleanup standard.

The following supporting documentation for determination of the radium benchmark dose is attached:

- The RESRAD Data Input Basis (Appendix C-1) provides a summary of the modeling values used as input parameters. A sensitivity analysis was performed for parameters that are important to the major component dose pathways and for which no site-specific data were available.

- Selected graphs produced with RESRAD that present the results of the sensitivity analysis performed on the input parameters are attached (Appendix C-2).
- A full printout of the final model results for the resident farmer scenario with the chosen input values is attached (Appendix C-3 and C-4).
- Graphs in Appendix C-5 provide the modeling results for the estimated doses during the 1,000 year time span for both radium-226 (Ra-226) and natural uranium (U-nat). A series of graphs depicts the summed dose for all pathways and the component pathways that contribute to the total dose.

The maximum dose from Ra-226 contaminated soil for the residential farmer scenario was 41.1 millirem per year (mrem/yr). This dose was based upon the 5 picocuries per gram (pCi/g) above background surface (0 to 6-inch) Ra-226 standard and occurred at time, t = 0 years. The most significant dose pathways (representing 90 percent of the maximum dose) were external exposure and plant ingestion (water independent). A sensitivity analysis was performed for important parameters used in these two pathways for which no site-specific information was available. The 41.1 mrem/yr dose from Ra-226 is the "Benchmark dose" at which the U-nat radiological end point soil standard will be based. Methods used to determine the U-nat soil concentration that would result in the radium "Benchmark dose" are describe in Section 3.0.

6.4.1.2 Determination of Natural Uranium Soil Standard

RESRAD was used to determine the concentration of U-nat in soil distinguishable from background that would result in a maximum dose of 41.1 mrem/yr. The method involved modeling the dose from a set concentration of U-nat in soil. This dose was then compared to the radium benchmark dose and scaled to arrive at the maximum allowable U-nat concentration in soil.

To facilitate calculations, a preset concentration of 100 pCi/g U-nat was used for modeling dose. The fractions used were 48.9 percent (or pCi/g) uranium-234, 48.9 percent (or pCi/g) uranium-238, and 2.2 percent (or pCi/g) uranium-235. The distribution coefficients used for each radionuclide were RESRAD default values. A sensitivity analysis was performed using a range of distribution coefficients to evaluate the potential effects of not using site-specific data. All other input parameters were the same as those used in the Ra-226 benchmark modeling. RESRAD output showing the input parameters is provided in Appendix C-3.

A U-nat concentration in soil of 100 pCi/g, resulted in a maximum dose of 8.1 mrem/yr. at time, t = 0 years. The printout of the RESRAD data summary is provided in Appendix C-4.

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

$$\text{Uranium Limit} = \left(\frac{100 \text{ pCi/g natural uranium}}{8.1 \text{ mrem/yr. natural uranium dose}} \right) \text{x } 41.1 \text{ mrem/yr radium benchmark dose}$$

$$\text{Uranium Limit} = 507 \text{ pCi/g natural uranium}$$

The U-nat limit is applied to soil cleanup with the Ra-226 limit using the unity rule. The unity rule approach will be used to determine if site soil cleanup standard are met. To determine whether an area exceeds the cleanup standards, the standards are applied according to the following formula:

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

6.4.1.3 Uranium Chemical Toxicity Assessment

The chemical toxicity effects from uranium exposure were 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 75 percent of the meat and milk, and 25 percent of fruits and vegetables are grown at the site. Intake of contaminated food through the aquatic pathway was considered improbable. Also, the model showed that the contamination would not affect groundwater quality. The model endpoint is dose based on U-nat activity concentrations in various compartments. This activity concentration can easily be converted to mass concentrations to evaluate the chemical toxicity of U-nat. Therefore the same model was used in assessing the chemical toxicity. In addition, the intake from eating meat and drinking milk was shown to be negligible compared to the plant pathway and, therefore, is not shown here.

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. The soil-plant conversion factor is based on a dry weight, so the annual consumption is multiplied by the dry-weight to wet-weight ratio to convert it to a dry-weight basis. Parameters for these calculations are given in Section 6.5.9 of NUREG/CR-5512 Vol. 1.

Table 6-5 provides the parameters used in these calculations and annual human intakes for leafy vegetables, other vegetables, and fruit. Annual intakes of 14 and 97 kilograms per year (kg/year) were assumed for leafy vegetables and other vegetables and fruit, respectively. It was assumed that the concentration of U-nat in the garden or orchard soil was 507 pCi/g. This corresponds to the uranium Benchmark Concentration for surface soils determined for the Antelope-JAB project site. Multiplying the specific activity of U-nat, 677 pCi per milligram, by 507 pCi/g results in a soil concentration of 748

milligrams per kilogram (mg/kg). The intake shown in the first column of Table 6-5 is equal to the product of the parameters given in the subsequent columns. Table 6-5 shows that the total uranium intake from all food sources from the site is 49.3 mg/yr.

Table 6-5 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
8.9	748	1.7E-2	3.5	0.2	Leafy Vegetables
34	748	1.4E-2	13	0.25	Other Vegetables
6.4	748	4.0E-3	12	0.18	Fruit
49.3	**Total**				

A two-compartment model of uranium toxicity in the kidney from oral ingestion was used to predict the burden of uranium in the kidney following chronic uranium ingestion (ICRP, 1995). This model tracks the distribution 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 (macrophages), and other soft tissues.

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:

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

Where:

Q_P = uranium burden in the plasma, μg
IR = dietary consumption rate, mg uranium/d
f_1 = fractional transfer of uranium from GI tract to blood, unitless
f_{ps} = fractional transfer of uranium from plasma to skeleton, unitless
f_{pr} = fractional transfer of uranium from plasma to red blood cells, unitless
f_{pl} = fractional transfer of uranium from plasma to liver, unitless
f_{pt} = fractional transfer of uranium from plasma to soft tissue, unitless
f_{pk1} = fractional transfer of uranium from plasma to kidney, compartment 1, unitless;
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:

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

The parameter input values for the two-compartment kidney model include the daily intake of uranium estimated for residents at this site, and values recommended by the ICRP as listed below (ICRP, 1995).

IR = 0.14 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
λ_{k2} = ln(2)/7 days

From the last equation above, the calculated uranium in the kidneys is 0.0093 mg, or a uranium concentration of 0.03 μg/g. This is three percent of the 1.0 μg U/g value that has generally been understood as the threshold of the toxic effects of uranium to the kidney.

The US 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 a water intake of 2 liters/day, this corresponds to an intake of 0.04 to 0.2 mg/day. Using data obtained from toxicity experiments with animals 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. 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 in Table 6-5 indicates that a soil limit of 507 pCi/g of U-nat would result in an intake of approximately 0.14 mg/day (49.3 mg/yr divided by 365 days). Using the most conservative daily limit corresponding to the National Primary Drinking Water standard, a soil concentration of 217 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 217 pCi/g of natural uranium should not result in chemical toxicity effects.

6.5 DECOMMISSIONING HEALTH PHYSICS AND RADIATION SAFETY

The health physics and radiation safety program for decommissioning will ensure that occupational radiation exposure levels will be kept as low as reasonably achievable during decommissioning. The Radiation Safety Officer, Radiation Safety Technician or designee will be on site during any decommissioning activities where a potential radiation exposure hazard exists. In general, the radiation safety program discussed in Section 5 will be used as the basis for development of the decommissioning health physics program. Health physics surveys conducted during decommissioning will be guided by applicable sections of Regulatory Guide 8.30[7] or other applicable standards at the time.

6.5.1 Records and Reporting Procedures

At the conclusion of site decommissioning and surface reclamation, a report containing all applicable documentation will be submitted to the NRC. Records of all contaminated materials transported to a licensed disposal site will be maintained for a period of five years or as otherwise required by applicable regulations at the time of decommissioning.

6.6 FINANCIAL ASSURANCE

Uranium One will maintain surety instruments to cover the costs of reclamation including the costs of groundwater restoration, the decommissioning, dismantling and disposal of all buildings and other facilities, and the reclamation and revegetation of affected areas. Additionally, in accordance with NRC and WDEQ requirements, an updated Annual Surety Estimate Revision will be submitted to the NRC and WDEQ each year to adjust the surety instrument amount to reflect existing operations and those planned for construction or operation in the following year. After review and approval of the Annual Surety Estimate Revision by the NRC and WDEQ, Uranium One will revise the surety instrument to reflect the revised amount.

Groundwater restoration costs are based on treatment of 1 pore volume for groundwater sweep and 7 pore volumes for reverse osmosis and reductant/bioremediation. Wellfield pore volumes are determined using the following equation:

Wellfield Pore Volume = (Affected Ore Zone Area) x (Average Completed Thickness) x (Flare Factor) x (Porosity)

Flare factor has been determined for PRI's Smith Ranch wellfields to be approximately 1.5 to 1.7. This flare factor was estimated using a three dimensional groundwater flow model (MODFLOW) in conjunction with an advective particle tracking technique (MODPATH). Horizontal and vertical flare factors of 1.5 and 1.3, respectively, have been approved by the US Nuclear Regulatory Commission for the Hydro Resources, Inc. Churchrock licensing action in New Mexico. COGEMA Mining, Inc., at the Irigaray/Christensen Ranch sites, uses an overall flare factor of 1.44. Accordingly, Uranium One is using a flare factor of 1.5 for the surety estimate attached in Appendix D.

6.7 REFERENCES

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[4] U.S. Nuclear Regulatory Commission, NUREG-1569, *Standard Review Plan for In situ Leach Uranium Extraction License Applications."* 2003.

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[6] Argonne National Laboratory, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil*, 1993.

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