STRATA ENERGY INC
A WHOLLY-OWNED SUBSIDIARY OF PENINSULA ENERGY LIMITED

March 30, 2018

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Deputy Director, Division of Decommissioning, Uranium Recovery and Waste Programs
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Mail Stop T-8F5, 11545 Rockville Pike
Rockville, MD 20852-2738

RE: Strata Energy Inc. Ross ISR Project
Source Materials License SUA-1601, Docket No. 40-9091
2017 Annual Report

To Whom it May Concern,

As required by License Condition 11.1 and 11.2, Strata Energy, Inc. (Strata) hereby submits the Annual report for 2017.

If you have any questions regarding the provided information, please contact me at (307) 467-9375 or by email at rpond@stratawyo.com.

Sincerely,
STRATA ENERGY INC.

Royal Pond
Manager HSE/RSO

cc: Ben Schiffer, WWC Engineering

NMSS01

Strata Energy, Inc.
Ross ISR Project

Source Materials License Number SUA-1601

Docket Number 040-09091

2017 Annual Report

January 1 – December 31, 2017

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APPENDICES

1 ANNUAL REVIEW OF SERPS

Per License Condition 9.4(E), a summary of the changes deemed appropriate by Strata's Safety and Environmental Review Panel (SERP) are provided below. Per License Condition 9.4(E), page changes to the License Application resulting from the approved SERPs are included in Appendix A of this report.

SERP 17-1 Approval of Radiation Safety Officer – Royal Pond and Changes to the Strata Organization Chart

The SERP met on January 30, 2017 to evaluate the proposed approval of Royal Pond as Radiation Safety Officer at the Ross Project and proposed changes to the Strata organizational chart. The committee reviewed the requirements outlined in TR Section 5.4.1 and NRC Regulatory Guide 8.31. The committee determined that Royal Pond meets and exceeds the requirements to fulfill the position of RSO and the committee approved him as an RSO at the Ross Project. The SERP committee also reviewed the proposed change to add the Manager HSE position to the organizational structure. The committee determined that the organizational structure would not significantly change how the HSE programs function and the change should enhance the performance. Therefore, the SERP Committee approved the change to the organizational structure. In accordance with the SERP Committee meeting it was determined that a license amendment from the NRC was not required to approve Mr. Pond as RSO or change the organizational structure.

SERP 17-2 Review and Approval of Header House 7 (MU2)

A SERP was convened on February 14, 2017 to ensure that Mine Unit 2 header house 7 construction and proposed operation are consistent with technical requirements and do not conflict with any requirements stated in the Source Material License. The SERP reviewed Strata's Header House Start Up Checklist form. It was determined that all items have been completed with the exception of testing the pressure and flow alarms. The header house startup checklist form was attached to the SERP evaluation. The SERP approved the proposed activities pending verification that the pressure alarms have been tested prior to operation in header house 7.

SERP 17-3 Change of Pond Monitor Well Action Levels

A SERP was convened on March 31, 20176 to evaluate a proposed change in the Pond 1 monitor well action levels. The proposed change was a result of an exceedance of the chloride action level by more than 20 percent in one monitor well (P1-C3) on February 28, 2017. Strata investigated the potential for a pond liner leak and increased the sampling frequency to at least once every 7 days in all pond compliance monitor wells. Strata also determined that the action levels should be reviewed against groundwater quality data collected since September 2016. The SERP reviewed the calculation of the new action levels prepared by WWC Engineering. The data used for the calculations began with post transition data beginning in May 2016 and ran through April 2017. The SERP approved the new action levels. The SERP determined that the Environmental Management Program would need to be revised to update the pond monitor well action levels and the Strata lab would need to be notified of the new action levels. In addition, the SERP determined that the NRC should be notified to conclude the reported exceedance of the action levels. The SERP also determined that the sampling frequency of the pond monitor wells could return to normal operation frequency (i.e., monthly for the first year of operation, then quarterly).

SERP 17-4 Change to Operational Airborne Particulate Radiation Monitoring Program

The SERP met on May 3, 2017 to evaluate the proposed changes to the Operational Monitoring Program. The committee evaluated discontinuing one of the six monitoring station (i.e., South). The SERP documented the reasons for the change, including supporting information which was attached to the SERP. The committee determined that it was reasonable to discontinue operational monitoring at the South monitoring station. In accordance with the SERP Committee meeting it was determined that a license amendment from the NRC was not required to make these minor changes.

SERP 17-5 Review and Approval of Header House 8

A SERP was convened on May 18, 2017 to ensure that Mine Unit 2 header house 8 construction and proposed operation are consistent with technical requirements and do not conflict with any requirements stated in the Source Material License. The SERP reviewed Strata's Header House Start Up Checklist form. It was determined that all items have been completed with the exception of testing the pressure and flow alarms. The header house startup checklist form was attached to the SERP evaluation. The SERP approved the proposed activities pending verification that the pressure alarms have been tested prior to operation in header house 8.

SERP 17-6 Review and Approval of Technical Report As-Built Update

A SERP was convened on May 30, 2017 to review proposed changes to the NRC License Application Technical Report (TR). Strata completed a thorough review of the TR and determined that as-built conditions required revisions to a number of sections to ensure an updated application was maintained. In order to facilitate the review by the SERP, Strata prepared a red-lined version of each section in Word format and a final Adobe PDF version. A copy of the redline and final versions are attached to the SERP.

SERP 17-7 Review and Approval of Mine Unit 2 Shallow Aquifer Upper Control Limits

The SERP met on July 31, 2017 to evaluate proposed upper control limits (UCLs) for the Mine Unit 2 (MU2) SA well (MU2-SA1). The data from the SA well from the third and fourth quarters of 2016 and the first and second quarters of 2017 were used to determine the UCLs in accordance with the methods in the approved license. The MU2 Wellfield Data Package was revised to include the SA well UCLs and submitted to WDEQ and NRC. In accordance with the SERP Committee meeting it was determined that a license amendment from the NRC was not required to make these minor changes.

SERP 17-8 Review and Approval of Revised MU2 PM Well Upper Control Limits

The SERP met on July 24, 2017 to approve changes to the TR to implement Amendment 7 to SUA-1601 and to review proposed changes to upper control limits (UCLs) established for certain perimeter monitor (PM) wells in Mine Unit 2 (MU2). Amendment 7 allows for PM well spacing between 300 and 500 feet. To ensure excursion detection in wells spaced greater than 420 feet and less than 500 feet from the production unit boundary, Strata developed a procedure to calculate UCLs. Attachment 1 of the SERP describes the procedure used to recalculate the UCLs for five (5) PM wells in MU2 that are located greater than 420 feet but less than 500 feet from the production unit boundary. The SERP determined that the proposed changes to the UCLs for the five PM wells in MU2 conformed to the calculation methods proposed by Strata and subsequently approved by NRC in Amendment 7 of SUA-1601. The SERP approved the changes to the UCLs and directed the VP of Operations to have the Strata lab update the revised UCLs. The SERP also determined that the proposed changes to the approved application are necessary to implement the commitments in Amendment 7.

SERP 17-9 Review and Approval of Header House 9 (MU2)

A SERP was convened on August 15, 2017 to ensure that Mine Unit 2 header house 9 construction and proposed operation are consistent with technical requirements and do not conflict with any requirements stated in the Source Material License. The SERP reviewed Strata's Header House Start Up Checklist form. It was determined that all items have been completed with the exception of testing the pressure and flow alarms. The header house startup checklist form was attached to the SERP evaluation. The SERP approved the proposed activities pending verification that the pressure alarms have been tested prior to operation in header house 9.

SERP 17-10 Review and Approval of Installation of Disposal Well 2 Injection Pump

A SERP met on August 25, 2017 to evaluate proposed changes to the Disposal Well 2 (DW2) surface facilities to increase the injection pressure. The proposed changes included a high pressure injection pump and a sump and curb with level alarms and controls. The SERP determined that the proposed changes would improve the existing facilities and that the improvements exceed the requirements of the approved application, of the WDEQ-WQD Class I permit, and the program contained in Chapter VIII of the WQD rules. In accordance with the SERP Committee meeting it was determined that a license amendment from the NRC was not required to make these minor changes.

SERP 17-11 Modification for Venting of Process Lines

A SERP was convened on November 16, 2017 to evaluate a proposed modification to the ventilation system piping. The proposed modification would pipe a connection line from an air vent on the 20-inch injection and recovery lines to the ventilation piping which leads to the Transfer Water and Decant tanks, which would allow for venting air from the process lines during operation. The SERP identified a potential concern with water flowing back into the process line, and determined that manual check valves would be installed to prevent water, which would be emitted from the IX columns during the backwash process, from back flowing into the injection and recovery lines. The SERP identified the need for a revision to the Backwash Standard Operating Procedure (SOP-O-16), which would be initiated by the Production Superintendent. The TR of the approved License Application required no wording changes by the SERP and any required changes to figures in the TR from the SERP would be captured by a future update. In accordance with the SERP Committee meeting it was determined that a license amendment from the NRC was not required to approve the modifications.

2 LICENSE CONDITION 11.1(F) – MODIFICATIONS TO INVENTORY OF WATER SUPPLY WELLS AND LAND USE SURVEY

2.1 INVENTORY OF NEARBY WATER SUPPLY WELLS

An inventory of water supply wells within 2 km of any production area was accomplished by reviewing the permit records at the State Engineers Office. There were no new water supply wells permitted during the reporting period.

2.2 LAND USE SURVEY

A land-use survey within 2 km of any production area was completed. There was no change in land use during the reporting period.

3 LICENSE CONDITION 11.2 - ANNUAL REVIEW OF RADIATION PROTECTION PROGRAM

As required by License Condition 11.2 of SUA-1601, the 2017 Annual ALARA Audit was performed at the Ross ISR Project during the period January 30 and 31, 2018. This audit report contains the analysis of dose to individual members of the public. The ALARA audit report is included as Appendix B.

Appendix A

Page Changes to License Application Resulting from Approved SERPs

SERP 17-1

5.1.6 *Manager Health, Safety and Environment (HSE)*

The Manager Health, Safety and Environment (Manager-HSE) is responsible for all radiation protection, health and safety, and environmental programs. This position is located at the Ross ISR Project and the responsibilities may be combined with the position of RSO depending on the extent of uranium mining and yellowcake processing operations occurring at the facility. The Manager-HSE directly reports to the VP-PREC. The position fulfils the responsibilities the Radiation Safety Officer (RSO) or directly supervises the RSO. The position also directly supervises the Radiation Safety Technician (RST) and the Safety/Environmental Coordinator to ensure that the radiation safety, industrial safety and environmental monitoring and protection programs are conducted in a manner consistent with regulatory requirements and company objectives.

5.1.7 Radiation Safety Officer

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs. The responsibilities of the RSO may be combined with the position of Manager-EHS depending on the extent of uranium mining and yellowcake processing operations occurring at the facility. The RSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The RSO is responsible for the implementation of all on-site environmental programs, including emergency procedures, training programs for both the staff and the Radiation Safety Technician, and sampling and inspection procedures. The RSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The RSO works closely with all supervisory personnel to review and approve new equipment and changes in processes and procedures that may affect radiological safety and to ensure that established programs are maintained. The RSO is also responsible for the collection and interpretation of employee exposure related monitoring, including data from radiological safety. The RSO makes recommendations to improve any and all radiological safety related controls as well as provide quality assurance/quality control for all health and environmental radiological monitoring programs. The RSO cannot be overruled by other members of the management team on any decision regarding radiation safety. The RSO has no production related responsibilities and reports directly to the Manager-EHS.

1.

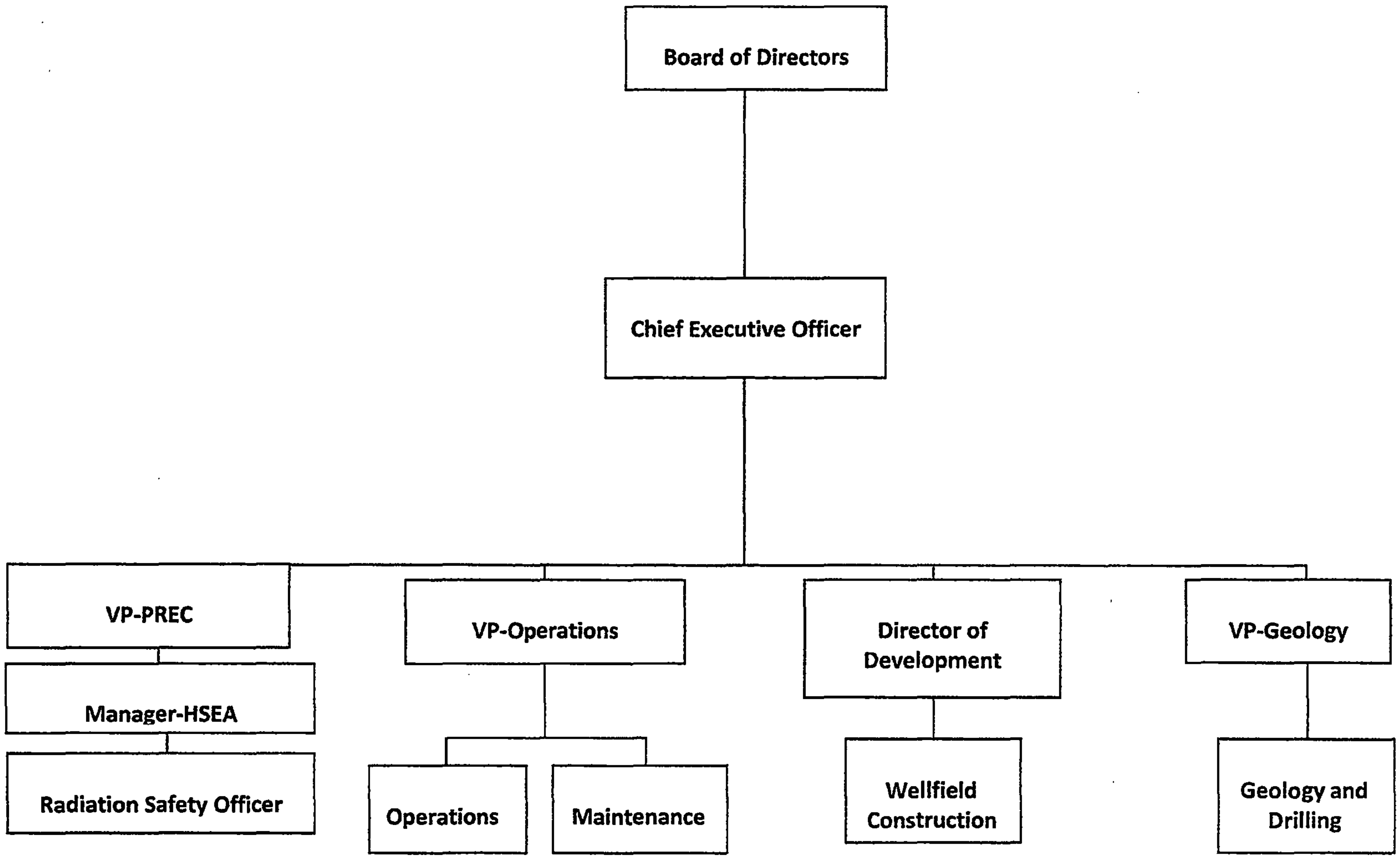


Figure 5.1-1. Ross ISR Organizational Chart

SERP 17-4

in Section 2.9 and will include similar media, sampling locations, methods and procedures referenced therein. Groundwater and surface water radiological sampling is discussed in Section 5.7.8.

This operational environmental monitoring program will be conducted in accordance with the recommendations of NRC Regulatory Guides 4.14, (NRC 1980), 4.15 (NRC 1979) and 8.37 (NRC 1993a).

Field sample collection and/or measurement techniques will be conducted in accordance with accepted scientific protocols, e.g., field survey and sampling methods described in NUREG/CR-5849 (NRC 1992c), and/or NUREG-1575 (NRC 2000), as applicable. For sampling and analysis of water, guidance from the EPA-625-/6-74-003a (EPA 1974), will also be used. These field methods were incorporated into the SOPs that were used and are cross-referenced to the applicable program elements in Table 2.9-1 of Section 2.9. These SOPs are contained in Addendum 2.9-A.

The operational environmental monitoring program will include the measurement of naturally occurring radionuclides as described in NRC Regulatory Guide 4.14, Table 2 and as summarized in Table 5.7-1 below.

5.7.7.1.1 Ambient Monitoring

The operational airborne radiation monitoring program will utilize the air particulate sites established for the pre-operational baseline monitoring program, discussed in Section 2.9.2.3 with the exception of the South station. Baseline monitoring and MILDOS-AREA modeling confirmed that the monitoring locations, depicted in Figure 2.9-24, are consistent with Regulatory Guide 8.30. Additionally, the monitoring stations meet the recommendations of Regulatory Guide 4.14, which states that:

> "Air particulate samples should be collected at (1) a minimum of three locations at or near the site boundary, (2) the residence or occupiable structure within 10 kilometers of the site with the highest predicted airborne radionuclide concentration, (3) at least one residence or occupiable structure where predicted doses exceed 5 percent of the standards in 40 CFR Part 190, and (4) a remote location representing background conditions."

Strata will utilize F&J Specialty Products Models DF-40L-BL-AC and LV-1D samplers or equivalent. Filters will be collected from each air-sampling unit

SERP 17-6

3.0 DESCRIPTION OF PROPOSED FACILITY

The project area encompasses approximately 1,721 acres. The CPP will be located in the NE¼ of the SE¼ of Section 18, Township 53N, Range 67W and will include a uranium recovery circuit, uranium elution circuit, uranium precipitation circuit, and yellowcake drying/packaging along with a vanadium removal and drying/packaging circuit. Adjacent buildings will house the administrative office, maintenance shop, and warehouse. Waste disposal facilities in the CPP area will include lined retention ponds and a Class I Injection well. The total disturbed area of the surface features at the CPP area is estimated at 51 acres. The CPP and adjacent buildings will be fenced to exclude livestock, and to control access to the site. The lined retention ponds will be fenced to a height of 8 feet to exclude wildlife.

The proposed injection and recovery wellfields will occupy portions of Sections 7, 18, and 19, in Township 53N, Range 67W and portions of Sections 12 and 13 in Township 53N, Range 68W. The proposed wellfields will be divided into two Mine Unit development areas as shown on Figure 3.1-1. Mine Units will be further divided into wellfield modules. Within the project, wellfield modules will be used to delineate the portion of each Mine Unit which will be assigned to a specific central collection facility called a module building. This type of facility is typically referred to in other ISR applications as a header house. It is currently anticipated that the project will contain a total of 4 to 20 modules, however, ongoing delineation and development drilling activities are expected to increase the total size of the wellfields and number of modules. The wellfield injection and recovery wells will be piped individually to the module buildings which will contain manifolds and piping, along with monitoring and control equipment. The wellfield areas will be fenced to exclude livestock.

Key proposed facility characteristics include:

- Permit area = 1,721 acres,
- Production area (wellfields and CPP) = 215 acres,
- Wellfield areas (wellfields and PM ring) = 918 acres,
- Production roll-front systems targeted = 5,
- Maximum recovery flow = 7,500 gpm,
- Average recovery flow = 5,075 gpm,
- Maximum restoration flow = 1,100 gpm,

- Average restoration flow = 950 gpm,
- Two Mine Units comprised of 4-20 wellfield modules,
- 1,400 to 2,200 recovery/injection wells,
- 140 to 250 monitor wells (perimeter, shallow, and deep),
- Ion-exchange recovery circuit = 750,000 lbs/year,
- Yellowcake drying/packaging capacity = 3,000,000 lbs/year,
- 119.1 ac-ft of lined retention pond storage capacity, and
- Five proposed deep disposal wells.

Figure 3.1-1 depicts the CPP area facilities including the CPP, wellfields, office, parking area, maintenance shop, warehouse, lined retention ponds, deep disposal wells, access roads, administrative and maintenance buildings, and areas where delineation drilling has indicated future wellfields may be located.

3.1 ISR Process and Equipment

3.1.1 Ore Body Description

At the Ross ISR Project, uranium will be recovered from the upper Fox Hills and the lower Lance formations (see regional stratigraphic column, Figure 2.6-3). The host formations are of Cretaceous age and consist of interbedded sandstone, siltstone, and shale. Uranium deposits are found in the permeable sand zones in stacked roll fronts and tabular ore bodies. The average depth to the top of the ore is 490 feet, and the depth ranges from less than 300 to more than 700 feet. The ore thickness averages 8.9 feet. Spatial distribution of economic mineralization extends across the project area as shown on Figure 3.1-2. This figure also depicts the areas where current delineation activities have indicated that mineralization may exist.

The sources of the uranium were most likely the granites eroded from the surrounding mountainous uplifts and/or volcanic material deposited in the overlying White River Formation, which was also subsequently removed by erosion in the area. The oxygenating groundwater solubilized the uranium and roll fronts were formed when the groundwater moved downdip through the permeable sand zones until contacting a reducing environment where it was precipitated and concentrated. Additional discussion is included in Section 2.6.3. A typical roll front is shown in Figure 3.1-3. The uranium occurs as interstitial fillings between sand grains and thin coatings on the sand grains.

The uranium host sands are saturated and have been determined to be confined aquifers. Natural conditions, governed by the depositional environment during the Late Cretaceous period when the Lance/Fox Hills formations were deposited (discussed in detail in Sections 2.6 and 2.7) resulted in highly heterogeneous sandstones with similarly varied permeabilities, both vertically and laterally. To quote Buswell (1982), "The heterogeneous permeability and transmissivity of the host sediments modifies the migration of the groundwater the alteration projections [roll fronts] formed in response to increased flow through the more permeable channel sandstones." The limits of mineralization also define the limits of the higher permeability sediments. Otherwise, uranium mineralization would be more ubiquitous, and not concentrated in the various roll front deposits underlying the project area. Aquifer pump tests and laboratory core testing have shown that the ore zone sands have greater horizontal permeability than vertical permeability. The horizontal to vertical anisotropy is particularly apparent within the confining shales. Laboratory core analyses data indicate the shale samples had very low conductivity values (Addendum 2.7-F), and the vertical to horizontal conductivity ratio for at least two samples was less than 0.001. The continuous shale layers above and below the host sands provide significant confinement for the recovery solutions and prevent vertical excursions.

Ore body and geologic interpretation at the proposed Ross ISR Project utilized Gemcom Gems© software. The three-dimensional, database driven geologic software platform allowed integration of historic Nubeth drilling data (approximately 1,500 holes) and recent delineation drilling (approximately 500 holes). Utilizing geophysical logs, lithologic descriptions, and contemporary surveying technology, Gems provides resource modeling and drill hole and mine planning in addition to detailed delineation of critical geologic contacts.

3.1.2 Well Construction and Integrity Testing

3.1.2.1 Well Construction Methods and Materials

The recovery and injection wells will be installed with identical completion methods (see Method 1 below) to allow the function of the wells to be changed if desired. The ability to change the well function allows for improved uranium recovery and more efficient restoration as well as an improved ability to respond to potential excursions of recovery solutions. The monitor wells will be installed utilizing Method 2 or Method 3, which are also described in detail below. Wells will be constructed of polyvinyl chloride (PVC) or fiberglass with a sufficient pressure rating to withstand the maximum anticipated injection pressure, the maximum external collapsing pressure, the maximum pressure of cementing, and in accordance with Wyoming State Engineers Office (WSEO) and WDEQ regulations. Wells at the proposed project will be constructed in accordance with WDEQ/LQD Chapter 11. Due to reported failures of screw and glue joints at similar facilities, the casings will be joined using an O-ring and spline locking system. All well casing will be cemented in place from bottom to top with cement slurry that will provide adequate compressive strength to support the casing and zonal isolation and sealing of the drilled formation. The cement slurry will also be formulated such that it will prevent collapse and/or over-heating of the well casing during cementing operations. Depending on the depth of the well, and corresponding hydrostatic pressure limitations that could cause the well casing to collapse, the cement slurry will consist of neat cement slurry or thixotropic lightweight cement slurry mixed to the required specifications (approximate unit weight of 12.5 to 15 lbs./gallon).

Method 1 (see Figure 3.1-4)

1. A pilot hole 5 to 6.5 inches in diameter is drilled through the projected mineralization zone. Geophysical logs consisting of gamma, resistivity, spontaneous potential, and deviation are then completed. From the geophysical logs, the grade of each mineralized intercept is calculated.

2. If, after geophysical logging, it is determined that the mineralization is not of sufficient quality or that the ore continuity is inadequate to warrant completion, the hole is sealed from the bottom to the top with high solids bentonite. An Abandonment Record is then completed for each sealed hole.

3. Assuming the decision is reached to complete the well, the hole is reamed to a diameter of 8 to 10 inches (a minimum of 3 inches larger than the casing OD) to a depth approximately 15 feet below the bottom of the mineralization. Alternatively, in areas where the geologist is more confident in intercepting mineralization, the initial hole may be drilled at the final diameter of 8 to 10 inches in one pass followed by the geophysical logging.

   Fiberglass or PVC casing (minimum rating of SDR 17) with an outside diameter (OD) of 4.95 to 6.5 inches is placed in the reamed hole to a depth approximately 10 feet below the mineralization. PVC centralizers are placed on the casing string at a maximum spacing of one per 40 feet.

4. A calculated amount of cement slurry mixed to the required specifications is placed inside the casing through a cementing or pump-down head. A calculated volume of displacement water is then pumped into the casing forcing the cement slurry out the bottom of the casing and up the annulus between the casing and the reamed hole until cement reaches the surface. After displacement, the valve on the cementing head is closed which holds the cement in place while hardening occurs. Due to shrinkage of the cement during curing the well annulus will be topped off with cement to the surface prior to any additional drilling activities.

5. After a minimum of four days, the well is underreamed through the mineralized zones to a diameter of 10 to 14 inches. The underreaming is completed by a specialized tool utilizing retractable blades. The blades are closed for the trip down the well and are opened by pressure from the rig mud pump. The blades are held open by the weight of the drill string. After underreaming the designated zone through the casing and cement, the blades are again retracted for the trip out of the well. The well may

be caliper logged as necessary to verify the correct interval has been opened. If deemed necessary, to support sand zones that are not competent, PVC screen is telescoped into the casing using a J-collar hooked to the drill pipe. The uppermost screen openings will be placed below the top of the underreamed interval and below the bottom of the annular seal. A PVC riser pipe is extended from the top of the screen approximately 10 feet. One or more k-packer(s) will provide a seal between the riser pipe and the casing. Filter sand may be placed between the screen and the underreamed hole.

6. The well is developed to remove contaminants and fines from the drilling and completion process and maximize the flow rate. A Well Installation Record is completed which contains all the details on drilling, geophysical logging, completion materials, casing depth, completion interval, and the cement mix.

7. After drying, the drill cuttings contained in the pits are covered with subsoil and the stockpiled topsoil. The ground surface is then recontoured and reseeded.

8. The well is integrity tested as discussed in Section 3.1.2.3 below.

Method 2 (see Figure 3.1-5)

1. A pilot hole 5 to 6.5 inches in diameter is drilled through the projected completion interval. Geophysical logs consisting of gamma, resistivity, spontaneous potential, and deviation are then completed.

2. The hole is reamed to a diameter of 8 to 10 inches (a minimum of 3 inches larger than the casing OD) to the top of the zone to be completed. The pilot hole below the bottom of the reamed hole is filled with drill cuttings during the reaming process.

3. Fiberglass or PVC casing (minimum rating of SDR 17) with an OD of 4.95 to 6.5 inches is placed in the reamed hole. PVC centralizers are placed on the casing string at a maximum spacing of one per 40 feet.

4. A calculated amount of cement slurry mixed to the required specifications is placed inside the casing through a cementing head. A calculated volume of displacement water is then pumped into the casing forcing the cement slurry out the bottom of the casing and up the annulus between the casing and the reamed hole until the cement reaches the surface. After displacement, the valve on the cementing head is closed which holds the cement in place while hardening occurs. Due to shrinkage of the cement during curing the well annulus will be topped off with cement to the surface prior to any additional drilling activities.

5. After a cement-hardening period of at least two days, the designated completion interval is cleaned out below the casing to the pilot hole diameter. If the sand zone is competent, the completed interval may be left open and unsupported. If PVC screen is necessary, and a clean hole has been drilled, the screen assembly may be installed immediately. Underreaming of the completed interval to a larger diameter may be completed prior to the installation of the screen. The uppermost screen openings will be placed below the bottom of the casing and the annular seal. A PVC riser pipe is extended from the top of the screen approximately 10 feet. A seal between the riser pipe and the casing is provided by one or more k-packer(s). Filter sand may be placed between the screen and the underreamed hole.

6. The well is developed to remove contaminants and fines from the drilling and completion process and maximize the flow rate. A Well Installation Record is completed which contains all the details on drilling, geophysical logging, completion materials, casing depth, completion interval, and the cement mix.

7. After drying, the drill cuttings contained in the pits are covered with subsoil and the stockpiled topsoil. The ground surface is then recontoured and reseeded

8. The well is integrity tested as discussed in Section 3.1.2.3 below.

Method 3 (see Figure 3.1-6)

1. A pilot hole 5 to 6.5 inches in diameter is drilled to the top of the projected completion interval. Geophysical logs consisting of a minimum of gamma, resistivity, and self potential are then completed.

2. The hole is reamed to a diameter of 8 to 10 inches (a minimum of 3 inches larger than the casing OD). An option for this method is to drill to the final hole diameter of 8 to 10 inches in one pass followed by the geophysical logging.

3. Fiberglass or PVC casing (minimum rating of SDR 17) with an OD of 4.95 to 6.5 inches is placed in the reamed hole. PVC centralizers are placed on the casing string at a maximum spacing of one per 40 feet.

4. A calculated amount of cement slurry mixed to the required specifications is placed inside the casing through a cementing head. A calculated volume of displacement water is then pumped into the casing forcing the cement slurry out the bottom of the casing and up the annulus between the casing and the reamed hole until cement reaches the surface. After displacement, the valve on the cementing head is closed which holds the cement in place while hardening occurs. Due to

shrinkage of the cement during curing the well annulus will be topped off with cement to the surface prior to any additional drilling activities.

5. After a cement-hardening period of at least two days, the designated completion interval is drilled below the casing with a bit that is smaller than the casing inside diameter (ID). Geophysical logs consisting of gamma, resistivity, spontaneous potential, and deviation are then completed in the newly drilled hole. If the sand zone is competent, the completed interval may be left open and unsupported. If PVC screen is necessary, the completion interval may be underreamed to a larger diameter prior to the installation of the screen. The uppermost screen openings will be placed below the bottom of the casing and the annular seal. A PVC riser pipe is extended from the top of the screen approximately 10 feet. A seal between the riser pipe and the casing is provided by one or more k-packer(s). Filter sand may be placed between the screen and the underreamed hole.

6. The well is developed to remove contaminants and fines from the drilling and completion process and maximize the flow rate. A Well Installation Record is completed which contains all the details on drilling, geophysical logging, completion materials, casing depth, completion interval, and the cement mix.

7. After drying, the drill cuttings contained in the pits are covered with subsoil and the stockpiled topsoil. The ground surface is then recontoured and reseeded.

8. The well is integrity tested as discussed in Section 3.1.2.3 below.

3.1.2.2 Well Development

Following installation, the well is developed by pumping, air lifting, jetting and/or swabbing to clean and improve the hydraulic efficiency of the well. The goal will be to remove drilling fluids and fines from the completion zone to provide good hydraulic communication and maintain the natural geochemical conditions. During well development, progress will be monitored with pH, turbidity, and conductivity measurements to determine when cleanup has been achieved, as measured by stable measurement of these parameters.

Water produced during initial well development will have minimal radiological impact and is expected to meet State of Wyoming temporary WYPDES discharge standards, therefore this water will be directly discharged to adjacent mud pits.

During operation, injection or recovery wells will be routinely taken off line for maintenance and enhancement, which could include air lifting, swabbing, underreaming, or chemical treatment. Examples of chemicals used for enhancement include a weak acid solution to dissolve calcite or sodium hypochlorite to eliminate bacteria. Water produced during routine stimulation of active wells will be collected and placed in lined retention ponds or injected in a deep disposal well.

3.1.2.3 Well Mechanical Integrity Testing

Prior to being placed into operation, the integrity of the wells will be verified by a pressure based mechanical integrity test (MIT). After initial testing, the well will be retested at 5-year intervals. In addition, the MIT will be repeated if the well is entered by a drilling bit, underreaming tool, or if it is suspected that well damage is possible for any reason. The well integrity information will be documented and filed on site and provided to WDEQ/LQD on a quarterly basis. As part of the well integrity documentation provided in the quarterly report, WDEQ/LQD will also be provided records which detail the quantities and procedures used for annular sealing of the wells. This information will include the cement density, quantities of cement, bentonite, and displacement water, and confirmation that cement was pumped to the surface during sealing. The quarterly report will also include required information on failed wells.

The MIT is conducted by placing inflatable packers near the top of the casing and above the screen interval. The packers are inflated and the interval between the packers is pressurized with water to the test pressure (maximum allowable injection pressure plus a safety factor of 25%). Since the maximum injection pressure (measured in the module building) is 140 psi, the integrity test will be conducted at 175 psi. This pressure must be maintained within 10% for 10 minutes to pass the MIT. An alternative to using a top inflatable packer may be utilized where the top of the casing is sealed by a specially designed completion cap. A well integrity record will be completed for each tested well. If a well shows an unacceptable pressure drop during the integrity test, the packers may be reset and the equipment checked for leaks. If in successive tests the well passes the integrity requirements, the well will be deemed acceptable for use as injection, recovery, or monitor well. If a well continues to fail MIT, it will be plugged and abandoned. Any well which is abandoned due to MIT failure or has arrived at the end of its useful life will be sealed with cement slurry. Plugging and abandonment procedures are detailed in Addendum 2.6-E. Monitor wells

3.1.3.2 ISR Chemistry

The lixiviant will be fortified with complexing agent at the CPP and then pumped to the module buildings where the oxidant addition and, potentially, CO_2 addition will be completed at the manifold. During initial circulation of a headerhouse the complexing agent may be added locally. The lixiviant is then injected, passed through the ore, and the uranium enriched lixiviant is pumped from the recovery wells and returned to the CPP. At the CPP, uranium is extracted by the IX process and the barren solutions are refortified with the oxidizing/complexing agents and circulated back to the injection wells in a continuous cycle. The recovery process will be continued in a particular wellfield until the uranium concentration in the recovered solutions is considered to be uneconomical.

Leaching (approximately neutral pH)

The in-place uranium mineral (uraninite) is oxidized to change the uranium valence from the insoluble +4 state to the soluble +6 state using hydrogen peroxide or gaseous oxygen. Oxygen is usually used due to economic and ease of use considerations. The complexed uranium is uranyl dicarbonate or uranyl tricarbonate depending on pH conditions. Due to the excess carbonate in the system, the uranyl tricarbonate will be the dominant species with a minor amount of uranyl dicarbonate existing in the solutions. Additional chemicals that may be added prior to injection include carbon dioxide to adjust the pH and provide a carbon source, and chlorine to eliminate bacteria.

The chemical reactions for the in situ recovery of uranium are shown below:

Oxidation: $UO_2 + ½ O_2 \rightarrow UO_3$ or $UO_2 + H_2O_2 \rightarrow UO_3 + H_2O$

Complexing: $UO_3 + 2HCO_3^- \leftrightarrow [UO_2(CO_3)_2]^{2-} + H_2O$ or

$UO_3 + CO_3^{2-} + 2HCO_3^- \leftrightarrow [UO_2(CO_3)_3]^{4-} + H_2O$

3.1.4 Wellfield Design and Operation

Strata is currently in the process of delineating uranium ore within the Ross project area. At this time, ISR wellfields are expected to encompass up to 160 acres within the project area. This includes additional uranium ore which Strata anticipates will be discovered. In some areas, multiple vertically stacked roll fronts have been identified. ISR operations within the stacked roll fronts will occur simultaneously, which will help to minimize the overall bleed requirements of the system. The wellfield will be divided into discrete modules with approximately 30 recovery wells per module. Wells within each module will be individually piped to a module building where they will be manifolded together. The Ross ISR Project is expected to encompass some 4 to 20 modules with the final number of modules dependent on ongoing delineation efforts.

The flow capacity of each wellfield module will range from 300 gpm to 850 gpm. Electrical power will be distributed to the module buildings by overhead power lines or underground lines depending on each location. Electrical distribution to the individual recovery and injection wells will be buried. Wellfield access roads will be constructed in accordance with regulatory guidelines.

The recovery and injection wells will be arranged in 7-spot, 5-spot, line drive, or staggered line drive patterns. The patterns will be modified to fit the ore body, and well spacing will range from 50-250 feet. In support of this application, a groundwater flare evaluation was performed using MODPATH and MODFLOW as described in Addendum 2.7-H. During the modeling exercise, it was apparent that a line drive pattern is likely to have a greater flare than a typical 5 or 7-spot. The additional flare means that increased restoration efforts will be required. In order to minimize restoration efforts, Strata plans limited use of line drive patterns. Where it is not possible to avoid the use of line drive patterns, Strata will perform additional modeling to determine the most efficient well spacing to provide the most effective restoration.

Each wellhead will be covered by a well cover in order to provide protection and spill containment. The protective cover includes a solid base with access holes for well casing, electrical, leak detection, and lateral water lines. The solid base will act to contain small leaks and will include leak detection. Well identification labeling will be installed on both the protective covers and wellheads. A typical wellhead and protective cover is depicted on Figures 3.1-7 and 3.1-8. The recovery and injection wells will be connected to the module buildings utilizing individual 1-inch to 2-inch HDPE pipelines. The pipelines will be buried to a depth of 2 to 6 feet to prevent freezing and to provide unrestricted wellfield access. Each recovery well will contain a submersible pump sized to carry solutions from the well to the module building. Injection wells will have stingers for delivery of lixiviant to the ore zone and air release systems to relieve pressure in the wells from injection.

The module buildings will be located throughout the wellfield and will be approximately 15 feet by 40 feet in size. Piping inside each module building will consist of HDPE, PVC, brass, or stainless steel rated for an operating pressure greater than the proposed maximum injection pressure. Each well line will have a totalizing flow meter and a manual valve to control the flow rate. A small sample collection valve for each well will be included on the recovery flow lines. The recovery wells will be manifolded together in the building and the injection wells will be manifolded together within the building. Flow meters providing rate and totalizer readings will be located on the module feeder lines. All flow meters and pressure transmitters will have the capability of being monitored locally and at the CPP. Booster pumps may also be necessary to provide the design pressure of refortified barren lixiviant in the injection trunk lines and to carry pregnant lixiviant to the CPP in the recovery trunk lines. Additionally, the module buildings will contain the electrical control equipment required for the recovery pumps. The injection manifold will be fitted with a pressure transmitter and oxidant dispersal equipment. A schematic of typical module building piping and instrumentation is shown in Figure 3.1-9.

The wellfield flows will be balanced based on the module injection and recovery feeder line meters. The module injection and recovery feeder line flows will be compared to the summation of the individual injection and recovery well meters. The individual well flow targets will be determined on a per pattern basis to assure that local wellfield areas are balanced on at least a weekly basis.

The maximum injection pressure will be less than the formation fracture pressure, which is typically estimated at 0.67 psi per foot of overburden (approximately 325 psi at the Ross ISR Project) and less than the pressure rating for operation of the piping and other equipment. Although injection pressures are initially expected to be relatively low, the ability to inject fluids within a specific wellfield generally tends to decrease with time. In order to maintain flow rates and wellfield balance, some wells will require flexibility in their allowable injection pressure. The maximum injection pressure will be limited to 140 psi measured at the injection manifold.

While injectivity issues plagued the Nubeth R&D site, improvements to well design, well development, and filtration systems will be utilized at the proposed Ross ISR Project. Improved well construction technologies developed by other producers and field tested during regional baseline well installation include underreaming, screening and filter pack installation. Well development will employ quantitative measurements of key water quality parameters to ensure removal of fines prior to operation. Testing of well development procedures was utilized during baseline well purging while ongoing leaching tests will assist in developing filtration system requirements.

HDPE injection and recovery feeder lines will convey lixiviant and recovery solution between the trunklines and module buildings. Feeder lines will be buried and connected to the main HDPE trunk lines, which deliver solutions to and from the CPP. Feeder line and trunk line junctions will be contained in valve manholes, located along the trunk lines. Each module building will have the capability of being isolated from the trunk lines by manually operated valves contained in the valve manholes. A typical valve manhole is depicted on Figure 3.1-10. The manholes will have leak detection devices, which will activate an audible and visible alarm at the CPP in the event of a leak. Pressure transmitters on each manifold will relay pressure readings back to the CPP control room. In the event of a pressure reading that is outside of acceptable operating parameters, an audible and visual alarm will occur at the CPP. Automatic sequential shutdown of the trunk line pumps and/or module building booster pumps and recovery well pumps will then occur if operating parameters do not return to normal ranges within a specified amount of time. A booster pump station may be required on the trunk lines if the distance from the module building to the CPP exceeds initial pump capability.

During recovery operation, more solution, termed production bleed, is recovered from the wellfield than is injected. At the Ross project, the production bleed will range from 0.50% to 2.00% and will average 1.25%. The purpose of this production bleed is to maintain a net inward hydraulic gradient as measured at the perimeter monitor wells as required in License Condition 10.7. At the maximum flow rate, this is equivalent to approximately 94 gpm of production bleed. Production bleed creates a cone of depression within the wellfield and maintains an inward flow of groundwater. The inflow will prevent the migration of leach solutions toward the perimeter monitor well ring. Preliminary groundwater modeling of a sample wellfield has indicated that wellfield control can be maintained with a 1.25% bleed.

Maintenance of sufficient bleed to minimize water management and consumption while eliminating the potential for hydraulic anomalies outside of the uranium recovery areas will utilize wellfield data collection and integration within a suitable reservoir engineering software platform. Wellfield data collection will consist of individual injection and recovery rates combined with level readings in both internal baseline wells and perimeter monitor wells. MODFLOW three dimensional simulations (presented in Addendum 2.7-H) indicate that hydraulic anomalies would be quickly detected in the perimeter monitor wells, integration with injection and recovery rates on a well-by-well basis will allow for detailed controls to maintain sufficient bleed. Well efficiency deviations will be measured utilizing data from the injection manifolds.

During operation, a portion of the injection solution will be removed and processed by two phases of reverse osmosis (RO). After treatment, most of the high quality permeate will then be circulated back to the injection stream in order to make up the correct bleed amount, the remainder will be discharged to the lined temporary storage ponds for other uses or disposal. By treating part of the injection stream, Strata hopes to help maintain the water quality of the injection solution. Efforts to maintain the injection stream will reduce the buildup of salts and other dissolved constituents, which will aid in aquifer restoration. The quantity of the injection stream that will be treated will vary throughout the life of the project, depending on operating conditions such as the amount of production bleed being utilized in the wellfields, the waste management capacity, and the water quality of the injection stream.

A three-dimensional groundwater model was developed for the proposed Ross ISR Project using Groundwater Vistas as the pre-processor and the USGS code MODFLOW. As part of the modeling exercise, the calibrated model was used to evaluate an ISR simulation for the ore bodies currently delineated within the permit area. During the simulation, production bleed from ISR, groundwater sweep, and aquifer restoration were removed from the aquifer at currently estimated bleed rates for each respective ISR stage. Simulated flow volumes were based on water balance flow rates presented in Section 3.1.5 and the project schedule as presented in Figure 1.9-1. The primary purpose of this simulation was to evaluate regional impacts from the ISR operations. The simulation was a "one size fits all" simulation that did not adjust flow rates to take into account specific well field changes. For example, where the hydraulic conductivity of the formation is lower than average the production rates may need to be adjusted accordingly. This simulation did not adjust flow rates to account for different conditions. However, the "one size fits all" simulation does conservatively predict include 1,025 gpm from modules in the reverse osmosis and permeate injection stage of aquifer restoration, as well as 75 gpm from modules in the groundwater sweep stage. In this phase, all of the permeate is routed either to the injection stream for refortification and injection, or to the restoration injection stream. No permeate will be discharged to the lined retention ponds during the typical flows. Brine waste from the secondary RO unit will consist of 202 gpm from both the recovery and restoration streams. As in the operation only phase, it will be possible to minimize or maximize permeate and brine flow rates by adjusting the RO feed rate. The highest rate of excess permeate discharging to the lined retention ponds will occur during the first few months of the concurrent operation and aquifer restoration phase when groundwater sweep is occurring without RO reinjection to modules in aquifer restoration. While up to 0.5 PVD has been proposed for the ground water sweep phase, selective recall of lixiviants in areas identified during operations may also be utilized. Preliminary groundwater modeling indicates that there may be areas within a wellfield where local hydraulic anomalies or wellfield geometry result in extraordinary flare. By selectively sweeping these areas, the sweep will be more targeted and thus, significantly reduce the amount of water withdrawn from the aquifer.

The aquifer restoration only phase will take place when all modules have been depleted and only aquifer restoration activities are occurring. Aquifer restoration flows will be 1,100 gpm and, similar to the concurrent operation and aquifer restoration phase, no permeate will be discharged to the lined retention ponds. The brine stream during this phase will be 165 gpm. Including the typical flow of other liquid 11e.(2) byproduct material from the CPP, the total brine stream will be 190 gpm. The water balance for this phase is illustrated and tabulated in Figure 3.1-13. During this phase, excess clean water will be required for plant make up. Strata will utilize either excess permeate stored in the lined retention ponds, or increased bleed from aquifer restoration activities as necessary to supply plant make up water during this phase.

3.1.6 Monitor Well Layout and Design

The wellfields will be surrounded by perimeter monitor wells spaced 400 feet apart and at a distance of approximate 400 feet from the edge of the wellfield to detect potential excursions. Figure 3.1-14 shows the proposed locations of perimeter monitor wells adjacent to a typical wellfield. Due to the level of ore zone aquifer confinement, simulations of recovery and aquifer restoration indicate that the 400-600-foot spacing can successfully detect concentrations measured in fully penetrating regional baseline wells and discreetly completed observation wells in the ore bearing sandstones correlate very well. In addition, the hydrogeologic system analyzed by Mayo (2010) was highly stratified and lacked the confinement measured at the proposed Ross ISR Project.

Baseline water quality and quantity will be collected from approximately 24 well clusters spaced at 1 cluster per 3-4 acres of wellfield. The baseline wellfield monitoring well clusters, as well as the currently installed regional baseline well clusters are presented in more detail in Sections 2.7 and 5.7.8. Completions for the deep (DM) and shallow (SM) monitoring wells will likely mimic the regional baseline cluster installations, while the ore zone (OZ) baseline wells will likely resemble the observation wells installed for the multi-well aquifer test with more limited, gamma based completions. These wells will be utilized as recovery wells during ISR operations.

Excluding the installation of pressure transducers in the fully penetrating monitor wells, water levels will be routinely measured during sampling in the perimeter, overlying, and underlying monitor wells in order to provide an early warning for impending wellfield problems. An increasing water level in a perimeter monitor well has shown be an indication of a local flow imbalance within the wellfield, which could result in an excursion. An increasing water level in an overlying or underlying monitor well could be caused by the migration of fluid from the production zone or by an injection well casing failure. This monitoring effort will allow corrective action to be immediately taken to locally balance the injection and recovery flows or shut down individual injection wells as necessary.

All previously drilled exploration/delineation holes that can be located on the project and are within a monitor well ring will be re-entered to total depth and sealed with an appropriate sealant specified in WDEQ/LQD Rules and guidance. Historic exploration holes are located using a hand-held metal detector that finds a brass cap with the borehole ID. After the holes are located, a small drilling rig sets up over the holes and drills them out to total depth. The holes are then sealed from the bottom to the surface. Details of the plugging each borehole will be recorded on an abandonment record, (examples in Addendum 2.7-F) which will be filed at the adminstration office in the appropriate hole record and provided with the respective wellfield data package. Anecdotal data collected during the abandonment process will provide valuable information for future abandonment operations. For example, during abandonment of 55 boreholes in the vicinity of the 12-18 regional baseline well cluster it was noted that natural sealing of the clays above the ore zone sands is common, and that circulation of water and minor drilling fluids was necessary to get the holes sufficiently cleaned out prior to cementing.

Monitor wells installed as part of the wellfield data package will be constructed per WDEQ/LQD guidelines and a passing MIT record will be provided as part of the wellfield package provided to WDEQ/LQD and NRC.

3.1.7 Wellfield Leak Detection and Instrumentation

Wellfield control and monitoring will be conducted in the Module buildings' Programmable Logic Controllers (PLCs) and the data relayed to the Master Control System (MCS) in the control room at the CPP. The MCS will remotely monitor and be capable of shutting down any device or process at the module buildings. Starting capabilities will reside solely at the module buildings. The wellfield control philosophy at the Ross ISR Project will be based around a fault hierarchy which allows adjustment through the PLC for fault settings and allowable time intervals for fault values. This will allow parameters to stabilize, such as during startup or in the event of a brief anomalous condition, before triggering a fault. In this manner, Strata will reduce the number of automatic faults and subsequent shutdowns that occur.

Flows and pressures for the main injection and recovery trunklines will be monitored continuously and displayed at the CPP control room. Proposed leak detection and monitoring equipment from the wellfields to the CPP is depicted on Figure 3.1-15. Changes in flow or pressure that are outside of normal operating parameters will result in the activation of visual and audible alarms and eventually automatic sequential shutdown of pumps and control valves if the condition is not corrected promptly. The flows and pressures of the injection/recovery feeder lines and the individual injection/recovery wells will be monitored locally at the module building and on a display located at the CPP control room. If flows and pressures are not maintained within a set operating range, a visual and audible alarm will be activated at the CPP.

Leak detection sensors will be located in the module building sumps and the valve manholes, which will trigger audible and visual alarms at the location and at the CPP if fluid is detected. Strata may also utilize dual leak detection in these areas, which would consist of two sensors at high and low levels within the containment systems. When fluid is detected at the first sensor, an audible and visual alarm would be triggered at the location and at the CPP. If fluid is detected at the second sensor, automatic pump shutdown would occur to prevent the fluid from overflowing the containment system and contaminating the surrounding environment.

Piping and fitting leaks at the wellheads will be detected by sensors located in the well head sumps. In addition, a system will be instituted in the operating plan for an operator to inspect the interior of each well box on a monthly basis. Minor leaks or other problems will be detected and repaired in this manner to avoid the possibility of major spills. Weekly inspections of the wellheads are discussed in Section 5.3.3.

The main trunk lines and the module building feeder lines will undergo pressure testing with fresh water or air prior to burial to assure mechanical integrity. In addition, the individual injection and recovery well lines will undergo pressure testing after installation and before burial. The pressure tests will be conducted in accordance with manufacturer's recommendations or industry standards prior to final burial. In the event of leakage from pipelines or fittings, the defective component will be replaced. Prior to backfilling, a final inspection of all pipes, valves, thrust blocks and similar will be conducted in addition to evaluating embedment material and trench systems for potential unsuitable backfill. Installation and backfilling will follow typical quality assurance procedures, including:

- Laying of pipe at required grades and lines,
- Minimizing accumulation of water during laying or backfilling,
- Limiting lateral displacement with use of embedment material,
- Preventing contamination of pipe trench with foreign, unsuitable material,
- Covering pipe with at least 2-6 feet of material,
- Use of properly sized and placed bedding material,
- Use of proper backfill material, which will not impose undue shock or unbalance to the pipe (i.e., frozen soils, mud, snow, etc.),
- Use of trench plugs at the appropriate spacing, particularly at or near areas of elevated groundwater, and
- Installing pipelines using direct bore techniques when necessary.

3.1.8 CPP Site Hydraulic Control

Surface water and groundwater control at the Ross CPP will be necessary to mitigate the possibility of the release of process fluids to the surrounding environment. The following section describes the surface water and groundwater control at the Ross ISR Project CPP.

3.1.8.1 Site Surface Water Control

Storm water runoff at the Ross CPP will be collected and stored in a sediment pond. This will allow Strata to ensure that storm water runoff from the CPP area does not provide a pathway for contaminants to be released to the environment. The Ross CPP facility layout is depicted on Figure 3.1-16.

The areas directly adjacent to the CPP will be surfaced with gravel. These areas will be sloped to drainage ditches that will convey runoff to the sediment pond. The sediment pond will be designed to contain the direct runoff from an approximate 100-year, 24-hour runoff event. The runoff volume calculations ignore surface abstractions, which results in a conservative runoff estimate. After a significant storm event, the sediment pond will be dewatered by pumping to the adjacent diversion channel if the water meets discharge requirements.

3.1.8.2 Site Groundwater Control

Preliminary evaluations of the surficial aquifer (SA) potentiometry indicated the potential for relatively shallow water levels in the area near the proposed CPP site. Four 2-inch diameter piezometers surrounding the site were installed during initial shallow groundwater and geotechnical investigation drilling performed in May 2010. Materials encountered during drilling included unconsolidated silty clays and sandy, silty clays from 0-27 ft below ground level (BGL). The Lance Formation bedrock varied from 4-27 ft BGL depending on the monitor well location. Subsequent quarterly monitoring has indicated

fluctuating water levels with a typical depth to water of 8-12 ft BGL. Two wells indicate water in the shallow bedrock while the northern most well exhibits 15-17 ft of saturation in the unconsolidated materials overlying the Lance Formation. Well logs and completion details for the CPP area piezometers as well as soil laboratory results are included in Addendum 3.1-A. A cross section which uses well and borehole log data from the piezometers and previously drilled exploration boreholes is also included in this addendum. Water quantity and quality monitoring results for the surficial aquifer are detailed in Section 2.7.

Elevated water levels directly beneath the CPP site may create a higher risk of contamination in the event of a spill, as well as create construction and operational issues for the CPP and adjacent facilities. In order to mitigate these risks, a continuous containment barrier wall (CBW) (also known as a soil-bentonite slurry wall) was constructed hydraulically upgradient as shown on Figure 3.1-16. This structure will serve as a barrier between the shallow groundwater upgradient of the CPP site and the shallow groundwater immediately beneath the plant facilities.

The CBW consists of a highly impermeable in situ mixture of soil and bentonite that forms a continuous barrier to divert the movement of shallow groundwater around the CPP site and permit it to be pumped at the dewatering wells and/or a French Drain. This will allow the level of shallow ground water to be lowered around the entire CPP site. . This wall is 1.5 ft to 2 ft thick and extends from the ground surface through the soil and unconsolidated surficial material to a point at a minimum of 2 ft into bedrock. Figure 3.1-17 shows a typical cross section of a CBW. The target permeability of this CBW will be less than the lowest permeability of the soils that lie beneath the CPP site. Preliminary tests indicate that the clays underlying the CPP have a permeability of about 2.8E-07 cm/sec (approximately the same as typical concrete); therefore, target permeability for the CBW will be about 5.0E-08 cm/sec. The target permeability of the CBW will be reached by adjusting the soil-bentonite mixture. A typical soil-bentonite mixture contains 3% by dry weight of bentonite.

The photograph on Figure 3.1-17 shows a typical in situ mixed soil-bentonite slurry wall being constructed. This particular wall serves as a positive cut-off to prevent seepage from passing beneath an earthen dam. These slurry walls are used very successfully in a wide variety of subsurface applications where a relatively impermeable barrier is required, including highly contaminated EPA super-fund sites. These structures have a history of providing highly effective groundwater barriers with only minimal surface and environmental disturbance.

Following construction of the CBW, a French drain located immediately upgradient of the CBW was installed and is used to intercept groundwater in the CPP area. Intercepted groundwater is conveyed to a collector well in the french drain and then routed to the diversion for discharge. The french drain along with the underdrains constructed below the retention ponds (see Section 4.2.2), will be used as needed throughout the operating life of the CPP to maintain a depressed water level inside the CPP area. Monitoring wells are installed on both sides of the CBW. These wells contain dedicated pressure transducers and are monitored to ensure that there is always a negative gradient for the groundwater to flow from outside the CBW to the inside, and to monitor seepage. Any seepage and/or spillage collected on the inside of the CBW will be discharged to the sediment ponds for storage and discharge. In the unlikely event of a process fluid spill, hazardous chemical spill, or failure of the disposal systems, this CBW and associated dewatering system will prevent migration of contaminated liquids from entering and contaminating shallow groundwater outside the facilities area. Approximate locations of dewatering and monitoring infrastructure are shown on Figure 3.1-16.

Dewatering infrastructure and monitoring wells will be installed and subsequently plugged and abandoned according to WDEQ/WQD standards. In addition, all locatable exploration holes within the CPP area fence will be abandoned from bottom to top with WDEQ/LQD-accepted sealant materials.

3.1.9 Flood Protection

Protection of equipment and facilities from large runoff events will typically be accomplished by placing the facilities on high ground out of the flood plain. When facilities must be placed in or near a drainage channel, proper engineering controls will be used to ensure safety and environmental protection.

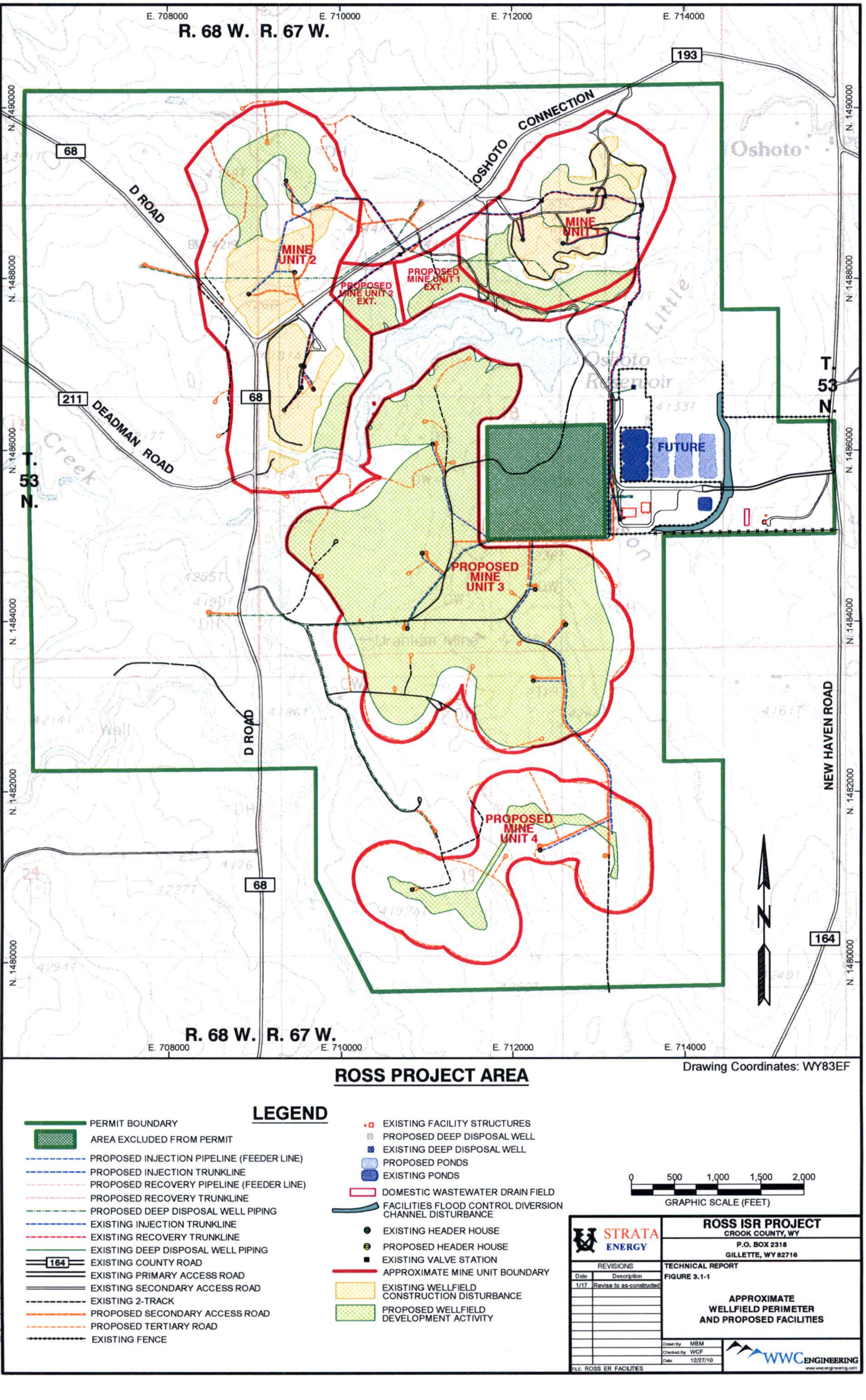
The CPP at the Ross ISR Project is partially located in the channel of an ephemeral stream. The site is located on an active dryland hayfield. Historically, the ephemeral channel once bisected the facility site but has since been adjusted to the east in order to optimize irrigation efforts. To route surface runoff around the CPP, a diversion channel capable of passing the 100-year, 24-hour runoff event was constructed to the east of the facility. The primary access road for the CPP area comes from the east off of New Haven Road. Two corrugated metal pipe (CMP) culverts were installed in the diversion channel will provide access for this road.

A plan view of the diversion is shown on Figure 3.1-18 (2 sheets) along with key hydraulic and design characteristics. Erosion control will utilize Armorflex® or a similar erosion control mat near the CMP culvert outlets. Given the low velocities, the berm upstream of the culvert and the remainder of the channel below the culverts will not use erosion protection but will be vegetated as soon as possible after construction.

Two 6-foot CMP culverts were selected to convey runoff under the access road due to the large capacity required during the 100-year, 24-hour runoff event. The CMP culverts provide for ease of installation and low maintenance considering the design life of the facility.

NUREG-1569 states that the probable maximum flood (PMF) should be used as the design flood for diversion channel designs. It is presumed that NUREG-1569 has based this from guidance presented in NUREG-1623 (NRC 2002), which states that the PMF should be used as the design flood in diversion channel and erosion protection design for uranium mill tailings storage facilities. Generally, design requirements for hydraulic structures are based on the design life of the facility. NUREG-1623 was written based on assumptions of a uranium tailings storage facility, where design life may equal or exceed 1,000 years. In the case of ISR facilities, design lives are commonly in the range of 10 to 20 years. A diversion channel at an ISR facility designed for the PMF would be both impractical and uneconomical considering the relatively short design life. Therefore, Strata has determined that a reduced design flood will be sufficient for design of the diversion channel and erosion protection. A 100-year, 24-hour design storm was selected. A 100 year storm event has an annual exceedance probability of 1%, which means that the design storm has a 1% chance of occurring, or a 99% chance of not occurring in any given year. Over the design life of the facility, which is expected to be up to 25 years if the facility is retained to process uranium loaded resins from other generators, there is approximately a 22% chance that the design flood for the diversion channel will be exceeded. In addition, several conservative assumptions were made during the design of the diversion structure. The peak flow was calculated without taking into account runoff that will be impounded by multiple small reservoirs that are located upstream of the CPP area (Section 2.7.1 describes the hydrologic evaluation for the basin in which the CPP is located). Also, the diversion channel will have 0.5 foot of freeboard while passing the design flow. Assumptions used in the design of the diversion channel will be discussed in Addendum 3.1-A.

In the unlikely event that recovery, injection, and/or monitor wells must be located within flood plains, engineered controls and instrumentation detailed in Section 3.1.4 will act to prevent leakage to the environment or contamination to the wells from a flood event. The well seals detailed on Figure 3.1-7 and 3.1-8 will prevent inflow of flood waters down the well casing while the fiberglass structure and bottom containment feature will limit exposure of the well to the


E. 708000
E. 710000
E. 712000
E. 714000
R. 68 W. R. 67 W.
193
N. 1490000
N. 1488000
N. 1486000
N. 1484000
N. 1482000
N. 1480000
68
D ROAD
OSHOTO CONNECTION
Oshoto
MINE UNIT 2
MINE UNIT 1
PROPOSED MINE UNIT 2 EXT.
PROPOSED MINE UNIT 1 EXT.
Little
Oshoto Reservoir
T. 53 N.
211
DEADMAN ROAD
FUTURE
PROPOSED MINE UNIT 3
PROPOSED MINE UNIT 4
D ROAD
NEW HAVEN ROAD
164
ROSS PROJECT AREA
Drawing Coordinates: WY83EF
LEGEND
PERMIT BOUNDARY
AREA EXCLUDED FROM PERMIT
PROPOSED INJECTION PIPELINE (FEEDER LINE)
PROPOSED INJECTION TRUNKLINE
PROPOSED RECOVERY PIPELINE (FEEDER LINE)
PROPOSED RECOVERY TRUNKLINE
PROPOSED DEEP DISPOSAL WELL PIPING
EXISTING INJECTION TRUNKLINE
EXISTING RECOVERY TRUNKLINE
EXISTING DEEP DISPOSAL WELL PIPING
EXISTING COUNTY ROAD
EXISTING PRIMARY ACCESS ROAD
EXISTING SECONDARY ACCESS ROAD
EXISTING 2-TRACK
PROPOSED SECONDARY ACCESS ROAD
PROPOSED TERTIARY ROAD
EXISTING FENCE
EXISTING FACILITY STRUCTURES
PROPOSED DEEP DISPOSAL WELL
EXISTING DEEP DISPOSAL WELL
PROPOSED PONDS
EXISTING PONDS
DOMESTIC WASTEWATER DRAIN FIELD
FACILITIES FLOOD CONTROL DIVERSION CHANNEL DISTURBANCE
EXISTING HEADER HOUSE
PROPOSED HEADER HOUSE
EXISTING VALVE STATION
APPROXIMATE MINE UNIT BOUNDARY
EXISTING WELLFIELD CONSTRUCTION DISTURBANCE
PROPOSED WELLFIELD DEVELOPMENT ACTIVITY
0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
STRATA ENERGY
ROSS ISR PROJECT
CROOK COUNTY, WY
P.O. BOX 2318
GILLETTE, WY 82716
REVISIONS
Date Description
1/17 Revise to as-constructed
TECHNICAL REPORT
FIGURE 3.1-1
APPROXIMATE WELLFIELD PERIMETER AND PROPOSED FACILITIES
Drawn By MBM
Checked By WCF
Date 12/27/10
FILE: ROSS ER FACILITIES
WWC ENGINEERING

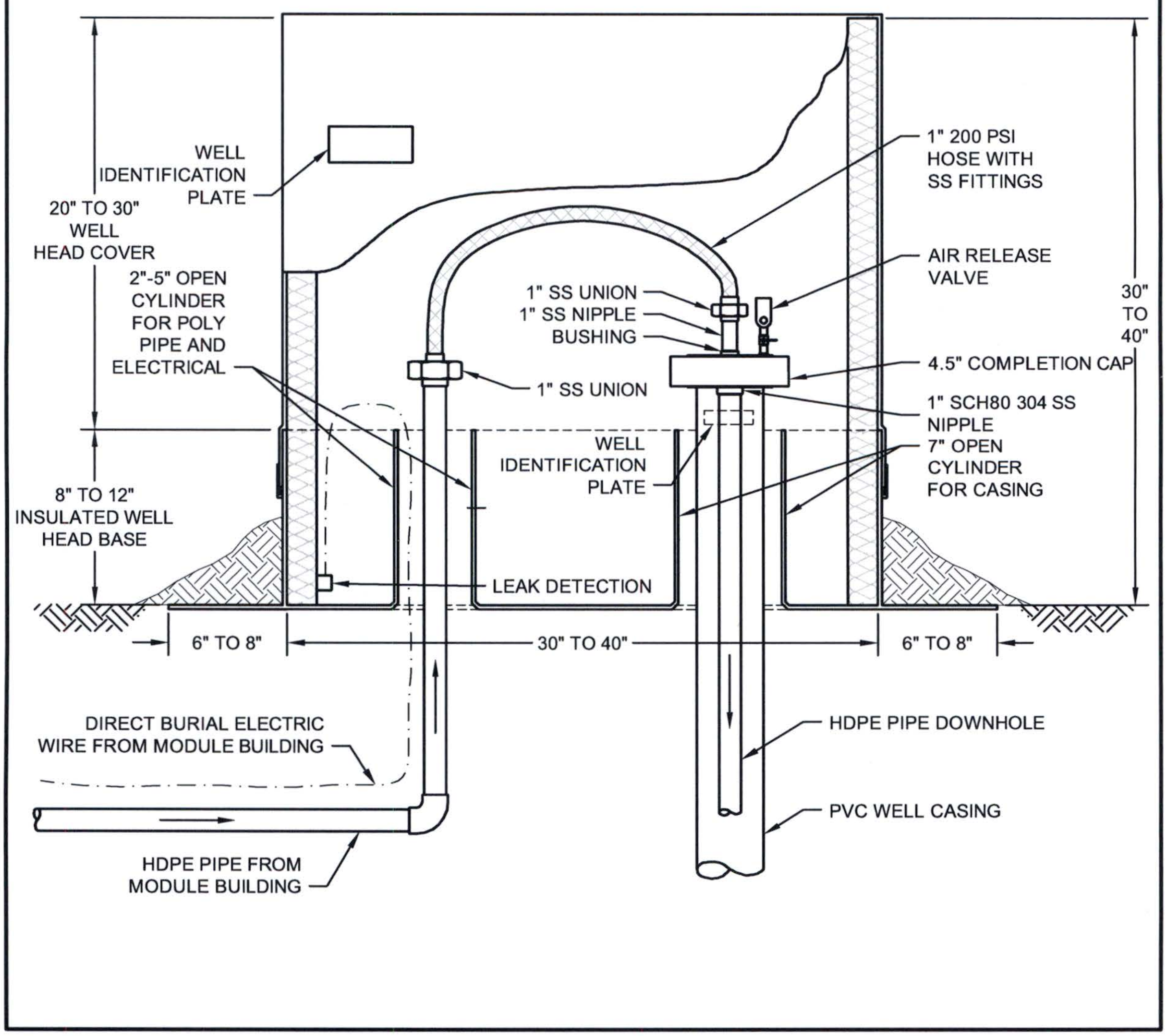
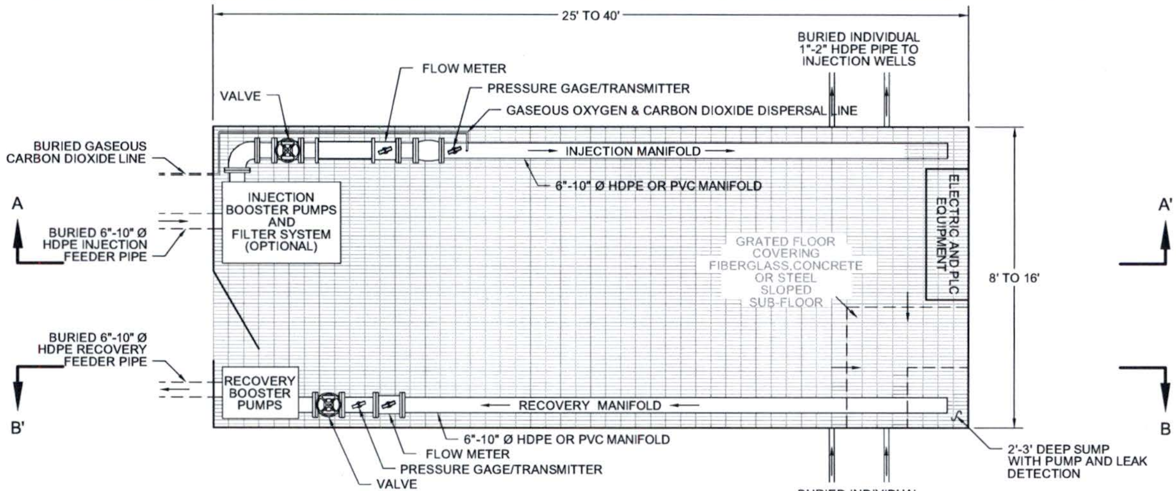
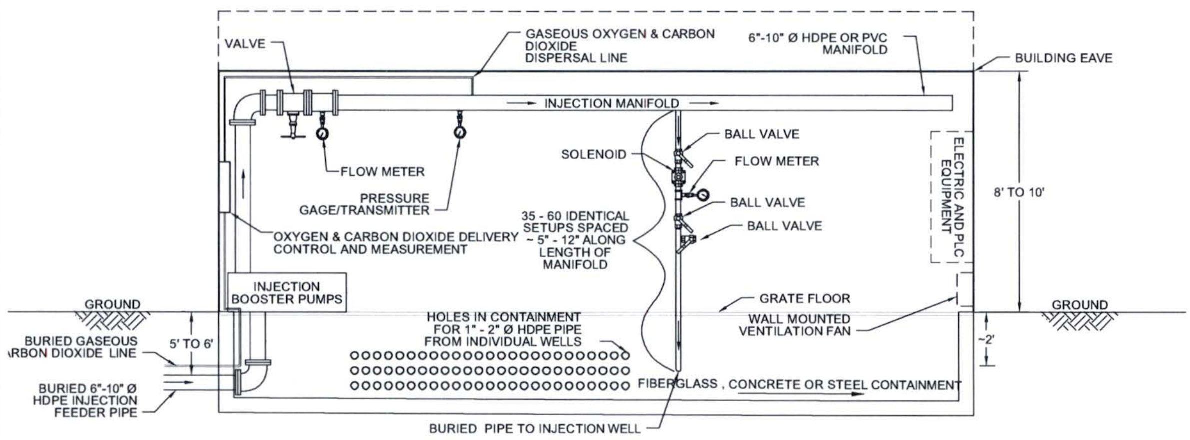


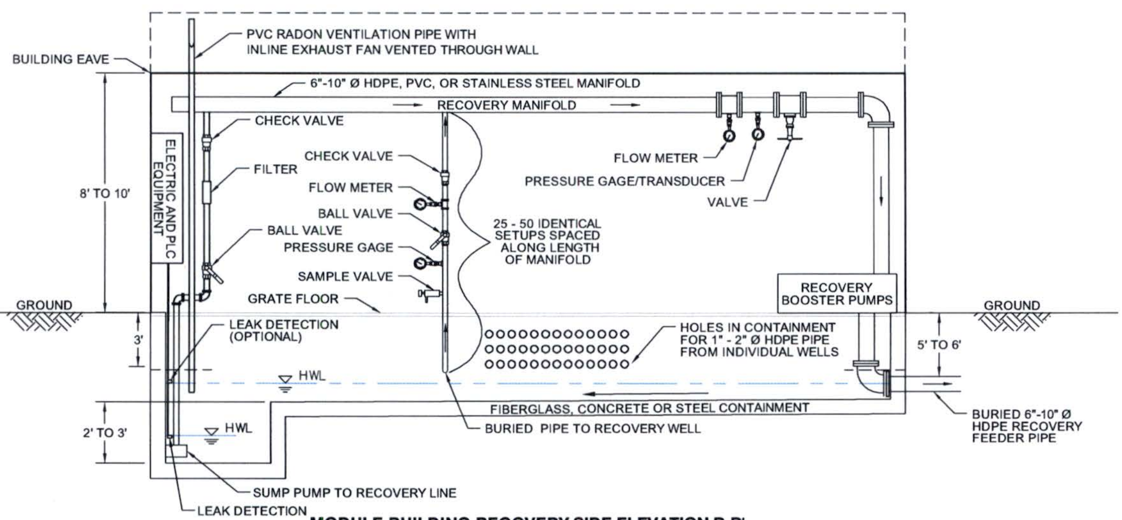
Figure 3.1-8. Typical Injection Wellhead



MODULE BUILDING PLAN
NOT TO SCALE



MODULE BUILDING INJECTION SIDE ELEVATION A-A'
NOT TO SCALE



MODULE BUILDING RECOVERY SIDE ELEVATION B-B'
NOT TO SCALE

Notes:
1. Flow meters will be instantaneous with the total flow reported via PLC algorithm to the SCADA System.
2. Flow and pressure instrument signals will be recorded via the PLC.

STRATA ENERGY

ROSS ISR PROJECT
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REVISIONS	
Date	Description
6/28/17	REVISE TO AS-BUILT

TECHNICAL REPORT
FIGURE 3.1-9

WELLFIELD MODULE BUILDING DETAILS

Drawn By: RAM
Checked By: BJS
Date: 11/29/10

WWC ENGINEERING

FILE: ROSS TR FAC MODBLDG REVISED 6-14-2017JD

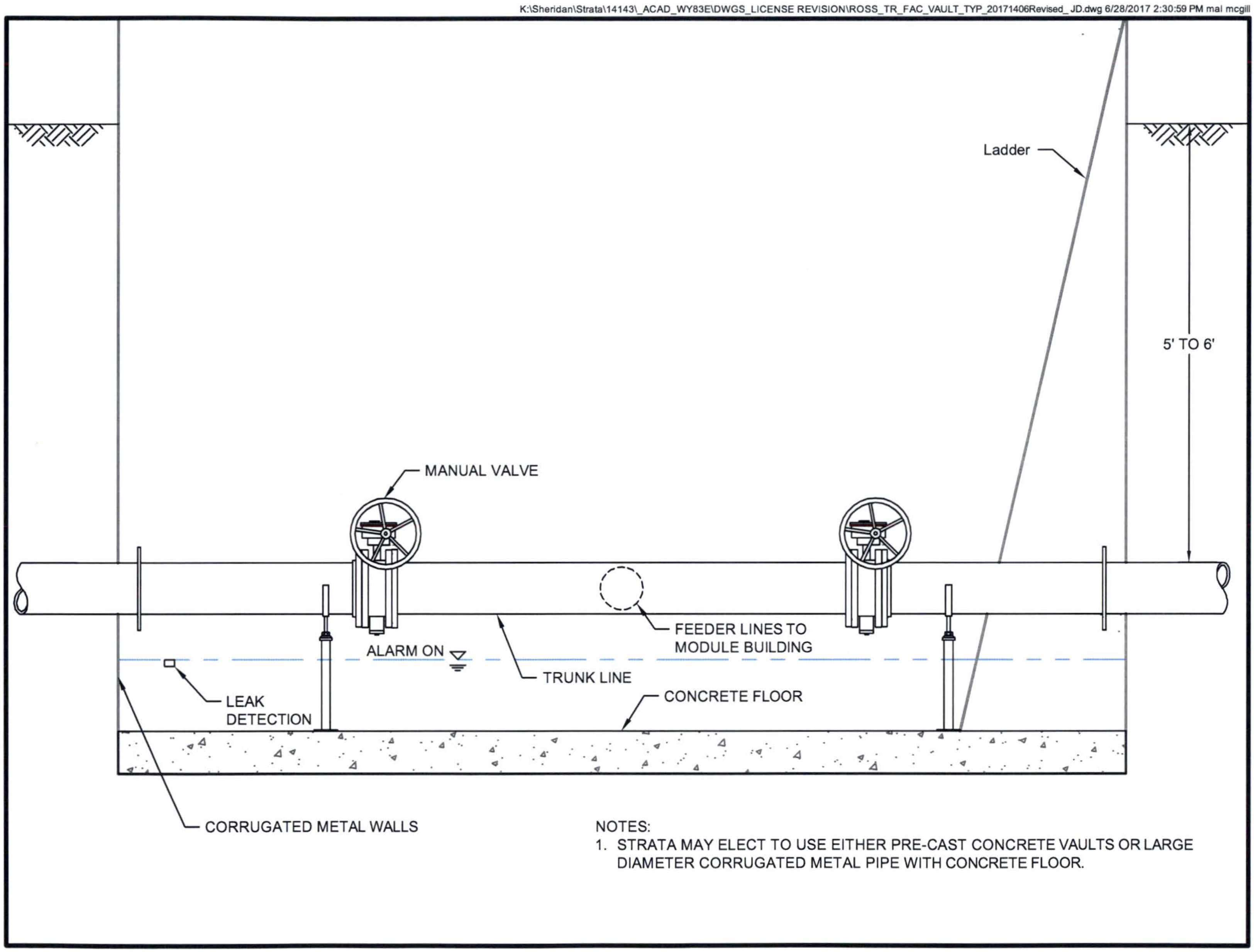
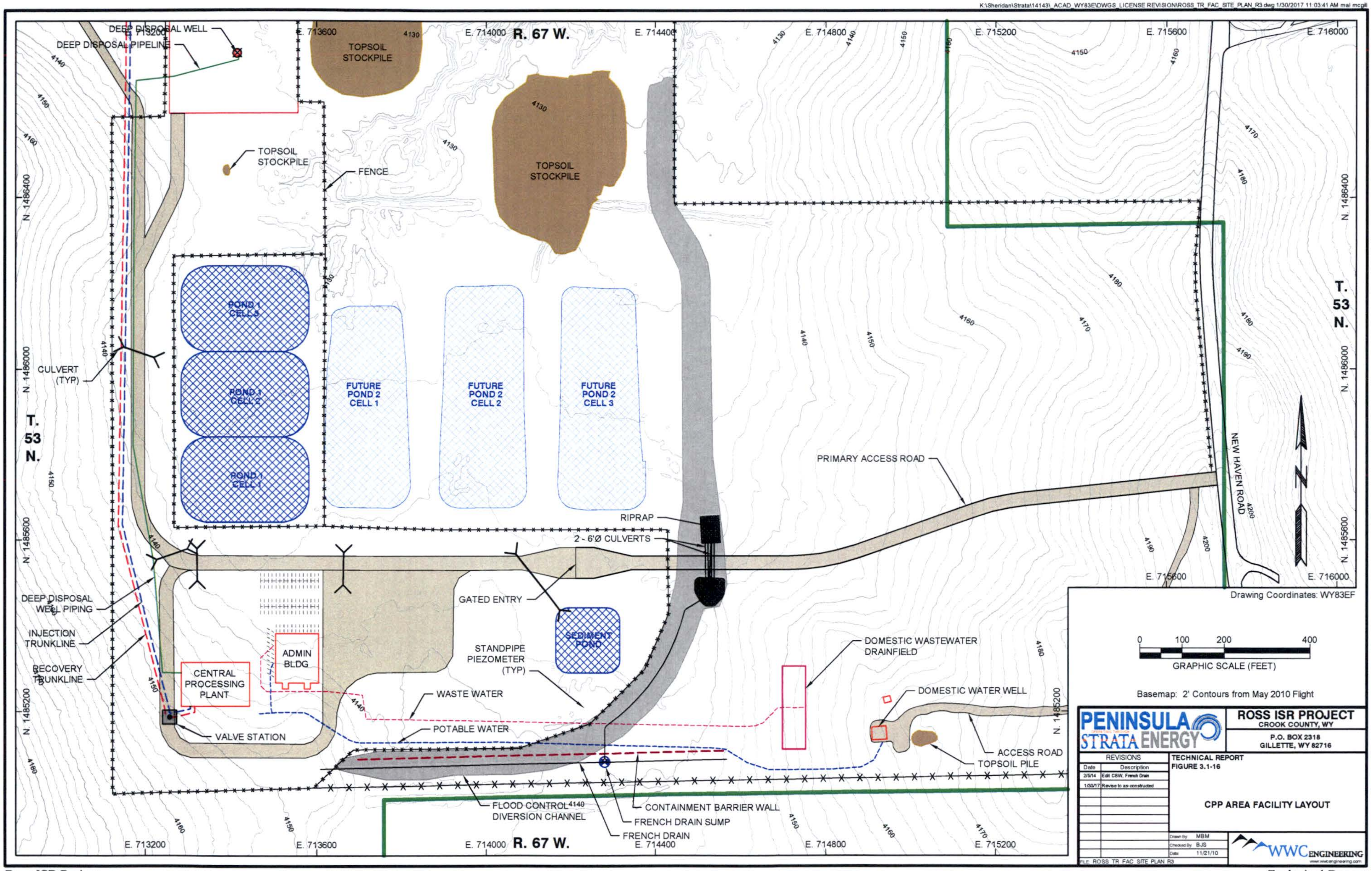
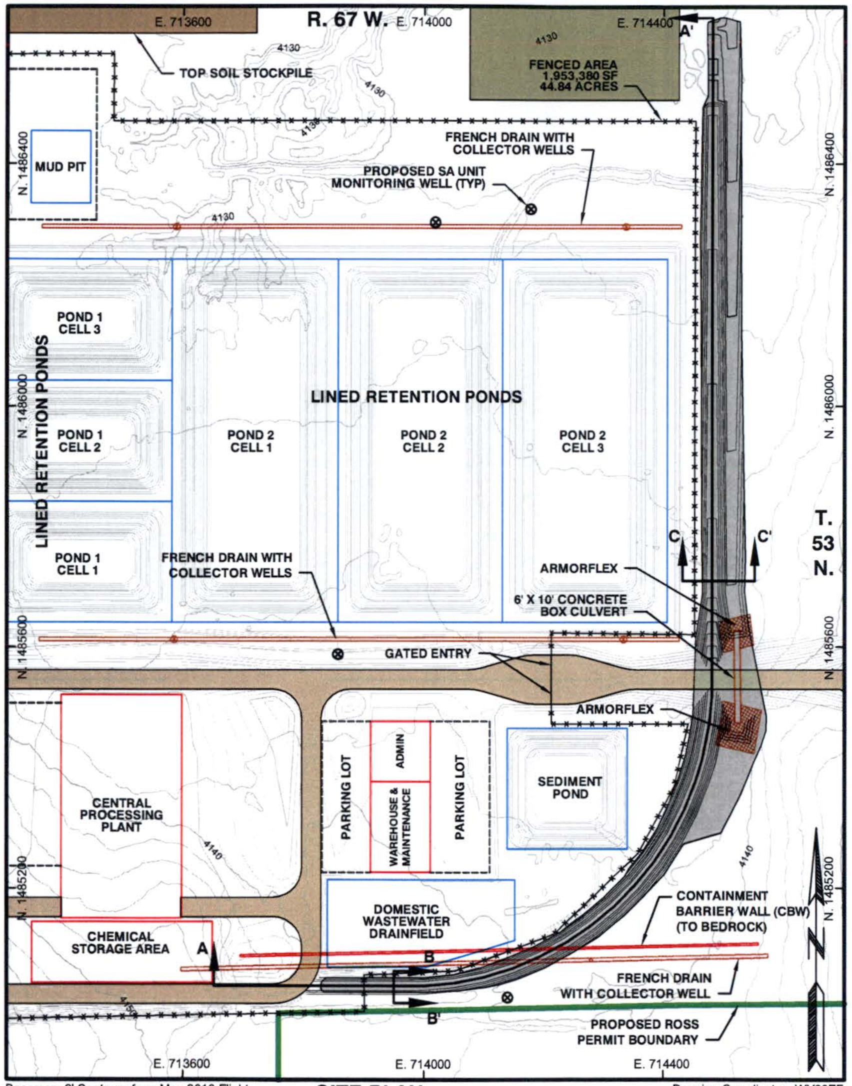


Figure 3.1-10. Typical Valve Manhole


DEEP DISPOSAL WELL
DEEP DISPOSAL PIPELINE
E. 713600
TOPSOIL STOCKPILE
E. 714000
R. 67 W.
E. 714400
E. 714800
E. 715200
E. 715600
E. 716000
TOPSOIL STOCKPILE
FENCE
TOPSOIL STOCKPILE
N. 1486400
N. 1486000
N. 1485600
N. 1485200
T. 53 N.
POND 1 CELL 3
POND 1 CELL 2
POND 1 CELL 1
FUTURE POND 2 CELL 1
FUTURE POND 2 CELL 2
FUTURE POND 2 CELL 3
CULVERT (TYP)
PRIMARY ACCESS ROAD
NEW HAVEN ROAD
RIPRAP
2 - 6'Ø CULVERTS
GATED ENTRY
SEDIMENT POND
DEEP DISPOSAL WELL PIPING
INJECTION TRUNKLINE
RECOVERY TRUNKLINE
CENTRAL PROCESSING PLANT
ADMIN BLDG
STANDPIPE PIEZOMETER (TYP)
WASTE WATER
POTABLE WATER
VALVE STATION
DOMESTIC WASTEWATER DRAINFIELD
DOMESTIC WATER WELL
ACCESS ROAD
TOPSOIL PILE
FLOOD CONTROL DIVERSION CHANNEL
CONTAINMENT BARRIER WALL
FRENCH DRAIN SUMP
FRENCH DRAIN
E. 713200
Drawing Coordinates: WY83EF
0 100 200 400
GRAPHIC SCALE (FEET)
Basemap: 2' Contours from May 2010 Flight
PENINSULA STRATA ENERGY
ROSS ISR PROJECT
CROOK COUNTY, WY
P.O. BOX 2318
GILLETTE, WY 82716
TECHNICAL REPORT
FIGURE 3.1-16
CPP AREA FACILITY LAYOUT
WWC ENGINEERING

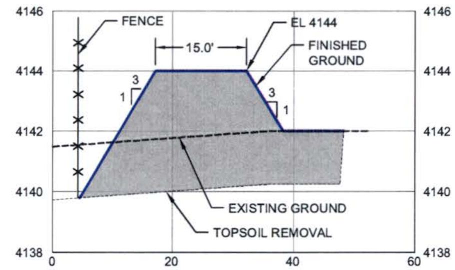
K:\Peninsula_Minerals\09142\ACAD_WY83E\DWGS_PERMIT_REVISIONS\ROSS_TR_FAC_DIVERSION_R2.dwg 2/5/2014 4:28:10 PM mbmcg



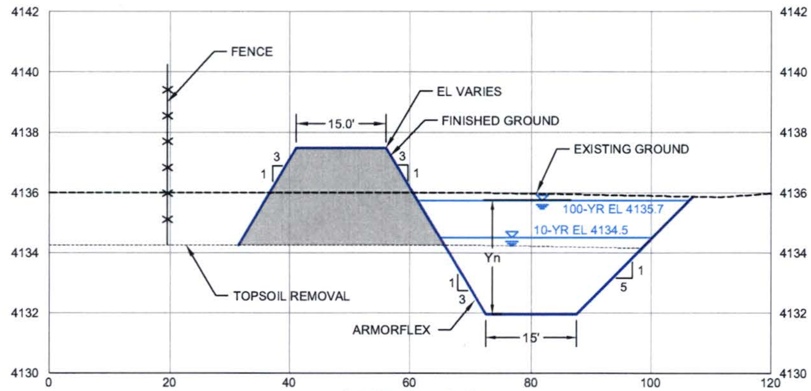
SITE PLAN

0 100 200 400

GRAPHIC SCALE (FEET)



SECTION B-B'
BERM WITHOUT DIVERSION
EXAGGERATION 5H:1V (FT)



SECTION C-C'
BERM WITH DIVERSION
EXAGGERATION 5H:1V (FT)

HYDRAULICS FOR DIVERSION CROSS SECTION

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$ (Manning's)

10-yr, 24-hr		100-yr, 24-hr	
Q = 311.30 cfs	A = 63.91 ft²	Q = 681.10 cfs	A = 112.79 ft
n = 0.03	WP = 35.98 ft	n = 0.03	WP = 46.03 ft
S = 0.0045 ft/ft	R = 1.78 ft	S = 0.0045 ft/ft	R = 2.45 ft
b = 15 ft	V = 4.87 fps	b = 15 ft	V = 6.04 fps
	Yn = 2.54 ft		Yn = 3.76 ft

Note: Berm and Diversion will be reseeded with WDEQ/LQD approved seed mixture.

PENINSULA STRATA ENERGY

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REVISIONS	
Date	Description
3/19/12	Update Plan and Profiles
2/5/14	Edit CBW, French Drain

TECHNICAL REPORT
FIGURE 3.1-18

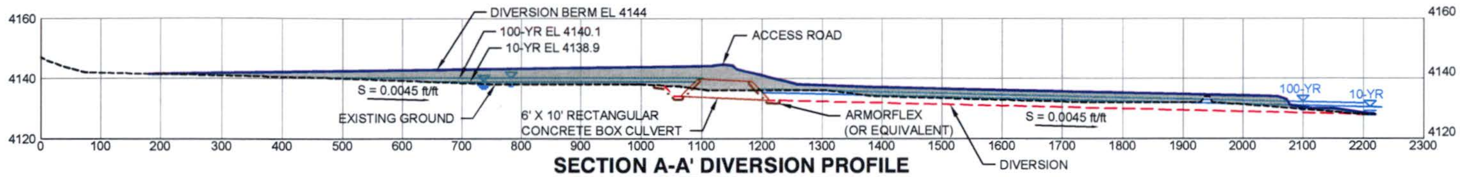
SHEET 1 OF 2

FLOOD CONTROL
DIVERSION CHANNEL

Drawn By MBM
Checked By DEB
Date 12/18/10

FILE: ROSS_TR_FAC_DIVERSION_R2

WWC ENGINEERING

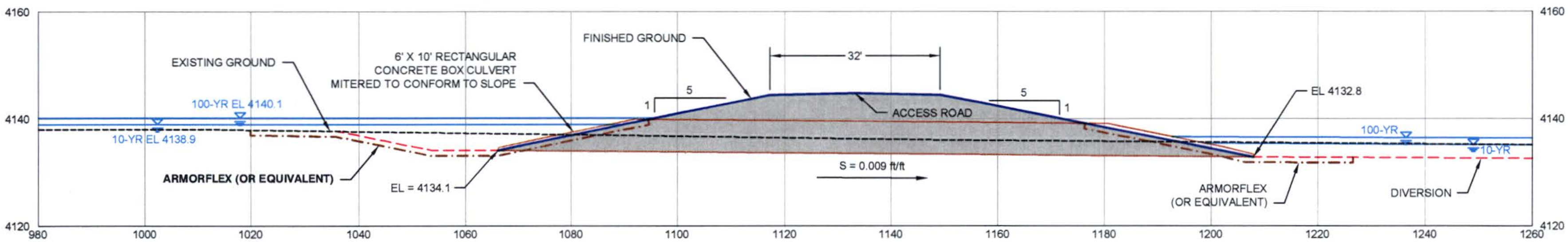


SECTION A-A' DIVERSION PROFILE
EXAGGERATION 5H:1V (FT)

HYDROLOGIC DESIGN STORM CALCULATIONS[1,2,3] (HEC-HMS)

DRAINAGE BASIN PARAMETERS			10-YR, 24-HR STORM			100-YR, 24-HR STORM		
DRAINAGE AREA (sq-mi)	CURVE NO. (CN)	WATERSHED LAG TIME (hrs)	10-YR, 24-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)	100-YR, 24-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)
1.65	78	1.26	2.8	311.3	87.0	4.2	681.1	180.2

NOTES: 1. RUNOFF VOLUMES AND PEAK INFLOWS WERE COMPUTED BY THE HEC-HMS COMPUTER PROGRAM USING THE SCS TYPE II RAINFALL DISTRIBUTION
2. SEE FIGURE 2.7-3 FOR DRAIN
3. SEE TR SECTION 2.7 FOR METHODOLOGY



CULVERT ROAD CROSSING

HYDRAULICS FOR CULVERT ROAD CROSSING 10-YR

DISCHARGE GOVERNED BY WEIR FLOW

$$Q = C_dA(2g(H_w-Y_c))^{1/2}$$

$Q_{10,24}$ = 311.3 cfs   g = 32.2 ft/s^2

Cd = 0.95 H_w = 4.83 ft

A = 31.11 ft^2 Y_c = 3.11 ft

Note: Hydraulic calculations according to Strum, 1976.

HYDRAULICS FOR[1,2] CULVERT ROAD CROSSING 100-YR

DISCHARGE GOVERNED BY ORIFICE FLOW CONDITIONS

$$Q = C_dA(2g\Delta h)^{1/2}$$

$Q_{100,24}$ = 681.1 cfs

g = 32.2 ft/s^2 Δh = 3.54 ft

A = 50.47 ft^2 C_d = 0.894

T_w = 3.76 ft

Notes: 1. Hydraulic calculations according to Brater & King, 1976
2. Water surface elevation determined by adding the Δh and T_w to outlet elevation

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REVISIONS	
Date	Description
3/6/12	Update Plan and Profiles

TECHNICAL REPORT
FIGURE 3.1-18   SHEET 2 OF 2

FLOOD CONTROL DIVERSION CHANNEL

Drawn By MBM
Checked By DEB
Date 12/18/10

WWC ENGINEERING

FILE: ROSS_TR_FAC_DIVERSION

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3.2 Recovery Plant, Processing, and Chemical Storage Facilities

Recovery of uranium from the pregnant lixiviant at the Ross ISR Project will be accomplished at the CPP. Processes used at the CPP to recover uranium will include the following circuits (described in detail in the following sections):

- Resin loading (IX circuit)
- Resin elution
- Uranium Precipitation
- Uranium Product washing, drying and packaging
- Vanadium recovery, precipitation, and packaging

The IX circuit at the CPP will be capable of processing up to 7,500 gpm of pregnant lixiviant. The elution, precipitation, and drying and packaging circuits will be designed to process approximately 3 million pounds per year of U_3O_8. In addition, it has been determined that vanadium may also be produced from the Ross ISR Project; however the relationship of vanadium production to uranium production appears to be quite variable, so a range of production is likely. Given available information, it appears that a likely range of 0.1 To 2.0 lbs of vanadium as V_2O_5 will be produced for each pound of uranium as U_3O_8.

All primary operating equipment and materials required to support the uranium recovery operations will be housed in or near the CPP building. The CPP building will also include equipment for a restoration circuit with the capacity to treat groundwater from wellfield modules that are in restoration. The conceptual general arrangement of the components of the CPP is illustrated in Figure 3.2-1.

The following sections provide a description of each processing system and the equipment and materials used. A complete process flow diagram which shows process flows and equipment is shown in Figure 3.2-2. Table 3.2-1 shows a preliminary mass balance for uranium recovery at the CPP. The initial Phase 1 construction of the Ross CPP involved the construction of a "satellite" facility including an IX processing circuit rated at 3,750 gpm. The facility also includes equipment for addition of sodium bicarbonate and carbon dioxide, an RO system for processing production bleed, a truck bay for shipping IX resin to a toll milling facility, and liquid waste management systems. Future Phase 2 and 3 expansion plans include the construction of additional IX capacity and uranium elution, precipitation, and drying facilities as discussed in the following sections.

3.2.1 *Ion Exchange Circuit*

Recovery of uranium from the pregnant lixiviant will be accomplished through a pressurized down-flow IX process. Pregnant lixiviant from the wellfield modules will flow through the IX resin and the uranium complexes will be exchanged with chloride, bicarbonate, or sulfate ions on the resin surface as shown in the following chemical reaction where R is the IX resin:

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

$$2RHCO_3 + UO_2(CO_3)_2^{2-} \rightarrow R_2UO_2(CO_3)_2 + 2HCO_3^-$$

$$4RCl + UO_2(CO_3)_3^{4-} \rightarrow R_4UO_2(CO_3)_3 + 4Cl^-$$

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

Each resin loading circuit will consist of two pressurized vessels operating in series; each designed to contain a 500 ft^3 batch of anionic IX resin. The IX circuit will capture both the uranium and the vanadium products from the lixiviant. These vessels are expected to be configured in up to seven parallel trains for two-stage down flow loading.

Prior to passing through the IX columns, the pregnant lixiviant may pass through a de-sanding system consisting of sand or other media filter type, centrifugal separators, or settling type clarifiers. The choice of a de-sanding system will depend on the character and amount of any suspended solids in the pregnant lixiviant. A resin shaker deck system is used for filtration purposes. The resin shaker deck system has a ventilation hood to remove radon which can escape the process solution at this stage in production. The roof vent for the resin shaker system is properly located and constructed to minimize the potential of evacuated radon being pulled into the ventilation system for the CPP. In the event that additional filtration is needed, sand filters may be utilized either in the plant or in individual module buildings. If sand filters are used for filtration purposes, the sand filters will periodically require cleaning. This would be accomplished by backwashing accumulated solids from the filter. Barren lixiviant would be pumped upward to fluidize the bed of sand and carry away solids while not removing any sand. The backwash slurry would then be pumped into a holding/settling tank where the solution will be allowed to settle and the barren lixiviant will be sent back to the de-sanding system for recovery. The settled solids would be dewatered in a mobile or stationary filter press. The filter press filtrate is barren lixiviant and would be refortified and returned to the wellfield as lixiviant; the filter cake becomes waste and must be disposed of as 11e.(2) byproduct material. This dewatering step minimizes the volume of 11e.(2) waste produced. The sand filter media will become 11e.(2) waste at the end of project operations.

The IX columns, which are shown in detail on Figure 3.2-3, will also act as media filters and trap particulates in the pregnant lixiviant. During times when the suspended solid concentration in the pregnant lixiviant is very low, the IX columns alone may serve as adequate primary media filters to trap particulates and could be operated as the primary filter when the de-sanding system is offline for cleaning and regeneration. The de-sanding system (if required) will be operated as necessary to minimize fouling and plugging in the IX columns. The solids captured by the primary or secondary filtering methodologies will be stored for proper disposal as 11e.(2) byproduct material. The captured suspended solids will be stored in the 11e.(2) material storage area where it will be collected and shipped to an approved facility. The solids which will be removed from the lixiviant prior to reinjection are expected to include radium, uranium and vanadium attached to clay, silt and sand particles. Information on size distribution of these suspended solids will be required for proper sizing of the appropriate de-sanding system. All solid effluents will be managed as discussed in Section 4.2 of this TR.

The barren lixiviant exiting the second IX loading stage will be monitored and will normally contain less than 2 ppm of uranium. Booster pumps will be located upstream and downstream of the IX trains and a guard column will be located downstream of the IX trains just downstream of the RO unit. IX "guard" columns are used to ensure that all possible uranium is removed from bleed and restoration streams before further treatment. The bleed stream of barren lixiviant is pumped through a guard column similar in construction to a normal IX recovery column or may be built with a deeper bed, but will use the same resin. The specific flow rate (gpm/ft^2) or flux for flow through a guard column is designed to be much lower than what is normally used in a uranium recovery column in order to ensure maximum removal of uranium from the feed stream. A typical guard column will reduce uranium concentrations from 2 ppm to non-detectable levels. The rate that the resin loads with uranium is low due to the low flow rates and feed concentrations. Generally, the resin in a guard column will need elution no more often than once every six months or once a year.

Carbon dioxide is to be added in the CPP, upstream of the resin vessels. The carbon dioxide controls the pH of the pregnant lixiviant to optimize the IX loading capacity of the uranium and the vanadium.

An example of a commercial resin is Dowex 21K XLT resin. This is a resin in widespread, successful use in ISR facilities in the U.S. and elsewhere. It is conventional to use a standard resin that has been tested and thoroughly accepted throughout the industry.

The uranium enriched (or pregnant) lixiviant is expected to arrive in the CPP at ground temperature of about 50 to 60 degrees with a pressure ranging from 80 to 125 psi.

The lixiviant flows through the two columns and the uranium loads on the resin. As resin in the first stage IX vessel becomes loaded, or saturated, and is extracting very little additional uranium from the lixiviant, the vessel is isolated from the normal process flow. The 500 ft^3 batch of loaded resin is removed from the first stage vessel and replaced with stripped, or barren, resin. It is expected that a resin column will likely be loaded in a few days.

Resin manufacturers indicate that the anion resin of choice for uranium extraction also has a slightly lower affinity for vanadium. Therefore, during the loading phase the resin will attract both uranium and vanadium. During the latter stages of loading the resin will tend to have more affinity for the uranium, but the operation will focus upon optimizing the capture of uranium from the lixiviant.

3.2.1.1 Ion Exchange Circuit Equipment

Materials of construction and general specifications for the major IX circuit equipment are listed below.

- IX Vessels and IX Guard Columns

The IX vessels are pressure vessels constructed of mild steel with an epoxy internal coating. Internal distribution headers are constructed of 304SS steel or other material that meets applicable codes and standards. The IX vessels will operate in pressure down-flow mode.

- Booster Pumps

Booster pumps are standard pumps of steel construction.

3.2.2 *Elution Circuit*

The elution circuit will separate both the uranium complexes and the vanadium complexes from the resin as well as regenerate the resin capacity by replacing chloride and bicarbonate ions on the resin exchange sites. The primary chemical reaction involved in elution is shown below. Similar reactions also occur for the displacement of uranyl dicarbonate (UDC) and for bicarbonate loading.

$$R_4[UO_2(CO_3)_3] + 4NaCl \rightarrow 4RCl + Na_4[UO_2(CO_3)_3]$$

The elution of vanadium is believed to behave in a fashion similar to the uranium elution and is expected to strip from the resin under the same conditions as the uranium.

As can be seen in Figure 3.2-4, prior to elution, the loaded resin will be transferred to vibrating screens to wash sand, silt, broken resin, scale, and other trash from the resin before it is placed in the elution columns. All solids recovered during this secondary filtration step will be collected, stored, and disposed as 11e.(2) byproduct material. Resin is then gravity fed to the elution vessels where uranium is recovered and the resin is regenerated.

In addition to the resin from the CPP, resins from other uranium-loaded resin generators may also be eluted at the facility. As mentioned previously, the final CPP will have the capacity to elute 3 million pounds of uranium per year. The IX resin will be pumped from the resin truck to the resin screens and then into the eluate tank, mimicking the same process that is used for the CPP resin. After elution, the regenerated resin is pumped back into the truck for transfer back to the IX generators site. The elution will be conducted in batch mode for the resin being eluted.

The eluate solution, which will contain approximately 10% sodium chloride and 2% sodium carbonate, will be added to the elution vessels, stripping the resin of uranium and vanadium and regenerating the resin for further use. In some cases, it is necessary to add an additional regeneration stage by employing a rinse of hydrochloric acid. If chloride buildup in the lixiviant becomes a problem, a sodium bicarbonate rinse may be included in the elution process. Eluted resin, or barren resin, is then rinsed with fresh water and returned to IX vessels for further loading. The rinse water is then used to make up additional fresh eluate. The elution process will consist of four stages: three (3) eluant stages will contact one 500 ft^3 batch of resin with three bed volumes of eluant each and one (1) rinse stage will contact the batch with four bed volumes of fresh water. Uranium complexes (as uranyl carbonate) and vanadium are then contained in the rich eluate solution. The pH of the solution will be approximately neutral.

3.2.2.1 Elution Circuit Equipment

Materials of construction and general specifications for the major elution circuit equipment are listed below. Further specifications and dimensions will be addressed during detailed engineering.

- Elution Vessels

The Elution vessels are constructed of mild steel with an epoxy internal coating. The Elution vessels will operate in up flow mode and are vented.

- Eluant Tanks

The Eluant tanks are constructed of mild steel with 316SS steel agitators. They are enclosed, agitated, and vented.

- Vibrating Resin Screen

The vibrating resin screen is constructed of 304SS and uses a mesh style vibration screen to separate water from the loaded resin before it is fed to the elution vessel.

3.2.3 Precipitation Circuit

The purpose of the precipitation circuit is to break the uranium complexes and precipitate the uranium. This process will produce uranium peroxide slurry. Multiple precipitation tanks plumbed in series with mechanical agitators will accomplish the steps needed to form the slurry. Precipitation chemicals include sulfuric acid, caustic soda or ammonia, and hydrogen peroxide. Anhydrous ammonia is the least expensive reagent choice for pH control in the precipitation circuit. It is well proven in practice, is easy to control and may have a beneficial effect on product quality. However, use of anhydrous ammonia will require additional permits for control of potential air emissions and issues with Homeland Security. Caustic soda solution can be temporarily substituted for anhydrous ammonia with a few, inexpensive additions to the plant (3 small

- Reverse Osmosis System

The reverse osmosis unit and related pumps will be of stainless steel construction.

- RO Guard Column

The RO vessels will be constructed of mild steel with an epoxy internal coating. Internal distribution headers are constructed of 316SS steel. The guard vessel will operate in pressure down-flow mode.

3.2.6 Bleed Treatment Circuit

The bleed treatment circuit system configuration and components will be very similar to the restoration circuit described above. A bleed flow ranging from 0.50% to 2.00% will be removed from the barren lixiviant stream. The purpose of the bleed is to maintain a net inward hydraulic gradient as measured at the perimeter monitor wells as required in License Condition 10.7. During typical operation, the bleed will enter a holding tank and will then be routed through a two-stage RO system. A portion of the permeate from the RO will be added back to the barren lixiviant stream such that the net production bleed is maintained at approximately 1.25%. The remainder of the permeate will be routed to modules in restoration or a lined retention pond for disposal or recycling. Production bleed may or may not be routed through the RO system depending on the barren lixiviant water quality as well as liquid disposal capacity.

3.2.7 Vanadium Removal Circuit

3.2.7.1 Vanadium Precipitation

The uranium-depleted supernate solution overflows the uranium thickener number 2 and is then pumped to the vanadium precipitation circuit. The vanadium bearing solution is placed into a feed surge tank from where it is pumped to a vanadium precipitation conversion tank, where steam, plant air and ammonia are added in vigorous agitation to convert the vanadium to the pentavalent (+5) state, which is a form better suited to precipitation, prior to placement into one of four agitated precipitation tanks. These tanks typically will work in batch mode with two tanks working at a time.

Ammonium sulfate is added to the vigorously agitated precipitation tanks to effect the precipitation of the ammonium metavanadate (NH_4VO_3) through the formation of crystals. The crystal formation is expected to be sufficient such that where corrosive fluids could be spilled will be coated with corrosion resistant materials as recommended by the manufacturer. Pre-leach tanks, leaching tanks and thickeners will be of plain carbon steel construction lined with chlorobutyl or bromobutyl rubber and capable of operating at 175 F in a highly acidic environment. Elastomeric linings will also be used to resist abrasion from the slurries in these tanks. All slurry piping will use materials that are abrasion and corrosion resistant and solution piping will be appropriately corrosion resistant. Tanks that carry solutions only will be constructed from FRP using resins and liners appropriate to the conditions as recommended by the manufacturers.

3.2.8.1 Process Related Chemicals

3.2.8.1.1 Oxygen

Oxygen will be added to the injection stream either upstream of the injection manifolds within the module buildings or at each well head. Oxygen will be stored as a cryogenic liquid either near the wellfield module buildings or in the chemical storage area adjacent to the CPP. Oxygen will be stored in storage vessels designed, fabricated, tested, and inspected in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. Oxygen storage vessels will be equipped with safety relief devices and will be located at least 25 feet from buildings or as required by applicable NFPA and OSHA standards. Oxygen will be delivered and stored as a cryogenic liquid and then conveyed to the injection point (either upstream of the injection manifold within the module building or at each well head) as a gas through steel piping or other materials that meet applicable codes and standards. Oxygen storage and delivery systems will be designed and fabricated in accordance with NFPA 55 and OSHA standards for the installation of bulk oxygen systems on industrial premises (29 CFR 1910.104).

The hazards associated with oxygen storage include combustion and explosion. To reduce the risk of an accident which could potentially affect other processes or storage facilities and radiological safety, oxygen will be stored a sufficient distance from other infrastructure and storage areas. Facilities used to store oxygen at the project will conform to standards detailed in the NFPA NFPA-55 publication (NFPA 2010). Typically, oxygen storage and dispensing systems will be leased from the bulk oxygen vendor.

Conveyance systems for oxygen will be clean of oil and grease because these substances will burn violently if ignited in the presence of oxygen. The proper pressure relief devices, component isolation and barriers will also be employed. Cleaning of equipment used for delivering and storage of oxygen will be done in accordance with the Compressed Gas Associations CGA G4.1 and/or other industry standards. The design and installation of oxygen piping system will be done according to the requirements of CGA G4.4. Strata has developed procedures that implement emergency response instructions for a spill or fire involving oxygen systems.

3.2.8.1.2 Carbon Dioxide

Carbon dioxide may be used in the ISR process at two locations. Carbon dioxide may be used as a source of carbonate to fortify the barren lixiviant as it leaves the CPP. Carbon dioxide may also be used upstream of the IX vessels to control the lixiviant pH and increase the resin loading capacity. The carbon dioxide storage and feeding system will be a vendor-supplied packaged system including cryogenic tank, vaporizer, pressure gauges, and pressure relief devices. Carbon dioxide will be stored adjacent to the CPP in the chemical storage area. Carbon dioxide presents few potential hazards in its use. The main hazard is through asphyxiation if it is allowed to accumulate in a confined area. To reduce this risk of a harmful accident, carbon dioxide will be stored in the chemical storage area adjacent to the CPP in large tanks. Floor-level ventilation and carbon dioxide monitoring at low point(s) within the CPP will be provided to protect workers from accidental leaks of carbon dioxide.

3.2.8.1.3 Anhydrous Ammonia

Anhydrous ammonia will be used at the CPP as part of the vanadium recovery circuit and, potentially, to adjust the pH of the eluate solution in the precipitation tanks. In the uranium precipitation circuit a base is required to neutralize the acid that forms as a direct result of the yellowcake precipitation reaction. In practice either ammonia or sodium hydroxide is used to accomplish this. Ammonia is more difficult to permit and requires additional safety measures, while sodium hydroxide is typically more expensive and used on a temporary basis until the ammonia permitting is approved. The anhydrous ammonia system will include a storage tank, piping, instrumentation, and safety control devices. All components of the anhydrous ammonia system will be designed in accordance with the American National Standards Institute (ANSI) K61.1 (ANSI 1999) and 29 CFR 1910.111, "Storage and Handling of Anhydrous pounds and TPQs contained in 40 CFR Part 355, Emergency Response Plans for TQs in excess of 1,000 pounds.

3.2.8.1.5 Sodium Carbonate

Sodium carbonate (soda ash) will be used to make up fresh elution brine and will be stored in tanks as a saturated solution in equilibrium with a bed of crystals in the storage tank. Sodium carbonate solution must be kept above 100°F (38°C) to prevent precipitation in the tank and piping. This will be accomplished by heating the water added to the tank, and continuously circulating liquid from the tank through a heat exchanger. An electric heater will be used to heat a thermal fluid to heat the exchanger. Dry sodium carbonate will be delivered by truck and will be blown into the storage tanks using air pressure. Sodium carbonate has a low risk of affecting radiological safety at the proposed project.

3.2.8.1.6 Sodium Chloride

Sodium chloride will be used to make up fresh elution brine and will be stored in tanks as a saturated solution (approximately 26% by weight) in equilibrium with a bed of crystals in each storage tank. Dry sodium chloride will be delivered by truck and will be blown into the storage tanks using air pressure. Sodium chloride has a low risk of affecting radiological safety at the proposed project.

3.2.8.1.7 Sulfuric and Hydrochloric Acid

Sulfuric acid will be used in the precipitation circuit of the CPP to break down the uranium carbonate complexes. The hazards associated with the use and storage of sulfuric acid include corrosiveness, toxicity to tissue, and reactivity with other chemicals which will be used at the project such as ammonia, sodium carbonate, and water. The acid storage tanks will be isolated from the above listed chemicals to reduce the risk of reactions.

The acid storage and feeding system will include one or more storage tanks and delivery pumps. The storage tank will be located adjacent to the CPP building in the chemical storage area. The chemical storage area will include a lined concrete secondary containment basin designed to contain at least 110% of the largest tank volume. This secondary containment basin for acid storage will be lined retention ponds. If the feed solution is added to the ponds, the discharge pipe will release the solution along with permeate below the pond surface to minimize radon release.

3.2.8.2 Non-Process Related Chemicals

Non-process related chemicals that will be stored at or near the proposed CPP include gasoline, diesel and propane. Due to the flammable and/or combustible properties of these materials, all bulk quantities will be stored outside of the CPP in a designated hydrocarbon storage area. All liquid storage tanks will be located above ground within secondary containment structures designed to accommodate at least 110% of the volume of the largest tank in the containment structure. Since the aboveground hydrocarbon storage capacity exceeds 1,320 gallons, Strata has prepared a Spill Prevention, Control, and Countermeasure (SPCC) plan in accordance with EPA requirements in 40 CFR Part 112.

3.2.9 Occupational and Environmental Safety Considerations

3.2.9.1 Control of Emission of Hazardous Materials

Throughout the CPP the release of hazardous compounds to the atmosphere will be mitigated by staged filtration, as well as water scrubbing equipment installed in appropriate process and laboratory ventilation circuits. Where particle control is needed such as in drying and packaging circuits, bag house air filters will be used to ensure that no product is lost to the atmosphere. In acid producing systems, the ventilation systems will contain mist eliminating and recycling systems that return materials to the process circuit. Radon and possible other gaseous daughter products that can be liberated in the IX and elution transfer process will be captured by ventilation systems and directly discharged outside of the CPP without any filtration.

3.2.9.2 CPP Liquid Containment

The CPP will employ three levels of containment for liquid process fluids and effluents: process tanks, secondary containment berms, and an impermeable liner below the building foundation.

The primary form of containment throughout the processing building is each individual process tank or vessel. Secondary containment will consist of concrete curbing. There are two philosophies used for curbing within the CPP, total containment in the event of tank failure and containment of leaks or spills during operations. Curbing to contain a failed tank will be used in areas that pose a major health risk or potential product recovery; these areas will have curbing to contain at least 110% of the volume of the largest tank. Curbing for spill containment only will be employed in areas where it is unnecessary or impractical to contain the total volume of fluid in that area but where it is still desirable to contain spills, one such area is near the yellowcake thickeners. The use of sloped floors within designated areas throughout the CPP will direct any spilled/leaked fluid to an appropriate sump to be disposed of or returned to the process. Table 3.2-2 shows the dimensions and capacities of process vessels, chemical storage tanks, and secondary containment.

The CPP building foundation will incorporate a curb extending at least 12" above finished floor at the base of the walls of the building's perimeter. This wall feature will serve as an additional level of containment for the entire building and will be able to contain 110% of the volume of the two largest tanks used to contain process or chemical liquid in the CPP. The volume of the Concrete surfaces at risk of coming in contact with process fluids or chemical reagents will be sealed with appropriate chemical resistant epoxy coatings. Areas expected to see heavy traffic volume, such as the truck bay, will have a chemical and wear resistant floor coating system. Working in concert with the curbing, the reinforced concrete slab will be sized to minimize (or eliminate) the number of construction or contraction joints necessary and thus will minimize potential leak sites.

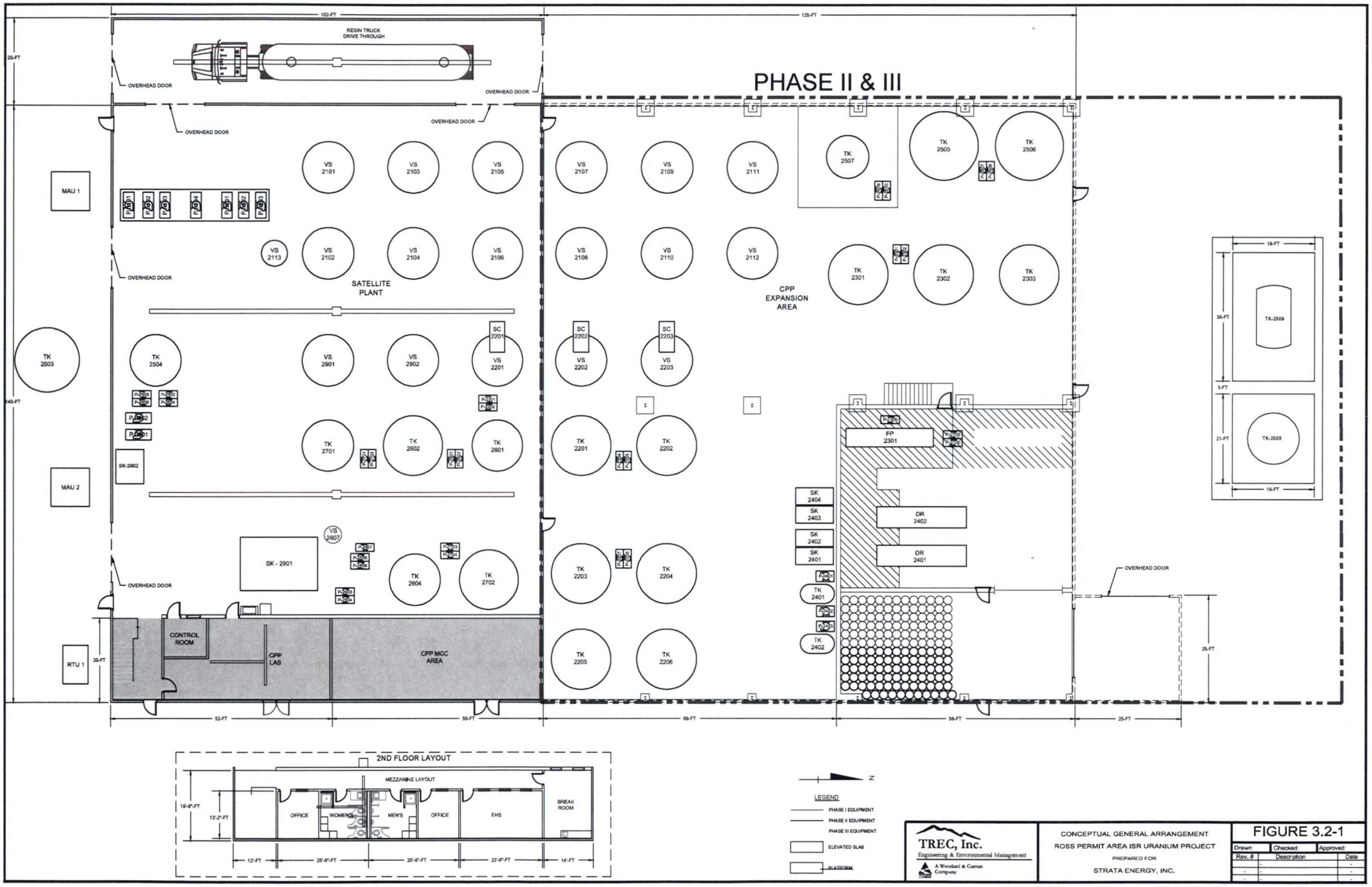
An impermeable liner will be installed under the foundation slab. An example of an appropriate barrier is a single layer of 60 mil HDPE liner as is commonly used to line tailings impoundment ponds in conventional milling operations.

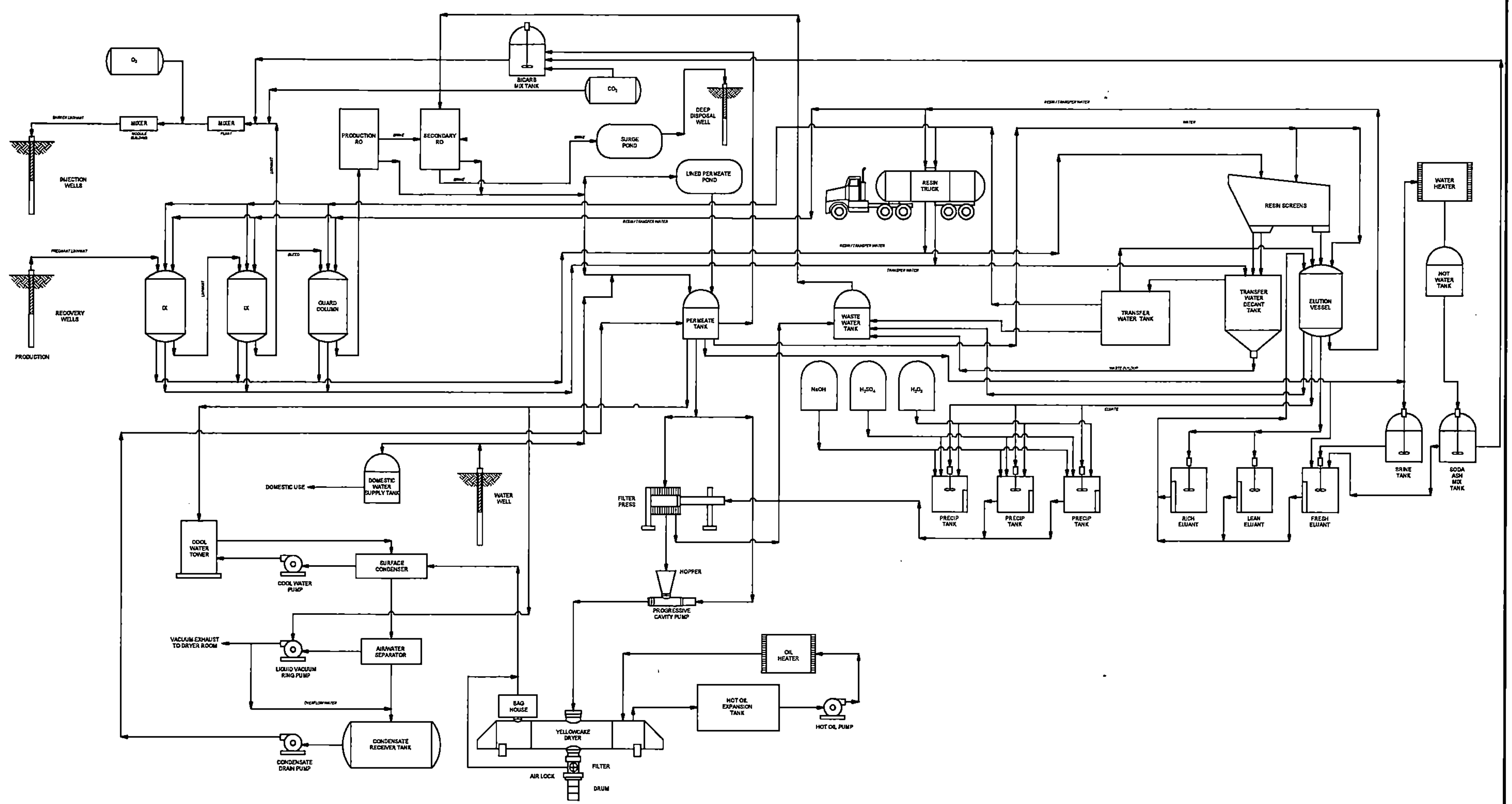
The adjacent chemical storage building and area will employ curbing to contain at least 110% of the volume of the storage tank. Secondary containment in this area will be necessary to keep spills from entering the surrounding environment and to prevent the mixing of chemicals with deleterious effects. The chemical storage area will also include a 60 mil HDPE liner beneath the pad foundation.

Table 3.2-2. CPP Primary and Secondary Containment Capacities

	Largest Tank					Secondary Containment Area				
	Diameter (ft)	Height (ft)	Cone Height (ft)	Volume (cu. ft)	110% of Volume (cu. ft)	Long Side (ft)	Short Side (ft)	Curb Height (ft)	Containment Volume[2] (sqft)	Volume Sufficient for Total Containment of Largest Tank
Process Area Phase I										
Waste Water (Brine Storage	12	18.583		2101.7	2311.9				12240	Yes
IX Vessel[2]	12	6.896		1232.3	1355.5				12240	Yes
RO Area[2][3]		13							12240	Yes
Bicarbonate Mix	12			1470.3	1617.3				12240	Yes
Building Foundation[1][4]						140	102	1	12240	
Process Area Phase II										
Waste Water (Brine) Storage	12	18.583		2101.7	2311.9				25540	Yes
IX Vessel[2]	12	6.896		1232.3	1355.5				25540	Yes
RO Area[3]									25540	Yes
Bicarbonate Mix	12	13		1470.3	1617.3				25540	Yes
Waste Water (Brine) Storage	12	18.583		2101.7	2311.9				25540	Yes
Uranium Precipitation	14	11.19	7	2081.8	2289.9				25540	Yes
Eluate Tanks	14	14		2155.1	2370.7				25540	Yes
Brine Generation	12	14.917		1687.0	1855.7					Yes
Sodium Hydroxide	10	12		942.5	1036.7	22	21	2.25	1039.5	Yes
Building Foundation[1][4]						227	102	1	25540	
Exterior Chemical Storage Area										
Sulfuric Acid	12	12.167		1376.0	1513.6	21	19	3.8	1516.2	Yes
Hydrogen Peroxide	8	13		787.5	866.2	30	19	1.52	866.4	Yes

Notes:
(1) Containment volumes do not include sloped floors below base of curb.
(2) Tank volume based on pressure vessel with a 2:1 ellipsoidal head; Height listed refers to straightwall of vessel.
(3) RO containment area is not rectangular therefore multiple areas are added to calculate volume (see Figure 5.7-4).
(4) Area calculated as building footprint less the lab, electrical and control room, packaging and storage rooms.


PHASE II & III
RESIN TRUCK DRIVE THROUGH
OVERHEAD DOOR
SATELLITE PLANT
CPP EXPANSION AREA
CONTROL ROOM
CPP LAB
CPP MCC AREA
2ND FLOOR LAYOUT
MEZZANINE LAYOUT
OFFICE
WOMEN'S
MEN'S
OFFICE
EHS
BREAK ROOM
LEGEND
PHASE I EQUIPMENT
PHASE II EQUIPMENT
PHASE III EQUIPMENT
ELEVATED SLAB
PLATFORM
TREC, Inc.
Engineering & Environmental Management
A Woodard & Curran Company
CONCEPTUAL GENERAL ARRANGEMENT
ROSS PERMIT AREA ISR URANIUM PROJECT
PREPARED FOR
STRATA ENERGY, INC.
FIGURE 3.2-1



TREC, Inc.
Engineering & Environmental Management
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OVERALL PROCESS FLOWSHEET
ROSS PERMIT AREA ISR PROJECT
STRATA ENERGY, INC.
CROOK COUNTY, WYOMING

FIGURE 3.2-2

Drawn:	Checked:	Approved:
Rev. #	Description	Date

3.3 Instrumentation and Control

3.3.1 Instrumentation and Control

Process control at the CPP will be conducted from a central control facility wherein plant operations can be monitored and controlled 24 hours a day. In addition, other control capabilities will exist throughout the wellfield and the CPP so that local control can be exercised by field operations personnel.

The Master Control System (MCS) will reside at the CPP and consist of a PLC system capable of monitoring and controlling the CPP as well as some functions in the module building. Each module building will also have its own PLC system that communicates with the CPP and will allow for continuous operation even if communication to the CPP is lost.

Operators can interface with the control system in several ways. The PC based Central Operator Station (COS), located in the main control room of the CPP is one such way. Customized screens representing the various areas and systems display information in an easy to understand fashion and allow for intuitive control and process manipulation. The COS or comparable computer system will also be loaded with a historical data software package used for tracking and trending critical values and event timing. Alarms and notifications for both the CPP and Module buildings will be displayed on the COS.

Limited, local control is achieved using panel mounted HMI touch screens. Manual hand switches may also be utilized where needed.

3.3.2 Wellfield

Wellfield instrumentation and control are discussed in Section 3.1.

3.3.3 CPP

Flow rates and line pressures will be monitored throughout the CPP to manage and guide plant operations. These flow rates and line pressures will be monitored at locations such as:

- Feed to the IX columns;
- Feed to the RO guard column;
- Feed to the RO Unit #1;
- Barren lixiviant feed to filter;

- Plant air
- Antiscalant

In addition, level controls will be used in tanks such as:

- Eluant tanks
- Precipitation tanks
- Resin transfer tanks
- Bleed fluid tank
- Uranium thickener
- Uranium thickener overflow tank
- Vanadium precipitation feed surge tank
- Vanadium precipitation conversion tank
- Vanadium precipitation tanks

The system will also have pressure indicating transmitters on all pressurized tanks such as IX vessels and pH metering and control in the eluant system. The differential pressure across the IX and elution vessels will be monitored closely and used to trigger alarms and automatic shutdown sequences should the values exceed the safe limit. Low differential pressure may indicate a leak or malfunction. Level, pH, temperature, and flow will also be monitored throughout the site and used to automate to the desired level.

The system will be controlled by the MCS with alarms and automatic shutoff capability built into the control system at appropriate limits for each individual monitoring and control point. All pumps and motors will be monitored and controllable through the MCS system.

The overall control system will be designed so that appropriate redundancy exists for safe plant operation. Critical pumps will have backup pumps designed into the system such that if a failure occurs, the pumping operation can be easily controlled. Redundancy will also occur from installing multiple monitoring points for each process. If a monitoring point fails, other monitoring points can be used to provide an indication of plant conditions while a monitoring point is checked for replacement or repair. Typical monitoring equipment is provided in Table 3.3-1 and preliminary monitoring point locations are shown in Figure 3.3-1. In accordance with 10 CFR Section 2.390(a)(4), the plant designs are

4.0 EFFLUENT CONTROL SYSTEMS

This section describes the effluent control systems for the Ross ISR Project. Effluents will be typical of Wyoming ISR projects and will include gaseous emissions, airborne particulates, and solid and liquid waste. The effluent control systems proposed at the Ross ISR Project include existing technologies that have demonstrated success at controlling effluents using specific procedures, training, and engineering controls to reduce effluent production and minimize the potential for accidental releases. The proposed monitoring and control systems have been located to optimize their intended function and are appropriate for the types of effluents generated during ISR construction, operation, aquifer restoration and decommissioning. These procedures include recycling/reusing materials through segregation of waste, careful control of all materials delivered to or transported from the proposed project area in accordance with US DOT and 10 CFR Part 71 requirements, extensive employee training in hazard recognition and prevention of accidental releases, use of signage, detailed Standard Operating Procedures and Spill Prevention/Response Plans, and use of engineering controls for all types of effluent. SOPs and spill prevention plans will address contingencies for all reasonably expected system failures and include appropriate personnel to be notified, measures to efficiently detect and mitigate a release to the environment and confirmation that the SOPs comply with notification requirements.

dryer. The design of the vanadium dryer is similar to that of the uranium dryer. Emissions from the vacuum dryers are easily contained because the dryers operate under a vacuum and process material does not come into contact with the heating system. Off gas from the dryer will be treated with filtration, and then routed to a condenser to remove the water vapor and ammonia. Vanadium precipitation tanks will be vented to a wet scrubber which will remove the ammonia and ammonium sulfate. Ammonia and ammonium sulfate is then recycled back to the vanadium precipitation system.

4.1.2 Radioactive Gaseous Emissions and Control Measures

Radon gas will be the primary source of radioactive gaseous effluent at the Ross ISR Project. Radon is a radioactive, colorless and odorless gas that occurs naturally as the decay product of radium. Radon is present in the lixiviant solution that is extracted from the wellfields and piped to the CPP for processing. Radon gas may potentially be released in the CPP as a result of solution spills, filter changes, IX resin transfer operations, and maintenance activities. Routine monitoring of radon progeny within the CPP (see section 5.7.3.2) will identify exposure levels and initiate corrective actions, if necessary, to ensure exposures of workers are maintained as low as reasonably achievable (ALARA). These measurements will form the basis of worker dose assessment from radon progeny and assignment of this component of internal dose (exposure in working level hours, along with breathing zone sampling results) is described in Section 5.7.4. Additionally, these radon sources contribute to the overall facility source term and consequent off-site public dose as demonstrated by the MILDOS analysis described in Section 7.3.

Areas within the CPP where radon exposure will be of concern include the IX vessels, resin transfer area, resin shaker screens, and in fluid collection sumps. Pressurized down-flow IX vessels with vents in the top of each vessel will be used which will minimize radon releases. The primary method of radon control at the CPP is by venting tanks through piping and exhaust fans to the outside ("local ventilation"). The resin shaker screens will have exhaust hoods and exhaust fans. Vents from these local ventilation control systems may be connected to a manifold and will be discharged through vents on the plant roof (see additional discussion below). Vents will be located away from plant ventilation intakes and will be located on the leeward side of the CPP. Exhaust fans for these systems will create a negative flow, ensuring that air will not enter the process areas from the vessels or systems. Spare fans and/or critical parts will be maintained on-site to ensure that inoperable equipment can be repaired in a timely manner. Radon exposure risks to personnel in the CPP will be further reduced by the general plant area HVAC system. The general plant area ventilation system will circulate air within the CPP by exhausting air outside the building, forcing fresh in. The HVAC system will typically only be operated during the winter months when heating is required. It is expected that passive ventilation and local ventilation will be sufficient during the warmer months to maintain acceptable radon levels in the CPP. The general plant area HVAC system will be designed to provide a minimum of 6 air changes per hour, which will require fans sized to generate an intake flow rate of 40,000 cubic-feet per minute (cfm). Air sampling for radon progeny will be conducted regularly in the plant as described in Section 5.7.3 to test the adequacy of the ventilation and assess if the amount of ventilation can be reduced to conserve electricity and natural gas. Additionally, a radon daughter continuous air monitor (CAM) will be utilized for the first year of operations to continually monitor the air in the CPP for radon daughters and ensure radon control measures are adequate and that radon daughter concentrations are maintained below 25% of the DAC.

Exhaust points used for radon control may be ducted through a common system terminated above the facilities roof per local and federal codes. The general air within the facility will be gravity ventilated up through a ridge vent. This used air will not come in contact to any critical process air and needs no filtration. Tanks containing hazardous materials, such as acid, will contain a filtration unit or demister type system prior to discharge outside the CPP.

Minor amounts of radon gas may be released outside of the CPP from the wellheads, module buildings, and lined retention ponds. At the wellheads and lined retention ponds, radon will be released directly to the atmosphere where it will rapidly disperse. Wellhead enclosures may be vented to reduce radon buildup which could otherwise expose wellfield personnel during inspection and maintenance activities. If vents are not installed on wellhead enclosures, SOPs will be used for accessing wellheads to ensure exposures to personnel are minimal. Module buildings will have ventilation systems consisting of a roof- or wall-mounted fan.

The CPP and module buildings will also be ventilated passively by opening doors during processes when radon may be released. Ventilation of this type will be suitable most months of the year. Applicable SOP's will include this requirement.

4.2 Liquid Waste

4.2.1 Sources of Liquid Waste

The proposed Ross ISR Project will generate several types of liquid waste during construction, operation, and restoration activities. Liquid waste at the Ross ISR Facility can be divided into two general categories: AEA-regulated wastes, and non-AEA-regulated wastes. AEA-regulated wastes include wastes 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." AEA-regulated liquid wastes include brine and excess permeate from the treatment of production bleed and aquifer restoration water, decontamination waste water, spent eluate and other process liquids, and "affected" groundwater generated during well enhancement and maintenance activities. Non-AEA-regulated liquid wastes will include TENORM (technologically enhanced naturally occurring radioactive materials); storm water runoff; Hazardous waste such as petroleum products and chemicals; and domestic sewage. TENORM liquid waste includes drilling fluid and "native" groundwater generated during construction and development of monitor, recovery and injection wells, and groundwater generated during sample collection, and aquifer testing of wells.

As discussed in Section 3.1.5, uranium recovery will follow a "phased" mode, consisting of the operation only phase, the concurrent operation and aquifer restoration phase, and the aquifer restoration only phase. Figures 3.1-11 through 3.1-13 present the anticipated water balance during each phase.

4.2.1.1 AEA-Regulated Liquid Wastes

4.2.1.1.1 Brine

At the Ross ISR Project, brine will be generated from RO treatment of the production bleed and treatment of groundwater from aquifer restoration. Two stages of RO will be used in treating both the production bleed and restoration water. From the second phase RO brine will be discharged into the lined retention ponds for storage and eventually disposal in the deep disposal wells. Methods used to dispose of brine as well as brine generation and disposal rates are discussed below in Section 4.2.3.

monitor well is expected to use between 3,000 and 30,000 gallons of water during drilling and well development and average around 6,000 gallons. Volumes generated during work over and enhancement operations are expected to be similar.

4.2.1.2 Non-AEA-Regulated Liquid Wastes

4.2.1.2.1 TENORM

TENORM liquid waste includes drilling fluids and drill cuttings from monitor wells and from the construction and development of recovery and injection wells prior to using the wells for ISR uranium recovery. TENORM drilling fluids will be stored and disposed of on-site in mud pits, which will be constructed adjacent to the drilling pad. TENORM groundwater produced during baseline activities was discharged under a temporary WYPDES permit as discussed below. It is expected that other TENORM groundwater generated during the operation and decommissioning phases will be discharged in a similar manner as long as the well is not completed in an interval which could have been affected by uranium recovery operations.

During hydrologic baseline activities, TENORM groundwater was discharged during sample collection and aquifer testing. The "native" groundwater had not been exposed to any uranium recovery processes or chemicals. The groundwater recovered during these activities was discharged to the surface in a non-erosive manner. This discharge was authorized under temporary WYPDES permit WYG720229. In accordance with the permit, the discharge was monitored for flow, TDS, TSS, pH, radium, and uranium, and the results reported to WDEQ/WQD. These discharges occurred during water quality sampling at each of the 6 baseline well clusters and throughout July of 2010 during aquifer tests conducted at each of the baseline well clusters.

As discussed above, a typical injection, recovery, or monitor well is expected to use between 3,000 and 6,000 gallons of water during drilling and well development and average around 4,000 gallons. In addition, installation of each well is expected to yield approximately 5 to 15 cubic yards of drill cuttings.

4.2.1.2.2 Storm Water Runoff

Storm water management is controlled under WYPDES permit(s) issued by the WDEQ/WQD. Regulations under the federal Clean Water Act and

Chapter 2 of the Wyoming Water Quality Rules and Regulations require operators of construction sites that disturb one acre or more to obtain coverage under a storm water permit. As part of the permit, a storm water pollution prevention plan (SWPPP) has been prepared that describes best management practices (BMPs) used to keep pollutants out of surface waters and storm drains. Periodic review of BMPs will ensure that storm water runoff is not a potential source of pollution.

Facility drainage is designed to route storm water runoff away from or around the CPP, parking areas, and other associated structures. As discussed in Section 3.1, storm water runoff from the area around the CPP is collected in a storm drain system and routed to a sediment pond for disposal.

4.2.1.2.3 Waste Petroleum Products and Chemicals

Small quantities of used oil will be generated from equipment and vehicles used at the project. The waste petroleum products will be temporarily stored on site before being transported to a nearby recycling or disposal facility. These wastes will not have been affiliated with the processing or generation of 11e.(2) byproduct material and will not be classified as AEA-regulated waste.

Used petroleum will be stored in suitable container(s) located in a secondary containment in accordance with the Strata SPCC. Secondary containment will contain 110% of the tank volume. Spills of waste petroleum will be contained, mitigated, cleaned up, and reported in accordance with WDEQ requirements.

Strata has determined that the Ross ISR Project is classified as a conditionally exempt small quantity generator (CESQG) by WDEQ/SHWD. As such, the project is required to generate less than 220 pounds (100 kg) of 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 continue to meet the requirements for a CESQG, it would 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).

4.2.1.2.4 Domestic Sewage

Domestic sewage generation will vary throughout the phases of the project based on the number of workers on site. The maximum anticipated number of workers will occur during the construction phase when approximately 200 workers will be on site. Based on a peak waste generation rate of 30 gallons per day (gpd) per industrial employee (Chapter 11, Wyoming Water Quality Rules and Regulations), the peak daily domestic wastewater generation rate is expected to be up to about 6,000 gpd during construction. The average daily wastewater generation rate during operation will likely be up to about 800 gpd, based on the EPA (2002) domestic wastewater generation rate of 13 gpd for industrial building employees.

Domestic waste is disposed in an on-site wastewater treatment system. The system was designed and permitted through WDEQ/WQD. The system includes a septic tank for primary treatment and is pumped from a dosing tank to a pressure-dosed drainfield.

The number of contract workers at times may be more than operating personnel, Strata may use temporary holding tanks (porta potties) pumped by a wastewater disposal contractor to cover these periods. This would reduce the amount of on-site effluent disposal.

4.2.2 Lined Retention Pond Design

Two ponds are planned as part of the waste storage infrastructure at the Ross project area. Each pond will include three cells and will be built utilizing common containment berms. Interconnected piping within the ponds will allow the transfer of liquids between cells. Ponds will include double liners and leak detection systems as described in Section 4.2.2.1.

Lined retention ponds will be designed to meet the requirements of both NRC Regulatory Guide 3.11 for embankment retention systems and Wyoming Water Quality Rules and Regulations, Chapter 11, for lined wastewater storage ponds. The proposed pond designs will not be covered under the National Dam Safety Program because the proposed impoundments do not meet the criteria listed in NRC Regulatory Guide 3.11. The primary purpose of retention ponds is to manage permeate and brine inflows to optimize disposal techniques and provide for waste storage in the event of upset conditions. Sheet 1 of Figure 4.2-1 shows the location and layout of Pond 1 as constructed and the location of proposed Pond 2.

Pond cells will be rectangular, with maximum internal slopes of 3 horizontal to 1 vertical. Ponds will be 17 feet deep with 3 feet of freeboard and a maximum hydraulic depth of 14 feet. Wherever possible, ponds will be almost entirely incised to minimize embankment fill and minimize the volume of water that could be released during a catastrophic embankment failure. Final pond designs for Pond 1 were prepared following a geotechnical analysis of foundation and borrow soil conditions. Designs were prepared and submitted to WDEQ and NRC by a licensed professional engineer registered in the State of Wyoming. Designs for Pond 1 were also submitted to EPA Region 8 for construction approval. Typical pond design details are shown on Sheet 2 of Figure 4.2-1. Final pond designs will be included in a separate facilities design report, Addendum 3.1-A, submitted at a later date following further evaluation through geotechnical drilling programs. Final designs for the ponds will include a quality control program for installation, tests to demonstrate liner resistance to chemicals and any other pertinent analysis required to establish that the structures meet all necessary regulatory requirements.

As discussed in Sections 3.1 and 2.7 of this report, preliminary evaluations of the surficial aquifer at the CPP site indicate that shallow groundwater is present at depths ranging from 8-12 feet below grade. Current proposed pond depths extend up to 14 feet below grade. In order to mitigate the effects of the surficial aquifer on the ponds, each pond cell is equipped with an underdrain. The underdrain for each cell consists of a gravel filled trench with a slotted drain pipe located below the secondary geosynthetic liner. The slotted collection pipe is sloped to a sump which contains a pump, float controls, and a high water alarm. The high water alarm will be set at an elevation 1 foot below the bottom of the pond. The underdrains along with the CBW and french drain described in Section 3.1.8.2 will ensure that shallow groundwater does not impact the pond liner or leak detection systems. Due to the presence of consistent low permeability bedrock below the site, it is expected that maintenance dewatering efforts will be minimal once the water table is initially lowered. Water generated from the underdrains will meet surface discharge standards and will therefore be discharged under a WYPDES permit.

Under normal operating conditions, the water levels in the pond cells will be maintained such that the total volume of liquid in any one cell of the pond can be transferred to the other two cells to allow for leak repair. Two water levels will be considered in the pond designs, as indicated on Figure 4.2-1: (1) high water level (HWL), which is the highest water level that will be obtained in any pond while maintaining a minimum of three feet of freeboard, and (2) normal water level (NWL). The NWL is the maximum level that will provide sufficient storage in the event that brine or permeate from a leaking pond cell needs to be transferred to other cells within a pond. The capacity at the NWL is termed the operating capacity and the capacity between the HWL and NWL is termed the auxiliary capacity (see Figure 4.2-1, Sheet 2). Table 4.2-1 shows the anticipated operating capacity, auxiliary capacity, and total capacity for the ponds. The minimum freeboard depth of 3 feet will be sufficient to capture direct precipitation resulting from the 100-year, 24-hour storm and protect the embankment from wave runup. In the Oshoto region, the 100-year, 24-hour precipitation total is about 4.2 inches as discussed in Section 3.1 of the ER. The contributing drainage area of each pond is nearly equal to the HWL area so therefore the 100-year, 24-hour precipitation event is expected to result in a net water level increase of less than 0.5 foot in each pond.

Prevention of overfilling due to abnormal operation, malfunctions in level equipment or human error will be minimized through frequent inspections and maintenance of freeboard.

Potential impacts to avian wildlife from liquid waste in the sediment and lined retention ponds will be reduced by using avian specific deterrents such as bird proofing (netting) and/or aversion techniques (sound/visual hazing systems or best available control technologies (BACT) as determined after construction and as indicated by monitoring efforts.

4.2.2.1 Pond Liner and Leak Detection Systems

The retention ponds liners and leak detection systems will meet the requirements of Regulatory Guide 3.11. Each pond will be equipped with an impermeable high density polyethylene (HDPE) or polypropylene (PP) primary liner with a minimum thickness of 36 mils (0.036 inch). HDPE and PP liners are generally very resistant to chemicals and alkaline and acid agents, with the exception of oxidizing acids, and salt solutions (Renken et al 2005). Site preparation and liner installation will be in accordance with manufacturer's specifications.

The leak detection system will consist of a permeable drainage layer and a collection piping system. The permeable drainage layer will be located directly under the primary liner. This layer will provide support for the overlying liner, and will also transmit any leakage to collection pipes. The drainage layer will be constructed of suitable transport media (i.e. sand). Geocomposite fabric will be used on the side slopes to allow movement of the leakage to the collection pipes. The pond bottom will be sloped from the center outward. The perforated pipes will be installed along the same slope as the pond floors and will drain to riser pipes located in the embankment. The presence of liquid in these riser pipes above a specified level (i.e., six inches) will be followed by sampling for water quality to confirm a leak is the cause of the moisture. Water quality analysis will include electrical conductivity and other major ions required to evaluate and mitigate a liner integrity issue. A cross section of the ponds leak detection system is shown in Sheet 2 of Figure 4.2-1.

Beneath the leak detection system will be a secondary geosynthetic liner, with a minimum thickness of 36 mils (0.036 inch). The liner will be installed on top of the underlying foundation material and will function to contain potential leakage. Geotechnical investigations of the underlying foundation material it may indicate that conditions favor installation of natural clay liner instead of the geosynthetic liner. This determination will be made after falling head permeability tests are conducted on bulk soil samples of the foundation material. If the permeability of foundation material is a minimum of two orders of magnitude less than either the graded sand or geocomposite drainage materials that make up the leak detection system, the permeability contrast ensures that any leakage through the primary synthetic liner will be detected before saturation of the foundation materials could occur. If the foundation materials do not have the required permeability, bentonite may be mixed with the foundation material to decrease its permeability. Use of a natural clay or soil-bentonite secondary liner is preferred over the use of synthetic materials due to the self-healing properties of these liners and the proximity of the proposed project to bentonite supplies.

The use of sand and geocomposite drainage material beneath the primary synthetic liner eliminates the need for air vents beneath the liner since gases produced under the liner would be vented through the sand and geocomposite drainage material.

Routine pond inspections and monitoring will be conducted as stated in Section 5.3.2 and consistent with the requirements detailed in Regulatory Guide 3.11. Inspection sheets and monitoring results will be maintained on-site and submitted in annual reports to NRC and WDEQ/LQD. In the event of a confirmed loss of liner integrity a verbal notification to NRC will occur within 48 hours to be followed by a written report to the NRC within 60 days detailing suspected cause of the leak, estimated amount of leaked material, chemical nature of leaked material and mitigation efforts undertaken to repair and re-capture any effluent leaked into the native materials. In addition, the report will provide methods to prevent a similar event in the future.

4.2.3 AEA-Regulated Liquid Waste Disposal Plan

The AEA-regulated liquid waste at the Ross ISR Project will be managed through discharge to the lined retention ponds. Ponds will allow for surge and storage capacity, and provide additional disposal capacity through evaporation in summer months. Regulated flow of liquid waste will be routed from the ponds to the different disposal options that are discussed below.

4.2.3.1 Excess Permeate Disposal and Use

Excess permeate generated during uranium recovery and aquifer restoration activities at the proposed project will be used beneficially through surface discharge, recycling for use as plant make-up water, land application, or disposed of with brine in the Class I deep disposal well. As discussed previously, most permeate generated during RO treatment of the production bleed and aquifer restoration streams will be recycled back to the wellfield. Times when excess permeate is present, such as during the operation only phase, it will be discharged into lined retention ponds, where it will be used or disposed of by one of four methods discussed above. Aside from beneficially use and disposal it is also expected that evaporation of excess permeate from lined retention ponds will be an additional abstraction. Evaporation estimates are discussed in Sections 4.2.3.1.5 and 4.2.2.3.2.

Permeate from the RO systems will be a high quality effluent, Table 4.2-2 summarizes the anticipated permeate water quality. Methods used to obtain the estimated water quality are discussed in Section 6.1.

4.2.3.1.1 Surface Discharge

The Federal Water Pollution Control Act of 1972, as amended by the Clean Water Act of 1977 and the Water Quality Act of 1987, provides the EPA with the authority to regulate the discharge of pollutants to waters of the U.S. through the National Pollutant Discharge Elimination System (NPDES) Program. Since this phase of recovery. At a flow rate of 32 gpm, excess permeate will accumulate at a rate of 4.4 ac-ft per month if no disposal options were available, such as in an upset condition. The storage capacity in Pond #1 would allow for up to 3.8 months of excess permeate storage at this rate.

Concurrent Operation and Aquifer Restoration

A flow schematic of the concurrent operation and aquifer restoration phase is shown on Figure 3.1-12. The anticipated operation flow rates during this phase will be the same as discussed previously in the operation only phase. At this point in operation, aquifer restoration of some of the modules will have begun. The anticipated maximum aquifer restoration flow rates will consist of 1,025 gpm of restoration water from RO treatment and reinjection, and 75 gpm from groundwater sweep for a total of 1,100 gpm. Similar to the production bleed, groundwater recovered from restoration activities will be treated with two stages of RO. The final flow rate of excess permeate resulting from the treatment of the production bleed and restoration groundwater will be 1,118 gpm. Of this permeate, 126 gpm will be injected into the recovery solution and 992 gpm will be injected to wellfield modules undergoing the RO treatment with permeate injection phase of restoration. Due to the permeate demand for injection into the recovery and restoration streams, no excess permeate will be produced during this phase. An exception to this will be during the beginning of concurrent operation and aquifer restoration phase when the first several modules in restoration will be in groundwater sweep and no modules will be in the RO treatment and permeate reinjection phase. Groundwater sweep is expected to occur over a 1 to 4 month period with flow rates of 37.5 to 150 gpm per wellfield module. Assuming an average of two months are needed to complete the groundwater sweep phase, the flow of excess permeate to the lined retention ponds would be approximately 184.5 gpm. It is of importance to note that concurrent operation and groundwater sweep will only occur for a short period of time. In addition, the recovery and aquifer restoration flow rates used in this water balance represent near maximum conditions and therefore are conservatively high due to the variability in individual well flow rates. In order to manage the excess permeate during this time, disposal options may also include groundwater transfer between wellfields in restoration and operation, which is discussed in more detail in Section 6.1. In addition, extra storage capacity available in Pond #2 may be used to store excess permeate.

Because no excess permeate is available during most of the concurrent operation and aquifer restoration phase, the required plant make up flow of 25 gpm will come from permeate in storage or if needed, the production and aquifer restoration bleed and/or RO reject rates will be adjusted to produce the required permeate.

Aquifer Restoration Only

The aquifer restoration only phase will begin when uranium recovery has been completed in all modules. The typical water balance for this phase is shown on Figure 3.1-13. Similar to the concurrent operation and aquifer restoration phase, all permeate generated will be injected into wellfield modules undergoing restoration.

4.2.3.2 Brine Disposal

Most of the brine generated by the Ross ISR Project will be disposed of in Class I deep disposal wells. Deep well disposal was selected as the preferred method of brine disposal due to minimal potential impacts to human health and the environment and reduced cost compared to other brine disposal alternatives such as evaporation ponds or off-site brine transport. In addition to deep well injection, the effects of evaporation in lined retention ponds have been considered in the brine water balance. These disposal options are discussed in more detail below.

The anticipated brine water quality is presented in Table 4.2-5. The brine water quality was estimated using the anticipated water quality at the end of uranium recovery, the typical RO salt rejection rates, and the quality and quantity of brine originating from other sources such as the elution bleed from the CPP.

4.2.3.2.1 Class I Deep Disposal Wells

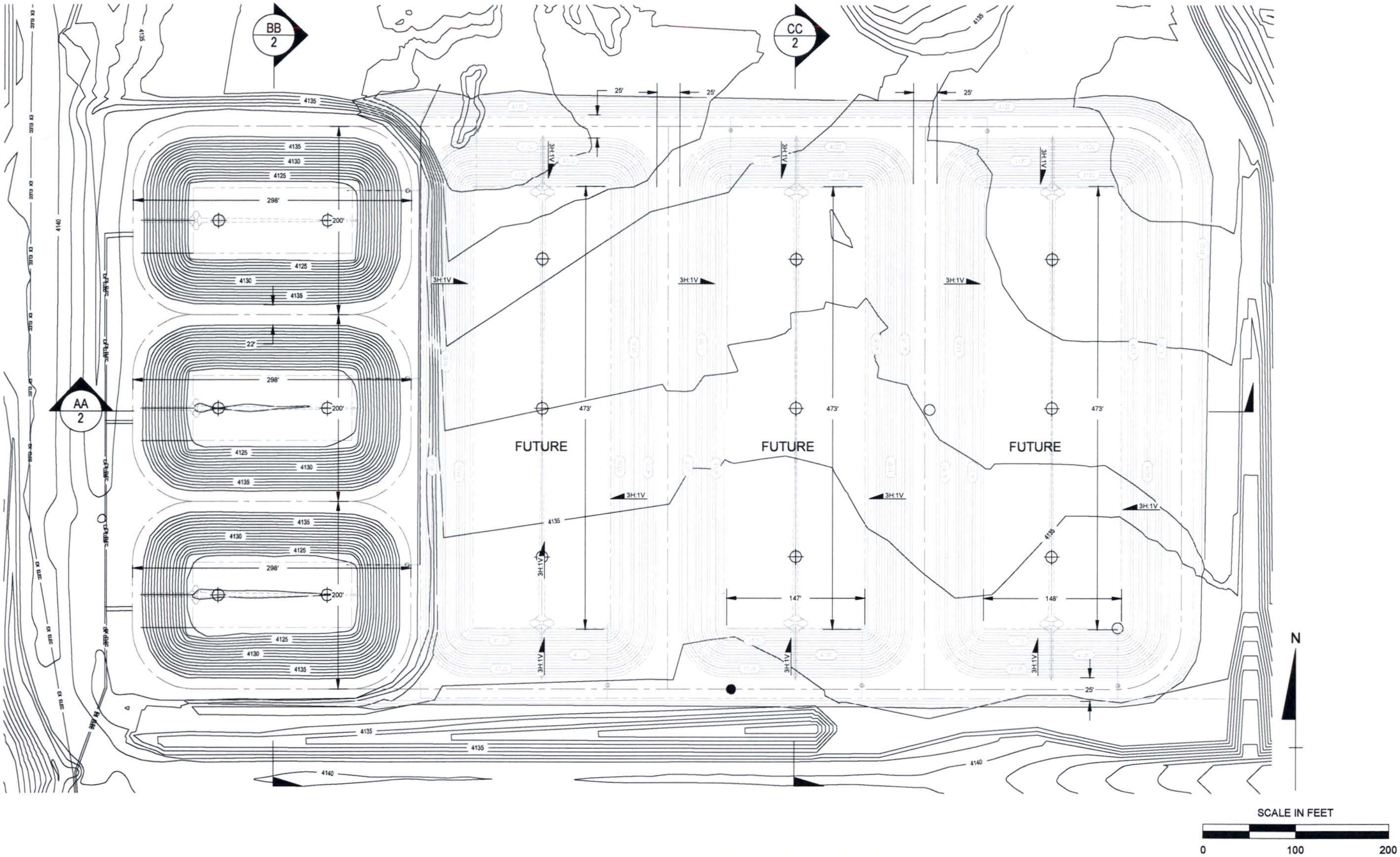
Strata was issued Class I UIC permit number 10-263 by the WDEQ on April 3, 2011. Strata's permit includes up to 5 Class I deep disposal wells. The application is included as Addendum 4.2-A of this document. Correspondence received throughout the deep disposal well permit process is included in Addendum 4.2-B. Class I deep disposal wells inject hazardous and nonhazardous wastes into deep, isolated rock formations that are below the lowermost underground source of drinking water (USDW). The receiving formations are the Cambrian-age, Deadwood and Flathead Formations, both of which are at least 500 feet below the lowermost potential USDW, the Madison Formation. Estimated depths for the target formations range from 8,160 feet below ground surface to 8,560 feet below ground surface. The receiving Cambrian sandstones are confined above by the Ice Box Shale member of the Winnepeg Group which is overlain by the Red River Formation. The Red River Formation also separates the Deadwood and Flathead Formations from the Madison Formation. Granitic and metamorphic rocks of the Precambrian basement provide the lower confining interval for the Deadwood and Flathead Formations.

Based on the anticipated porosity, thickness, lateral extent, and permeability of the receiving formations, the capacity of each Class I deep disposal well is expected to range from 35 to 80 gpm.

Figure 4.2-2 is a typical deep disposal well construction schematic. 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. Strata will also perform regular monitoring and perform internal and external MITs in accordance with WDEQ and the conditions of the UIC permit.

Each well location will consist of an approximately 250' by 250' pad. Surface equipment for the deep disposal wells will include pumps, filtration systems, instrumentation and control systems, and equipment for injection of treatment chemicals. Well pads will be either asphalt pavement or gravel and will be retained through the life of the disposal well in order to conduct maintenance. Access roads to the sites will be constructed on existing roads where possible and will have widths up to 14 feet. The supply pipelines to the wells will be HDPE. Pressures and flow rates for the piping and the disposal well will be constantly monitored at the CPP.

Instrumentation details for the deep disposal wells are provided in Addendum 4.2-A, and consist of the necessary measures to ensure safe operation of the disposal system. At a minimum, these will include a flow totalizer, flow rate, pressure indicator with alarms and shutdown controls, pressure switch, annular pressure indicator with alarms and shutdown controls, and injection pressure chart recorder. Water quality, quantity and rates will be provided to the WDEQ/WQD UIC program as required by the permit.



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LINED RETENTION PONDS: SHEET 1 OF 2
LAYOUT AND DESIGN DETAILS
ROSS ISR PROJECT
CROOK COUNTY, WYOMING

FIGURE 4.2-1

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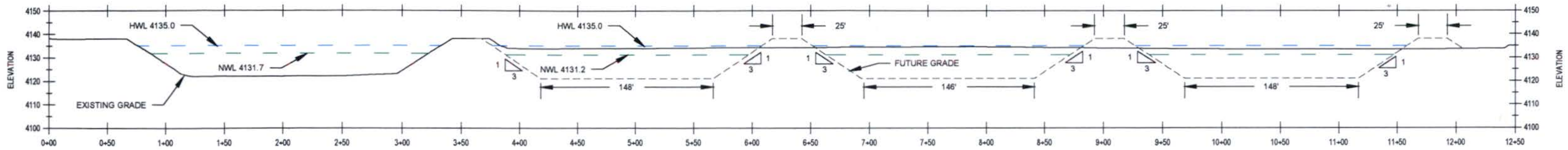
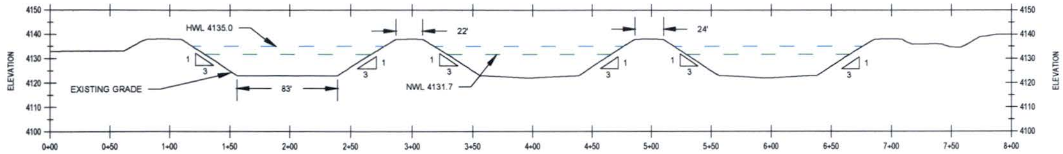


Section AA



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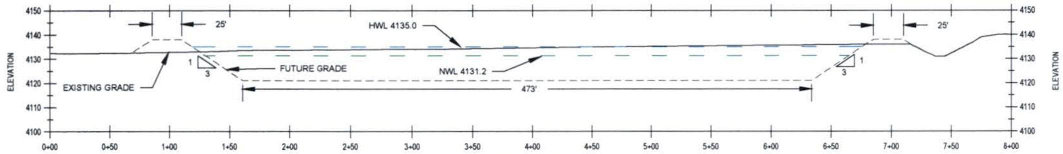

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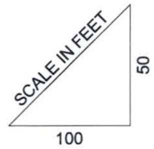


POND 1: CELLS 1-3 AREA CAPACITY TABLE

ELEVATION (FT)	AREA (AC)	AVG. AREA (AC)	CAPACITY INCR.	CAPACITY ACCUM.
4122	0.03			0
		0.52	0.52	
4123	1.01			0.52
		1.07	1.07	
4124	1.14			1.60
		1.19	1.19	
4125	1.25			2.79
		1.31	1.31	
4126	1.37			4.10
		1.43	1.43	
4127	1.49			5.53
		1.55	1.55	
4128	1.62			7.08
		1.68	1.68	
4129	1.75			8.76
		1.82	1.82	
4130	1.89			10.58
		1.96	1.96	
4131	2.03			12.54
		2.10	2.10	
4132	2.18			14.64
		2.25	2.25	
4133	2.33			16.89
		2.41	2.41	
4134	2.48			19.30
		2.57	2.57	
4135	2.65			21.86
		2.73	2.73	
4136	2.81			24.59
		2.90	2.90	
4137	2.98			27.49
		3.07	3.07	
4138	3.17			30.57

TOTAL CAPACITY 21.9 AC-FT

OPERATING CAPACITY 14.6 AC-FT

AUX. CAPACITY 7.2 AC-FT

FREEBOARD STORAGE 8.7 AC-FT

POND 2: CELLS 1-3 AREA CAPACITY TABLE

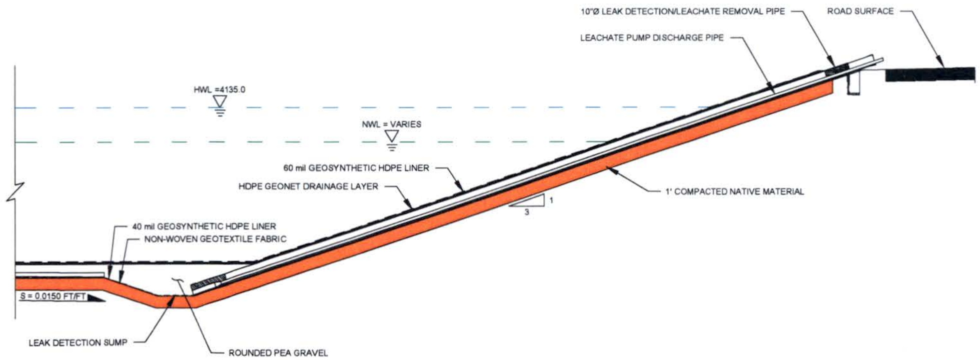
ELEVATION (FT)	AREA (AC)	AVG. AREA (AC)	CAPACITY INCR.	CAPACITY ACCUM.
4121	4.82			0
		4.95	5.05	
4122	5.08			5.05
		5.21	5.31	
4123	5.34			10.36
		5.47	5.58	
4124	5.61			15.94
		5.74	5.85	
4125	5.88			21.78
		6.01	6.12	
4126	6.15			27.90
		6.29	6.40	
4127	6.43			34.30
		6.57	6.68	
4128	6.70			40.98
		6.85	6.96	
4129	6.99			47.94
		7.14	7.25	
4130	7.28			55.19
		7.43	7.54	
4131	7.57			62.73
		7.72	7.84	
4132	7.87			70.57
		8.02	8.14	
4133	8.17			78.71
		8.32	8.44	
4134	8.47			87.16
		8.63	8.75	
4135	8.78			95.91
		8.94	9.07	
4136	9.10			104.98
		9.25	9.38	
4137	9.41			114.36
		9.57	9.70	
4138	9.73			124.06

TOTAL CAPACITY 95.9 AC-FT

OPERATING CAPACITY 70.6 AC-FT

AUX. CAPACITY 25.3 AC-FT

FREEBOARD STORAGE 28.2 AC-FT



CONTAINMENT DETAIL

NOT TO SCALE

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LINED RETENTION PONDS: SHEET 2 OF 2
CROSS SECTIONS AND DESIGN DETAIL
ROSS ISR PROJECT
CROOK COUNTY, WYOMING

FIGURE 4.2-1

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11e.(2) byproduct material will be transported by a contract shipping company to a disposal facility licensed by NRC or an agreement state. Strata will obtain an agreement with an off-site disposal facility prior to the commencement of operations. Strata 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. Potential disposal facilities include:

- Pathfinder Mine Corporation, Shirley Basin Facility, Shirley Basin, Wyoming
- Energy Fuels Inc., White Mesa Uranium Mill, Blanding, Utah
- EnergySolutions LLC, Clive Disposal Site, Clive, Utah
- Waste Control Specialists LLC, Byproduct Material Disposal Facility, Andrews, Texas

Based on the anticipated 11e.(2) byproduct material generation rate of 100 cubic yards per year during production and aquifer restoration, about 5 shipments of 11e.(2) byproduct material are anticipated during these project phases. During decommissioning, which is estimated to last 12-18 months, up to 200 shipments are expected.

4.3.2 Non-AEA-Regulated Solid Waste

4.3.2.1 Solid Waste

Solid waste includes solid material and equipment that are not generated by source material recovery or which have been successfully decontaminated and will include hazardous and non-hazardous waste. The proposed Ross ISR project is expected to produce approximately 1,000 yd^3 of non-contaminated solid waste per year during construction and operation. During decommissioning, up to 2,000 yd^3 will be produced.

Non-hazardous materials may include construction debris, office trash, and decontaminated material and equipment. Non-hazardous materials will be stored in commercial trash containers located near the CPP and will be disposed by a contracted waste disposal operator to a municipal landfill permitted by WDEQ Solid and Hazardous Waste Division (WDEQ/SHWD). The nearest non-hazardous solid waste disposal facility is the municipal landfill located in Moorcroft (approximately 23 road miles south).

4.3.3 Hazardous Solid Waste

Hazardous solid waste may include oily rags, oil-contaminated soil, used batteries, expired laboratory reagents, fluorescent lightbulbs, solvents, cleaners, and degreasers. As discussed in Section 4.2.1.3, the Ross ISR Project is classified as a Conditionally Exempt Small Quantity Generator of hazardous waste. Hazardous solid waste will be stored in secure containers within the maintenance building. Hazardous solid waste will be transported according to DOT regulations to an approved management facility licensed by WDEQ/SHWD or to a suitable facility in a nearby state.

4.3.4 Domestic Solid Waste

Septic system solid waste will be stored in septic tanks near the CPP and administration building. 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.

5.1 Corporate Organization and Administrative Procedures

Strata will maintain a performance-based approach to the management of environment and employee health and safety, including radiation safety. The responsibility of management personnel will be to provide for development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and groundwater monitoring programs, quality assurance programs, routine and non-routine maintenance activities, changes to any of these programs or activities, and all necessary training associated with the above. Strata's management structure is shown in Figure 5.1-1. The structure is applicable to site construction and site management. Figure 5.1-1 represents the management levels that play a key part in the Radiation Protection Program (RPP). These individuals may also be members on the Safety and Environmental Review Panel (SERP) described under Section 5.2.4

5.1.1 Board of Directors

The Board of Directors has the ultimate responsibility and authority for setting corporate policy and related procedural guidance but delegates ultimate responsibility and authority for occupational (including radiation) safety, environmental protection, and compliance with all NRC regulations and license conditions and all state and local regulations/permit conditions to Strata management as described below.

5.1.2 Chief Executive Officer

The Chief Executive Officer (CEO) is responsible for interpreting and acting upon the Board of Director's policy and procedural decisions. The CEO is authorized by the Board of Directors to have the responsibility and authority for the radiation safety and environmental compliance programs at all Strata facilities. The CEO is directly responsible for ensuring that Strata personnel comply with corporate industrial safety, radiation safety, and environmental protection programs. The CEO is also responsible for company compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The CEO has the responsibility and authority to terminate immediately any activity that is determined to be a threat to employees, public health, the environment, or a violation of state or federal regulations. The CEO has the authority to assign corporate resources (e.g., capital equipment, personnel, budget) to ensure corporate environmental, health, and safety goals and directives are met.

5.1.3 Vice President of Operations

The Vice President (VP) of Operations is responsible for all uranium production activities at the various project sites, including the Ross ISR Project. In addition to production activities, The VP of Operations is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with operations. The VP of Operations is authorized to immediately implement any action to correct or prevent hazards. The VP of Operations has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The VP of Operations reports directly to the CEO.

5.1.4 Production Superintendent

The Production Superintendent is responsible for all uranium production activity at the proposed Ross ISR Project. All site operations, maintenance, construction, environmental health and safety, and support groups report directly to the Production Superintendent. The Production Superintendent is authorized to immediately implement any action to correct or prevent hazards. The Production Superintendent has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Production Superintendent cannot unilaterally override a decision for suspension, postponement or modification if that decision is made by the CEO, the VP of Operations, and/or the VP of Permitting, Regulatory and Environmental Compliance. The Production Superintendent reports directly to the VP of Operations.

5.1.5 Vice President (VP) of Permitting, Regulatory and Environmental Compliance

The Vice President of Permitting, Regulatory and Environmental Compliance (VP-PREC) is responsible for all radiation protection, health and safety, and environmental programs as stated in the RPP and for ensuring that Strata complies with all applicable regulatory requirements. The VP-PREC reports directly to the CEO and supervises the Radiation Safety Officer (RSO) to ensure that the radiation safety and environmental monitoring and protection programs are conducted in a manner consistent with regulatory requirements. This position assists in the development and review of radiological and environmental sampling and analysis procedures and is responsible for routine auditing of the programs. The VP-PREC has no production-related responsibilities. The VP-PREC also has the responsibility to advise the CEO, VP of Operations and the Production Superintendent on matters involving radiation safety and to implement changes and/or corrective actions involving radiation safety.

5.1.6 Radiation Safety Officer

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs. The RSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The RSO is responsible for the implementation of all on-site environmental programs, including emergency procedures, training programs for both the staff and the Radiation Safety Technician, and sampling and inspection procedures. The RSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The RSO works closely with all supervisory personnel to review and approve new equipment and changes in processes and procedures that may affect radiological safety and to ensure that established programs are maintained. The RSO is also responsible for the collection and interpretation of employee exposure related monitoring, including data from radiological safety. The RSO makes recommendations to improve any and all radiological safety related controls as well as provide quality assurance/quality control for all health and environmental radiological monitoring programs. The RSO cannot be overruled by other members of the management team on any decision regarding radiation safety. The RSO has no production related responsibilities and reports directly to the VP-PREC.

5.1.7 Radiation Safety Technician

The Radiation Safety Technician(s) (RST) will assist the RSO with the implementation of the radiological and industrial safety programs. The RST is responsible for the orderly collection and interpretation of all monitoring data, to include data from radiological safety and environmental programs. The RST reports directly to the RSO and must satisfy training requirements prescribed by the RSO.

5.1.8 Site Department Supervisors

The Ross ISR Project staff includes the Director of Development, the Senior Geologist, and the VP of Geology. These positions in combination with the Production Superintendent are responsible for the direct supervision of site activities including construction, operation, and maintenance of the Ross ISR Project CPP, wellfields, and water disposal facilities. The supervisors will be responsible for enforcing compliance with all aspects of the RPP and Standard Operating Procedures (SOPs) to control exposure to ionizing radiation and radioactive materials in accordance with the Strata ALARA Program. Supervisors will perform and document an annual review of each SOP within his or her area of responsibility to ensure continued accuracy and relevance. These individuals report directly to the CEO, the VP of Operations, or the VP of Geology.

5.1.9 ALARA Program Responsibilities

The purpose of the ALARA (As Low As Reasonably Achievable) program is to keep exposures to all radioactive materials and other hazardous material as low as possible and to personnel, contractors, visitors, and the public. The ALARA program will take into account the state of technology and the economics of improvements in relation to benefits to health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.

In order for an ALARA program to correctly function, all individuals including management, supervisors, health physics staff, and workers, must take part in and share responsibility for keeping all exposures as low as reasonable achievable. This policy addresses this need and describes the responsibilities of each level in the organization.

5.1.9.1 Management Responsibilities within the ALARA Program

Consistent with Regulatory Guide 8.31 (NRC 2002a), Strata senior management is responsible for the development, implementation, and enforcement of rules, policies, and procedures as directed by regulatory agencies and company policies. These responsibilities include the following:

7. Conduct training and/or provide training requirements for the RST.

The RSO will investigate any dosimetry result > 25% of applicable exposure limits and will determine cause and/or institute corrective actions as may be necessary to maintain exposures ALARA. This applies to results reported by the vendor for external exposure personal dosimeters of exposures > 25% of the limits of 10 CFR § 20.1201, and air sampling or bioassay results indicating the potential for an intake > 25% of the applicable ALI in 10 CFR Part 20, Appendix B, Table 1.

5.1.9.3 Supervisor Responsibility within the ALARA Program

Supervisors are responsible for implementing the ALARA program. Each supervisor shall be trained and instructed in the general radiation safety practices and procedures. Their responsibilities include:

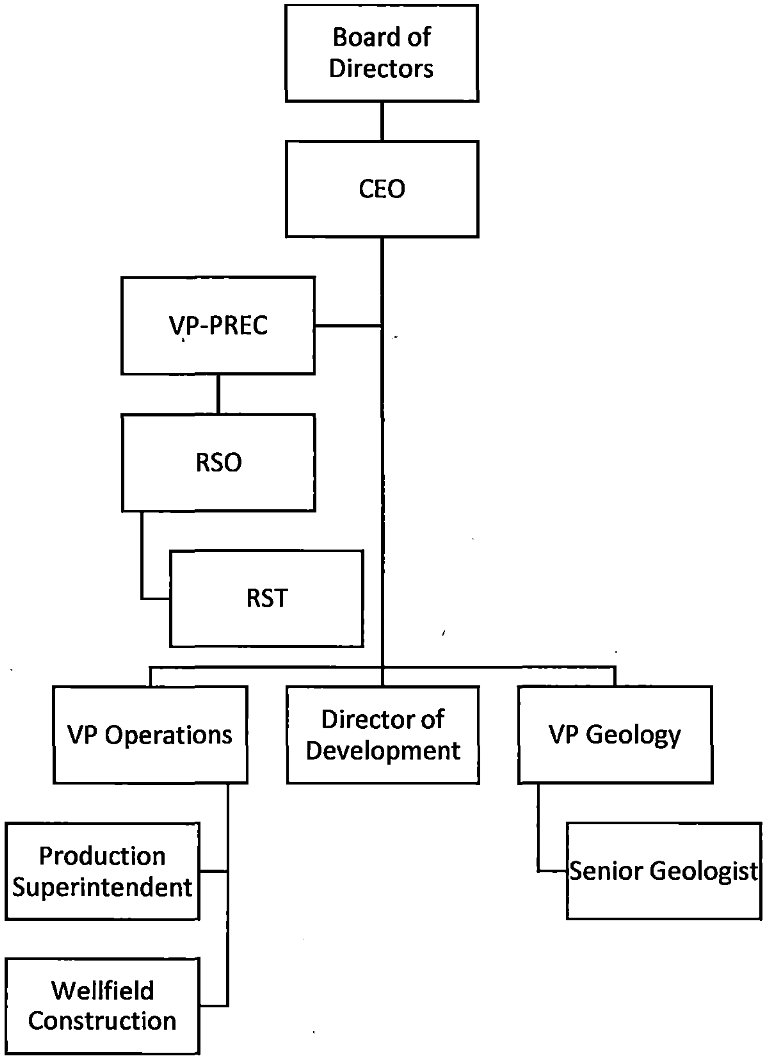
1. Adequate training to implement the general philosophy behind the ALARA program;
2. Provide direction and guidance to subordinates in ways to adhere to the ALARA program;
3. Enforcement of rules and policies as directed by the RPP, which implement the requirements of regulatory agencies and company management; and
4. Seek additional help from management and the RSO should radiological problems be deemed by the supervisor to be outside his or her sphere of training.

5.1.9.4 Worker Responsibility within the ALARA Program

The success of the ALARA program and the RPP are reliant on the cooperation and adherence to those policies by the workers themselves. Therefore, worker responsibilities at the Ross ISR Project include:

1. Adherence to all rules, notices, and operating procedures as established by management and the RSO through the RPP;
2. Making suggestions for improvements to the RPP and ALARA program; and
3. Reporting to the immediate supervisor equipment malfunctions or violations of standard practices or procedures that could result in increased radiological hazard to any individual.

Figure 5.1-1. Ross ISR Organizational Chart



5.2 Management Control Program

This section describes the management control program put in place within the Strata organization to ensure activities will be conducted in a manner to protect the health and safety of employees, the public, and the environment.

5.2.1 Operating Procedures

Management controls will be implemented throughout Strata by written procedures or instructions consistent with the corporate policies and standards and regulatory requirements. All routine activities involving handling, processing, or storing of radioactive material will be documented by written Standard Operating Procedures (SOPs). The SOPs will include all pertinent radiation safety practices. The Radiation Protection Program (RPP) will consist of written SOPs for all process activities including those activities involving radioactive materials. Written SOPs will also be established for record keeping, document control, quality assurance, environmental and health physics monitoring, emergency procedures, and industrial safety.

A current copy of each SOP will be kept in the area where it is used and accessible to all employees. All SOPs will be reviewed and approved in writing by the RSO prior to being implemented to ensure proper safety principles and practices are included and to ensure that the SOPs follow the ALARA program. All proposed changes to SOPs will also be reviewed and approved by the RSO. The RSO will also perform a documented annual review of the SOPs to ensure they follow currently established radiation protection practices. SOPs which will be implemented at the Ross ISR Project include but are not limited to the following (if applicable):

- Operation Activities Involving Radioactive Materials
- Non-Operational Activities Involving Radioactive Materials
- Handling of Radioactive Materials
- Processing of Radioactive Materials
- Storing of Radioactive Materials
- Work Within Restricted Areas
- Transportation Security and Radiological Surveying
- Diversion Channel Inspection and Maintenance
- Retention Pond Inspections and Maintenance

- Statistical Assessment of Baseline Water Quality Data
- Determination of Upper Control Limits
- Excursion Verification, Reporting, and Mitigation
- External Radiation Monitoring Plan
- Radiation Safety Practices
- Radon Daughter Monitoring
- Radiological Monitoring During Soil Remediation
- Air Particulate Monitoring
- Bioassay Program
- Quality Control Requirements for Environmental Bioassay Program
- Respirator Protection Program
- Radiological Sampling, Equipment Maintenance, and Calibration
- Laboratory Quality Control
- Well Installation, Completion, and Development
- Borehole Plugging and Abandonment
- Well Plugging and Abandonment
- Monitoring for Radon In Air
- Environmental Gamma Monitoring
- Air Particulate Sampling
- Sediment and Soil Sampling
- Food Crop and Vegetation Sampling
- Direct Gamma Field Survey
- Surface Water Sampling
- Ground Water and Domestic Well Sampling
- Animal Tissue Sampling
- Sample Management
- Data Management
- Emergency Emission Control System Procedures
- Gamma Exposure Rate Surveys
- Hazardous/Radioactive Accident Emergency Response
- Spill Response and Remediation

- Receiving and Unloading Hazardous Chemicals
- Storage and Handling of Hazardous Chemicals
- Loading, Surveying, and Packaging of Yellowcake

5.2.2 Radiation Work Permits

Any activities for which no operating procedure exists where there is the potential for significant exposure to radioactive materials will require radiation work permits (RWPs). The RWP will describe the following:

- The scope of the task to be performed.
- The precautions necessary to maintain radiation exposures ALARA.
- The supplemental radiological monitoring and sampling to be conducted for the task.
- The specific training that will be required.
- The personal protective equipment that will be required.

The RSO must review and approve, by signature, the RWP before initiation of the work. The RSO may designate a person of the radiation safety staff who has received the proper training to approve RWPs in the RSO's absence.

5.2.3 Record Keeping and Retention

Records will be maintained as hard copy originals or stored electronically in accordance with the requirements of 10 CFR 20 Subpart L and 10 CFR 40.61 (d) and (e). Records will be readily available for regulatory inspection and may be transferred to the NRC after license termination. Records will also be provided to a new owner or new licensee in the event that the property or license is transferred.

The following significant information will be permanently maintained and retained until license termination:

- Records of the receipt, transfer, and disposal of any source or byproduct material processed or produced at the facility.
- Records of on-site radioactive waste disposal such as by deep well injection, discharge, or burial under 10 CFR 20.2002 and 20.2007.
- Records required by 10 CFR 20.2103(b)(4).

- Records required by 10 CFR Part 40, Appendix A, Criteria 8 and 8A.
- Records containing information important to decommissioning and reclamation, including:
    - ◊ Descriptions of any spills, excursions, contamination events or unusual occurrences, including the dates, locations, areas, or facilities affected; assessments of hazards; corrective and cleanup actions taken; assessment of cleanup effectiveness, and the location of any remaining contamination; nuclides involved; quantities, forms and concentrations, and descriptions of hazardous constituents; descriptions of inaccessible areas that cannot be cleaned up; and sketches, diagrams, or drawings marked to show areas of contamination and places where measurements were made.
    - ◊ Information related to site characterization such as: residual soil contamination levels, on-site locations used for burials of radioactive materials, hydrology and geology characteristics that could contribute to contamination and locations of surface impoundments and wellfield aquifer anomalies.
    - ◊ As-built drawings or photographs of structures, equipment, restricted and secured areas, wellfields, areas where radioactive materials are stored, and any modifications showing the locations of these structures and systems through time.
    - ◊ Drawings of areas of possible inaccessible contamination, including features such as buried pipes or pipelines.
    - ◊ Pre-operational background radiation levels at and near the site.

Duplicates of all significant records will be maintained in the corporate office or other off-site location. The RSO will be responsible for ensuring that the required records are maintained and controlled with adequate safeguards against tampering and loss.

5.2.4 Safety and Environmental Review Panel

A SERP will be established to evaluate proposed changes in the facility or procedures described in the license application, and tests or experiments with respect to whether they first require a license amendment.

The SERP will consist of a minimum of three members. One member will have expertise and management authority and will be responsible for managerial and financial approval for changes. One member will have expertise in operations and/or construction and will have responsibility for implementing any operational changes. One member will be the RSO, or equal, with responsibility of ensuring that the changes conform to radiation safety and environmental requirements. Additional members may be included on the SERP when aspects of the change, experiment, or test, are beyond the expertise of the other members. The additional members may serve temporarily and may be consultants or attorneys.

5.2.4.1 SERP Procedures and Responsibilities

The SERP will function in accordance with a written operating procedure. The procedure will ensure that approvals of changes in the facility or procedures as described in the license application, and tests and experiments are properly documented and reported, and if the proposed changes will require a license amendment. The changes will not require a license amendment pursuant to 10 CFR, Part 40.44 as long as the changes do not:

- Conflict with a requirement within an existing license condition.
- Create a possibility of an accident unlike what is evaluated in the license application.
- Create a possibility for a malfunction or a structure, system, or control with a different result than previously evaluated in the license application.
- Result in a departure from the method of evaluation described in the license application used in establishing the final Safety Evaluation Report (SER) or the ER or TR or other analyses and evaluations for license amendments.

The changes may be derived from operational, economic, or regulatory requirements. The SERP may review the following to determine the impacts of the proposed change:

- The operating criteria and critical equipment if the proposed change impacts the operations or significantly changes the processes used at the facility.
- The operating procedures for the proposed change with respect to existing operation procedures.

- The emergency response plan to determine the compatibility with the proposed change.
- The monitoring and recordkeeping requirements of the proposed change to ensure compliance with existing programs.
- The need for additional training and key personnel training records to verify the training needs of the proposed change.
- The environmental and safety requirements to ensure the proposed change will not deviate from existing programs.
- The need to significantly increase the surety.

5.2.4.2 SERP Record Keeping and Reporting

Detailed records of the evaluations made by the SERP will be kept until license termination. The records will be maintained by the RSO and copies distributed to theVP-PREC and the VP of Operations. The records kept will include a description of the proposed change, test, or experiment, the names and titles of each SERP member, the conclusions and recommendations of the SERP including required actions, deadlines, and assignment of responsibility. An annual report summarizing all SERP actions will be submitted to the NRC. This report will include replacement pages to the license application which will have a change indicator adjacent to the revised language and an indication of the revision date.

5.2.5 Reporting

Strata will report all reportable spills, lined retention pond leaks, excursions of recovery solutions, or process chemicals to the NRC Headquarters Project Manager by telephone or electronic mail within 24 hours of the event. This notification will be followed by submittal of a written report to the NRC Headquarters Project Manager detailing the conditions leading to the spill or incident/event, corrective actions taken, and results achieved within 30 days of the notification.

Strata will submit an annual report to the NRC that includes the ALARA audit report, land use survey, monitoring data, corrective action program report, one of the semiannual effluent and environmental monitoring reports, and the SERP information.

5.2.6 Radioactive Materials Postings

All entrances to the facility will be conspicuously posted with the words "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL," in order to be exempted from the requirements of 10 CFR 20.1902(e) for areas within the facility.

5.2.7 Historic and Cultural Resources Inventory

Strata will administer a historic and cultural resources inventory before engaging in any development activity not previously assessed by NRC or any cooperating agency. Any disturbances to be associated with such development will be addressed in compliance with the National Historic Preservation Act (NHPA), the Archeological Resources Protection Act, and the guidelines discussed in Section 3.8 of the ER. Strata will cease immediately any work resulting in the discovery of previously unknown cultural artifacts to ensure that no unapproved disturbance occurs. Strata will notify appropriate authorities per any license conditions and will not go forward without appropriate approvals from NRC or other agencies as appropriate. Any such artifacts will be inventoried and evaluated, and no further disturbance will occur until authorization to proceed has been received. Strata recognizes that the NHPA environment is not static, but rather is ongoing up to and through final license termination.

5.3 Management Audit and Inspection Program

Inspections and audits will be performed periodically at the Ross ISR Project to ensure compliance with radiological health, operational, and environmental standards. The following section describes the managerial responsibilities, frequencies, scope, and action measures of the inspection and audit program.

5.3.1 Radiation Health Inspections

5.3.1.1 Daily Inspections

A daily walk through inspection will be conducted by the RSO or RST or qualified designee of all work and storage areas. The purpose of the inspection is to determine if proper radiation safety procedures and good housekeeping practices are being used in order to minimize contamination. Specifically, the inspection will focus on the effluent control systems, security features, instrumentation and alarm systems, and radiation monitoring devices. Problems, poor practices, or deviations from SOPs and ALARA principles noted during inspections will be documented, including a description and/or drawing, date and signature by the inspection personnel.

5.3.1.2 Weekly Inspections

The RSO along with the Production Superintendent or qualified designee will conduct weekly inspections of all facility areas to observe general radiation control practices and to review required changes in procedures or equipment.

Similar to daily inspections, issues identified during the weekly inspections will be documented, including a description and/or drawing of the problem, the date, and the inspector's signature. Records of the inspection issues will be retained for a minimum of one year. The inspection issues will then be reviewed and discussed by the VP-PREC and the VP of Operations and the Department Supervisor who has the authority to mitigate the problem.

5.3.1.3 Monthly Inspections

A minimum of once monthly, the RSO will review the results of the daily and weekly inspections, including a review of all monitoring and exposure data for the month. The RSO will then provide the VP of Operations, VP-PREC, and Department Supervisors a written report which details the month's significant worker protection activities that contains a summary of the most recent personnel exposure data, including bioassays and time weighted calculations, and a summary of all pertinent radiation survey records. The report will specifically address the trends and any deviations from the radiation and ALARA programs, including a review of the adequacy of the implementation of license conditions regarding radiation protection and ALARA. In addition, the summary reports will also describe unresolved problems and the proposed corrective action. Monthly reports will be maintained and readily available for at least five years from the date of the report.

5.3.2 Lined Retention Pond Inspections

Lined retention ponds at the Ross ISR Project will be inspected in accordance with NRC Regulatory Guide 3.11. Engineering data related to the design, construction, and operation of the lined retention ponds will be kept on-site and available for reference and inclusion in inspection reports. The following section describes the routine inspections for the lined permeate and brine ponds.

5.3.2.1 Daily Inspections

A daily inspection of each lined retention pond will be conducted by a trained employee who is knowledgeable of the pond construction and safety features. The inspection will be documented on and conducted in accordance with a standard checklist. Inspection records will be kept on site and retained until termination of the project. Daily inspections will include the following:

- Water levels will be recorded and examined to ensure that minimum freeboard is maintained.
- The condition of pond inlet and outlet structures, associated piping, and instrumentation will be inspected to ensure proper operation.
- The embankments will be visually inspected for signs of erosion, cracking, slumping, or evidence of seepage.
- The liner will be visually inspected for damage or practices that may result in damage to the liner.
- The pond area will be visually surveyed for the presence of animals.
- The pond leak detection riser pipe will be examined for signs of leakage.
- The underdrain pumping system will be inspected for proper operation.

5.3.2.2 Monthly Inspections

Monthly inspection of each lined retention pond will be conducted by a trained employee who is knowledgeable of the pond construction and safety features. The inspection will be documented on and conducted in accordance with a standard checklist. Inspection personnel will be responsible for reviewing inspection issues with the VP of Operations and the VP-PREC. Inspection records will be kept on site and retained until termination of the project. Monthly inspections will include the following:

- Runoff diversion channels and berms will be inspected for erosion and flow obstructions.

- The perimeter fence and associated signage will be inspected to ensure adequate protection and warning from unauthorized entry.

5.3.2.3 Quarterly Inspections

A quarterly inspection of each lined retention pond will be conducted by a trained employee who is knowledgeable of the pond construction and safety features. The inspection will be documented on and conducted in accordance with a standard checklist. The results of the inspection will be reviewed by theVP of Operations and the VP-PREC. Inspection records will be kept on site and retained until termination of the project. Quarterly inspections will include the following:

- The embankment top, side slopes, and toe will be visually inspected for settlement, surface cracks, erosion, and changes in alignment. If unusual conditions or depressions are observed, the area will be surveyed to assess the extent of the problem.
- Downstream embankment toes and slopes will be examined for evidence of seepage.
- Instrumentation and safety equipment will be tested to ensure proper operation.
- Groundwater samples will be collected from pond monitoring wells as well as wells within 2 kilometers of the ponds that are used for drinking water.
- Surface water samples will be obtained from each nearby surface impoundment that may be affected by pond failures.
- A detailed examination of the liner system will be conducted to determine if degradation is occurring.

5.3.2.4 Annual Technical Evaluation

A technical evaluation of the ponds will be done annually to evaluate the hydraulic and hydrologic capacities of the ponds and diversion ditches and the structural stability of the embankments. Inspections will be conducted by either a trained employee or an independent expert. Information obtained from the annual technical evaluation will be compiled along with previous inspection and water quality data for an annual report. The report will be kept on-site until the termination of the project. The technical evaluation report will be reviewed by the VP of Operations and the VP-PREC. The annual technical evaluation will include the following:

- If determined necessary by a Professional Engineer, a survey of the embankment will be completed and compared to as-constructed dimensions of the ponds. The survey will be evaluated to ensure embankment settlement is within acceptable limits.
- An assessment of the hydraulic and hydrologic capacities will be evaluated to determine if existing pond infrastructure is adequate to guard against pond failure.
- Quarterly water quality data will be evaluated for indication that the seepage control measures are not functioning properly.
- Daily, monthly, and quarterly inspection data will be reviewed to ensure that issues have been addressed.
- The underdrain pumping system will be inspected and tested for proper operation.

5.3.3 Module Building, Wellhead, and Valve Vault Inspections

Strata will implement a continuous wellfield monitoring program based on roving wellfield personnel. Wellfield personnel will be trained, and intimately familiar with the functions and normal operating characteristics of equipment in these areas. Inspections of the module buildings, and valve vaults will be conducted on a weekly basis. Inspections of module buildings will coincide with flow and pressure record collection. Inspections will involve visual surveys of pipes, valves, pumps, manifolds, ventilation equipment, and leak detection equipment. Wellheads and other equipment at wellfields will be monitored (observed) on at least a daily basis by roving wellfield personnel. On a monthly basis, wellhead covers will be removed from wellheads and they will be visually inspected for leaks. Leak detection equipment will be tested on at least a monthly basis. In addition, operational testing of ventilation system equipment will be performed in accordance with R.G. 3.56 (NRC 1986a), and operational tests of leak detection equipment will be performed in accordance with manufacturer specifications. The inspection will be documented on and conducted in accordance with a standard checklist. Inspection records will be kept on site and retained until termination of the project.

5.3.4 *Diversion Structure Inspection*

A visual inspection of the condition of the diversion structure and culvert(s) will be conducted monthly as well as immediately following large storm events. Personnel competent in the evaluation of these structures will conduct the inspections on a standard checklist. Personnel will visually inspect the embankment top, side slopes, and toe for settlement, surface cracks, erosion, and changes in alignment. The culvert(s) will be inspected for structural integrity, obstructions, and scouring. Erosion protection will be inspected for scouring, and the condition of anchoring. If unusual conditions are observed, the area will be surveyed to assess the extent of the problem. Inspection records will be kept on site and retained until termination of the project.

5.3.5 *Containment Barrier Wall Inspection*

Visual inspection of the CBW itself is limited due to the lack of surface expression of the wall itself, however, the french drain as well as instrumentation installed to demonstrate the effectiveness of the structure will be inspected on a monthly basis. Key features for the monthly inspection include the french drain/collector well system and monitoring wells on both sides of the CBW. Inspections could include the following; manual water levels to confirm pressure transducer readings, testing of the pumping system installed in the collector well, and a check of the monitoring wells surface condition. Monitoring frequency may be increased during periods of heavy precipitation or seasonally to confirm the necessary contrast in water levels across the CBW. In the event of a hi alarm in the collector well, an immediate inspection will occur to verify functionality of the pumping system. Records will be kept on site and retained until termination of the project.

5.3.6 *Annual ALARA Audit*

Strata will conduct annual audits of the RPP and ALARA program. The purpose of the audit will be to evaluate the effectiveness of RPP and ALARA program, to ensure that all regulations, policies, and license conditions are being followed, and to explore methods to further reduce employee and public exposure to radiological contaminants. The audit will be conducted by a team of members who are knowledgeable of the RPP with at least one member who is experienced in the operational aspects of the radiation protection practices at the facility. The RSO will accompany the audit team to provide information when needed but will not be allowed to participate in the audit conclusions. Strata may also elect to use qualified personnel from another uranium facility or an independent radiation protection consultant to conduct the audit. Based on the findings of the audit, an audit report will be compiled and kept on record at the facility until project termination. The CEO, the VP-PREC, and the RSO will review the audit conclusions and recommendations and ensure that the proper corrective actions are implemented.

The annual ALARA audit report will summarize the following items:

- Employee exposure records (external and time weighted calculations);
- Bioassay results;
- Inspection log entries and summary reports of daily, weekly, and monthly inspections;
- Documented training program activities;
- Radiation safety meeting reports;
- Radiological survey and sampling data;
- Reports on overexposure of workers submitted to the NRC, Occupational Safety and Health Administration (OSHA), or State of Wyoming;
- Operating procedures that were reviewed during this time period.
- The report will specifically discuss the following:
- Trends in personnel exposures for identifiable categories of workers and types of operational activities;
- Whether equipment for exposure control is being properly used, maintained, and inspected;
- Recommendations on ways to further reduce personnel exposure from uranium and its daughters.

Option 1:

- Education: An associate degree or two or more years of study in the physical sciences, engineering, or a health-related field.
- Training: At least a total of four weeks of generalized training (up to two weeks may be on-the-job training) in radiation health protection applicable to uranium recovery facilities.
- Experience: One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a uranium recovery facility.

Option 2:

- Education: A high school diploma.
- Training: A total of at least three months of specialized training (up to one month may be on-the-job training) in radiation health protection related to uranium recovery facilities.
- Experience: Two years of relevant work experience in applied radiation protection.

5.4.3 Designee Qualifications and Training

5.4.3.1 Designated Operator

Qualifications and training for the designated operators is discussed in Section 5.7.6.5. The Designee is used at off-shift times (principally weekend and holidays) to complete the Daily Radiation Safety Inspection of all work and storage areas of the facility (see Section 5.3.1) in the absence of both the RSO and the RST. The Designee will not perform more involved procedures such as contamination surveys for the release of items for unrestricted release, survey instrument calibrations, air sampling, issuing RWP's, etc. The qualified Designee may perform daily inspections on weekends, holidays, or when both the RSO and RST must be absent (e.g. illness or offsite training). A Designee shall not perform daily inspections for more than two consecutive days except in the event of a Federal or company holiday, whereby the Designee will not exceed more than four consecutive days. Reports generated by the Designee will be reviewed by the RSO or RST as soon as practical, but no later than 3 hours from the beginning of the next work day following an absence, weekend, or holiday. The VP-PREC, RSO, or RST(s) will be available by telephone while the qualified Designee is performing the daily inspections. The RSO shall make the determination that an individual meets the education, training, and experience requirements to be trained and qualified as a Designee. The training program for the Qualified Designated Operator is contained herein.

The Qualified Designated Operator must meet the qualifications as an experienced CPP Operator and have the following combination of education, training and experience:

- Education: A high school diploma or equivalent. The RSO will review and approve on a case by case basis.
- Training: New employee radiation safety training as specified in Section 5.5 and annual refresher training as required, and additional training specific to conducting daily inspections at the CPP facilities. In addition, the Designated Operator will need to demonstrate proficiency to the RSO for conducting daily walk through inspection of the CPP. Specific onsite training and proficiency requirements to perform the daily inspection are included below.
- Experience: At least 3 months of employment at a uranium recovery facility in the capacity of a Central Plant or IX Satellite operator, or supervisor, familiar with operations of the facility and knowledgeable of health physics, industrial safety and industrial hygiene practices used to maintain radiological levels ALARA.

Onsite training for the Qualified Designated Operator will be conducted by the RSO and will consist of at least five (5) inspections where the trainee accompanies the RSO on daily inspections and the RSO is the inspector, and three (3) hours of classroom type and instruction.

As part of the training, as a Qualified Designated Operator, the trainee will successfully complete a written test that demonstrates the trainee's proficiency with any equipment and understanding and all requirements of the inspections and use of the form. Proficiency will be acceptable with a test core of 80% or greater.

Prior to final approval by the RSO, the trainee will complete four (4) daily inspections as the inspector with the RSO supervising. Upon successful completion of the test and inspections, the RSO may authorize the trainee as a Qualified Designated Operator. All documentation will be retained on file.

The RSO and RST will continually assess the adequacy of daily inspections completed by all Qualified Designated Operators. On a recurring basis the RSO or RST will accompany Qualified Designated Operators on no less than semi-annual inspections. A Qualified Designated Operator will also be required to complete annual refresher training on the topics discussed above. The Designee will demonstrate comprehension by completing a written test and obtaining a test score of 80% or greater. The RSO or RST will signify in writing by signing (initialing) and dating the inspection reports completed by Designees. All training and testing will be documented in writing.

This work practice has historically been approved by the NRC and is consistent with the relatively low radiological risks associated with ISR facilities where radiation exposures are typically a small fraction of regulatory limits. Employees working at the Ross ISR Project will be trained as radiation workers and as such will have daily responsibility for recognizing, reporting, and correcting radiation hazards. Additionally, the Designee will have been provided on-the-job training in conducting the daily radiation safety inspections as described above and, accordingly, will be cognizant of circumstances suggesting off-normal conditions. In addition to all radiation workers being trained on how to handle emergency conditions, the RSO or RST will be contacted in such events so additional instruction can be provided as needed. Depending on the circumstances, the RSO or RST may choose to go to the site to assist with the corrective action if they deem it necessary.

5.4.3.2 Designated Surveyors

If potentially contaminated equipment, material, or packages (material) are moved from a restricted or controlled area through an uncontrolled area and back into a controlled or restricted area, the material must be properly surveyed. In addition to the trained and qualified Radiation Safety staff, employees who meet certain requirements will be deemed qualified to perform surveys of the type described above. A Designee is not permitted to perform surveys which release equipment or materials for unrestricted use.

The designee will have the following education, experience, and training:

- Education: A high school diploma or equivalent. The Radiation Safety Officer (RSO) will review and approve on a case by case basis

- Experience: At least 3 months of employment at a uranium recovery facility; Familiar with operations of the facility and knowledgeable of health physics, industrial safety and industrial hygiene practices used to maintain radiological levels ALARA.

- Training: Completion of new employee radiation protection training and annual refresher training, as required; Completion of training specific to surveying. Proficiency will be acceptable with a test score of 80% or greater; Completion of a minimum of five (5) release surveys under the supervision of the RSO or a qualified Radiation Safety Technician (RST). The supervised surveys will be documented with signatures of the RSO or a qualified RST and the Designee. If initial proficiency is not demonstrated, re-evaluation may be allowed by performing additional surveys. The additional release surveys will be supervised by the RSO and proficiency must be demonstrated to the satisfaction of the RSO; Completion of a minimum of five (5) release surveys without direct supervision of the RSO or a qualified RST. Upon completing the survey, the RSO or a qualified RST will perform the same survey to verify the accuracy of the measurements obtained by the Designee.

The RSO and/or RST will continually assess the adequacy of surveys completed by all qualified Designees. On a recurring basis the RSO or RST will supervise surveys completed by Designees on no less than a semi-annual basis. The RSO or RST will signify in writing by signing (initialing) and dating the survey form completed by the Designee. Training documentation will include new employee radiation safety training, training specific to surveying, training tests, and supervised surveys. All training and testing will be documented in writing and will be maintained by the RSO. A list of all personnel who have met the requirements of a qualified "Designee" will be kept by the RSO. The date the employee met the requirements for a "Designee" and the dates when the semi-annual "refresher" surveys were supervised will be noted.

5.5 Radiation Safety Training

Radiation safety training at the Ross ISR Project will be designed to inform employees of the inherent risks of exposure to radiation as well as the fundamentals of protection against exposure to uranium and its progeny. The radiation safety training program will be administered according to guidance provided in NRC Regulatory Guide 8.31, NRC Regulatory Guide 8.29 and NRC Regulatory Guide 8.13 (NRC 2002a, NRC 1996 and NRC 1999, respectively). Specific details of the radiation safety policy will be addressed in the Radiation Safety Manual. All employees will be provided access to and made familiar with instructions outlining radiation safety and emergency procedures. The radiation safety training program content will be under the management of the RSO. The RSO will be responsible for updating training material according to changes in regulatory requirements, license amendments, plant operational experience, and the ALARA concept.

5.5.1 Initial Training

New employees at the facility will receive training on the following topics:

1. Fundamentals of Health Protection
    - The radiological and toxic hazards of exposure to uranium and its progeny,
    - How uranium and its daughters enter the body (inhalation, ingestion, and skin penetration),
    - Why the concept of ALARA is important with respect to minimizing exposure to uranium and its progeny.
    - Relative risks associated with exposure to ionizing radiation and potential risks from working specifically with materials containing uranium and its progeny.
2. Personal Hygiene at ISR Facilities
    - The use of protective clothing and other PPE,
    - The correct use of respiratory protective equipment,
    - Eating, drinking, and smoking only in designated areas,
    - Using proper methods for decontamination and self survey.
3. Facility Provided Protection
    - Ventilation systems and effluent controls,
    - Cleanliness of the work place,

- Features designed for radiation safety for process equipment,
- Standard operating procedures,
- Security and access control to designated areas,
- Electronic data gathering and storage,
- Automated processes.

4. Health Protection Measurements
   - Measurement of airborne radioactive materials,
   - Bioassay to detect uranium,
   - Surveys to detect contamination of personnel and equipment,
   - Personnel dosimetry.

5. Radiation Protection Regulations
   - Regulatory authority of NRC, OSHA, and the State of Wyoming,
   - Employee rights according to 10 CFR Part 19,
   - Radiation protection requirements in 10 CFR Part 20.

6. Emergency Procedures

In addition to the above topics, female employees and all supervisors of female employees will be given training which addresses prenatal radiation exposure. The training will be based upon NRC Regulatory Guide 8.13, and may be given as instruction in a classroom setting or as an informational pamphlet. This training will consist of the following:

- Risks associated with prenatal radiation exposure and employee rights
- Regulations concerning exposure limits and dose monitoring provisions for pregnant women,
- Strata's policy for pregnancy declaration.

A written or oral test with questions directly related to the radiation safety training will be administered to each employee. The instructor will review the test with each employee and discuss any incorrect answers so that the employee understands the correct answer. Workers who do not pass the test with 70% of the answers correct will be retested after receiving additional training.

If the employee is a supervisor, they will be given special instruction pertaining to their supervisory responsibilities in the area of worker radiation protection. Radiation safety issues or concerns that arise during operations will be addressed during regularly scheduled weekly safety meetings.

Additionally, employees will also be given general training and specific instructions on the health and safety aspects and non - radiological hazards based on the jobs they will perform. This training will comply with the OSHA training requirements specified in 29 CFR 1910 and training guidelines described in OSHA 2254 (OSHA 1998). Additionally, on-the-job training will be provided to address job/task specific hazards.

Records of the training program syllabus, dates of administration, attendance lists and records of exam results will be maintained in employee records.

5.5.2 Refresher Training

Each employee will receive a radiation safety training refresher course annually. The training will include a brief review of topics covered in the initial training as well as relevant information that has become available with regard to safety issues that have arisen, changes in regulations and license conditions, and employee exposure trends.

5.5.3 Contractor Training

Contractors doing work at the Ross ISR Project will receive appropriate radiation safety training. Contractors who work on contaminated equipment, in contaminated and/or radiation areas will receive the same training that is required of ISR employees as described in Section 5.5.1. Contractors who have previously received full training from prior work experience at the facility or have evidence of recent and relevant radiation safety training elsewhere may only need to receive job-specific radiation safety training at the discretion of the RSO.

5.5.4 Visitor Training

Visitors to the Ross ISR Project will receive hazard recognition and avoidance training for areas of the facility they will be visiting. All visitors that have not received training described in Section 5.5.1 will be escorted by someone properly trained and knowledgeable about the hazards at the site.

5.6 Security

As required in 10 CFR Part 20, Subpart I, Strata will secure from unauthorized removal or access all licensed material that is stored in controlled or unrestricted areas as part of the security program. Security measures will include the following passive and active controls:

- Areas where licensed material is located or stored such as wellfields, lined retention ponds, and the CPP will be fenced.
- Gates or doors for access to areas where licensed material is located or stored will have appropriate signage and be locked when facility personnel are not within the area to prevent unauthorized access.
- The main access gate to the project will be locked with coded and remote activated entry. The gate will be equipped with an intercom and video surveillance so that plant or administrative personnel can identify contractors and other site visitors. During normal working hours the gate will be controlled by personnel in the administration building. During night shifts the gate will be controlled by personnel in the Central Control Room. Contractors and visitors will be required to sign in and will be given applicable safety training as described in Section 5.5.4.
- Staff will be on-site 24-hours per day, 7-days a week to monitor unauthorized access.
- Daily inspections of access controls and signage will be conducted by facility operators.

Also as required in 10 CFR Part 20, Subpart I, Strata will control and maintain constant surveillance of any licensed material that is in a controlled or unrestricted area and that is not in storage. This includes transportation of loaded ion exchange resin from future satellite facilities or other resin generators to the CPP. The following passive and active controls will be used at the Ross ISR Project to maintain control and surveillance of licensed material:

- Transportation security risks will be documented and SOPs concerning these risks will be strictly followed.
- All access to containers and vehicles where license material is located when not in storage will be locked, or under constant surveillance.

5.7 Radiation Safety Controls and Monitoring

Processes at the Ross ISR Project include work with radioactive materials and will produce gaseous, liquid, and solid radioactive effluents as described in Chapter 4.0 of this report. Strata is committed to the control of these materials and effluents in order to protect occupational and public health at the Ross ISR Project. The methods used for control and monitoring of radioactive materials and effluents are described in the following section.

5.7.1 Effluent Control Techniques

5.7.1.1 Gaseous and Airborne Particulate Radiological Effluents

5.7.1.1.1 Gaseous Effluents - Radon

Under routine operations, the only gaseous radioactive effluent at the Ross ISR Project will be Rn-222 gas from the production and restoration solutions. Processing of uranium to produce yellowcake will be performed in a vacuum dryer. As described in detail in Section 7.3 and summarized below, no particulate radiological emissions to the environment are expected from the dryer and the associated off gas treatment system (see Section 5.7.1.1.2).

Rn-222 dissolved in the pregnant lixiviant will come from the wellfield into the Ross processing facility. The production flow will be directed to the CPP for recovery of uranium. The uranium will be separated by passing the recovery solution through pressurized down flow IX units. The vents from the individual vessels and the resin transfer area (elevated shakers, i.e., resin screens to remove fines and degraded resin and interface with elution system) will be connected to a manifold that will be exhausted outside the plant building through the elevated shaker stack. Areas where radon and progeny exposure will be of concern in the CPP include the vents from the IX vessels, the resin transfer area, and in fluid collection sumps. IX vessels will be operated in a pressurized manner with vents in the top of each vessel. The resin shaker screens will have exhaust hoods. Vents from these systems will be connected to a manifold and discharged on the plant roof. Discharge points will be located away from plant ventilation intakes and will be located on the leeward side of the CPP. Exhaust fans for these systems will create a negative flow ensuring that air will not enter the process areas from the vessels or systems. Radon exposure risks to personnel in the CPP will be further reduced by the general plant area HVAC system which is discussed in Section 4.1. Air sampling for radon progeny will be conducted regularly in the plant as described in Section 5.7.3. The general HVAC arrangement is depicted in Figure 5.7-1

Airflow through any openings in the vessels will be from the process area into the vessel and then into the ventilation systems, maintaining negative flow into the vessel and controlling any releases. (Note that the lixiviant circuit through IX will be a closed system; atmospheric pressures will initially be encountered during resin transfer at the shaker screens. This is where radon is expected to be released from the lixiviant circuit. Tank ventilation and local exhaust systems of this type have been successfully utilized at other ISR facilities and have proven to be an effective method for radon management and minimizing employee exposure (Brown 1982, 2007, 2008, NRC 2009, NMA 2007).

Venting to the atmosphere outside of the plant building minimizes personnel exposure to radon and its progeny which is a primary radiological and occupational health risk at modern ISRs. Rn-222 may be released in the plant building during solution spills, filter changes, IX resin transfer operations and maintenance activities. The plant building will be equipped with general area exhaust fans to remove any radon that may be released in the building before any significant ingrowth of progeny can occur. Personnel exposure to Rn-222 and progeny is expected to be minimal based on experience at similar facilities.

During plant start up, these potential in-plant radon sources will be monitored and ventilation adjustments made as necessary, including provisions for additional local exhaust systems if necessary (see Sections 4.1, 5.7.3 and Figure 5.7-1). The general HVAC system in the plant will further reduce employee exposure by removing radon from plant air, which will be exhausted as described previously. This system will be connected via ductwork and manifolds to the eluant and precipitation tanks.

5.7.1.1.2 Particulate Effluents Yellowcake

The vacuum dryers will be steel vessels heated externally and fitted with rotating plows to stir the yellowcake. The chamber will have a top port for loading the wet yellowcake and a bottom port for unloading the dried product. A third port will be provided for venting through the bag house during the drying procedure. The bag house and vapor filtration unit will be mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The bag house parameters (sudden pressure drop, reduction in air flow, etc) would be immediately identified which is monitored in the control room and the off gas treatment system is inspected at least once per shift. The dryer off gas system will be instrumented sufficiently to operate automatically and to shut down if malfunctions such as this vacuum system failure were to occur. The system will alarm if there is an indication that the emission control system is not performing within operating specifications. While the likelihood of an unnoticed seal rupture is low, the potential ramifications of this situation are addressed in Section 7.5, Effects of Accidents.

If the system is alarmed due to off normal conditions in the emission control system, the operator will follow SOPs contained in the plant operations manual to recover from the alarm condition, and the dryer will not be unloaded or reloaded until the emission control system is returned to normal service.

Ventilation and effluent control equipment will be inspected for proper operation as recommended in R.G. 3.56 (NRC 1986a) via routine equipment inspections and as discussed in Section 5.3. To ensure that the emission control systems are performing within specified operating conditions, instrumentation will be installed that signals an audible alarm if the air pressure (i.e., vacuum level) falls below specified levels, and the operation of this system is routinely monitored during dryer operations. The operator will perform and document inspections of the differential pressure or vacuum every operating shift. Additionally, the air pressure differential gauges for other emission control equipment is observed and documented at least once per shift during dryer operations.

<u>Demonstrating Compliance with Public Dose Limits at 10 CFR 20.1301</u>

NUREG-1569, Appendix D, discusses the MILDOS-AREA methodology acceptable to the NRC. The MILDOS code is capable of calculating off-site public dose and demonstrating compliance with the 100 mrem/yr public dose limit of 10 CFR 20.1301. The MILDOS-AREA computer code calculates the radiological dose commitments received by individuals and the general population within an 80-km radius of an operating uranium recovery facility. In addition, air and ground concentrations of radionuclides, as a result of deposition of radon progeny on soil and vegetation, are estimated for individual locations, as well as for a generalized population grid. Extra-regional population doses resulting from transport of radon and its progeny can also be estimated.

The transport of radiological emissions from point and different area sources is predicted with a sector-averaged Gaussian plume dispersion model. Mechanisms such as radioactive decay, plume depletion by deposition, ingrowth of decay products, and resuspension of deposited radionuclides are included in the transport model. Alterations in operation throughout the facility's lifetime can be accounted for in the input stream. The exposure pathways considered are inhalation; external exposure from groundshine and cloud immersion; and ingestion of vegetables, meat, and milk. Dose commitments are calculated primarily on the basis of the recommendations of the International Commission on Radiological Protection (ICRP). Only airborne releases of radioactive materials are considered in MILDOS-AREA; releases to surface water and to groundwater are not addressed in MILDOS-AREA. MILDOS-AREA is a multi-purpose code that can be used to evaluate population doses for NEPA assessments, maximum individual doses for predictive 40 CFR 190 compliance evaluations, or maximum offsite air concentrations for predictive evaluations of 10 CFR 20 compliance. Ingrowth of radon progeny in the environment between the emission source (plant, wellfield, etc.) and point of interest (location of member of public) including application of applicable exposure scenarios through direct inhalation, ingestion, ground shine, etc. is included in the MILDOS calculation of offsite doses from the ISR radon source term.

Throughout the 30 years of ISR operational experience in the US there is no evidence of public exposure from radon releases (including effect of progeny) in excess of public exposure criteria. For example, NUREG-1910, Table 4.2-2 presents a number of dose estimates to offsite receptors from radon releases from ISR facilities, all of which are ≤ 40 mrem/yr. Further, Section 4.2.11.2.1 states "all doses reported are well within the 10 CFR 20 annual radiation dose limit for the public of 1 mSv (100 mrem/yr)."

The MILDOS–AREA computer code as described above will be used, in conjunction with measured source terms applicable to the previous year of facility operation, to estimate the annual dose to the public. The operational environmental monitoring program for the Ross ISR Project will provide for continuous radon monitoring at site boundary locations and analysis of soil samples including for radon progeny (e.g., Pb-210) as described in Section 2.9 and 5.7.7. This will validate modeling results with regards to potential for radon progeny in the environment and demonstrate compliance to criteria for releases of radioactive material in effluents to unrestricted areas per 10 CFR 20, Appendix B, table 2.

5.7.1.2 Liquid Effluent

The production bleed and water from restoration are the primary sources of liquid waste as previously discussed in Section 4.2. Water from these processes will be routed to a reverse osmosis system (RO) for treatment. A portion of the resulting permeate from the RO will be routed back to the production and restoration injection streams and the remainder will be recycled in the plant, used beneficially, or disposed of. Brine will be routed to lined retention ponds and subsequently disposed of in Class I deep disposal wells. Figures 3.1-11 through 3.1-13 depict process liquid waste streams.

Other liquid waste streams at the project will include CPP wash down water, spent eluate, decontamination waste water, filter backwash water, fluids generated from work over operations on injection and recovery wells, and contaminated reagents.

5.7.1.2.1 Liquid Effluent Accidents

5.7.1.2.1.1 Responsibilities

The RSO will be charged with the responsibility to develop and oversee implementation of appropriate procedures to address spills of byproduct material. Personnel representing the engineering and operations functions will assist the RSO in this effort. Basic responsibilities of plant management and the RSO in this regard will include:

- Identification of potential spill sources including lessons learned from review of past incidents of spills.
- Assignment of resources and manpower.
- Responsibility for materials management and inventory.
- Establishment of spill reporting procedures and visual inspection programs.
- Establishment of employee emergency response training programs.
- Responsibility for program implementation and subsequent review and updating.
- Review of new construction and process changes that may require updating of spill prevention and control programs.

5.7.1.2.1.2 Failure of Process Tanks

Leaks from failures of process tanks will be contained within the CPP building. Where it is feasible, process area within the CPP building will have secondary containment consisting of concrete curbs. Secondary containment basins will drain to sumps which will allow the transfer of the spilled solutions to appropriate tankage, pondage or directly to the deep well injection system. In addition an overall plant containment berm will be incorporated into the building foundation which will contain spills during a catastrophic event or spills from areas where it is not feasible to include secondary containment berms. Plant secondary containment design features are shown on Figure 5.7-4. Details concerning the secondary containment capacity in the plant are discussed in Sections 3.2 and 7.5 of this report.

5.7.1.2.1.3 Surface Releases between the Wellfield and CPP

The most common form of surface releases from in-situ recovery operations occurs from breaks, leaks, or separations within the piping system that transfer recovery fluids between the CPP and the wellfield. These leaks will generally be limited to small releases due to engineering and instrumentation controls at the Ross ISR Project. Instrumentation and controls will include leak detection sensors in module buildings, valve manholes, and wellheads, as well as pressure monitoring instrumentation on pipelines which will trigger alarms and automatic shutdown in the case of an upset condition.

In general, piping within the wellfield will be constructed of PVC or HDPE pipe with butt welded joints, or equivalent. All pipelines will be pressure tested according to manufacturer's specifications and industry standards prior to final burial. In the event of leakage from the fitting, the defective component will be replaced. Prior to backfilling, a final inspection of all pipe and appurtenances will be conducted.

In order to prevent spills of mining solutions, the following precautions will be taken.

- Piping and associated fittings will only be constructed of materials that are chemically compatible, able to withstand the expected operating pressures, and compatible with ambient conditions.
- Wellfield pipelines and manifolds will be pressure checked before being placed into operation and after significant repairs.

- Regular inspections of operating wellfields will be conducted as outlined in Section 5.3.3. The entire plant also will be inspected at least daily when operating as discussed in Section 5.3.1.
- Automated monitoring will be installed in so any significant deviations in operating parameters will signal alarms and automatic shutdown.

Each operating module building will be inspected at least once per week by the operations staff with the results documented. The inspector will look for the following:

- Leaks of lixiviant in the module building;
- Failing pipes and fittings;
- Conditions that may lead to a release of lixiviant;
- Proper capping of wellheads and pipes that are not in use;
- Exposed scale that could become airborne; and
- Exposed piping that is supposed to be buried.

Any condition discovered during the inspection that may lead to the spread of contamination will be repaired in a timely manner or made safe. Results of the inspection will be made available to the RSO and will be maintained for the life of the license.

5.7.2 External Radiation Exposure Monitoring Program

This section describes Strata's approach for assessing the external exposure or deep dose equivalent (DDE) of personnel working at the Ross ISR Project. The approach includes general area surveys with hand held instrumentation and the use of fixed location thermos-luminescent or optically stimulated luminescent dosimeters (TLD/OSL dosimeters) to determine radiological conditions throughout plant areas as well as personnel dosimetry involving assignment of TLD/OSL to all regular, full-time personnel who may exceed 10 percent of the dose limit from 10 CFR §20.1201(a). Additionally, visitors and other occasional personnel will not be permitted access to any area which the dose rate exceeds 2 mrem/hr without being provided personnel dosimetry. Figure 5.7-5 displays the plant general arrangement with the radiological survey plan while monitoring locations for external radiation within the greater facility will be provided once final facility designs have been prepared.

5.7.2.1 General Area Gamma Surveys

Gamma surveys of the process area will be performed at least once a month to maintain a record of external exposure rate data and allow quick identification of changed conditions and help maintain that personnel exposures are kept ALARA. All surveys of this nature will be completed by a radiation safety technician meeting the training and experience requirements described in Section 5.4.2. These surveys will be performed using hand held instrumentation. Comprehensive surveys will be conducted initially at start up to verify assumptions regarding where external exposure rates will be highest. Survey locations and frequencies may be adjusted should process conditions change in the future affecting the external exposure profile of the plant and wellfields. Additionally, fixed location, area TLDs (or OSLs) will be emplaced at locations at which initial surveys indicate highest potential for gamma exposure as well as in non process areas such as offices, change rooms and lunchroom. These dosimeters will be exchanged on a quarterly basis or more frequently based on survey results at the discretion of the RSO.

Surveys will be performed at worker occupied process areas of potentially elevated gamma levels where radium may concentrate or precipitate and in areas where uranium concentrates are processed and/or stored. These areas will include wellfield module buildings within which precipitates from dried leaks could form, loaded IX and elution tanks, resin transfer system, RO unit, yellowcake precipitation, thickening, drying/packaging and storage areas, and other areas where 11e.(2) byproduct material is accumulated and stored. Figure 5.7-5 depicts areas of potential external exposure within the CPP where at a minimum, regular gamma surveys will be performed. Additionally, since elevated gamma levels can be an indication of surface contamination, areas where elevated gamma levels are identified during routine surveys that are not typically elevated, will also be assessed for surface contamination (see Section 5.7.6).

Designated "Radiation Areas" will be areas with external radiation levels at which an employee could receive an exposure greater than 5 millirems (0.05 millisievert) in one hour at 30 centimeters from the source and will be posted as such. These circumstances are considered unlikely at an ISR operation, except in areas where concentrations of radium precipitates accumulate and/or large quantities of final product concentrate is stored awaiting shipment (these will be restricted areas with limited personnel access). Should such exposure rates be encountered, an evaluation will be performed to determine the probable process circumstances that result in this condition and if practical opportunities exist to reduce exposure levels ALARA. In these circumstances, survey frequencies may need to be increased, sources (e.g., drums in storage) may need to be repositioned and/or stay times reduced as practical based on results of the ALARA analysis. Additionally, ad–hoc surveys will be performed during maintenance of systems which may contain concentrations of radium precipitates (e.g., tank clean outs.)

External gamma surveys will be performed with survey equipment that meets the following minimum specifications:

- Range - Lowest range not to exceed 100 micro Roentgens per hour (uR/hr) fullscale with the highest range to read at least 50 mill Roentgens per hour (mR per hour) full scale.
- Battery operated and portable.

An example of satisfactory instrumentation that meets these requirements is the Ludlum Model 19 micro R meter. Gamma survey instruments will be calibrated at the manufacturer's suggested interval or annually (whichever is more frequent) and will be operated in accordance with the manufacturer's recommendations. Verification of instrument consistency of operation will be performed using check sources prior to each use. Variations from reference readings greater than 20 percent will require the instrument to be removed from service and re-calibrated. Calibration records of gamma survey equipment will be retained on-site.

Gamma exposure rate surveys will be performed in accordance with standard operating procedures as defined in the project Radiation Protection Program (RPP). These SOPs will be developed and surveys performed in accordance with NRC guidance (NRC 2000, NRC 2002a).

5.7.2.2 General Area Beta Surveys

Regulatory Guide 8.30 recommends that, in addition to gamma surveys, beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake be performed to ensure that extremity and skin exposures are not unduly high. Beta exposure rate surveys will be performed at the specific operations that involve direct handling of large quantities of aged yellowcake. This would include in plant areas associated with precipitation, dewatering (filter press) and drying/packaging. These surveys will be performed near the surface of the material (e.g., within 10 cm) so as to be representative of beta exposure rates to workers' hands and skin during the handling of the material. Any beta exposure rate evaluations for these operations that are performed in lieu of instrument surveys will use the information provided in Regulatory Guide 8.30 Figures 1 and 2.

However, it is noted that modern ISRs typically involve a "process life cycle" for uranium measured in hours or a few days. (time from extraction of the uranium *in-situ* through final packaging in steel drums). Accordingly, no aged yellowcake is expected that could have experienced significant in growth of beta emitting daughters (i.e., Pa-234, Th-234). (Small amounts of precipitates which could contain aged yellowcake as scale in pipes and/or tanks are not accessible to workers except potentially for very brief periods during maintenance activities, and workers would not be "handling" such scale for exposure periods longer than a few minutes at a time).

Nonetheless, during the initial operational period, beta surveys will be performed as described here to verify the experiences at other operating ISRs and/or assess the needs for routine beta monitoring moving forward. See discussion on beta emitters below and also the discussion of air sample and product characterization in Section 5.7.3.1.

Beta contamination surveys will similarly be performed in these same plant areas initially and whenever a procedural and/or equipment change may increase risk of beta contamination (i.e. when performing maintenance on tanks/pipes that may accumulate materials over time) and could present a potential for ingrowth of beta emitting progeny (see commitment for use of radiation work permits below). These surveys will be performed with a Ludlum 43-1-1 alpha–beta phoswich scintillation probe or equivalent. This probe has an active window area of 83 cm^2, rated efficiencies of 30% alpha (Pu^{239}) and 30% beta (Sr^{90}/Y^{90}) and typical backgrounds of 3 counts per minute (cpm) alpha and <300 cpm beta.

However, it should be recognized that there is no aspect of the ISR process that would separate beta emitters Th-234 or Pa-234 from their alpha emitting uranium parents and therefore, there cannot be "beta contamination" associated with spills or maintenance activities in the absence of detectable alpha. In the event that there was a spill on a complex matrix (carpet, wood, etc) alpha surveys may not indicate the presence of contamination due to self absorption effects; however it is unlikely that a spill would occur on this type of surface in an ISR plant since only in office areas would there be carpeted and/or wood floors. Special care will be taken to survey for beta emitters in the unlikely event that a spill occurs on such a complex material. (Maximum beta possible would be when Th-234/Pa-234 are at equilibrium with the uranium at approximately 4 months post mining). Strata will typically transport offsite all yellowcake as soon as a full shipment is accumulated. Accordingly no aged yellowcake is stored on site.

It is therefore highly unlikely that under conditions of routine operations or as a result of spills or maintenance activities, beta exposure rates to which workers could be exposed could result in shallow dose equivalents to the skin or the skin of extremities ≥10% of the limits at 10 CFR 20.1201 (a)(2) requiring individual beta monitoring per 10 CFR 20.1502 (10% of 50 Rem/yr = 5 Rem /yr). For any maintenance work and/or spill clean up activities (typically not covered by existing standard operating procedures) a radiation work permit will be prepared which will define specific radiological monitoring and controls for the task. These will include beta exposure rate monitoring if it is suspected that the material in question may be aged yellowcake.

However, if these circumstances were to be identified, an ALARA analysis will be performed to evaluate needs for additional surveys and controls, including provisions for personnel beta monitoring (e.g., ring and/or wrist badges).

It is of interest to note that Cameco Resources Corporation has performed extensive beta surveys at both the Smith Ranch and Crow Butte ISRs in 2010 throughout their plants. These surveys were performed with GM detectors in the open vs. closed shield modes and indicated no difference at any location surveyed (including proximate to products in yellowcake areas) between measured exposure rates in the open (beta plus gamma) vs. closed (gamma only) configurations. That is, the beta exposure rates were zero (Brown 2010a).

5.7.2.3 Personnel Dosimetry

NRC regulations require exposure monitoring for adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits which are defined in 10 CFR 20.1201. Ten percent of the dose limit would correspond to a deep dose equivalent (DDE) of 0.5 Rem.

All full-time employees with the potential to exceed 10 percent of the dose limit from 10 CFR §20.1201(a) (as required in 10 CFR §20.1502) will be provided personal monitoring devices (TLDs or OSLs). Strata will determine routine monitoring requirements in accordance with the NRC guidance R.G. 8.30

(NRC 2002b), R.G. 8.34 (NRC 1992a) and R.G. 8.36 (NRC 1992b). Nonetheless, Strata believes that it is unlikely that any employee working at the Ross ISR Project will accrue a dose approaching 10 percent of the regulatory limit and therefore require monitoring per 10 CFR 20.1502(a)(1) (i.e., 10 percent of 5 Rem or 500 mrem/yr).

Strata will issue dosimeters to all regular, full-time employees with the potential to exceed 10 percent of the dose limit from 10 CFR §20.1201(a) and will exchange and have them analyzed on a quarterly basis (more frequently if dictated by exposure conditions at the discretion of the RSO). Dosimeters will be provided by a vendor that is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology. The dosimeters will have a range of 1 mR to 1000 R. Results from personnel dosimetry will be used to assess individual DDE for use in determining total effective dose equivalent (TEDE). Results from the external dosimetry program will be entered into each employee's personal exposure record and integrated into the overall dose assessment program as described in Section 5.7.4, Exposure Calculations.

At modern ISRs, current data indicates annual doses very rarely exceed 500 mrem/yr TEDE (Brown 2010a). In general, at any uranium recovery facility, personal exposures are typically much less than 1 rem/yr (IAEA 1976).

5.7.3 In-Plant Airborne Radiological Monitoring

5.7.3.1 Airborne Uranium Particle Monitoring

Very low levels of uranium particulates are expected in a modern ISR plant due the nature of low temperature vacuum drying equipment. The main potential source of particulate uranium particulate is at the location of the yellowcake packaging equipment. This area of the plant will be closed off (ventilation system isolated) and posted as an airborne radioactivity area. Additionally, surveys for airborne uranium will be performed to:

- Demonstrate compliance with the occupational dose limits for workers, specified in 10 CFR 20.1201, and DAC/ALI values specified in 10 CFR 20, Appendix B, Table 1.
- Determine if an area needs to be posted in accordance with NRC regulations found in 10 CFR 20.1902(d).
- Determine whether additional precautionary measures are required to comply with 10 CFR 20.1701 and 20.1702.

uCi/ml, which is 10% of the DAC; this ensures that the LLD/L_D for multiple measurements is also less than 3E-11 uCi/ml.

5.7.3.1.1 Potential for Mixtures of Radionuclide Particulates in Air

It is important to recognize the radiological environment of a modern ISR as related to the potential radionuclides of concern that could become airborne. Studies performed in the late 1970s and early 1980s of radionuclide mobilization from several ISRs and subsequent measurements at operating ISRs indicate a relatively small portion of the uranium daughter products in the ore body are actually mobilized by the lixiviant (Brown 2007).

In addition to the fact that very little of these uranium daughter products are mobilized *in-situ,* the (IX) resin used in ISR facilities is specific for removal of uranium. Thorium compounds are not removed by the IX resin and are therefore not expected in the process downstream of the IX columns (e.g., elution, precipitation, and drying circuits). Accordingly, the "nuclide mix" that can potentially become airborne in the precipitation, drying and packaging areas of a modern ISR facility is expected to be almost exclusively U-nat. Ingrowth of the first few short lived daughter products (Th-234, Pa-234) takes approximately 4 months to reach equilibrium, and therefore is not expected to be associated with the relatively fresh product present in an operating ISR CPP.

Additionally, it should be noted that in accordance with 10 CFR 20.1204(g), nuclides can be ignored in a mixture in air if the following conditions are met; 1) total activity in the mixture is used to determine compliance with 20.1201 and 20.1502(b), 2) any nuclides ignored are <10% of the mixture, and 3) the sum of all nuclides ignored are <30% of the mixture. For modern ISRs, these conditions are expected to be met.

In order to establish that natural uranium isotopes are the exclusive alpha emitting radionuclides of concern in air and to establish if there is any significant contribution from beta emitters, composite samples (long sampling times to maximize collected material) from several representative air particulate monitoring locations will be collected and radiologically characterized. These sample locations will adequately characterize various points in the process (e.g., lixiviant, precipitation, and drying/packaging areas). Samples will be analyzed for U-nat, Th-230, and Ra-226 and for gross alpha vs. beta activity. Results will be compared with the mixture exclusion conditions defined in 10 CFR 20.1204(g) to ensure that the appropriate DAC limits from 10 CFR, 20 Appendix B, Table 1 are used. If a mixture is present greater than the 10 CFR 20.1204(g) exclusion, a "sum of fractions rule" will be applied to establish the appropriate DAC. Additionally, yellowcake product will also be characterized to verify the radiological composition of fresh yellowcake is essentially exclusively uranium.

This comparison will determine if any nuclides are "unaccounted for" (e.g., gross beta > 30% of total activity of mixture and/or if the difference of gross alpha activity vs. total uranium activity > 30 % of mixture). Should these conditions exist, further radiochemical analysis will be performed to ascertain the specific nuclide signature of the mixture for comparison to the 10% exclusion condition of 10 CFR § 20.1204(g). Based on these results, a sum of fractions rule may need to be applied to determine the appropriate DAC. However, e.g., if these analyses demonstrate that < 30 % of the total activity is from beta emitters, and neither the Th-234 or Pa-234 activity is > 10% of the total, it will not be necessary to consider a beta component in the analysis of air samples, nor for purposes of conducting separate beta surveys (See Section 5.7.2.2).

5.7.3.2 Airborne Rn-222 Progeny Monitoring

Rn-222 will be sampled by measuring its progeny as they are easier to measure and are the basis for the assignment of worker dose. Initial sampling will occur in many locations in the CPP as depicted on Figure 5.7-5.

Measurements of Rn-222 progeny will be taken on a monthly basis in areas where Rn-222 progeny routinely exceed 10% of the regulatory limit or 0.03 working levels (WL) above background. Other locations that are routinely below the 0.03 WL will be sampled quarterly. During the first few months of CPP operation, monthly sampling will occur.

If at any time the levels of Rn-222 progeny exceed 0.08 WL, the circumstances will immediately be investigated or mitigated. Samples will then be taken weekly at this location until 4 consecutive samples show levels below 0.08 WL. Additional samples will be taken in areas where there is an upset condition, maintenance, or operational change that could result in the release of radon and/or as may be required by an RWP. Radon progeny samples will also be required before an RWP can be issued for work in confined spaces likely to contain radon and progeny.

When collecting a sample, the date, time, and status of major equipment and processes in the area will be recorded. The LLD for Rn-222 daughter measurements will be no greater than 0.03 WL (10% of the DAC) and shall be calculated using guidance found in Appendix B of NRC Regulatory Guide 8.30. Measured values less than the LLD, including negative values, will be recorded on data sheets. The LLD is set high enough to provide a high degree of confidence that 95 percent of the measured values above the LLD are accurate and do not represent false positive values. Filter paper samples will be analyzed using standard alpha counting equipment (e.g. Ludlum Model 2929 alpha/beta sample counting system or equivalent).

The modified Kusnetz method will be used for measuring Rn-222 working levels. This is the standard, generally accepted method for determining radon decay product concentrations in air (Kusnetz 1956 and Thomas 1972).

One WL is that concentration of radon decay products in one liter of air that will result in the emission of 1.3×10^5 MeV of alpha energy when all of the decay products present, decay to Pb-210. The Kusnetz method involves collecting an air sample for, nominally, five minutes on a high efficiency glass filter. Alpha counts on the filter will be determined by counting with an alpha scaler for one to five minutes after a decay time of 40 to 90 minutes. Filter paper samples will be analyzed using standard alpha counting equipment (e.g. Ludlum Model 2929 alpha/beta sample counting system or equivalent).

The total alpha disintegration rate is divided by the volume of air sampled and an empirical factor (Kusnetz factor) that relates alpha activity per liter to WL for a specified decay period. An additional correction factor will be applied to the counting efficiency to account for any self absorption by the filter.

Air samplers will be calibrated as per manufacturer recommendations or at least semiannually with a mass flow meter or other primary calibration standard. A record shall be kept of all calibrations and radon progeny surveys by the RSO until license termination and in a form compliant with NRC Regulatory Guide 8.7, Instructions for Recording and Reporting Occupational Radiation Exposure, Revision 1.

Radon Progeny in Air will be determined via the modified Kusnetz method as follows:

$$\text{WL} = \frac{\text{Sample cpm - background cpm}}{(\text{SAF})(\text{Eff})(\text{Vol})(\text{TF})}$$

Where:

cpm = Counts per minute (sample – background)
Eff = Instrument counting efficiency

SAF	=	Filter paper self absorption factor
Vol	=	Total air volume pumped through filter (flow rate in liters per minute x sample time in minutes)
TF	=	Time factor ("Kusnetz" factor from table at 40 – 90 minutes after sampling)

5.7.3.3 Respiratory Protection Criteria

A Respiratory Protection Program will be implemented in accordance with 10 CFR 20, Subpart H. Although it is not anticipated that respirators will be required to control intake or necessary to reduce exposure to airborne radionuclides below 10 CFR 20 limits during routine operations at the Ross ISR plant, workers in the yellowcake drying and packaging areas may be required to wear respirators as standard PPE in the unlikely event that process upsets and spills occur. In other circumstances, respirators will only be used in the event that exposures cannot be maintained ALARA with engineering and/or administrative controls. The RSO will determine when respirators are needed, per NRC Regulatory Guide 8.31. All respirators used on the site will be certified by the National Institute for Occupational Safety and Health (NIOSH) and will be used in accordance with 10 CFR 20.1703.

5.7.4 Exposure Calculations

Radiation doses to personnel will be calculated using methodology described in NRC Regulatory Guides 8.30 and 8.34. Estimates of the Total Effective Dose Equivalent (TEDE) at the project area will be based on external gamma ray measurements via TLDs or OSLs as described in Section 5.7.2, results from air samples that are representative of the air breathed by workers as described in Section 5.7.3, and results of bioassay measurements described in Section 5.7.5. Radiation doses estimated from elevated uranium in urine samples will be integrated with the dose estimates described in this section. The referenced methods and requirements will be applicable to routine operations, maintenance activities and incident response. It should be noted that historically, occupational doses at US ISRs have been quite low, with most radiation workers receiving <200 mem/yr TEDE. As would be expected, the highest exposures are typically associated with yellowcake workers because they work in close proximity to uranium concentrates (external exposure measured via TLDs or OSLs) and are potentially exposed to uranium dusts in the drying and packaging operations (internal exposure measured via air sampling and urinalysis). However, even for these workers, annual doses very rarely exceed 500 mrem/yr TEDE (Brown 2010b).

Although breathing zone air samples are considered more representative of the air breathed by workers than area air samples, both will be used as dictated by airborne conditions and job activities as described in Section 5.7.3. General area air sampling results will be used to estimate intakes whenever results exceed 10% of the DAC in areas that have been occupied by workers. Time-weighted exposure assessments will be performed in these cases to estimate DAC - hours of exposure and intake. Breathing zone sampling data will be used to estimate DAC - hours and intakes for jobs and tasks that required workers to wear them, but these calculations may be supplemented with general area sampling data if appropriate. These decisions will be based on representativeness and statistical confidence of air sampling results, length of exposure periods and other factors at the discretion of the RSO. The methods used to calculate radiation doses and to obtain representative air samples are applicable to all operations and activities (routine, maintenance, and ad hoc). Determination of the worker's TEDE and CEDE will be based on assigned external and internal exposure as described in this section.

Potential for external exposure is the direct result of proximity to gamma emitting radionuclides. This will be measured via TLDs or OSLs as described in Section 5.7.4.3.

Potential for internal dose will be primarily from inhaled uranium and radon progeny with only rare, unusual potential contributions from ingestion, wounds, or absorption through the skin. All reporting and record keeping of the worker doses will conform to Regulatory Guide 8.7, which requires record retention through license termination. Historical radiation exposures will be used to assess long-term trends. The RSO will assess exposure trends during annual ALARA reviews (see Sections 5.2.4 and 5.3.3).

The CEDE is the estimated internal radiation dose accrued over 50 years from intakes during the year of interest and is calculated from the intake of uranium and from radon and its progeny which are inhaled. Exposure calculations will be consistent with Regulatory Guide 8.30, Section 3 and Regulatory Guide 8.34, Section 3.

determine if corrective actions are necessary. Regarding action levels based on bioassay results, the action levels and recommended actions specified in Tables 1 and 2 of Regulatory Guide 8.22 will be used. It is noted that Table 2 would only be applied in the event of suspicion of a very large intake. The conditions for utilizing Table 2 can be found in Regulatory Guide 8.22. There will not be routine in vivo lung counting performed on workers at the Ross site. See Section 5.7.4.5, Bioassay for justification of use of bioassay action levels and actions per Tables 1 and 2 of Regulatory Guide 8.22.

5.7.5 Bioassay Program

Strata will implement a bioassay (urinalysis) program at the project area. The primary purpose of the program will be to detect uranium intake by employees who are potentially exposed to uranium concentrates during work in yellowcake areas.

This section presents Strata's approach and methods for conduct of a bioassay program at the Ross ISR Project in accordance with NRC Regulatory Guide 8.22 (NRC 1988), NUREG-0874, (NRC 1986b) and other national standards that define acceptable methods for uranium bioassay sampling and analysis in urine (see HPS 1995). The program will have provisions for pre-employment samples to establish baselines, exit samples upon termination, and routine sample collection and analysis to verify adequacy of air sampling and engineering controls, as well as special sampling based on air sampling results, RWP requirements or incidents potentially involving intake.

5.7.5.1 Regulatory and Technical Basis of Bioassay Program

Bioassay (urinalysis) programs at uranium facilities must be appropriate for the specific characteristics of the uranium products to which employees are potentially exposed. Product-specific solubility characteristics can have metabolic implications for bioassay that impact appropriate action levels and the interpretation and dose implications of results (Cook and Holt 1974, Eidson and Mewhinney 1980, Brown and Blauer 1980, NRC 1988).

The Ross ISR Project will dry yellowcake using vacuum dryers operated at approximately 250°F. This is considered "low - fired yellowcake" since it is produced at temperatures below 400°F (NRC 1988). Accordingly, Strata will implement a bioassay program in accordance with NRC guidance for low fired yellowcake. The uranium concentrates and final product associated with this

- ◊ Blank and spiked samples will be submitted to the laboratory with employee samples as part of the Quality Assurance program. The minimum measurement sensitivity for the analytical laboratory will be 5 ug uranium /liter.
- ◊ Each batch of samples submitted to the analytical laboratory will be accompanied by two control blanks and two spiked control samples. These samples will be from persons that have not been occupationally exposed. The two spiked control samples will be spiked to a uranium concentration of 10 to 20 ug/l and 40 to 60 ug/l, respectively. Alternatively, synthetic "spiked" samples may be used. The results of analysis for these samples are required to be within ±30% of the spiked value for actual employee results to be considered valid.
- ◊ The analytical laboratory will spike 10% to 30% of all samples received with known concentrations of uranium and the recovery fraction will be determined. Results will be reported to Strata and analytical data/lab reports will be maintained on-site.

5.7.5.3 Action Levels and Corrective Actions Based on Urinalysis Results

Action levels and associated follow up and corrective actions to be taken in response to elevated uranium results in a uranalysis sample will follow Table 1 of Regulatory Guide 8.22. It is currently assumed that the yellowcake products produced at the Ross ISR Project will be relatively soluble "low fired yellowcake." Accordingly, for any two consecutive samples confirmed to be in excess of 35 ug/liter, or any single specimen confirmed to be in excess of 130 ug/liter, the affected employee will have urine samples collected daily. Follow-up and dose assessment will be performed, and the employee may be referred for an in vivo lung count to ascertain if he/she may have been exposed to at the discretion of the RSO based on circumstances of exposure, solubility characteristics of Ross ISR yellowcake and R.G. 8.22/NUREG-0874 recommendations.

5.7.5.4 Dose Assessment and Record Keeping

All bioassay results, including negative (i.e., < action level of 15 ug/l) results, will be retained in employee personnel files. For results confirmed in excess of action levels, an internal dose assessment will be performed including information obtained from follow-up actions and investigations including follow up bioassay results, if applicable. Estimates of the CEDE associated with the job as described in Section 5.2.2. RWPs will specify additional survey, personal protective equipment, documentation and related requirements to ensure the work can be performed safely and in accordance with ALARA principles.

5.7.6.2 Surveying Skin and Personal Clothing

Strata will designate and post the plant processing area as restricted and limit access to only those individuals who have received appropriate training and/or are escorted by an experienced employee. The restricted area is shown in Figure 5.7-4 while Figure 5.7-5 shows the locations of frisking stations. Signage will read, "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL" (or equivalent). Before leaving the restricted area, all individuals must perform and document an alpha/beta survey. Individuals who have been in the wellfields, byproduct storage area, near the deep well or storage ponds will perform and document an alpha/beta survey immediately upon returning to the plant before entering office areas, before eating, or before leaving the mine site. The personnel monitoring system will consist of a Ludlum Model 43-93 series alpha/beta detector (Background ≤3 cpm alpha, <300 cpm beta; efficiency rated for 20% Pu-239, 15% Tc-99, 20% Sr/Y-90) coupled to a Model 2360 alarming scaler/ratemeter or equivalent. The alarm will be set by the RSO after determining the efficiency of the system so that contamination above the limit will be detected. A typical alarm setting for this type of equipment is 20 cpm. The goal is no personal contamination above background levels. All workers shall receive training regarding how to properly perform and document alpha surveys. The RSO or RST shall post by each alpha/beta survey meter the written instructions for use of the system and the allowable limits in cpm.

All exit doors without a permanent or temporary scanning station will be designated and labeled as emergency exits only. A temporary scanning station may be set up for a limited period using an alpha/beta detector/meter system approved by the RSO. Unannounced quarterly spot surveys of personnel will be performed by the RSO or RST as recommended by NRC Regulatory Guide 8.30, Section 2.6. The spot surveys will also take place in non-restricted areas and will include personnel who work in the wellfield and other areas external to the CPP. Spot checks will ensure that employees perform self survey before leaving the restricted areas.

5.7.6.2.1 Response to Identification of Personnel Contamination in Excess of Background

Upon determination by any employee that contamination on his/her person, clothing or other personal effects exceeds background, the affected area(s) will be washed with water and soap and resurveyed. A second washing using modest abrasive methods may be required (soft brush or cloth). If the contamination remains above background, the RSO or RST will be contacted. More aggressive methods, e.g., use of detergents may be used, but abrasion of the skin should be avoided. If the ALARA objective of background cannot be achieved without more extensive and potentially abrasive methods, the methods and release limits specified in Regulatory Guide 8.30, Section 2.6 will be used and all detected activity would be assumed to be removable. If these limits cannot be achieved without abrasion of the skin or other potentially harmful impact to the employee, the RSO may need to refer the employee for medical intervention.

Since release limits for beta/gamma emitters are identical to alpha ("uranium and daughter products" at 1000/5000 dpm per 100 cm^2), use of these limits for total activity are protective (e.g., Regulatory Guide 1.86 and enclosure 2 of FC 83-23 [This and all other references to NRC FC 83-23 within this document are intended to indicate the April 1993 version of its enclosure 2, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material* unless otherwise noted.] as referenced in Regulatory Guide 8.30 – see discussion in Section 5.7.6.3).

Although the objective of personnel decontamination is to achieve background levels in accordance with Regulatory Guides 8.10 (NRC 1977) and 8.31 (NRC 2002a), should background not be achievable without potential damage to the skin of the affected employee, the approach and limits described in Regulatory Guide 8.30, Section 2.6 will be applied. No requirement is specified therein to establish the nuclide mix of the ≤1000 dpm/100 cm2 limit (5000 dpm/100 cm2 for soles of shoes) nor is there any technical basis for doing so since there is no need at levels approaching background to perform a "dose assessment."

Should contamination be detected in the facial areas and/or a respirator found to be internally contaminated following use, nose and mouth swabs using q-tips or equivalent will be performed. If any contamination is found on the swab, or other evidence suggests that the worker may have received an internal exposure, a bioassay sample will be collected as discussed in Section 5.7.5, Bioassay Program. Results of the bioassay analysis will be integrated with the workers exposure assessment as described in Section 5.7.4, Exposure Calculations.

5.7.6.3 Surveys for Release of Equipment to Unrestricted Areas

5.7.6.3.1 Methods and Procedures

The RSO or RST will survey potentially contaminated items before they are released from the facility. Items which cannot be representatively surveyed due to geometry or any other reason may not be released for unrestricted use. A Ludlum Model 2360 scaler/rate-meter counter and Model 43-93 scintillation probe, or equivalent, will be used for release surveys. Survey equipment shall be calibrated per manufacturer specifications at least annually. Instruments used to assess surface contamination shall be checked for proper response daily when the plant is operating. Operational tests will be conducted on all survey instruments to ensure they are in working order. All instrument documentation will be maintained on-site.

Equipment and surfaces shall not be painted over or plated for the purpose of meeting release criteria. However, if painting over an area with contamination that cannot reasonably be removed is determined by the RSO to be ALARA, it may be allowed as long as the contamination on the article or surface is characterized and documented. The item or area must be visibly labeled as contaminated. The radioactivity of pipes, drain lines, pumps, or duct work where access can be difficult, will be determined by making measurements at a trap or similar access point. Adequate records will be maintained to ensure that the article or surface is not inadvertently released for unrestricted use.

Strata will ship yellowcake to other facilities for further processing. Prior to the release of packages containing yellowcake from the ISR facility, the packages shall be washed and thoroughly surveyed to ensure compliance with DOT release standards found in 49 CFR 173.433(a) and (b). Shipment of yellowcake will also be transported in accordance with the applicable requirements of 10 CFR Part 71.

Figure 5.7-5 depicts the survey locations for yellowcake product and 11e.(2) byproduct material trucks and associated decontamination stations.

5.7.6.3.2 Contamination Limits to Be Applied for Release of Equipment and Materials From Restricted Areas

It is important and fundamental to recognize the radiological environment of a modern ISR as related to potential radionuclides of concern for which contamination surveys must be performed, and unrestricted release limits established. Studies performed in the late 1970s and early 1980s of radionuclide mobilization from several ISRs and subsequent measurements at operating ISRs, indicate a relatively small portion of the uranium daughter products in the ore body are actually mobilized by the lixiviant. (Brown 2007 and Brown 2008).

The vast majority of secular equilibrium radionuclides remain in the host formation. The majority of the mobilized Ra-226 (approximately 80-90%), which was estimated to be 5-15 percent of the calculated equilibrium radium concentrations in the host formation, followed the calcium chemistry in the ISR process and resulted in radium carbonates/sulfates in the calcite byproduct waste streams (e.g., as 11e.(2) byproduct material). It is only this material in which Ra-226 concentrations would be expected to be elevated relative to equilibrium with uranium but not without some uranium but only very small amounts of the short-lived daughter products (e.g., Pa 234, Th 234).

Accordingly, the existing, NRC guidance for unrestricted release of equipment and clearance limits for "U-nat, U-235, U-238 and associated decay products" are applicable and appropriate for ISR plants as described in NRC Regulatory Guide 8.30, Section B, which indicates, "The contents of this guide conform with NRC's current licensing practice." We are unaware of any revisions of RG 8.30, subsequently issued NRC regulatory guides and/or NRC rules and regulations that supersede the continued use of RG 8.30 as issued in 2002.

Recommended surface contamination limits are defined in RG 8.30 in its Table 2 entitled *Surface Contamination Levels for Uranium and Daughters on Equipment to be Released for Unrestricted Use, on Clothing and on Non Operating Areas of UR Facilities.* A footnote to RG 8.30 Table 2 indicates the stated contamination levels are taken from Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors* and from *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct Source or Special Nuclear Material* (NRC 1987). It is also of interest to note that the 1993 revision of enclosure 2 of NRC's Policy and Guidance Directive FC 83-23, (NRC 1993c; same title as the 1987 revision), in its Table 1, uses identical radionuclide categories and contamination limits as the 1987 revision as well as with Regulatory Guide 1.86.

Accordingly, FC 83-23 enclosure 2 (NRC 1993c) as well as the 1983 and 1987 versions use identical radionuclide categories and quantitative limits, although the 1987 and 1993 documents also specify dose rate guidance (mrad/hr for beta gamma emitters). Therefore the radionuclide categories, limits, and intended application of all three versions of enclosure 2 of FC 83-23 (1983 1987; and 1993), Regulatory Guide 8.30 and Regulatory Guide 1.86, are all consistent. Additionally, it is noted that analysis performed to access the dosimetric/risk based consequences of the application of these limits by NRC indicated they are protective and provide an appropriate standard of care (see NRC 1997).

Nonetheless, Strata commits to applying the beta/gamma release criteria of enclosure 2 of FC 83-23, which as discussed above are numerically equivalent to the "U-nat, U-235, U-238, and associated decay products" categories of Regulatory Guide 8.30.

5.7.6.4 Survey Methods and Instrumentation

The RSO, or individuals properly trained and authorized by the RSO, will perform contamination surveys of plant areas and of items removed from the restricted areas as described above. Guidance for instrument selection and survey methodology is provided in NRC (1992a) and NRC (2000).

Survey equipment will be calibrated annually or at the manufacturer's recommended schedule, whichever is more frequent. Verification of instrument operation will be performed using check sources prior to each use or at least daily. Variations from reference readings greater than 20% will require the instrument to be immediately removed from service and re calibrated.

Surface activity will be measured with an appropriate alpha/beta survey meter, e.g., Ludlum Model 2360 Scaler/Ratemeter with a Model 43-93 alpha/beta scintillation probe, or equivalent.

Survey equipment will be calibrated annually or at the manufacturer's recommended frequency, whichever is more frequent. Surface contamination instruments will be checked daily when in use. Alpha/beta survey meters for personnel surveys will be response checked before each use.

5.7.6.5 Routine Daily Inspections and Qualifications of Personnel Performing Contamination Surveys

In general, the RSO or radiation safety staff will perform all of the daily walkthrough inspections of the plant. However, this can prove problematic on weekends, holidays, or absences of both the RSO or RST because the RSO and radiation safety staff is typically on site during regular working hours. To address these inspection periods, it has been industry practice to train selected individuals (usually the plant operators) to perform the daily walkthrough inspections and to perform certain contamination surveys. In order to accomplish this, in addition to their training as radiation workers in accordance with guidance in RG 8.31, Section 2.5 *Radiation Safety Training,* these individuals will receive specific training for inspections for radiological safety and in the performance of contamination surveys of equipment or material when moving from a controlled or restricted area through an unrestricted area and then back into a controlled or restricted area. This training includes specific procedural requirements contained in Standard Operating Procedures and related documentation of inspections. A checklist will be prepared by the RSO or assistant RSO, which provides a "tool" that the designated worker uses to maintain consistency and continuity of this function. Training is documented in the individual's training records. The records of this training and the results of daily walkthrough inspections have been inspected by NRC at current licensees and found to be acceptable.

5.7.7 Airborne Effluent and Environmental Monitoring Program

5.7.7.1 Operational Environmental Monitoring Program

This section presents the methods that will be used for the Ross ISR Project airborne effluent and environmental monitoring program during operations. The program as described herein presents information on which media will be sampled, radionuclides analyzed, sampling locations and frequency and reporting requirements. This operational environmental monitoring program is a continuation of the pre-operational program described in Section 2.9 and will include similar media, sampling locations, methods and procedures referenced therein. Groundwater and surface water radiological sampling is discussed in Section 5.7.8.

This operational environmental monitoring program will be conducted in accordance with the recommendations of NRC Regulatory Guides 4.14, (NRC 1980), 4.15 (NRC 1979) and 8.37 (NRC 1993a).

Field sample collection and/or measurement techniques will be conducted in accordance with accepted scientific protocols, e.g., field survey and sampling methods described in NUREG/CR-5849 (NRC 1992c), and/or NUREG-1575 (NRC 2000), as applicable. For sampling and analysis of water, guidance from the EPA-625-/6-74-003a (EPA 1974), will also be used. These field methods were incorporated into the SOPs that were used and are cross-referenced to the applicable program elements in Table 2.9-1 of Section 2.9. These SOPs are contained in Addendum 2.9-A.

The operational environmental monitoring program will include the measurement of naturally occurring radionuclides as described in NRC Regulatory Guide 4.14, Table 2 and as summarized in Table 5.7-1 below.

5.7.7.1.1 Ambient Monitoring

The operational airborne radiation monitoring program will utilize the air particulate sites established for the pre-operational baseline monitoring program, discussed in Section 2.9.2.3. Baseline monitoring and MILDOS-AREA modeling confirmed that the monitoring locations, depicted in Figure 2.9-24, are consistent with Regulatory Guide 8.30. Additionally, the monitoring stations meet the recommendations of Regulatory Guide 4.14, which states that:

> "Air particulate samples should be collected at (1) a minimum of three locations at or near the site boundary, (2) the residence or occupiable structure within 10 kilometers of the site with the highest predicted airborne radionuclide concentration, (3) at least one residence or occupiable structure where predicted doses exceed 5 percent of the standards in 40 CFR Part 190, and (4) a remote location representing background conditions."

Strata will utilize F&J Specialty Products Models DF-40L-BL-AC and LV-1D samplers or equivalent. Filters will be collected from each air-sampling unit on a weekly basis (or more often as required by dust loading) and analyzed for uranium, Ra-226, Th-230 and Pb-210.

Strata will co-locate radon detectors and thermoluminescent dosimeters (TLDs) with the air particulate samplers as well as other areas of interest including the nearest residences, CPP, lined retention ponds, and wellfields.

Strata will utilize Landauer high sensitivity environmental radon Trak-Etch detectors and environmental low level TLDs. The results will be used to assess quarterly radon concentrations and gamma exposure rates at each of the sites.

5.7.7.1.2 Soils and Sediment Monitoring

During operations, Strata will conduct soil and sediment sampling on an annual basis. Soil samples will be collected at the five air particulate stations, while sediment samples will be collected at the surface water monitoring locations and Oshoto Reservoir as discussed in Section 2.7.1. All samples will be collected to a depth of 6 inches. Following the recommendations of Regulatory Guide 4.14, the samples will be analyzed for uranium, Ra-226, Pb-210 and gross alpha. In addition, sediment samples will be analyzed for Th-230.

5.7.7.1.3 Vegetation, Food, and Fish Monitoring

Monitoring for vegetation, food and fish will be based on the results of the MILDOS-AREA model and final NRC approval of the operational monitoring program. As stated in Regulatory Guide 4.14, "where a significant pathway to man is identified in individual licensing cases, vegetation, food and fish samples should collected." In the event that monitoring is required, sample collection will be conducted similar to the pre-operational baseline monitoring described in Section 2.9 and will meet the recommendations of Regulatory Guide 4.14.

5.7.7.2 Estimation of Radionuclide Effluents and Reporting

As stated in NUREG-1910 "...radon gas is emitted from ISL wellfields and processing facilities during operations and is the only radiological airborne effluent for those facilities that use vacuum dryer technology." The off gas treatment system and associated emission controls for the vacuum dryer system are described in Section 4.1 and 5.7.1 and are ALARA by design relative to potential for particulate emissions and therefore compliant with the requirements of 10 CFR 40, Appendix A, Criterion 8. NRC recognizes in NUREG-1910 that the emission of radionuclide particulates from this technology is essentially zero.

Nonetheless, Strata will estimate the emissions of air particulates from the CPP and each header house by the use of air sampling. Composites of the filters used in the sampling procedure will be sent to an outside accredited laboratory for analysis of the concentrations of the primary radionuclides of concern. The results of the analysis will be multiplied by the design ventilation rate of the respective exhaust systems to determine the quantity of each radionuclide particulate emitted during the reporting period. Regarding estimation of radon emissions from the CPP, periodic samples will be obtained from the recovery and injection process fluids. The samples will be sent to an outside accredited laboratory for analysis of Rn-222 in water. The difference in the concentration of Rn-222 between the recovery and injection process fluids will be attributed to a loss term which will be multiplied by the design ventilation rate of the exhaust system to produce the estimation of Rn-222 effluent emitted from the main processing facility. For estimating the effluent from the wellfield, each module building and 10% of the associated recovery wells will have a passive track etch detector placed inside. The track etch detectors will be sent to an outside accredited laboratory for analysis. The results of the analysis will be multiplied by the design ventilation rate of the exhaust system to estimate the amount of effluent emitted from these point and diffuse sources. It will be conservatively assumed that the radon progeny are in equilibrium with the radon parent when released in estimating the total quantities of radionuclides emitted during the previous six-month period.

Effluent Reports

Semi annual reports will be submitted to the NRC in accordance with 10 CFR 40.65, which will summarize the results of the ongoing environmental monitoring program. These reports will provide an estimate of the quantity of each of the principal radionuclides released to unrestricted areas in liquid and gaseous effluents during the previous 6 months, injection rates, recovery rates, methods and basis for these estimates, and any other data specified by license condition to be included in these reports.

5.7.8 Groundwater/Surface Water Monitoring Programs

During operations at the Ross ISR Project, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. The operational water monitoring program includes evaluation of groundwater on a regional basis, groundwater within the permit or licensed area, and surface water on both a regional and site specific basis. A summary of the groundwater and surface water monitoring programs is given in Table 5.7-1.

5.7.8.1 Wellfield Baseline Groundwater and Construction Phase Surface Water Monitoring

A groundwater and surface water monitoring program will be instituted after license approval in order to gather the required data to prepare a comprehensive wellfield package and to assess the impacts of construction activities for the Ross ISR infrastructure. The initial wellfield package for the first mine unit will be submitted to WDEQ/LQD for approval, as well as to NRC for review and verification. Subsequent wellfield packages will be submitted to WDEQ/LQD for review and approval and to NRC for review at least 60 days before the planned start of lixiviant injection. Each wellfield package will be reviewed and approved by the SERP.

The wellfield baseline groundwater monitoring program will evolve significantly from the pre-application submittal baseline program with the construction of additional monitoring wells. This monitoring program will also include the pre-application submittal sampling sites.

Construction Phase Monitoring – Surface Water

The Oshoto Reservoir will continue to be monitored for water quality on a quarterly basis. Because the focus of the construction-phase surface water monitoring program is to assess construction impacts, additional reservoirs may be sampled near concentrated construction areas. In addition, three surface water monitoring locations, which are located on Deadman Creek upstream of the wellfields (SW-3), on the Little Missouri River upstream of wellfields (SW-2), and downstream of wellfields on the Little Missouri River (SW-1) will be utilized for the life of the project. Figure 5.7-7 depicts the wellfield baseline and life of mine reservoir and stream monitoring locations.

Wellfield Baseline Monitoring – Private Wells

Existing private wells within two kilometers of the perimeter monitor well ring for active mine units are to be sampled on a quarterly basis with the landowner's consent. Samples will be analyzed for the parameters listed in Table 5.7-1. Baseline data acquisition efforts have indicated that under some circumstances private water wells are not always available for sampling for a number of reasons, including dry or abandoned, non-functioning, winterized, and/or not accessible. In the event that a private well is not sampled during a given quarter, it will be revisited quarterly until such time as a sample can be obtained. Pre-submittal reviews of Wyoming State Engineer's Office records along with anecdotal evidence from landowners are typically the best methods to identify groundwater resources and their level of current use. As with pre-license data, landowners will continue to receive water quality results and be apprised if a significant deviation is apparent in the data. Figure 5.7-8 depicts private wells for wellfield baseline and life of mine monitoring. If, during the course of groundwater model development for specific mine units, impacts to adjacent groundwater rights are predicted, Strata may request that data logging pressure transducers be installed in the well(s) in order to monitor any potential abstractions during operations.

Wellfield Baseline Monitoring - Wellfield

The wellfield baseline monitoring program is designed to define the primary restoration goals, determine upper control limits for horizontal excursions of lixiviant into the ore zone aquifer outside of the wellfield, and potential vertical excursions into the overlying or underlying water-bearing intervals. This program will be based on information obtained from baseline geologic and hydrologic information, groundwater model simulations, wellfield aquifer testing, and wellfield groundwater baseline sampling, which is described in detail below.

In order to determine operational groundwater monitoring objectives, a wellfield data package containing results of aquifer tests, potentiometric surface maps, water quality results, and groundwater modeling predictions will be assembled for LQD and SERP review and approval and NRC review. Based on the results of the pre-license monitoring efforts, the following program is implemented.

In accordance with LQD Chapter 11, one baseline well cluster will be installed for every four wellfield acres. License SUA-1601 currently requires one baseline well per two acres of pattern area. The Ross ISR Project wellfield baseline program will include approximately 24 baseline clusters, with a range of 15 to 30 possible clusters based on final wellfield acreage. Each cluster will include three wells targeting: 1) a 10-30 foot thick sandy interval in the Fox Hills Formation (designated as the DM unit) below the ore zone, 2) the ore zone (100-180 foot thick sand interval) completed in the lower Lance/Upper Fox Hills formations (designated as the OZ interval), and 3) a shallow Lance sandstone that is the first water-bearing unit above all mineralized zones (designated as the

SM unit). SM and DM interval/unit wells will utilize a fully penetrating completion while the OZ wells will target specific roll front horizons. License SUA-1601 currently requires installation of surficial aquifer (SA) monitor wells in areas of the wellfields where the SA aquifer is comprised of saturated unconsolidated alluvium. The SA monitor well locations must demonstrate that the wells provide early detection of a release (down topographic gradient). The existing network of SA wells and piezometers monitor both areas upgradient and downgradient from proposed wellfields. Similarly, the proposed DM and SM well locations target areas downgradient from recovery activities. Figure 5.7-9 depicts existing and proposed monitor well clusters.

As in the existing cluster wells, baseline wells in the proposed recovery areas will be equipped with dedicated submersible pumps and sounding tubes for manual water level measurement. Wells may also be equipped with pressure transducers which may be downloaded locally or relay water levels to the PLC in each module building. The wells which will be used to monitor the ore zone will be recovery wells that will be used during recovery operations. A pressure transducer or sounding tube will not be used on these wells. By using the pressure transducers to monitor aquifer pressure in real time, sample quality can be maximized as the yield can be adjusted to prevent well pump-off. Further, with the instrumentation in place, hydraulic properties can be measured during sampling. Well responses measured during sampling have proven to be highly effective for determining suitable pumping rates prior to aquifer testing. Given the low storage coefficient measured during aquifer test analyses (Addendum 2.7-F), head changes appear to be very good indicators of stress to the ore zone aquifer system. Field parameters to be monitored beyond yield and water level are listed in Table 5.7-2.

In addition to the wellfield area baseline well clusters that are located in proposed recovery areas, perimeter monitor wells are proposed to characterize baseline conditions and to act as sentries for detection of lateral movement of lixiviants outside of the mineralized areas during operations. A typical layout of the perimeter monitor well rings is shown on Figure 3.1-14. The perimeter monitor wells will fully penetrate the lower Lance and Upper Fox Hills mineralized sandstones of the OZ interval. One of the aquifer tests detailed in the supplemental report on the pre-license aquifer pump tests (Addendum 2.7-F) utilized a fully penetrating well as an observation well (12-18OZ) and a partially penetrating well with a more discreet, production-type completion as the pump well (OW1B57-1). Results indicate that the response time in the fully penetrating well was very similar to the response time when the fully penetrating well was pumped and the partially penetrating well was monitored during another aquifer test conducted at the same cluster. The nearly instant response in the fully penetrating well indicates that even with vertical geological heterogeneity, local wellfield imbalances would be observed as a head change in the perimeter monitor well. Figure 5.7-10 depicts a typical relationship between a perimeter monitor well and the adjacent wellfield. Like wellfield baseline wells, perimeter monitor wells would likely be equipped with dedicated submersible pumps, data logging pressure transducers and a sounding tube for manual water level measurement. Given the data collected during pre-submittal baseline efforts, water level deviations within monitoring wells are good indicators of stress within the aquifer system.

The regional groundwater model developed for the Ross ISR Project indicates that a spacing of 400 to 600 feet between the production wellfields and perimeter monitor well ring is sufficient to detect an excursion. In order to be conservative, spacing between the monitor wells is proposed to be 400 feet. Addendum 2.7-H details the results of the groundwater model simulations during operation and during an excursion. Briefly, simulations of excursions from a wellfield were modeled, points recording the modeled heads were located at 200 feet, 400 feet, and 600 feet from the active wellfield in both the downgradient and upgradient directions. The local wellfield imbalance was simulated for 30 days and resulted in nearly an 18 and 14-foot increase in water level 400 feet upgradient and downgradient from the wellfield, respectively. Similarly, nearly a 10 and 12-foot head change was apparent 600 feet both upgradient and downgradient from the wellfield respectively. Results of the simulation run for the upgradient and downgradient scenarios are presented on Figures 5.7-11 and 5.7-12. *Most importantly, the simulations indicate that a head change or hydraulic anomaly would rapidly become apparent in the perimeter wells, well before any geochemical influences would be detected.*

The groundwater model developed in support of the wellfield data packages will be utilized to confirm or adjust the spacing and offset distances of the perimeter monitor well ring. Strata proposes to present the wellfield package groundwater model results as a work plan to WDEQ/LQD prior to the monitor well installation. The wellfield data package will include model simulations demonstrating that the monitoring networks are sufficient to detect a hydraulic anomaly resulting from a local wellfield imbalance. In addition, initial model simulations clearly indicate the effects of an unbalanced wellfield. Thus, upon submittal the wellfield package will be hydraulically balanced.

Aquifer tests will be conducted following installation of the perimeter, deep, shallow and ore zone wellfield baseline wells. The tests will serve three purposes: one, to demonstrate that the overlying and underlying aquifers are hydrologically isolated from the mineralized sandstone; two, that the perimeter monitor wells are in communication with the ore zone and spaced to effectively detect an operational wellfield imbalance, and; three, to further improve and calibrate the groundwater model developed in support of the wellfield package. Wellfield aquifer testing will only be completed after nearby exploration and delineation boreholes which are within the area of influence (AOI) of the tests, have been abandoned with approved sealant materials from bottom to top, as well as after MITs have been completed on the all existing wells that will be used during operations.

Water quality data acquisition during wellfield baseline characterization will include at least four samples, with a minimum of 2 weeks between sampling events, for all perimeter, deep monitor (DM), OZ baseline wells and shallow monitoring (SM) wells. In addition, the SA well network will continue to be sampled on a quarterly basis through the wellfield data acquisition phase and be available for more frequent monitoring in the event of an upset condition, such as a significant spill or pipeline leak. The first and second sample events will include analyses for all WDEQ/LQD Guideline 8, Appendix 1, parts III and IV (WDEQ/LQD 2005), and NRC NUREG-1569, Table 2.7.3-1 parameters as shown in Table 5.7-2. The third and fourth sampling events may be analyzed for a reduced list of parameters as defined by the results of the previous sample events and pre-permit baseline efforts. Results from the samples are averaged arithmetically to obtain an average baseline value, as well as a maximum value for determination of upper control limits (UCLs) for excursion detection.

5.7.8.2 Operational Ground and Surface Water Monitoring

Operational Monitoring – Surface Water

Operational surface water monitoring will focus on those surface water features that could be impacted either due to a spill or pipeline leak or from surface discharges. Given the depths of the ISR operations (over 400 feet below ground level) and lack of hydrologic connection between the OZ interval and surface water features in the area, no direct impacts to surface water (quantity- or quality-wise) are anticipated during normal ISR operation. Operational sampling of surface water will be performed at the same sites that pre-operational surface water monitoring was conducted. A detailed description of the pre-operational surface water monitoring program is included in Section 2.7.1.7. Operational monitoring sites will consist of the three surface water monitoring locations (SW-1, SW-2 and SW-3) and the 11 reservoirs within or near the project area. Sampling at surface water monitoring locations and reservoir sites that may be affected by uranium recovery operations will be conducted on a quarterly basis. Surface water samples will be analyzed for dissolved and suspended uranium, Th-230, Ra-226, Po-210, Pb-210, gross alpha, and gross beta unless sufficient cause can be demonstrated to measure a parameter less frequently. Figure 5.7-7 depicts locations of the operational surface water monitoring sites. If a leak at the surface or from a pipeline occurs, inspections and reporting as stated in Section 7.5.1.6 will be conducted, and an investigation of the impact on the surface hydrologic features will occur.

Strata will permit all discharges to surface water through the WDEQ WYPDES program. Monitoring will be completed in accordance with permit requirements and samples will be analyzed for constituents identified in the permit. WYPDES permits will include a temporary WYPDES permit for well testing and construction water, one or more stormwater WYPDES permits, and, potentially, a WYPDES permit to discharge permeate during operation and aquifer restoration.

Operational Monitoring – CPP Area

The surficial aquifer, also known as the SA monitoring unit, is monitored in the wellfield areas by the SA cluster wells, and in the CPP area by the SA monitoring wells and piezometers. Monitoring efforts on the SA unit will be to demonstrate water level contrasts across the containment barrier wall (CBW) and measure and record the extent of surficial contamination from potential spills resulting from piping, tank, and pond failures as well as other accidents relating to the handling of the various solutions used in the CPP. Because of a relatively higher potential for contamination of the SA unit in the CPP area, the majority of the SA monitoring wells and piezometers will be located in this immediate area. Figure 5.7-13 depicts the locations of the SA wells in the CPP area.

As discussed in Section 3.1.8.2, due to a relatively high groundwater table in the CPP area, a continuous containment barrier wall (CBW) will be constructed hydraulically upgradient of the CPP. Monitoring wells will be completed in the SA unit to monitor water levels on both sides of the CBW. It will be necessary to dewater the CPP area prior to construction, and a groundwater control system will be used to manage groundwater levels over the life of the project.

The SA unit monitoring wells depicted on Figure 5.7-13 will monitor both the hydraulic gradient and groundwater quality across the CBW. Water level differentials adjacent to the CBW will serve to demonstrate the ability of the CBW to isolate the CPP area from the background groundwater flow regime of the SA unit, and to indicate adjustments that may be necessary in the dewatering system. In the event of a large spill at the CPP, samples collected at the monitor wells outside of the CBW will allow Strata to determine if contaminated groundwater was contained within the CBW.

In the vicinity of the CPP, groundwater levels within the SA unit monitoring wells will be monitored (note: wellfield baseline SA wells will be monitored manually). In conjunction with the monitoring wells, the dewatering french drain/collector well will also be monitored. Samples will be collected monthly at three down-gradient monitoring wells and at least one up-gradient monitor well and analyzed in accordance with the approved Groundwater Monitoring Detection Program (GWDMP).

<u>Operational Monitoring – Private Wells</u>

Stock, domestic, and industrial use wells within a 2-km radius of the active mine unit PM well ring will be monitored quarterly through the operational life of the facility. Results will be tabulated and provided to the NRC, LQD and well owners on an annual basis. Drawdown simulation with the regional groundwater model indicates that only a small percentage of the existing private wells may be impacted by ISR operations. With the well owner's cooperation, Strata may elect to geophysical log and instrument the wells where impacts may occur with recording pressure transducers to aid in the monitoring program. These results would also be provided to the WDEQ and NRC. Figure 5.7-8 depicts the private wells proposed for life-of-mine monitoring.

Operational Monitoring - Wellfield

Operational monitoring consists of sampling the perimeter, DM and SM monitor wells on a semimonthly basis and analyzing each sample for the excursion indicators. The LQD Permit to Mine and NRC License SUA-1601 currently requires that monitor wells be sampled semimonthly no less than 10 days apart except in the event of certain situations. These situations include inclement weather, mechanical failure, holiday scheduling, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment. In these situations the cause and the duration of any delays will be documented. No event will delay scheduled sampling for more than 5 days.

In addition to sampling for excursion indicators, Strata may utilize recording pressure transducers to obtain continuous water level measurements. The water levels would either be downloaded from the data logging equipment at each well, or transmitted via a telemetry or similar communication system to the CPP control room. Water levels in the adjacent aquifers would be integrated with the reservoir/mining software platform. The real-time integration of hydraulic, or hydrostatic pressure conditions, particularly in the perimeter monitor wells, would allow for an early warning (prior to excursion) of an impending lateral migration due to local wellfield imbalance. The software platform would include real time flows from the injection and recovery wells such that an operator could readily identify why and where the local imbalance was occurring. These data would lead to instant recommendations on imbalance rectification through decreased injection rates, increased production rates, or potentially changing an injector into a recovery well with the addition of submersible pump and removal of the injection stinger. Based on the results of continuous water level monitoring in the overlying and underlying aquifers, a migration of lixiviants would first be indicated by an upward deviation in the water levels. Again, this abstraction would be apparent quickly as there are little stresses on these systems and hence mitigated in a timely manner. It is anticipated that through strong drilling controls (i.e., preventing over-penetration into the DM interval), thorough cementing programs, mechanical integrity testing, and cementing/plugging of all exploration and delineation holes, that vertical migration of fluids will not occur. Unlike the ore zone aquifer, little instrumentation in the form of wells is available in the SM and DM units to mitigate a vertical migration. Mitigation instead becomes an investigation into well integrity, geologic integrity and, more often than not, the presence of unknown boreholes or poorly abandoned wells.

The following procedure will be utilized for detecting and controlling excursions at the Ross ISR Project:

1) During the recovery or restoration phase, routine monitoring is accomplished semimonthly for each perimeter, deep (underlying) and shallow (overlying) monitor wells within the active wellfield. Monitoring is to consist of measurement of a manual water level and sampling of the well for excursion indicator parameters.

2) Water samples will be analyzed by the lab for indicator parameters. If two or more parameters exceed the UCL's set forth in the approved wellfield package or one parameter exceeds the UCL by 20 percent, then the well must be re-sampled in 48 hours of when the first analysis was received.

3) If the resample confirms an excursion, then the well is placed on excursion status with verbal or email notification to the LQD and NRC within 24 hours. If the resample does not exceed UCLs, a third sample will be taken within 48 hours after the second set of sampling data are acquired. If the third sample does not exceed UCLs, the first sample will be considered an error. If however, two or more parameters exceed the UCLs in the third sample, the well will be placed on excursion status.

4) A recovery plan will be implemented to mitigate the excursion. Typically, an excursion is the result of an imbalance in wellfield flows between injection and recovery due to under recovery (e.g., a recovery well going off-line), over-injection or a combination of the two. Hence, mitigation will likely entail repair of the recovery well and turning down the injection rate at the wells proximal to the excursion well.

5) Follow-up sampling of the monitor well on excursion status will occur once every seven days. If after 30 days, UCL's are still in exceedance, the well on excursion status will be sampled for a full Guideline 8 parameter suite.

Impacts to financial assurance estimates from a lateral excursion will be significantly aided through the use of a groundwater model or aquifer management software platform. The regional groundwater model utilized for pre-license characterization appears to accurately predict where an excursion might take place and more importantly, the magnitude of the excursion in terms of volume of aquifer impacted. Based on the pore volume impacted, the financial assurance estimates will be increased and included within both the quarterly NRC reporting as well as in the annual reports for NRC and WDEQ/LQD.

Financial assurance estimates in the unlikely event of a vertical excursion will again utilize a modeling platform along with aquifer specific hydraulic and physical characteristics to determine the magnitude of the incident. In situ measurements of hydraulic conductivity will be provided for both the SM and DM systems to aid in surety updates.

Excursion Monitoring and Upper Control Limits

After baseline water quality is established for the monitor wells for a particular mine unit, UCLs are set for chemical constituents that would be indicative of a migration of lixiviant from the wellfield and provide an "early warning" of a potential excursion. Consistent with the ISR-GEIS, the constituents proposed for indicators of lixiviant migration and for which UCLs are set are chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the IX process (uranium is exchanged for chloride on the IX resin). Chloride is also a very mobile constituent in groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion as bicarbonate is the major constituent added to the lixiviant during recovery operations. Water levels are obtained and recorded prior to each well sampling. Rising water levels are indicative of an imbalance in the wellfield, which could result in an excursion. Although water levels are not proposed as an official excursion indicator, modeling indicates that such changes may provide a much earlier indication of an excursion than a geochemical anomaly measured in a monitoring well.

WDEQ/LQD Guideline 4 (WDEQ/LQD 1994) recommends that UCLs are set by adding five standard deviations to the mean baseline concentration of the excursion indicator. The UCL will be less than the lowest concentration that typically occurs in the lixiviant while the wellfield is in operation and greater than the mean baseline concentration for its respective excursion indicator. For chloride, WDEQ/LQD states that, the UCL may be determined by adding 15 mg/L to the baseline average if the resulting value is greater than the baseline mean plus five standard deviations.

Chloride, total alkalinity and conductivity appear to be strong indicators of dissolution during ISR operations. Therefore, these constituents as UCLs are proposed for excursion determination for the mineralized sandstones of the OZ aquifer as well as the shallow sandstones of the SM system. However, elevated natural/background chloride concentrations in the DM aquifer negate the use of chloride as downward movement of lixiviants into the DM aquifer would likely result in a decrease in chloride concentrations. In lieu of chloride, Strata proposes that sulfate will be used along with conductivity and alkalinity as a metric for determining that a vertical excursion downward has occurred. Water quality testing indicates concentrations of sulfate in the DM aquifer are typically less than 150 mg/L while ambient sulfate levels in the OZ aquifer range between 300 mg/L to more than 900 mg/L and are anticipated to increase during ISR operations by at least 150 mg/L. In addition, Section 6.1.6 compares water quality analogs at various operating ISR facilities, and increases of sulfate commonly occur during operations, which should be beneficial to detecting a downward vertical movement at the Ross ISR Project. Upper control limits for the excursion indicator parameters have not been calculated at this time due to the limited number of wells installed during the regional baseline program. Following completion of the necessary monitoring well network in order to develop the Mine Unit 1 wellfield package, sufficient data on the ore zone aquifer, DM, SM and laterally adjacent aquifers will be available to calculate UCLs.

As discussed previously, the Ross ISR Project may use an early warning system of pressure transducers to detect hydraulic anomalies in the form of hydrostatic pressure increases (beyond those caused by changes in barometric pressure) in the perimeter monitoring wells. Due to the high confining pressures in the OZ unit (Section 2.7.3.2), pressure transients propagate very quickly through the aquifer. Additionally, modeling indicates that local wellfield imbalances would be detected in perimeter monitoring wells spaced 400 to 600 feet from the wellfield as well as offset from one another by 400 to 600 feet within days, considerably before any geochemical evolution would be noted. Not only would the detection of a hydraulic anomaly potentially prevent a chemical excursion, the operational control of wellfields with pressure head data, both inside the wellfields as well as adjacent to the wellfields, would result in improvements in recovery efficiency, particularly in maintaining wellfield balance and minimizing interference. Strata may utilize internal ore zone trend wells to monitor wellfield head data and to provide a comprehensive hydraulic assessment to further aid recovery efficiency. Beyond the public perception and regulatory challenges posed by excursions, they are a significant distraction to the effectiveness of solution extraction and therefore an economic concern. The enriched lixiviants only produce uranium when they are focused within an ore body, hence there is reagent waste, electrical costs and manpower considerations any time recovery fluids migrate beyond the mineralized target.

Excursion Verification and Corrective Action

Through the use of water level measurements, operational data capture and possible integration with a suitable reservoir engineering software platform, Strata plans to minimize the potential for local wellfield imbalances to impact adjacent non-exempt aquifers. However, in the unlikely event that water level data indicate this potential the following procedures will be initiated in accordance with NRC and LQD regulations.

During routine sampling, if two of the three UCL values for excursion indicators are exceeded in a monitor well, or if one UCL value is exceeded by 20%, the well will be re-sampled within 48 hours and analyzed for the excursion indicators. If the second sample does not exceed the UCLs, a third sample will be taken within 48 hours. If neither the second nor third sample results exceeded the UCLs, the first analysis is considered in error.

If the second or third sample verifies an exceedance, the well in question will be placed on excursion status. Upon verification of the excursion, the NRC Project Manager will be notified by telephone or email within 24 hours and notified in writing within 7 days. A written report describing the excursion event, corrective actions, and corrective action results will be submitted to the NRC within 60 days of the excursion confirmation. If wells are still on excursion status when the report is submitted, the report will also contain a schedule for submittal of future reports describing the excursion event, corrective actions taken, and results obtained. In the case of a vertical excursion to an overlying or underlying aquifer, the report will contain a projected date when characterization of the extent of the vertical excursion would be completed.

If an excursion is verified, the following methods of corrective action will be instituted depending upon the circumstances:

- A preliminary investigation is completed to determine the probable cause;
- Adjustment of production and/or injection rates in the vicinity of the monitor well to increase the net over-recovery, thus inducing a hydraulic gradient toward the production zone; and
- Pumping of individual wells to enhance solution recovery.

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

In addition to the above corrective actions, the monitor well on excursion status will be sampled every seven days. An excursion will be considered concluded when the concentrations of excursion indicators do not exceed the criteria defining an excursion for three consecutive samples.

If an excursion is not corrected within 60 days of confirmation, injection of lixiviant into the wellfield will be terminated until the excursion is controlled, or the reclamation surety will be increased an amount that is agreeable to the NRC, which would cover the expected full cost of correcting and cleaning up the excursion. The surety increase will remain in force until the excursion is controlled. The written 60-day report will explain and justify the course of corrective action that be followed.

5.7.8.3 Lined Retention Pond Leak Detection Monitoring

The lined retention ponds will be equipped with leak detection system consisting of perforated subsurface pipes along the pond floor. Perforated pipes will drain to riser standpipes that can be accessed from the pond embankments. The presence and depth of water in the riser pipes will be checked as part of the daily inspections conducted for the ponds. These inspections are detailed in Section 5.3.2. Condensate will often be present in the leak detection systems; therefore, ponds will only be sampled if more than 6 inches of water is detected in the piping. The fluid from the riser pipe will be tested and compared to the water quality of the contents of the ponds. Strata will use common constituents such as conductivity and chloride to determine if the leakage is from the pond. If the sample is verified, the NRC will be notified within 48 hours and the contents of the pond will be transferred to the other two pond cells or into the deep disposal well. The liner will then be thoroughly inspected and leak tested to determine the source of the leak. After the leak has been repaired and the pond is back in operation, any fluid detected in the riser pipes will be sampled at least once every 7 days for at least 14 days. NRC will be provided a written report that explains the details of the leak investigation and mitigation, and the analytical results from the samples. This leak detection and mitigation report will be sent to NRC within 30 days of the initial notification of the leak.

Underdrains installed beneath the pond cells will also serve as monitoring points in the event of a leak. If a sample collected from the leak detection riser pipe is verified, a sample will be collected from the underdrain from the specific pond cell of concern to determine if the secondary liner also has a leak. If the sample from the underdrain indicates a breach of the secondary liner, the pump system will be activated and any effluent captured will be discharged to another (non-leaking) pond cell.

Water levels in the CPP area SA monitoring network and collector well would also be monitored to determine if any of the leaked substance reached the isolated environment underlying the facility. Capture of any leaked fluids would be conducted through the underdrain system.

5.7.9 Quality Assurance Program

Strata has established a quality assurance (QA) program at the facility consistent with the recommendations contained in NRC Regulatory Guide 4.14 Sections 3 and 6 and Regulatory Guide 4.15 (NRC 1979) following issuance of the license but no later than 60 days prior to the pre-operational inspection.

The purpose of the program is to ensure that all radiological and non-radiological measurements that support the environmental monitoring program are reasonable, valid and of a defined quality. These programs are needed to identify deficiencies in the sampling and measurement processes and report them to those responsible for these operations so that licensees may take corrective action, and to obtain some measure of confidence in the results of the monitoring programs to assure the regulatory agencies and the public that the results are valid.

The QA program contains the following:

- Formal delineation of organization structure and management responsibilities, responsibility for both review/approval of written procedures and monitoring data/reports is provided;
- Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program;
- Written procedures for QA activities, these procedures include activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting;

- Quality control (QC) in the laboratory, procedures cover statistical data evaluation, instrument calibration, duplicate sample programs and spike sample programs, outside laboratory QA/QC programs are included; and
- Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations, and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.
- Quality assurance and control procedures to ensure validity of measurements made as part of the worker radiation protection program to include considerations of:
  - ◊ External Radiation Exposure Monitoring Program
  - ◊ Airborne Radiation Monitoring Program
  - ◊ Bioassay Program
  - ◊ Contamination Control Program

QA procedures as described in RG 4.14, Sections 5 through 7, will be defined to ensure the quality of samples, that lower limits of detection consistent with requirements have been established, for sample and measurement precision and accuracy, and for recording and reporting of results.

QA recommendations contained in RG 4.14 and RG 8.22 will be incorporated in the environmental monitoring and bioassay programs, respectively. In general, the QC requirements for a specific activity will be incorporated into the SOP for that activity.

The QA program will be audited periodically. The audits will be conducted by individuals qualified in radiochemistry and monitoring techniques. However, the auditors will not have direct responsibilities in the areas being audited. An example of an appropriate auditor is an outside consultant. The results of the audits will be documented and provided to the NRC and made available to members of management with authority to enact any changes needed (i.e., RSO, VP of Operations, etc.). Authorities of personnel responsible for implementation of the QA program and how the QA function is integrated with Radiation Safety are presented in Section 5.1. Additional detail on the QA program, including the management control, audit and inspection programs are provided in Section 5.2 and 5.3. Minimum qualifications of personnel are defined in Section 5.4.

Table 5.7-1. Summary of the Major Elements of the Operational Environmental Monitoring Program

Program Element	Location	Radionuclides Analyzed	Sampling Frequency	Number of Sampling Locations
Groundwater – CPP and Pond Monitor Wells	Up-gradient and down-gradient from CPP and Ponds	Chloride, alkalinity, conductivity	Monthly for first year of operations; quarterly thereafter	6 during operation of Pond 1 (2 up-gradient, 4 down-gradient); 8 during operation of Ponds 1 and 2 (2 up-gradient, 6 down-gradient)
Groundwater – Existing Water Supply Wells	Private wells within 2 km of the monitor well ring	Dissolved and suspended uranium, Ra-226, Th-230, Pb-210, Po-210, gross alpha, gross beta	Quarterly	Up to 30
Surface Water	Surface waters passing through project area and reservoirs subject to runoff similar to pre-operational baseline monitoring	Dissolved and suspended uranium, Ra-226, Th-230, Pb-210, Po-210, gross alpha, gross beta	Quarterly (as available)	3 surface water monitoring locations and applicable affected reservoirs within project area
Particulates in Air(1)	Designated particulate in air locations and other areas of interest	Total uranium, Th-230, Ra-226, Pb-210	Continuous-Composites of weekly filters analyzed quarterly	5 or more
Radon in Air	Designated particulate in air locations and other areas of interest	Rn-222	Continuous via Track-Etch units – quarterly exchange and analysis of units	5 or more
Soil	Designated particulate in air locations and other areas of interest	Total uranium, Ra-226, Pb -210, gross alpha	Annually	5 or more
Sediment	Surface waters passing through project area and reservoirs subject to runoff	Total uranium, Ra-226, Pb -210, gross alpha	Annually (as available)	3 surface water monitoring locations and applicable affected reservoirs within License area
Direct Radiation	Designated particulate in air locations and other areas of interest	Continuous via TLD	Quarterly	5 or more

Table 5.7-1. Summary of the Major Elements of the Operational Environmental Monitoring Program (Continued)

Program Element	Location	Radionuclides Analyzed	Sampling Frequency	Number of Sampling Locations
Vegetation (2)	Particulate in air locations and other areas of interest	Ra-226 and Pb-210	Three times during grazing season, if required[2]	Grazing vegetation representing 3 different sectors that have the highest predicted concentrations of radionuclides
Animal Tissue	Livestock (cattle) raised within 3 km of the site and fish from Oshoto Reservoir similar to pre-operational baseline monitoring (Section 2.9, Figure 2.9-26)	Ra-226 and Pb-210	Once during site decommissioning and prior to license termination. Operational monitoring, if needed.[2]	3 samples of beef 1 fish sample (composite to meet laboratory MDL)

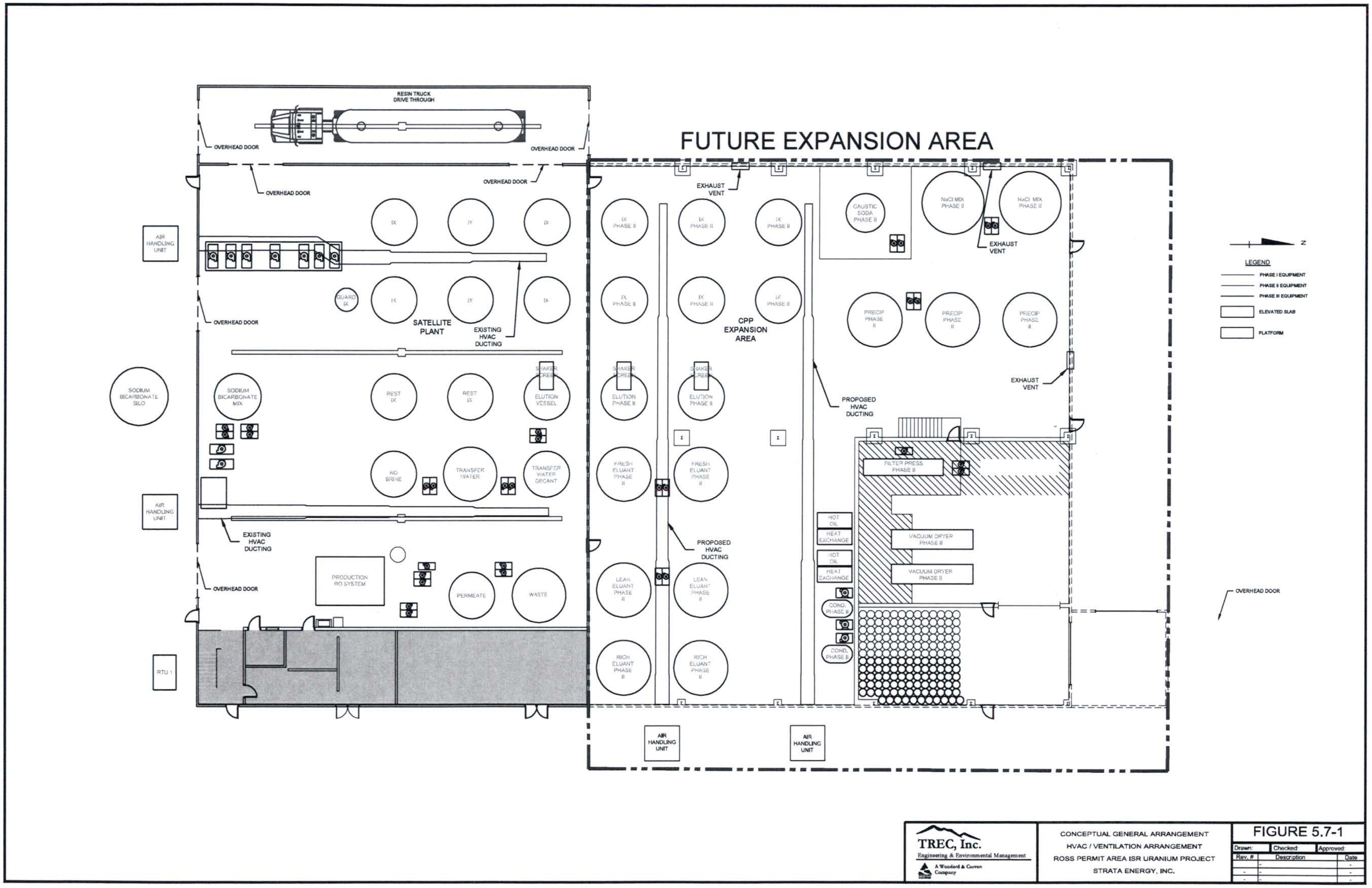
(1) The designated locations of air particulate samplers were chosen in accordance with the results of the pre-operational meteorological monitoring program (Section 2.5) and the results of the MILDOS-AREA analysis (Section 7.3).

(2) In accordance with the provisions of NRC Regulatory Guide 4.14, Footnote (o) to Table 2: "*vegetation and forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway...*" defined as a pathway which would expose an individual to a dose in excess of 5% of the applicable radiation protection standard. This pathway was evaluated by MILDOS-AREA and is discussed further in Section 7.3. In the event that monitoring is required, sample collection will be conducted similar to the pre-operational baseline monitoring described in Section 2.9 and will meet the recommendations of Regulatory Guide 4.14.

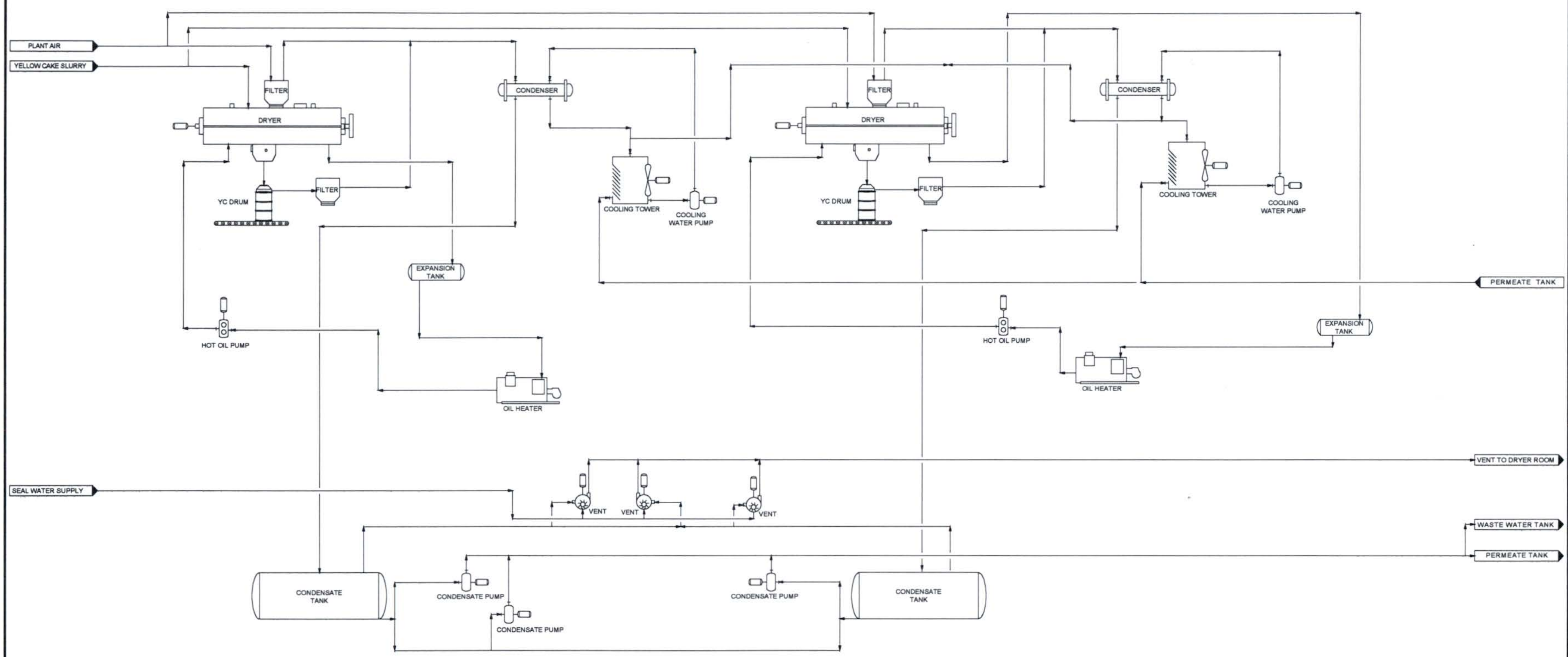
Table 5.7-2. Wellfield Baseline Aqueous Sampling Parameter List

Parameter	Units
Field	
Field conductivity	umhos/cm
Field pH	s.u.
Depth to water	Ft
Temperature	Deg C
General	
Alkalinity (as CaCO3)	mg/L
Ammonia	mg/L
Laboratory conductivity	umhos/cm
Laboratory pH	s.u.
Nitrate/nitrite	mg/L
Total dissolved solids	mg/L
Major Ions	
Calcium	mg/L
Magnesium	mg/L
Potassium	mg/L
Sodium	mg/L
Bicarbonate	mg/L
Carbonate	mg/L
Chloride	mg/L
Sulfate	mg/L
Metals	
Aluminum, dissolved	mg/L
Arsenic, dissolved	mg/L
Barium, dissolved	mg/L
Boron, dissolved	mg/L
Cadmium, dissolved	mg/L
Chromium, dissolved	mg/L
Copper, dissolved	mg/L
Iron, dissolved	mg/L
Lead, dissolved	mg/L
Manganese, total	mg/L
Mercury	mg/L
Molybdenum, dissolved	mg/L
Nickel, dissolved	mg/L
Selenium, dissolved	mg/L
Uranium, dissolved	mg/L
Vanadium, dissolved	mg/L
Zinc, dissolved	mg/L
Radiological	
Ra-226, dissolved	pCi/L
Ra-228, dissolved	pCi/L
Gross alpha	pCi/L
Gross beta	pCi/L

Source: SUA-1601 Amendment 2



RESIN TRUCK DRIVE THROUGH
OVERHEAD DOOR
FUTURE EXPANSION AREA
EXHAUST VENT
AIR HANDLING UNIT
SATELLITE PLANT
EXISTING HVAC DUCTING
CPP EXPANSION AREA
PROPOSED HVAC DUCTING
SODIUM BICARBONATE SILO
SODIUM BICARBONATE MIX
ELUTION VESSEL
TRANSFER WATER
TRANSFER WATER DECANT
PRODUCTION RO SYSTEM
PERMEATE
WASTE
RTU 1
FILTER PRESS PHASE II
VACUUM DRYER PHASE II
HOT OIL
HEAT EXCHANGE
LEGEND
PHASE I EQUIPMENT
PHASE II EQUIPMENT
PHASE III EQUIPMENT
ELEVATED SLAB
PLATFORM
TREC, Inc.
Engineering & Environmental Management
A Woodard & Curran Company
CONCEPTUAL GENERAL ARRANGEMENT
HVAC / VENTILATION ARRANGEMENT
ROSS PERMIT AREA ISR URANIUM PROJECT
STRATA ENERGY, INC.
FIGURE 5.7-1



TREC, Inc.
Engineering & Environmental Management
A Woodard & Curran Company

YELLOWCAKE PRODUCTION AREA FLOWSHEET
ROSS PERMIT AREA ISR URANIUM PROJECT
PREPARED FOR
STRATA ENERGY, INC.

FIGURE 5.7-2

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Rev. #	Description	Date
-	-	-
-	-	-
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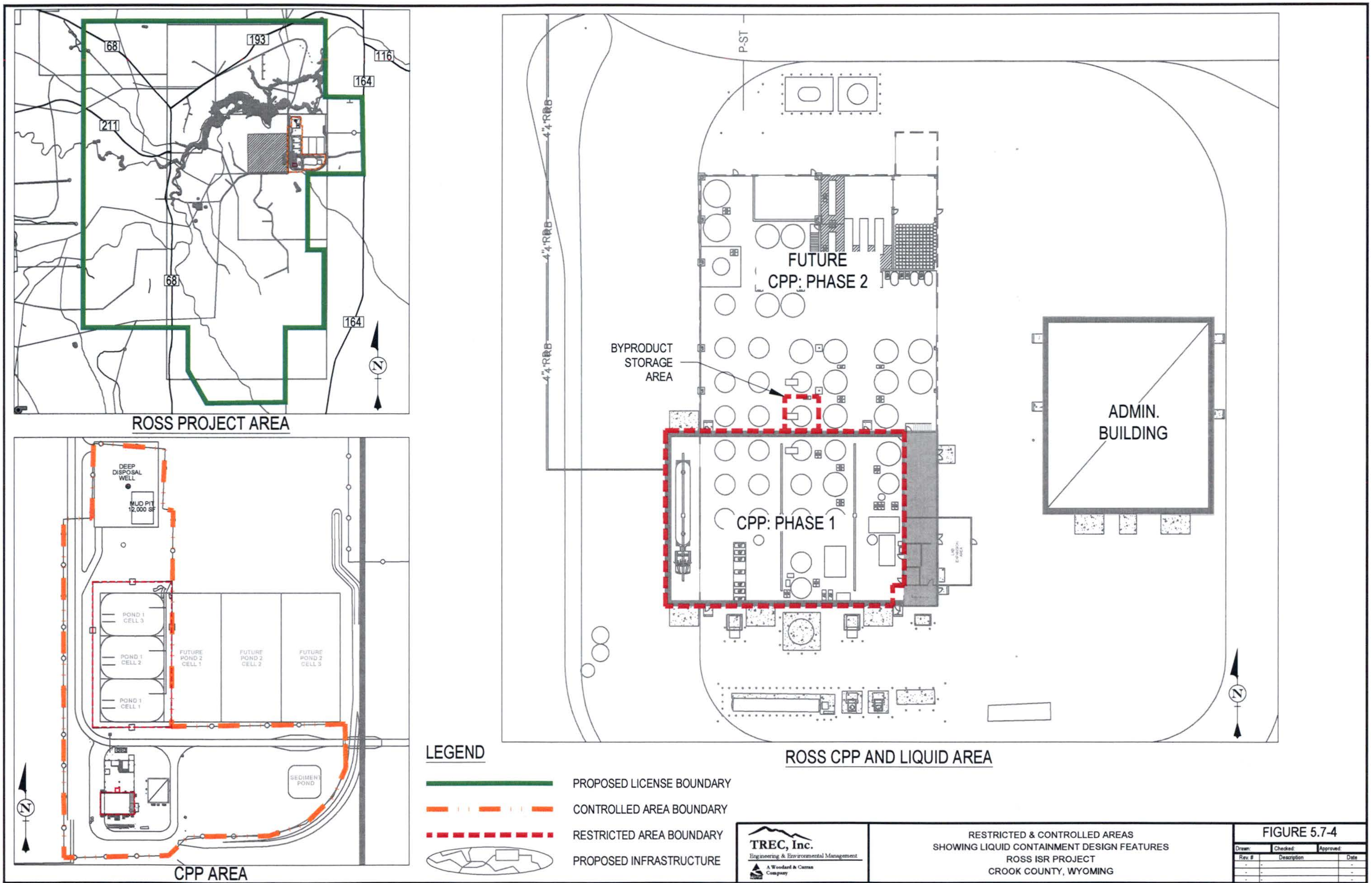
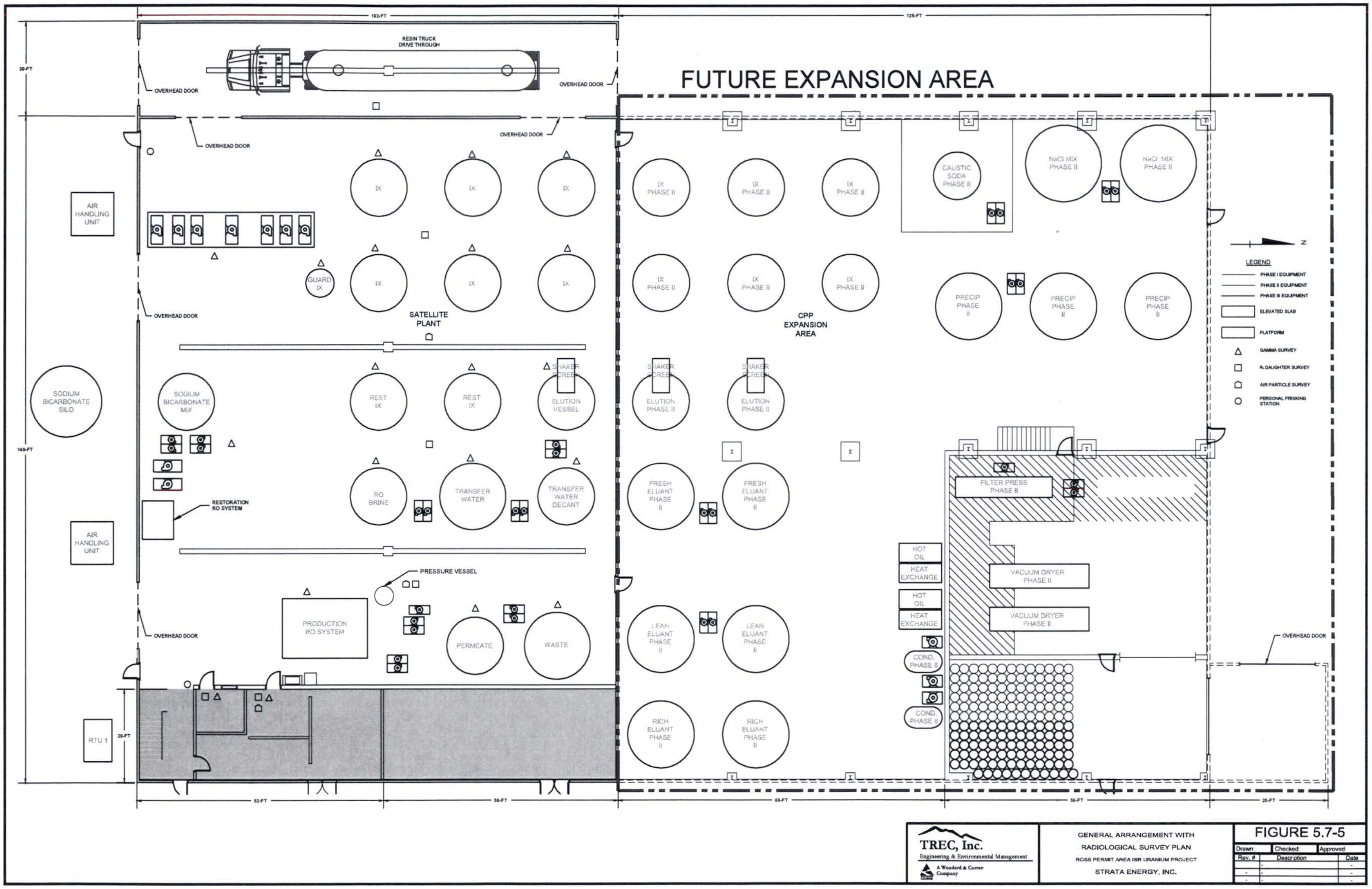


68
193
116
164
211
68
164
N
ROSS PROJECT AREA
DEEP DISPOSAL WELL
MUD PIT 12,000 SF
POND 1 CELL 3
POND 1 CELL 2
POND 1 CELL 1
FUTURE POND 2 CELL 1
FUTURE POND 2 CELL 2
FUTURE POND 2 CELL 3
SEDIMENT POND
N
CPP AREA
P-ST
4" RRB
4" RRB
4" RRB
FUTURE
CPP: PHASE 2
BYPRODUCT
STORAGE
AREA
CPP: PHASE 1
ADMIN.
BUILDING
N
ROSS CPP AND LIQUID AREA
LEGEND
PROPOSED LICENSE BOUNDARY
CONTROLLED AREA BOUNDARY
RESTRICTED AREA BOUNDARY
PROPOSED INFRASTRUCTURE
TREC, Inc.
Engineering & Environmental Management
A Woodard & Curran Company
RESTRICTED & CONTROLLED AREAS
SHOWING LIQUID CONTAINMENT DESIGN FEATURES
ROSS ISR PROJECT
CROOK COUNTY, WYOMING
FIGURE 5.7-4
Drawn: Checked: Approved:
Rev. # Description Date


FUTURE EXPANSION AREA
RESIN TRUCK DRIVE THROUGH
OVERHEAD DOOR
AIR HANDLING UNIT
SATELLITE PLANT
CPP EXPANSION AREA
IX
GUARD IX
IX PHASE II
CAUSTIC SODA PHASE II
NaCl MIX PHASE II
PRECIP PHASE II
SODIUM BICARBONATE SILO
SODIUM BICARBONATE MIX
REST IX
SHAKER SCREEN
ELUTION VESSEL
ELUTION PHASE II
RESTORATION RO SYSTEM
RO BRINE
TRANSFER WATER
TRANSFER WATER DECANT
FRESH ELUANT PHASE II
FILTER PRESS PHASE II
HOT OIL
HEAT EXCHANGE
VACUUM DRYER PHASE II
PRESSURE VESSEL
PRODUCTION RO SYSTEM
PERMEATE
WASTE
LEAN ELUANT PHASE II
COND. PHASE II
RICH ELUANT PHASE II
RTU 1
LEGEND
PHASE I EQUIPMENT
PHASE II EQUIPMENT
PHASE III EQUIPMENT
ELEVATED SLAB
PLATFORM
GAMMA SURVEY
R. DAUGHTER SURVEY
AIR PARTICLE SURVEY
PERSONAL FRISKING STATION
TREC, Inc.
Engineering & Environmental Management
A Woodard & Curran Company
GENERAL ARRANGEMENT WITH RADIOLOGICAL SURVEY PLAN
ROSS PERMIT AREA ISR URANIUM PROJECT
STRATA ENERGY, INC.
FIGURE 5.7-5
Drawn: Checked: Approved:
Rev. # Description Date

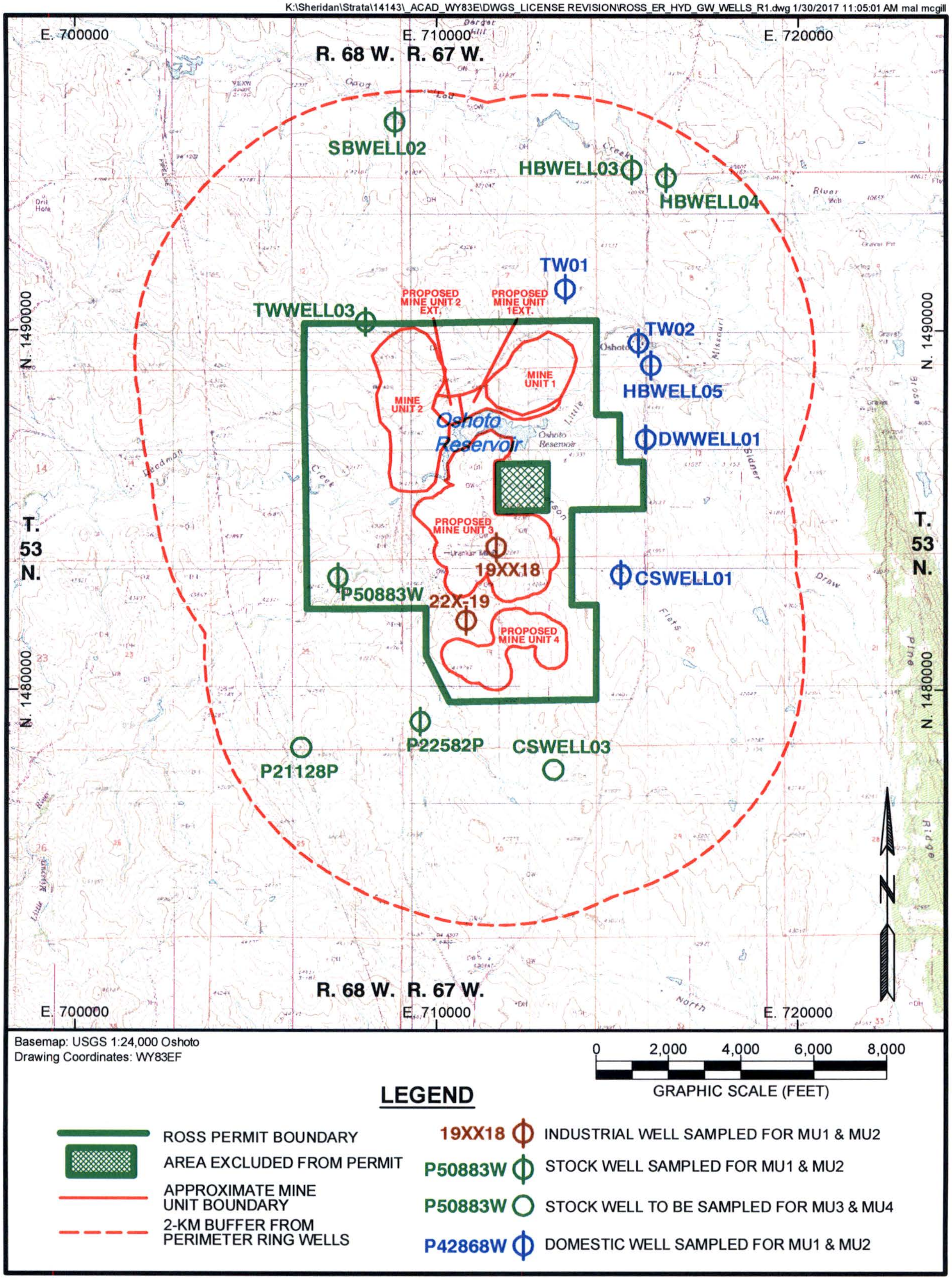


Figure 5.7-8. Sampled Water Supply Wells

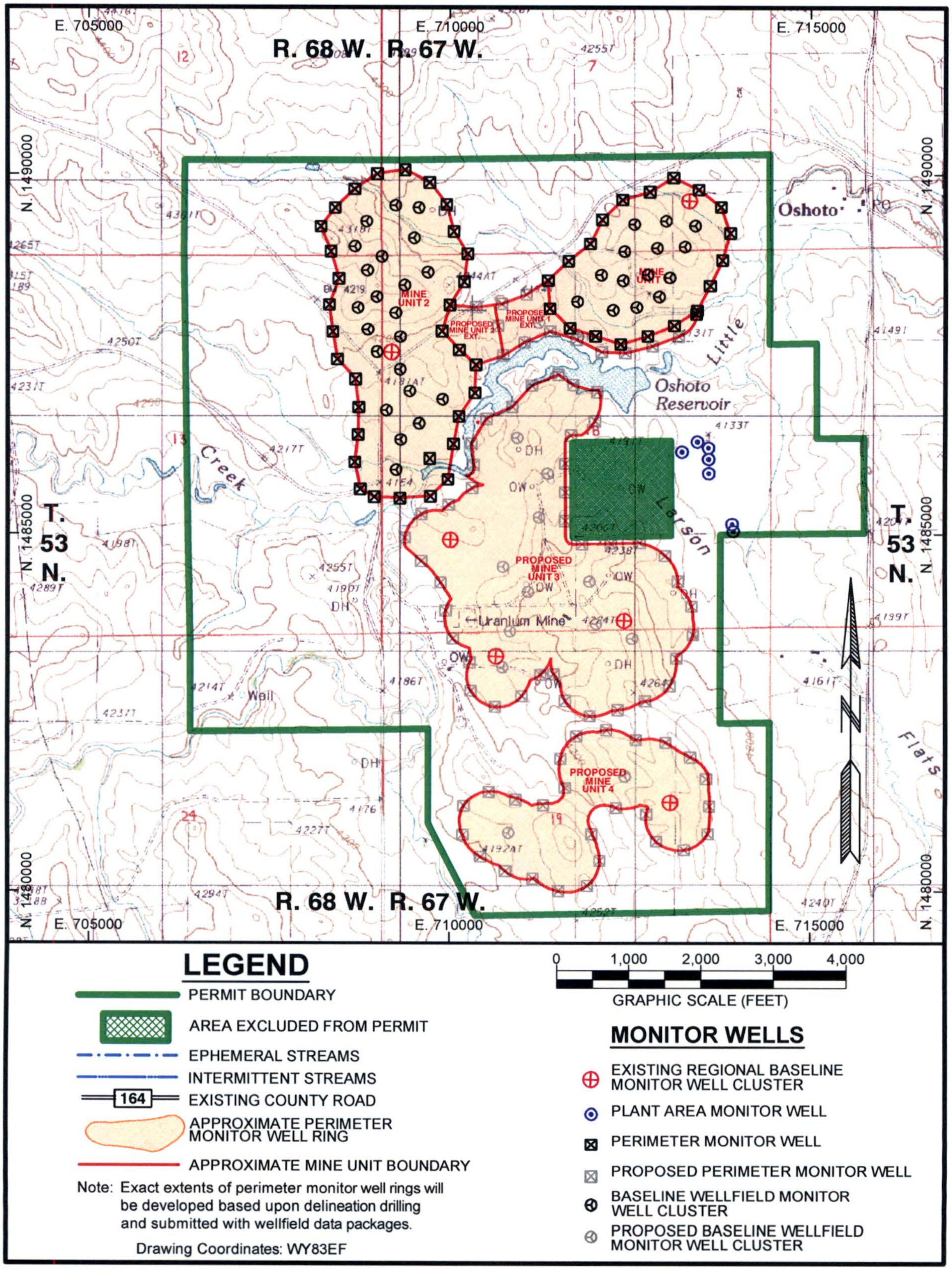
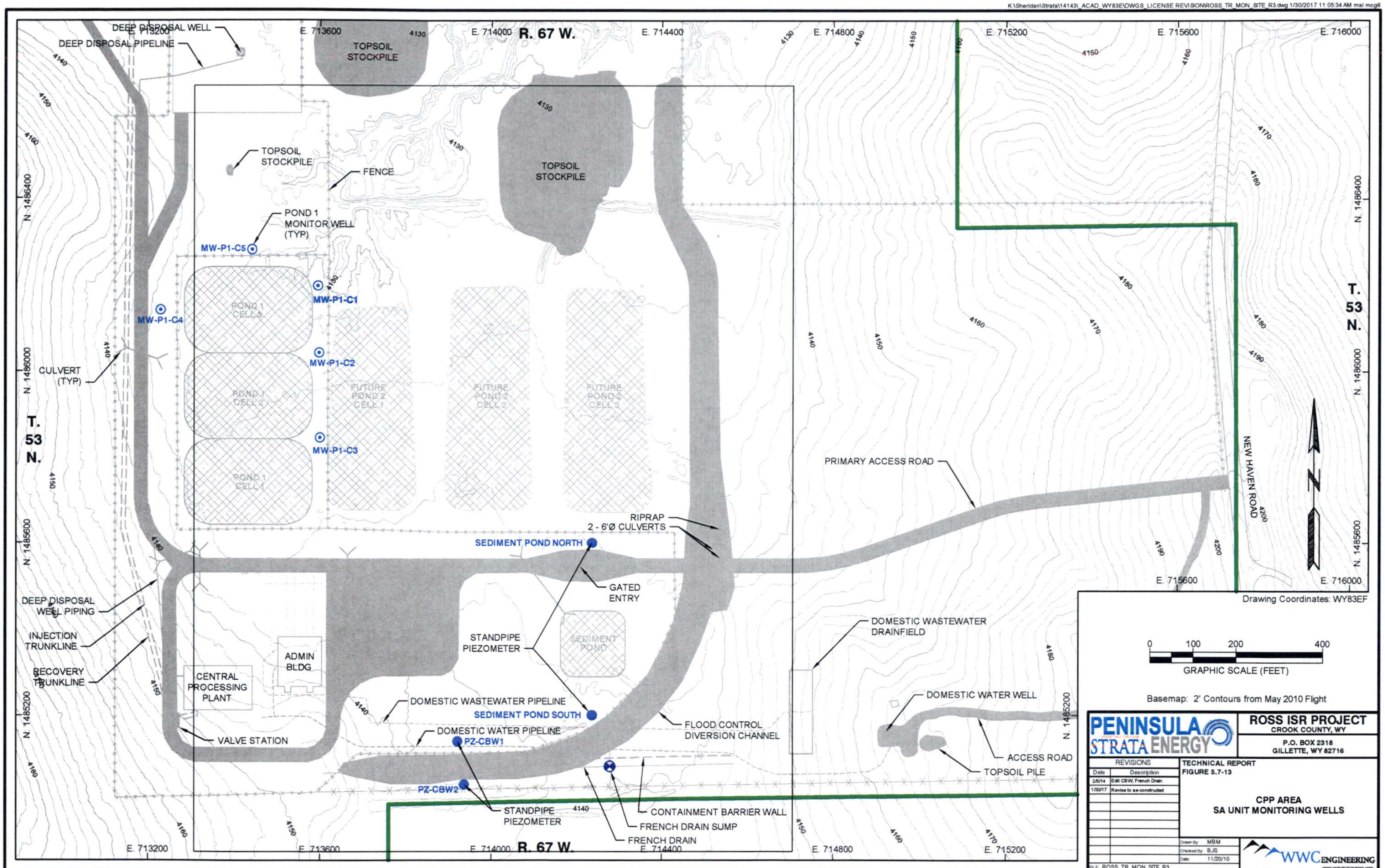


Figure 5.7-9. Proposed and Existing Wellfield Monitor Wells


K:\Sheridan\Strata\14143_ACAD_WY83E\DWGS_LICENSE REVISION\ROSS_TR_MON_SITE_R3.dwg 1/30/2017 11:05:34 AM mal mcgill
DEEP DISPOSAL WELL
DEEP DISPOSAL PIPELINE
TOPSOIL STOCKPILE
FENCE
POND 1 MONITOR WELL (TYP)
MW-P1-C5
MW-P1-C1
MW-P1-C4
MW-P1-C2
MW-P1-C3
POND 1 CELL 3
POND 1 CELL 2
POND 1 CELL 1
FUTURE POND 2 CELL 1
FUTURE POND 2 CELL 2
FUTURE POND 2 CELL 3
CULVERT (TYP)
T. 53 N.
R. 67 W.
PRIMARY ACCESS ROAD
NEW HAVEN ROAD
RIPRAP
2 - 6'Ø CULVERTS
SEDIMENT POND NORTH
GATED ENTRY
DEEP DISPOSAL WELL PIPING
INJECTION TRUNKLINE
RECOVERY TRUNKLINE
ADMIN BLDG
CENTRAL PROCESSING PLANT
STANDPIPE PIEZOMETER
SEDIMENT POND
SEDIMENT POND SOUTH
DOMESTIC WASTEWATER DRAINFIELD
DOMESTIC WASTEWATER PIPELINE
DOMESTIC WATER PIPELINE
DOMESTIC WATER WELL
FLOOD CONTROL DIVERSION CHANNEL
VALVE STATION
PZ-CBW1
PZ-CBW2
ACCESS ROAD
TOPSOIL PILE
CONTAINMENT BARRIER WALL
FRENCH DRAIN SUMP
FRENCH DRAIN
E. 713200
E. 713600
E. 714000
E. 714400
E. 714800
E. 715200
E. 715600
E. 716000
N. 1486400
N. 1486000
N. 1485600
N. 1485200
Drawing Coordinates: WY83EF
0 100 200 400
GRAPHIC SCALE (FEET)
Basemap: 2' Contours from May 2010 Flight
PENINSULA STRATA ENERGY
ROSS ISR PROJECT
CROOK COUNTY, WY
P.O. BOX 2318
GILLETTE, WY 82716
REVISIONS
Date Description
2/6/14 Edit CBW, French Drain
1/30/17 Revise to as-constructed
TECHNICAL REPORT
FIGURE 5.7-13
CPP AREA
SA UNIT MONITORING WELLS
Drawn By MBM
Checked By BJS
Date 11/20/10
FILE: ROSS_TR_MON_SITE_R3
WWC ENGINEERING

6.1 Groundwater Restoration

The primary goals of the groundwater restoration program are to:

1. Restore the groundwater consistent with Criterion 5(B)(5).
2. Complete groundwater restoration contemporaneously with ISR uranium recovery in accordance with 10 CFR 40.42.
3. Provide sufficient restoration capacity to restore each wellfield module in a phased approach as production in depleted wellfields ceases.
4. Minimize consumptive use of groundwater.
5. Apply state-of-the-art technology based on successes and lessons learned from operations, initial Strata restoration efforts and analog facilities.

This section presents the target restoration goals and Strata's specific plan to achieve these goals. The proposed groundwater restoration process is presented, beginning at the end of production, continuing through active restoration and post-restoration stability monitoring, and concluding with NRC and WDEQ/LQD approval of successful restoration for each Mine Unit. The groundwater restoration schedule is tied to production schedules and wastewater disposal capacity. Groundwater restoration analogs demonstrate that the ore body conditions and restoration methods will be similar to those at other ISR facilities that have successfully met target restoration goals and received regulatory approval for groundwater restoration. For more detailed information, refer to the RAP included as Addendum 6.1-A.

6.1.1 Groundwater Target Restoration Goal

Groundwater shall be restored consistent with the groundwater protection standards contained in 10 CFR 40, Appendix A, Criterion 5(B)(5) on a parameter-by-parameter basis using Best Practicable Technology (BPT). If the restoration activities are unable to achieve the background or maximum contaminant levels (whichever is greater) in Criterion 5(B)(5), Strata will submit a license amendment application request for NRC approval of alternate concentration limits (ACLs).

Criterion 5(B)(5) requires that each parameter be restored to one of the following levels:

1. The Commission approved background concentration of that constituent in the ground water or,

By sizing the restoration capacity equal to 15% of the production capacity, restoration will keep pace with production. Table 6.1-4 presents the anticipated flow range for each phase of groundwater restoration.

6.1.4.4 Restoration Fluid Disposal

Figures 3.1-11 through 3.1-13 depict the anticipated quantities of permeate and brine generated during each of the three operational phases: production only, concurrent production and restoration, and restoration only. During the two phases involving groundwater restoration, all permeate generated during both groundwater sweep and RO treatment with permeate injection will typically be reinjected into wellfield modules in the latter stage of groundwater restoration. The only exception is during groundwater sweep of the first two wellfield modules, when excess permeate will be generated. Section 4.2 describes the disposal of permeate and waste fluids generated during groundwater restoration, discusses waste fluid disposal capacity at various stages of production, and presents mitigation strategies to be implemented in the event that the operation of one or more disposal systems is interrupted.

Estimated permeate water quality is presented in Table 6.1-5. Hydranautics RO software was used to estimate permeate water quality based on the anticipated post-production water quality constituents (see Section 6.1.6 below). The estimated permeate water quality is based on specific ion rejection rates ranging from 94% to over 99%.

Table 6.1-6 presents the estimated concentrations of various constituents in the brine that will be discharged into the evaporation ponds and injected into the deep disposal wells. The site-specific estimate accounts for the anticipated water quality at the end of production, typical RO salt rejection rates, and the quantity and quality of brine originating from other sources, including the elution bleed from the CPP. This table also includes a comparison with actual concentrations of deep disposal fluids from other operating ISRs, including the Smith Ranch-Highland facility and Christensen Ranch/Irigaray Projects. The concentration of TDS and other dissolved constituents anticipated in the proposed project area is generally within the observed range at other facilities. The primary reason that some constituents are higher in the anticipated brine water quality compared to other facilities is that Strata is proposing a two-stage RO system, which will reduce the amount of wastewater but also concentrate the salts in the brine stream compared to a single-stage RO system. The two-stage

RO system decreases the amount of consumptive use of water by returning more permeate to the exempted aquifer.

6.1.5 Groundwater Restoration Schedule

Strata will adhere to the timelines in decommissioning regulations of 10 CFR 40.42. When groundwater restoration begins in a given wellfield module, NRC and LQD will be notified and a plan submitted for regulatory review and approval. If, at that time, groundwater restoration is estimated to take longer than 24 months, Strata will provide an explanation and request approval for an alternate schedule through a license amendment as allowed under 10 CFR 40.42(i).

6.1.5.1 Transition from Production to Restoration

Strata will monitor uranium concentrations in the recovery wells and trunk lines from producing wellfield modules to determine when a wellfield module will be taken out of production and started in restoration. The criteria used to determine when this will occur may include, but will not be limited to:

- An adequate recovery of uranium
- Uranium recovery grade below 10 mg/l
- Available production plant capacity.

The NRC and WDEQ/LQD will be informed when a transition from production to restoration occurs in a wellfield module. In addition to the typical transition criteria listed above, the following four conditions will trigger NRC notification of decommissioning (restoration) activities:

- The license has expired
- The licensee has decided to permanently cease principal activities (defined as the last date of lixiviant injection)
- No principal activities have been conducted for 24 months under the license
- No principal activities have been conducted in a specific wellfield.

The proposed production plant has been designed with a capacity of 7,500 gpm to permit simultaneous production in multiple wellfield modules. The large plant capacity will allow modules to remain in production for a relatively long period of time, resulting in greater uranium recovery and, potentially, easier groundwater restoration as result.

- Utilization of RO units during the production only phase to limit the potential for continuously increasing the concentrations of dissolved solids in the lixiviant along with ensuring equipment viability and personnel familiarity with the systems;
- Use of an adequately sized restoration plant with RO capacity sized at 15% of the production capacity to ensure that restoration keeps pace with production;
- Maintaining hydraulic control (bleed) between production and restoration such that there are no inactive wellfield modules;
- Employing the same groundwater model/reservoir engineering software platform used during the production phase to guide restoration hydraulics and performance;
- Testing reductants on a small area before widespread application; and
- Primary focus and significant restoration PVDs dedicated to RO treatment with permeate injection, which is primarily responsible for lowering the TDS and concentrations of other dissolved constituents.

The restoration analogs provide a technical basis for Strata's ability to meet the standards in 10 CFR 40, Appendix A, Criterion 5(B)(5).

6.1.7 Restoring Stacked Roll Fronts

Section 3.1 discusses Strata's proposed strategy for ISR uranium recovery, groundwater restoration, and excursion monitoring in stacked roll front deposits. To summarize, Strata proposes to complete recovery and injection wells in multiple zones in which recoverable uranium is present if the zones are in the same sand unit. If the stacked roll fronts occur in separate sand units, separate recovery and injection wells will be installed to address the ore in each sand. In this situation there would be multiple wells at each location. The stacked roll fronts would be produced and restored together, and the restoration processes and PVDs would be unchanged in the case of restoring stacked roll fronts.

6.1.8 Potential Environmental Impacts from Groundwater Restoration

Potential environmental impacts from groundwater restoration are discussed in Chapter 4.0 of the ER.

There are two primary categories of potential environmental impacts from the proposed groundwater restoration activities. The first is potential surface and groundwater quality impacts and the second is potential water consumption impacts. Other potential environmental impacts such as noise, air quality, and traffic impacts are not specific to groundwater restoration and are described in detail in Chapter 4.0 of the ER.

Potential water quality impacts include those potentially occurring to surface water and groundwater. Surface water quality impacts could occur in the event of a leak, spill, or equipment failure that would result in release of a process fluid to surface water. Instrumentation and controls designed to limit the likelihood of a surface water release and the magnitude of any release are described in Section 3.1. Potential accident scenarios and mitigation measures are described in Section 7.5 of this report and Section 4.4 and 5.4 of the ER. Potential surface water quality impacts are not limited to groundwater restoration, but are similar to those expected during construction, production, and decommissioning.

Potential groundwater quality impacts are also similar to those expected during production and are discussed in Section 4.4 of the ER. Potential groundwater quality impacts during groundwater restoration include horizontal and vertical excursions of recovery solutions; potential water quality impacts to the adjacent non-exempted aquifer from hot spots or constituents exhibiting increasing trends during stability monitoring, or potential shallow groundwater quality impacts to spills and leaks. Generally there is less potential for groundwater quality impacts during restoration compared to production since, a) the injection and recovery flow rates are lower in restoration compared to production, b) the duration that each wellfield module is in groundwater restoration is typically much lower than the production duration, and c) the production zone water quality will improve throughout active restoration. The purpose of groundwater restoration is to restore groundwater to target restoration values that minimize or eliminate the potential for adverse impacts on adjacent groundwater outside of the EPA/WDEQ exempted production area. The primary restoration *goal* is always background water quality or an MCL whichever is higher. If this cannot be met, in order to receive NRC and LQD approval of restoration success, Strata will demonstrate that BPT has been applied (i.e., it would not be technically or economically feasible to further reduce the constituent concentration) and that the constituent is not a threat to surrounding water users or potential water users outside the exemption area.

Table 6.1-2. Post-Restoration Stability Monitoring Parameters

Physical and Field Water Quality Parameters		
Static water level	Electrical conductivity, field	Temperature
pH, field		
General Water Quality Parameters		
pH, lab	Ammonia	Alkalinity
Electrical conductivity, lab	Nitrate-nitrite	Silica, dissolved
Total dissolved solids		
Major Ions		
Calcium		Bicarbonate
Magnesium		Carbonate
Potassium		Chloride
Sodium		Sulfate
Radiological		
Gross alpha		Radium 226, dissolved
		Radium 228, dissolved
Trace and Minor Elements		
Aluminum, dissolved	Fluoride	Molybdenum, dissolved
Arsenic, dissolved	Iron, dissolved	Nickel, dissolved
Barium, dissolved		Selenium, dissolved
Boron, dissolved	Lead, dissolved	Uranium, dissolved
Cadmium, dissolved	Manganese, total	Vanadium, dissolved
Chromium, dissolved	Mercury, dissolved	Zinc, dissolved
Copper, dissolved		

6.2 Reclamation of Disturbed Land

This section describes general procedures for the surface reclamation plan at the proposed Ross ISR Project. At the completion of the project, all of the disturbed lands will be returned to their pre-production conditions. In the case that the landowner wishes to preserve structures such as roads or buildings, approval of the alternative use from the appropriate agencies will be obtained. The surface reclamation plan goals will be to return the land to equal or better condition than existed prior to uranium recovery and thus making it available for "unrestricted use."

At the Ross ISR project area, the reclaimed land will be capable of supporting livestock grazing, dry land farming and wildlife habitat. Structures and equipment will be decontaminated or deposited at an NRC approved waste facility site. Details regarding disposal of structures and equipment are discussed in Section 6.3. Baseline soils, vegetation, and radiological data will be used to guide the reclamation activities. Prior to final decommissioning and surface reclamation of any area, Strata will submit a detailed decommissioning and reclamation plan to the NRC at least 12 months prior to the commencement of the activities.

Surface reclamation activities will include the following:

- Plug and abandon all wells as described in Addendum 2.6-E.
- Determine the proper soil cleanup criteria as described in Section 6.4.
- Perform a pre-reclamation radiological survey of all facilities, process related equipment and soils to determine the extent of contamination as described in Section 6.3.
- Clean up contaminated areas.
- Perform final soil radiological survey.
- Contour all disturbed areas.
- Establish vegetation and temporary erosion control on all disturbed areas.

6.2.1 Surface Disturbance

The primary surface disturbance areas at the proposed project site include the CPP and support buildings, waste disposal facilities, wellfield module buildings, pipeline corridors, and access roads. Less intensive surface choosing the extended reference area to ensure that the area adequately represents the reclaimed area being assessed. The success of the final revegetation and final bond release will be determined by WDEQ/LQD.

6.2.4 Access Road Reclamation

All primary, secondary, tertiary, and temporary access roads constructed for access to the facilities and wellfield will be removed and reclaimed unless exempted from reclamation by the request of landowners/lessees, in which case the landowners/lessees will assume responsibility for their long term maintenance and ultimate reclamation.

Prior to reclamation, any contamination resulting from ISR facility construction or operation will be cleaned to appropriate NRC standards and the contaminated material disposed at a licensed disposal facility. All contaminated soil or gravel that is determined to be 11e.(2) byproduct material will be disposed at a licensed 11e.(2) byproduct material disposal facility, while petroleum-contaminated soil will be disposed at a WDEQ/SHWD licensed facility. Removal of roads will be accomplished by removing excess imported road surfacing material and ripping the road surface and shallow subsoil to loosen the subsoil. Culverts will be removed and pre-construction drainages re-established. The area will be graded to a contour consistent with the surrounding landscape. Topsoil will be re-spread in a uniform manner and the area revegetated.

6.2.5 Waste Storage, Treatment, and Disposal Facility Reclamation

The Class I deep disposal wells will be abandoned and decommissioned in accordance with the requirements of the WDEQ/WQD UIC permit. Well abandonment procedures are included in Addendum 4.2-A. Surface facilities associated with the Class I deep disposal wells will be decommissioned and reclaimed in accordance with methods presented in Sections 6.3 and 6.2.1 through 6.2.4.

Wastes and equipment associated with lined retention ponds such as accumulated sludge, the pond liners, and leak detection piping and materials will be surveyed for radiological contamination and disposed of or released for unrestricted use. The soil beneath the pond will be surveyed for radiological contamination, and any areas that exceed limits for unrestricted use will be excavated and disposed of at an NRC- or Agreement State-approved facility.

6.2.6 *Containment Barrier Wall Reclamation*

At the end of operations at the proposed Ross ISR Facility, the containment barrier wall (CBW) at the CPP will be reclaimed to the extent necessary to restore the natural flux of shallow aquifer groundwater beneath the CPP and in the immediate vicinity outside the CBW. The reclamation of this wall will be accomplished by creating a series of breaches, also known as finger drains, along the CBW. Each finger drain will consist of a 1.5 ft wide by 25 ft long trench that is cut through the CBW at a right angle and to a depth that is 2 ft below the lowest historical groundwater level. Gravel will be placed in the trench from the bottom to a point 2 ft above the highest recorded groundwater level such that a highly permeable flow path is created through the CBW. The remaining trench will be backfilled with topsoil and seeded.

This method of CBW reclamation was selected as a means of effectively restoring the groundwater system in the CPP area, while minimizing surface and environmental disturbance.

Selected monitoring wells that were used to characterize the shallow aquifer at the site before installation of the CBW will be retained, and water levels will be monitored following CBW reclamation to verify that the natural flow of shallow ground water through the CBWs and beneath the CPP has been restored. Measured groundwater levels that show no appreciable gradient across the CBWs will verify that the CBW reclamation and groundwater system restoration are complete.

6.2.7 *Surface Restoration and Contouring*

There will be very few construction activities that will require any major contouring during reclamation due to the nature of ISR recovery. The central plant area and primary access road are the only areas that will require significant contouring during decommissioning. During decommissioning, the excess fill from the central plant area that was either used to construct the primary access road or stored in a stockpile will be hauled the short distance to the central plant area, redistributed, and compacted in place. All disturbed areas will be re-contoured as necessary to blend in with the natural terrain and consistent with the pre-construction topography. Any affected drainage channels will also be restored to pre-construction conditions during decommissioning. A survey of the preconstruction topography was conducted in July of 2010 using Light Detecting filters, and access points. Materials that can be decontaminated may include piping, valving, instrumentation, and various other types of equipment. The process buildings will most likely be decontaminated, dismantled, and released for use at another location.

Decontamination of salvageable building materials, equipment, pipe, and other materials to be released for unrestricted use will be accomplished by completing a preliminary radiological survey to determine the location and extent of the contamination and to identify any hazards. The preliminary review will be in the form of an alpha survey. The primary step will be to remove loose contamination from the object by use of high pressure washing. If required, secondary decontamination will consist of washing with dilute acid or equivalent compatible solution. Upon completion of decontamination processes a final alpha, and as needed beta surveys will be performed. The release limits for alpha and beta-gamma radiation from NRC Regulatory Guide 1.86 are as follows:

- Removable alpha contamination of 1,000 dpm/100 cm^2
- Average total alpha contamination of 5,000 dpm/100 cm^2 over an area no greater than 1 m^2
- Maximum total alpha contamination of 15,000 dpm/100 cm^2 over an area no greater than 100 cm^2
- Removable beta-gamma contamination of 1,000 dpm/100 cm^2
- Average total beta-gamma contamination of 5,000 dpm/100 cm^2 over an area no greater than 1 m^2
- Maximum total beta-gamma contamination of 15,000 dpm/100 cm^2 over an area no greater than 100 cm^2

The ALARA principle will apply to the decontamination of surfaces to reduce surface contamination to levels as low as practical. Equipment that cannot be decontaminated to these standards will be sent to an NRC- or Agreement State-licensed facility for disposal as 11e.(2) byproduct material.

Processing and water treatment equipment, including tanks, filters, IX columns, pipes, and pumps, will be prepared, including decontamination if necessary, for use at another location or dismantled and disposed of in accordance with applicable regulation. Materials contaminated with other industrial constituents will be disposed of at an appropriately licensed facility. Decontaminated and non-contaminated materials will be removed for salvage or disposed of at an appropriately licensed solid waste facility.

Structures will be decontaminated, if necessary, and moved to a new location and salvaged or disposed at an appropriately licensed solid waste facility. Concrete flooring, foundations, and foundation materials will be decontaminated, if necessary, broken up, and disposed of at an appropriately licensed facility. Clean concrete may be disposed at the Ross project site with appropriate approvals from the WDEQ and NRC.

Records of equipment decontamination, distribution, disposal, and related decommissioning activities will be maintained in accordance with the specifications of Section 5.7. Any necessary decontamination activities will be conducted in accordance with the operating procedures for the project.

6.3.4 Decommissioning of Non-11e.(2) Hazardous Constituents

Strata will decommission all equipment and facilities associated with non-radiological hazardous constituents from both operation and decommissioning activities.

Storage tanks and conveyance piping associated with process chemicals that are hazardous will be cleaned to remove any residual chemicals. The tanks will then be transferred for use at other Strata facilities, sold to another operator, or disposed of at an approved off-site landfill. Tanks and piping will be cleaned by qualified individuals who are trained in the risks of the chemicals and in a manner that is protective of the environment. Proper personal protective equipment will be required during these activities.

Appropriate storage facilities for hazardous chemicals, domestic waste, and other non-radiological wastes generated during decommissioning will be located on-site. Storage of these constituents will be done in accordance with OSHA, EPA, and WDEQ requirements.

The following sections present the results of the radium benchmark dose and cleanup criteria for natural uranium in soil. The model for the critical group assumed that the resident rancher would be located on the proposed project area directly over a 10,000-m^2 contamination zone, near a surface water body (i.e., Oshoto Reservoir) from which livestock drink. No contamination above background was assumed for drinking water. Additional specifics inputted into the RESRAD model, including assumptions, are provided in Addendum 6.4-A.

6.4.1.1 Determination of Radium Benchmark Dose

RESRAD calculations were performed over a 1000 year period for two scenarios to determine the radium benchmark dose. The first scenario modeled surface contamination (5 pCi/g Ra-226 over the first 15 cm of surface soil), while the second scenario modeled subsurface contamination (15 pCi/g Ra-226 over 15 cm subsurface soils with 15 cm clean cover).

The maximum Total Effective Dose Equivalent (TEDE) for each scenario is summarized in Table 6.4-1 and depicted in Figure 6.4-1. The results indicate that the maximum dose of surface contamination will occur at year zero, while the maximum dose of subsurface contamination will occur approximately 25 years following decommissioning. As previously stated, the radium benchmark dose is the greater of the two scenarios (33.4 mrem TEDE). The TEDE includes dose contribution from external deep dose equivalent associated with ground shine and internal dose from inhalation and ingestion of plants, animals and soil.

Since the TEDE is the sum of multiple pathways the contribution of each pathway was evaluated. Table 6.4-2 summarizes the contribution of each pathway for the maximum dose of the two scenarios. In both cases, the ground shine pathway (external exposure) is the dominant pathway, although it is not maximized in the subsurface scenario until the clean cover soil begins to erode away. Contributions from each pathway over the 1000-year period are presented in Figure 6.4-2 and 6.4-3 for the surface and subsurface scenarios, respectively.

A sensitivity analysis was also performed for several parameters that were considered particularly important to major dose pathways for the surface scenario. The sensitive parameters were identified as the area of the contaminated zone, mass loading for inhalation, wind speed, contaminated fraction of plant diet and fraction of time spent outdoors.

operation. Surface disturbing activities associated with deep disposal well construction include topsoil stripping, well pad grading, and mud pit excavation.

Of the four deep disposal wells proposed outside of the central plant area, all are proposed on land currently used for livestock grazing on rangeland. One well, proposed in the NWNE Section 13, T53N, R67W, is on land identified in as cropland and pasture. This land in not currently being used for crop or hay production, but it has been used for this purpose in the past and could be again in the future. Throughout the life of the proposed Ross ISR Project, areas used for deep disposal wells will change from the existing land uses (grazing and, potentially, crop land) to industrial use. However, the impact will be small, since the deep disposal wells occupy a very small portion (less than 0.3%) of the proposed project area and are very similar to oil production facilities currently present in the area.

Pipelines

Pipelines will include trunk lines carrying barren lixiviant and recovery solutions between the CPP and module buildings, feeder lines carrying these solutions between the module buildings and injection/recovery wells, and deep disposal well pipelines. The disturbance area associated with feeder lines, trunk lines, and deep disposal well pipelines adjacent to newly constructed access roads has been included in other estimated disturbance areas. The total estimated disturbance area resulting from trunk line and deep disposal well pipelines that are not in an access corridor is 15 acres. The amount anticipated during the year preceding operation is 5 acres.

Surface disturbing activities associated with pipeline construction will include topsoil stripping, trenching, backfill, topsoil replacement, and re-seeding. Pipeline corridors will be restored and re-seeded immediately, and changes in land use will be accordingly brief. Potential changes in land use are similar to those described previously for wellfield module construction surface disturbance will be minimized by locating pipelines in common corridors with access roads and utilities wherever possible.

Utilities

Utilities that are anticipated to be installed under the Proposed Action include a buried gas pipeline supplying natural gas to the central plant area, overhead electrical lines supplying electrical power from a nearby transmission

7.1.1.4 Livestock Grazing and Agricultural Restrictions

Approximately 95% of the land use within the proposed project area is attributed to livestock grazing and dry land crop production. No further restrictions will be made on these land uses beyond the access restrictions discussed in Section 4.1.1.1.2. Livestock and agricultural land use will be temporarily restricted from disturbed areas until they are restored and re-seeded. Long term access restrictions will occur for the fenced central plant area and the fenced wellfield areas.

Of the 40 BLM-administered surface acres, only 1.3 acres (3%) are anticipated to be disturbed under the Proposed Action. Grazing permits on State of Wyoming surface will potentially be impacted by construction of fenced wellfield areas. The total fenced wellfield area is estimated to be up to 50 acres at any one time. Surface use agreements will be established between Strata and surface owners/lessees to provide mitigation or compensation for temporary loss of areas currently used for livestock grazing or crop production.

7.1.1.5 Restrictions on Recreational Activities

Recreational activities, including hunting, will be minimally impacted under the Proposed Action. Hunting and recreation are not major land use activities in the proposed project area therefore, these activities will be minimally impacted due to access restrictions. To protect workers, hunting will be restricted from the proposed project area during the life of project. Big game hunting is currently limited in the proposed project area due to the small percentage of publicly owned lands (approximately 20.6%) and limited access. There is no public access to BLM lands and limited recreation opportunity on State of Wyoming lands therefore, the impact on these land uses due to the restricted access areas will be small.

7.1.1.6 Altering Historic and Cultural Resources

Potential impacts to historic and cultural resources will be kept small by avoiding construction in sites identified by the Class III inventory as potentially eligible for listing on the NRHP, by consultation with the appropriate SHPO and Tribal Historic Preservation Office, by negotiating a memorandum of agreement with the Wyoming Archeologist to ensure the preservation or data recovery from any historical, cultural, and archeological sites that may be present within the proposed project area, by implementing a phased identification of previously of the wellfields will be ongoing throughout the life of the project, reducing the area of disturbance during the final decommissioning activities.

7.2.6.2 Potential Impacts to Groundwater Quality during Operation and Decommissioning

During ISR operations the surficial aquifer has the potential to be impacted by leaks and spills. Lixiviant will be continuously injected and recovered from the wellfield modules during operation. The solutions will be transported through various pipelines to module buildings and pumped to the CPP for processing. Since the pipelines will be buried the solution has potential to seep undetected into the shallow aquifer. To reduce the risk of pipelines failing, Strata will pressure test all pipelines prior to use and install leak detection devices in manholes along the pipeline. Strata will also monitor the operating characteristics of production and injection pipelines and shut down affected pumps if a leak is detected.

The CPP area has the greatest potential for a spill since it is where the majority of chemicals will be stored and where process vessels will be located, and where liquid 11e.(2) waste will be stored. Strata will implement spill control, containment, and remediation measures in the CPP area. These include providing secondary containment for process vessels and chemical storage tanks, providing a liner beneath the plant foundation, providing two liners with leak detection systems for ponds, providing a sediment pond to capture storm water runoff, and providing a bentonite slurry cutoff trench to prevent the migration of contaminants from the plant area. Appropriate inspections of containment systems will be conducted as described in Section 5.3.

During operations the groundwater quality in the exempted aquifer will be impacted as part of the ISR process. The uranium and vanadium in the ore zone will be oxidized and dissolved by introducing lixiviant into the OZ aquifer using Class III injection wells. In addition to the uranium and vanadium, other constituents will be mobilized, including anions, cations, and trace metals. Impacts to the exempted aquifer water quality will be short term, since aquifer restoration will take place immediately following uranium production from any given wellfield.

Prior to operation, Strata will provide a wellfield package to the WDEQ/LQD and EPA with demonstration of wellfield integrity and exemptibility. Baseline water quality shows the OZ aquifer groundwater is of the Class IV type currently operated by Merit Energy utilize water from the OZ aquifer to stimulate oil production from wells completed in the underlying Minnelusa Formation. ER Table 4.4-2 summarizes the locations of wells within and adjacent to the Ross ISR Project that may experience drawdown. ER Figure 4.4-4 depicts the maximum estimated drawdowns at the end of uranium recovery operations and aquifer restoration along with the locations of the wells. Six wells completed in the OZ aquifer adjacent to the Ross ISR Project are also predicted to experience drawdown during the operation and aquifer restoration phases. The most significant estimated drawdown occurs in Wesley TW02 located in the SWSW Section 8, Township 53 North, Range 67 West, with 33.3 feet of drawdown or 42.4% of the available head. This well is located along the Little Missouri River floodplain adjacent to the no-flow boundary of the groundwater model; the presence of the no-flow boundary may conservatively bias the estimated drawdown. As explained in ER Section 4.4.2.3.4, the moderate reduction in available head should not materially decrease the yield from existing wells in the area.

The overlying aquifer (SM), underlying aquifer (DM), and non-exempt ore zone (OZ) aquifer outside of the exemption area could be impacted by an excursion of lixiviant during production. The most common types of excursions are due to a wellfield imbalance or well integrity failure. Potential impacts will be minimized by wellfield balance during operation, maintaining adequate bleed, properly installing and testing wells, and rapidly detecting and correcting excursions.

Strata will minimize the potential for excursions by pressure testing all wells during installation and during periodic MITs and by installing controls and alarms for well failure detection. Recovery and injection wells will be installed with identical completion methods to allow the function to be changed. Strata will maintain a bleed from the beginning of production through the end of active restoration, as discussed in Section 5.4 of the ER. The bleed will maintain an inward hydraulic gradient for each wellfield module. Strata will install perimeter monitor wells and monitor wells in the overlying and underlying aquifers to detect excursions. Pressure transducers will be provided for rapid excursion detection and response.

Strata proposes to utilize up to five Class I deep disposal wells within the proposed project area. A Class I UIC permit application for the injection wells was submitted to WDEQ/WQD on June 15, 2010, and a round of responses was

Nature of Problems Solved by MILDOS-AREA

The MILDOS-AREA computer code calculates the radiological dose commitments received by individuals and the general population within an 80-km radius of an operating uranium recovery facility. In addition, air and ground concentrations of radionuclides are estimated for individual locations, as well as for a generalized population grid. Extra-regional population doses resulting from transport of radon and export of agricultural produce are also estimated.

The transport of radiological emissions from point and different area sources is predicted with a sector-averaged Gaussian plume dispersion model. Mechanisms such as radioactive decay, plume depletion by deposition, ingrowth of decay products, and resuspension of deposited radionuclides are included in the transport model. Alterations in operation throughout the facility's lifetime can be accounted for in the input stream.

Exposure Pathways and Dose Conversion Factors Considered by MILDOS

The pathways considered for individual and population impacts are:

- Inhalation,
- external exposure from ground concentrations,
- external exposure from cloud immersion,
- ingestion of vegetables,
- ingestion of meat, and
- ingestion of milk.

Doses are calculated by use of dose conversion factors. Those in MILDOS-AREA are ultimately based on recommendations of the ICRP. These factors are fixed internally in the code, and are not part of the input options.

Source Description

Radionuclide releases are defined for each source for particulates and radon gas. The U-238 decay chain is assumed to be the only significant source of radiation for uranium milling operations. The contribution from the U-235 chain is less than 5% of that from the U-238 chain. Particulate releases are defined to include the radionuclides U-238, Th-230, Ra-226, and Pb-210. The gaseous releases are defined for Rn-222, with ingrowth of short-lived decay

- Production Wells: Rn-222 may be released via leaks/venting in the well heads or the module buildings.
- CPP: The pressurized, closed system for the production fluids is opened at the point of ion-exchange column transfer and point of conveyance discharge points (MILDOS-AREA defines this as "purge water") to the lined retention ponds near the CPP.
- Aquifer Restoration Wells: Circulating water and discharged water from the restoration process also contains Rn-222 which may be released during the process.

MILDOS-AREA parameters used to characterize and estimated atmospheric releases are provided in Table 7.3-2. For purposes of this analysis, it has been assumed that the Ross ISR project will have two Mine Units that will be operated concurrently over the span of 51 months. The proposed project schedule for the Ross ISR Project is shown in Figure 1.9-1.

In any areas of overlap, it was assumed that the part of the process that is active and produces the highest source term represents 100% of all wellfield operations (most conservative). For example, the operation phase of the project has larger source term than the new wellfield construction phase. Accordingly, during the time period of 13-43 months, it is assumed that the entirety of the wellfield is in operation even though in fact the source term will be smaller as portions of the Mine Units will be in construction or aquifer restoration.

7.3.4.4 Source Term Estimates

The source term estimates for Rn-222 releases were calculated for each of the sources described in the previous section. For modeling purposes the two Mine Units were assigned point locations based on the centroid of each unit. The locations and areas of the Mine Units are presented in Table 7.3-3. Source terms were calculated using equations provided in NUREG 1569, Appendix D and the ISR specific patch to the MILDOS-AREA code. A summary of calculated source terms for the Ross ISR Project is provided in Table 7.3-4.

New Wells

The primary source of Rn-222 during the construction process was identified as the mud pits. Construction source terms were calculated at the centroid of both Mine Units using the following equation:

$$Rn_{nw} = (10^{-12})(E)(L)([Ra])(T)(M)(N)$$

installed under the CPP foundation as well as Strata's ability to recover contaminates in the subsurface with the pond underdrain system. The geosynthetic liner and containment barrier wall are discussed in Chapter 3.0 of this report.

As discussed in Section 3.3, piping and process tanks within the CPP will be equipped with instrumentation which will monitor pressure at key points. Events such as leaks or spills which cause operating parameters to move outside of predetermined ranges will trigger alarms, and the pump system will immediately shut down, limiting any release.

NUREG/CR-6733 evaluated the potential dose to onsite workers and the public from a spill of pregnant lixiviant and IX resin as a result of a damaged IX vessel. Based on several assumptions, the predicted dose was 1.3 rem in a 30-minute period. It should be noted in this analysis that any change to the radon concentration or the exposure time will have a linear effect on the dose estimate. For example if the room size doubles or the exposure time is cut in half, the dose will be half as much. The analysis also operated under the conservative assumption that all of the radon contained in the pregnant lixiviant is immediately released into the facility, which would depend on the solubility of radon at atmospheric pressure. Aside from the assumption stated above, radiological risk of an accident of this type will further be mitigated by the presence of general area ventilation in the CPP and the response to spills by personnel following spill response procedures and utilizing personal protective equipment.

NUREG/CR-6733 also evaluated the potential impact of the failure of a yellowcake thickener releasing yellowcake into and outside the plant. This accident scenario is discussed in Section 7.5.2, Yellowcake Precipitation and Dryer Accidents.

7.5.1.2 Chemical Spills and Accidents

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 the Ross ISR Project are regulated by the OSHA. ISR facilities utilize chemicals during the extraction process and during restoration of groundwater quality. Bulk chemicals will be stored on-site in areas at a distance from the processing facilities that will pose no significant hazard to the public or workers' health and safety. Industrial safety aspects associated with the use of chemicals will be regulated by EPA and WDEQ in addition to OSHA.

Chemicals which will be stored and used at the proposed Ross ISR project will include some or all of the following: sulfuric and/or hydrochloric acid, sodium hydroxide, hydrogen peroxide, carbon dioxide, oxygen, sodium chloride, sodium carbonate, barium chloride, anhydrous ammonia, and non-process related chemicals such as gasoline, diesel and propane. Chemicals will be stored either in the CPP or in the chemical storage area. The chemical storage area will be located adjacent to the CPP as shown on Figure 3.1-16. The chemical storage area will be divided into two areas, one of which will be enclosed in a building and one outside. Chemicals stored outside within the chemical storage area will include oxygen (if stored at the CPP), ammonia, and carbon dioxide. The storage area is shown on Figure 3.2-8. In order to mitigate the potential release of hazardous chemicals into the environment, the chemical storage area will be provided with secondary containment similar to that in the CPP. Berms will divide areas to ensure that there is no mixing of incompatible fluids. The capacities of the secondary containment along with the chemical storage tank volumes are listed in Table 3.2-2. Sumps will be provided within containment berms so that spilled chemicals can be collected and pumped to temporary storage areas or to disposal.

Oxygen

The hazards associated with oxygen storage include combustion and explosion. Oxygen will be delivered to the site by truck and stored in a cryogenic tank in liquid form. Many materials that may not be combustible in atmospheric conditions may burn in an oxygen rich environment. Credible accident scenarios which exist when bulk oxygen is stored and used may include explosions and fires as a result of impacts to oxygen storage or conveyance equipment, improper design of storage and conveyance equipment, and incorrect operation and cleaning of oxygen systems. To reduce the risk of an accident which could potentially affect other processes or storage facilities and radiological safety, oxygen will be stored away from other plant infrastructure and storage areas. Where above ground oxygen storage or conveyance facilities exist, barriers will be used to prevent impacts from mobile equipment. All oxygen conveyance pipelines which are installed will be properly surveyed and marked with proper tracer wire to make them locatable by field personnel during excavation

Hydrogen Peroxide

Hydrogen peroxide is a strong oxidizer, can be very reactive, and is easily decomposable. Its hazardous decomposition products include oxygen and hydrogen gas, heat, and steam. Decomposition can be caused by mechanical shock, incompatible materials including alkalis, light, ignition sources, excess heat, combustible materials, strong oxidants, rust, dust, and a pH above 4.0. When sealed in strong containers, the decomposition of hydrogen peroxide can cause excessive pressure to build up which may then cause the container to burst explosively. In addition, solutions and vapors of hydrogen peroxide are irritants to body tissue, which can cause blistering of the skin and respiratory tract burns in the case of inhalation.

The hydrogen peroxide storage tank will be located in the chemical storage area and will be isolated from the storage areas for acids and reducing agents which will be used at the facility. The site will have storage facilities for 2,500 gallons (25,000 pounds) of 50% H_2O_2.

NUREG/CR-6733 evaluates an accident scenario involving a piping system leak, which could result in a vapor concentration which exceeds the IDLH value of 75 ppm within minutes. In addition, a leak within a confined space has the potential to create lethal conditions in an even shorter time. In order to minimize the risks associated with a hydrogen peroxide accident, Strata will follow design and operating practices published in accepted standards and codes which are recommended by NUREG/CR-6733. These may include the use of explosion proof ventilation equipment, local ventilation equipment, and recommendations for materials of construction.

Sodium Carbonate and Sodium Chloride

Sodium carbonate (soda ash) and sodium chloride (salt) generally present low risks of affecting radiological safety at ISR facilities. Sodium carbonate and sodium chloride are primarily inhalation hazards. Dry storage and handling will be designed to industry standards to control the discharge of dry material. This will generally be accomplished with adequate area ventilation in these areas.

Sulfuric Acid

Sulfuric acid is extremely irritating, corrosive, and toxic to tissue, resulting in rapid destruction of the tissue and causing severe burns. Other than direct skin contact, sulfuric acid fume inhalation during a spill may also be of concern to employees at the Ross CPP. The concentration of sulfuric acid fumes that are IDLH is 15 mg/m^3. According to a risk analysis conducted in NUREG/CR-6733 with a 93% sulfuric acid solution, sulfuric acid did not pose a significant inhalation hazard as long as normal air dilution is occurring from the building ventilation system. Additionally, sulfuric acid reacts vigorously with other chemicals which will be used at the project such as ammonia, sodium carbonate, and water. To minimize the potential for chemical reactions in the unlikely event of simultaneous tank leaks, the sulfuric acid storage tank(s) will be located away from other chemical storage tanks and away from process vessels at the chemical storage area, and the acid will be piped to an inside smaller storage tank for daily use.

The use of sulfuric acid is subject to Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 1,000 pounds. This is also the EPA reportable limit under CERCLA. As discussed in Section 3.2, the storage quantity of sulfuric acid at the Ross project will exceed the TPQ. Based on the design capacity, the CPP will be subject to Emergency Response Plan requirements which will qualify for coverage under the DHS Chemical Facility Anti-Terrorism Standards. A "Top Screen" analysis for sulfuric acid will be submitted to DHS by Strata.

7.5.1.3 Wellfield Spill/Pipeline Failure

A failure in a wellfield pipeline, module building, valve vault, or at a well head has the potential to release pregnant or barren lixiviant into the environment and contaminate the ground in the area of the failure. As discussed in Section 3.1, the operating parameters of injection and recovery lines from the modular buildings to the wellfields will be continuously monitored from the CPP. In the event that a significant piping failure causes a leak of injection or recovery fluids, the corresponding variation in flow or pressure will signal alarms in the module building and CPP. Automatic controls will stop operating equipment (primary pumps), and the operators will manually control equipment and valves to isolate and contain the leaking section of pipe.

All piping will be rated for a maximum operating pressure greater than the proposed maximum for injection or recovery. All piping will also be pressure tested for leakage prior to operation. Construction specifications for buried pipelines will include pipe bedding to provide support and prevent rocks in trench backfill from damaging the pipes. Thrust blocking will also be provided at in the perimeter monitor wells. Beyond monitoring and integration of flow and level metrics from the active wellfields, samples will be recovered from the wells completed in adjacent aquifers every two weeks. A more detailed description of the operational monitoring and controls can be found in Section 5.7.8.

If an excursion is detected, the recovery and injection wells will have the ability to respond and have been demonstrated through modeling to be capable of responding (see Addendum 2.7-H for groundwater model results). By reducing the imbalance caused by over-injection combined with the necessary maintenance of recovery well(s) a local wellfield imbalance can be rectified in the time required. In addition, injection wells will include the necessary electrical infrastructure to be 'changed over' to recovery wells, further enhancing Strata's ability to quickly and efficiently recall the lixiviant. Although the potential for lixiviant excursions do exist, with all these systems in operation an undetected excursion will be highly unlikely.

Preventing vertical excursions given the extensive nature of the natural geologic confining intervals requires two primary measures, abandoning all of the exploration and delineation holes with cement along with constructing wells that limit the potential for annular migration. Strata has already initiated an extensive exploration hole finding and sealing program in addition to verifying the integrity of the cementing program for the well installation procedures. MITs will be conducted prior to operations, if a well is reentered with a drilling bit or tool and every five years with the necessary reporting to the WDEQ/LQD and NRC. To further limit the potential for vertical excursions, Strata has initiated and will continue to limit over-penetration into the DM aquifer. Monitoring wells installed in the aquifers above and below the ore zone interval will be placed in downgradient locations to further improve the potential of detecting these rare events.

7.5.1.5 Lined Retention Pond Accidents

Liquid waste spills or leaks could occur if one of the ponds were to overtop or if the liner failed. The potential for pollution from the lined ponds will be minimized through careful construction and inspection of the pond liners during construction, routine inspection and testing of the leak detection equipment, and control of pond water levels. The ponds, liners, and leak detection systems will be constructed in accordance with Regulatory Guide 3.11 and WDEQ/WQD requirements. The liners will also be leak tested as part of the construction performance testing.

Normally the water levels in the lined ponds will be maintained at or below the NWL, which includes not only freeboard for runoff and wave runup, but also freeboard to pump the contents of a damaged pond cell into the remaining cells within that pond in the even of a liner failure. The water level will always be maintained at or below the HWL, which includes freeboard for direct precipitation resulting from the 100-year, 24-hour storm and wave runup. Pond levels will be recorded daily as part of inspections which are outlined in Section 5.3. If pond levels rise beyond the NWL, plant operations or the deep disposal well feed rate will be modified to bring the levels back to the specified level.

Leak detection piping will drain to riser standpipes which will be monitored daily for the presence of fluid. If the water level in the riser pipes is above a predetermined level, samples will be taken to determine if the water is of similar quality to the contents of the ponds. Strata will focus on common constituents such as conductivity and chloride to determine if the fluid is leaking from the pond. If the sample is verified, the contents of the pond will be transferred to the other two pond cells or into the deep disposal well. The liner will then be thoroughly inspected and leak tested to determine the source of the leak.

In addition to the measures discussed above, any leak from the lined retention ponds will be captured within the pond underdrains. The underdrains will allow Strata to recall fluids that could potentially reach shallow groundwater from an accident.

In the event of a leak from a lined pond cell, the NRC will be notified by telephone within 48 hours of verification. A written report including analytical data and descriptions of the correction actions and results of those actions will be submitted to the NRC within 30 days of initial leak notification.

7.5.1.6 Waste and Process Solution Spill Response and Remediation

Strata will implement an emergency response plan and SOPs to be used in the case of a spill of waste and process fluids at the proposed project. The RSO or HPT will be notified immediately so that a prompt inspection of the spill can be made. The spill inspection will include the following:

- A drawing of the affected area and equipment so that the location can be referenced during decommissioning

- A determination of the amount of fluid spilled
- An analysis to assess the radiological risks immediately present at the site
- Determination of safety precautions that need to be taken immediately, if any
- A preliminary determination of the cause of the spill
- A determination as to whether or not reporting is required pursuant to the regulations listed in 10 CFR 20.2202 (immediate notification within 24 hrs), 20.2203 (written report within 30 days), and 10 CFR 40.60 (24 hr immediate notification vs. written report within 30 days).

The RSO and HPT will be assisted as necessary by personnel with knowledge of the incident and the site supervisor. After the initial inspection, The RSO or HPT will prepare a report which includes the following information:

- The date, location, and description of the affected facilities and equipment
- The corrective and cleanup actions taken
- An assessment of the effectiveness of cleanup
- The location and a description of residual contamination
- A description of areas that where inaccessible during cleanup

At least once per year, the Manager of Health, Safety, and Environmental Affairs will convene a Spill Committee to review the cause of recent spills. The Spill Committee will consist of at least three individuals with experience in operations. After reviewing the causes of recent spills, the Committee will send a report to mine management detailing reasonable recommendations on how to prevent and minimize the size of future spills.

7.5.2 Yellowcake Precipitation and Dryer Accidents

Yellowcake Thickener Failure

NUREG/CR-6733 evaluates the potential impact of the failure of a yellowcake thickener which results in the release of approximately 20% of the thickener volume outside of the plant. This accident scenario is based on an event at the Irigary ISR Facility in 1994. The only substantial radiological hazard in this situation is the inhalation of yellowcake powder if the yellowcake slurry of explosive gases in the building. All employees will be trained on the proper procedures and evacuation plans should a fire or explosion occur.

Throughout Crook County there remains potential for future wildfires, however the potential is low. Crook County has a community wildfire protection plan and was developed by Crook County Fire Department (Crook County 2005). According to this plan, the proposed project area is not located in a high risk area. Strata is currently investigating strategically placing water loadout facilities near the processing facilities and wellfields as part of a dust suppression program, however they could also be used in the event of a fire. In addition, wellfield personnel will be trained in fire prevention and emergency notification procedures to further reduce the risk of a fire.

7.5.4 Transportation Accidents

Throughout the project several types of materials may be transported to or from the proposed Ross ISR project including:

- Shipments of 11e.(2) byproduct material from the site to a licensed disposal facility
- Shipment of yellowcake from the Ross ISR CPP to a uranium conversion facility
- Shipment of process chemicals and fuel from suppliers to the site
- Shipments of uranium-loaded IX resin to the site
- Shipment of vanadium to a processing facility

To minimize transportation accidents, extensive emergency response programs will be in place along with environmental emergency response contractors for spill cleanup. Strata will provide ongoing training for local emergency personnel including firemen, police and emergency medical technicians (EMT) in the hazards and emergency response procedures to ensure safe working practices in the presence of spilled materials.

All material shipments will be made by appropriately licensed transporters in accordance with U.S. DOT hazardous material regulations and applicable requirements of 10 CFR Part 71. The Federal Hazardous Materials Transportation Law (Federal Hazmat Law), 49 U.S.C. § 5101 et seq., is the basic statute regulating hazardous materials transportation in the United States. Section 5101 states that the purpose of the Federal hazmat law is to "protect against the risks to life, property, and the environment that are inherent in the

7.5.4.1 Shipment of 11e.(2) Byproduct Material

Solid 11e.(2) byproduct material or unusable contaminated equipment generated during operations and decommissioning will be transported to a licensed disposal site. Before operations begin, Strata will have an agreement in place with a licensed disposal facility to accept solid 11e.(2) byproduct material. As discussed in Section 4.2.1.2 of the ER, Strata has considered shipment of byproduct material to four disposal sites. These include one facility in Wyoming, two in Utah, and one in Texas. The distance of these facilities from the Ross Project ranges from 235 to 1,000 miles. Shipments will be handled as low-specific-activity (LSA) material and will generally be made in sealed roll off containers in accordance with the applicable U.S. DOT hazardous materials shipping provisions and applicable requirements of 10 CFR Part 71. Shipments of 11e.(2) byproduct material are expected to average about 5 per year during operation and then increase to between 100 and 200 per year during decommissioning.

The risk of an accident involving the transporting of 11e.(2) byproduct material will be kept to a minimum by the use of proper packaging and exclusive use shipments. Similar to transportation of yellowcake, Strata will contract with a transport company that provides training and emergency response procedures specific to the transport of 11e.(2) byproduct material. In addition, the solid material would be easily collected and contained in the event of an accident.

7.5.4.2 Shipment of Yellowcake

Transportation of dried yellowcake will be made in exclusive-use transportation vehicles to a licensed conversion facility, which transforms the yellowcake to uranium hexafluoride. The only currently permitted conversion facility is in Metropolis, Illinois, which is approximately 1,260 mile from the project area. The proposed annual yellowcake production rate for the proposed Ross ISR project is 3 million pounds. Based on weight limits for legal transport, each shipment will contain approximately 40,000 pounds of yellowcake, resulting in a total of about 75 shipments per year. Yellowcake is shipped in 55 gallon steel drums; each containing a maximum of 950 lbs.

Strata will contract with a transport company that specializes in shipment of yellowcake. The transport company will have extensive emergency response accident involving these trucks is approximately 2% per year, using the 180-mile distance to Casper. NUREG-0706 also provides a probability of an injury to a member of the general public resulting from an average shipment of anhydrous ammonia as 4.8 x 10^{-7}/mile. Based on this probability, the average annual probability of an injury to a member of the general public resulting from an ammonia transportation accident is 0.2%. Risks involving other process chemicals would generally be equal to or less than the risk in transporting ammonia.

Transportation accidents involving fuel (diesel, gasoline, and propane) shipment also present potential environmental impacts. During operation it is estimated that approximately 1 shipment of fuel will be transported to the site each day. Fuel will be transported from a nearby town such as Moorcroft, Gillette or Sundance, which will minimize the trip distance and keep the probability of an accident very low.

7.5.4.4 Shipment of Loaded Resin to the Ross ISR CPP Facility

The uranium recovery circuit at the CPP will be designed to process up to 3 million pounds per year of U_3O_8. The Ross ISR Project wellfield is estimated to produce 750,000 pounds per year of U_3O_8; therefore the CPP will be capable of processing additional uranium-loaded IX resin from satellite ISR facilities, including those owned and/or operated by Strata and those owned and/or operated by other ISR licensees, and from other water treatment entities generating uranium-loaded IX resins that are the same or substantially similar to those generated at ISR facilities. Uranium-loaded IX resin will be transported to the Ross ISR Project in tanker trailers with 500 cubic-foot or standard resin capacity. Based on a typical concentration of 50 g/L U_3O_8 (ISR GEIS Section 4.2.2.2), each truckload of uranium-loaded IX resin will contain approximately 1,500 pounds U_3O_8. Based on a maximum processing rate of 2.25 million pounds of U_3O_8 equivalent derived from uranium-loaded IX resin, up to 4 shipments would be made to the facility each day.

A transportation accident resulting in release of uranium-loaded IX resin would have a lower risk than the relatively low risk from an accident involving yellowcake described previously. As described in Section 4.2.2.2 of the ISR GEIS, IX resin contains a much lower concentration of uranium than yellowcake and the uranium is chemically bound to the IX resin and is therefore less likely to spread and easier to remediate in the event of a spill. Further, although there would be more frequent shipments of uranium-loaded IX resin than yellowcake, the distance traveled would typically be less, so the total distance traveled would likely be less. If an accident occurred with loaded resin the impacted soils will be salvaged and shipped to a licensed 11e.(2) byproduct material disposal site, the topsoil and vegetation will be replaced, and Strata will perform a post-reclamation radiological survey to verify that no long-term hazards would be present.

Transportation of loaded resin from satellite facilities not operated by Strata will be the responsible of the satellite facility, and covered under its source and byproduct material license. Strata will assume responsibility of the loaded resin when the shipment has reached the site. An unlikely but credible accident could occur if the truck was involved in a collision which ruptured the tanker trailer. The risk of an accident within the CPP area is low due to the short distance which would be traveled and the low speed limit of roads within the CPP area. In addition, if an accident did occur, cleanup and remediation efforts are expected to be very prompt considering the proximity to trained personnel.

7.5.4.5 Shipment of Vanadium

Vanadium Shipment

Vanadium will be shipped in sealed transport vehicles to prevent uncontrolled release into the atmosphere. AMV is considered a hazardous material by the USDOT (40 CFR Part 172.101). As such, vanadium will be shipped by an appropriately licensed transporter to a processing facility.

It is estimated that the quantity of vanadium produced from the Ross ISR Project may be up to 60% of the yellowcake quantity. This would be up to 1.8 million pounds per year. Since the weight limits for legal transport are 40,000 pounds, up to 45 shipments would be required annually. The location of the vanadium processing facility has not been finalized, but based on the reduced shipment frequency and the lack of radiological hazard compared to yellowcake shipment, the potential risk associated with vanadium shipment will be smaller than that associated with yellowcake shipment.

7.5.5 Natural Disaster Risks

The risks for widespread release of radioactive materials due to natural disasters are not high, although the potential for an earthquake or tornado does exist. NUREG/CR-6733 evaluated the potential risks of an ISL facility from an

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water will be required for plant make up. Strata will utilize either excess permeate stored in the lined retention ponds, or increased bleed from aquifer restoration activities as necessary to supply plant make up water during this phase.

3.1.6 Monitor Well Layout and Design

The wellfields will be surrounded by perimeter monitor wells to detect potential excursions. The distance between the nearest production unit and perimeter well will be between 300 and 500 feet and the spacing between perimeter wells will be between 300 and 500 feet provided that the maximum angle from the closest unit to the two nearest wells is less than 75 degrees. In the event a perimeter well exceeds the 400-foot spacing ± five percent from the nearest production unit, the UCLs for that perimeter well will be calculated as discussed in Section 5.7.8.2. Figure 3.1-14 shows the proposed locations of perimeter monitor wells adjacent to a typical wellfield using the standard 400 feet distances. Due to the level of ore zone aquifer confinement, simulations of recovery and aquifer restoration indicate that the 400-600-foot spacing can successfully detect hydraulic anomalies in the form of water level increases well before lixiviant has moved beyond the active uranium recovery areas. Results of excursion simulations are presented in Section 5.7.8 and in Addendum 2.7-H. The perimeter monitor wells will be completed through the entire production zone unit, as intervening shales in the mineralized sandstones are discontinuous. Monitor wells completed in the aquifer underlying the ore zone (the DM unit), and monitor wells completed in the aquifer overlying the ore zone (the SM unit) will also be installed at a density of one well per 3-4 acres of wellfield to detect vertical migration. Samples will be collected from the monitor wells once every two weeks to be analyzed for the excursion parameters, which are defined in Section 5.7.8.1 of this report. In addition, dedicated pressure transducers and/or in situ water quality instruments may be used in the perimeter monitor wells to provide early detection of potential excursions of hydraulic anomalies.

Wellfield and monitor well integrity will be demonstrated as a requirement of the wellfield data package for the proposed Mine Unit. Hydrologic testing through pumping of recovery wells in the wellfield area and measuring response in surrounding perimeter monitor wells is a significant component of this package. Wellfield pumping and measured response in the perimeter monitor wells not only demonstrates wellfield integrity through quarterly NRC reporting as well as in the annual reports for NRC and WDEQ/LQD.

Financial assurance estimates in the unlikely event of a vertical excursion will again utilize a modeling platform along with aquifer specific hydraulic and physical characteristics to determine the magnitude of the incident. In situ measurements of hydraulic conductivity will be provided for both the SM and DM systems to aid in surety updates.

Excursion Monitoring and Upper Control Limits

After baseline water quality is established for the monitor wells for a particular mine unit, UCLs are set for chemical constituents that would be indicative of a migration of lixiviant from the wellfield and provide an "early warning" of a potential excursion. Consistent with the ISR-GEIS, the constituents proposed for indicators of lixiviant migration and for which UCLs are set are chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the IX process (uranium is exchanged for chloride on the IX resin). Chloride is also a very mobile constituent in groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion as bicarbonate is the major constituent added to the lixiviant during recovery operations. Water levels are obtained and recorded prior to each well sampling. Rising water levels are indicative of an imbalance in the wellfield, which could result in an excursion. Although water levels are not proposed as an official excursion indicator, modeling indicates that such changes may provide a much earlier indication of an excursion than a geochemical anomaly measured in a monitoring well.

WDEQ/LQD Guideline 4 (WDEQ/LQD 1994) recommends that UCLs are set by adding five standard deviations to the mean baseline concentration of the excursion indicator. The UCL will be less than the lowest concentration that typically occurs in the lixiviant while the wellfield is in operation and greater than the mean baseline concentration for its respective excursion indicator. For chloride, WDEQ/LQD states that, the UCL may be determined by adding 15 mg/L to the baseline average if the resulting value is greater than the baseline mean plus five standard deviations. For perimeter monitor wells spaced from the nearest production unit beyond the standard 400 feet (i.e, 400

+/- five percent if the wellfield average is 400 feet), the UCLs for those wells will be calculated to provide reasonable assurance that an excursion will be detected within the same timeframe or less as an excursion for a well spaced at 400 feet using an UCL established by the standard method (baseline average plus five standard deviations, or in the case of chloride, the baseline average plus 15 mg/L). The UCL calculations will consist of the well- or wellfield-mean plus a specific number of standard deviations provided that the number of standard deviations is less than five. The analysis on timing for an excursion detection may be based on the specific modeling results found acceptable by NRC staff in its evaluation (ML17068A399) or a mine-unit specific fate and transport modeling such as MODFLOW/MT3D/PHAST or other equivalent methods (e.g., analytical models) The analysis will be documented in the wellfield package.

Chloride, total alkalinity and conductivity appear to be strong indicators of dissolution during ISR operations. Therefore, these constituents as UCLs are proposed for excursion determination for the mineralized sandstones of the OZ aquifer as well as the shallow sandstones of the SM system. However, elevated natural/background chloride concentrations in the DM aquifer negate the use of chloride as downward movement of lixiviants into the DM aquifer would likely result in a decrease in chloride concentrations. In lieu of chloride, Strata proposes that sulfate will be used along with conductivity and alkalinity as a metric for determining that a vertical excursion downward has occurred. Water quality testing indicates concentrations of sulfate in the DM aquifer are typically less than 150 mg/L while ambient sulfate levels in the OZ aquifer range between 300 mg/L to more than 900 mg/L and are anticipated to increase during ISR operations by at least 150 mg/L. In addition, Section 6.1.6 compares water quality analogs at various operating ISR facilities, and increases of sulfate commonly occur during operations, which should be beneficial to detecting a downward vertical movement at the Ross ISR Project. Upper control limits for the excursion indicator parameters have not been calculated at this time due to the limited number of wells installed during the regional baseline program. Following completion of the necessary monitoring well network in order to develop the Mine Unit 1 wellfield package, sufficient data on the ore zone aquifer, DM, SM and laterally adjacent aquifers will be available to calculate UCLs.

Appendix B

2017 Annual ALARA Audit Report

Ross ISR Project

2017 Annual ALARA Audit

1.0 Introduction/Summary

As required by NRC Regulatory Guide 8.31, dated May 2002 entitled "Information Relevant to Ensuring That Occupational Radiation Exposure At Uranium Facilities Will Be As Low As Is Reasonably Achievable (ALARA)", Section 2.3.3 "Radiation Protection and ALARA Program Audit" and License Condition 11.2 of SUA-1601, the Annual ALARA Audit was performed at the Ross ISR Project (Ross Project) during the period January 30 and 31, 2018 by Bill Kearney, contract Radiation Protection Specialist.

The records reviewed were for the period January 1 thru December 31, 2017. Royal Pond (Manager HSE/RSO) and Charlie Harless (RST) assisted with the audit but were not official members of the audit team. The audit resulted in two (2) Findings and four (4) Recommendations. The results of the audit, including the Findings and Recommendations, were discussed at the Audit Close Out meeting held on January 31, 2018 at the Ross Project. Attendees at this meeting included Ralph Knode, Chief Executive Officer (CEO), Mike Griffin Vice President- Permitting, Regulatory and Environment Compliance (VP-PREC), Jay Douthit Vice President-Operations (VP-OPS), Royal Pond, Charlie Harless and Bill Kearney.

In accordance with Section 2.3.3 of NRC Regulatory Guide 8.31 the following areas of the Radiation Protection Program were reviewed and the results are summarized in this report:

- Employee exposure records
- Bioassay results
- Inspection log entries, daily and weekly inspections , and monthly summary reports
- Documented training program activities
- Radiation safety meeting reports
- Radiological survey and sampling data
- Reports on overexposure of workers submitted to the NRC, OSHA or States
- Operating procedures that were reviewed during the past year
- Assess the radiologic environmental monitoring program and determine if there are any trends in the data

In accordance with NRC guidance, the report on the annual radiation protection and ALARA audit should specifically discuss the following:

- Trends in personnel exposures for identifiable categories of workers and types of operational activities.
- Whether equipment used for exposure control is being properly used, maintained, and inspected.
- Recommendations on ways to further reduce personnel exposures from uranium and its daughters.

The following sections describe the activities that took place during the audit and include "Findings" and "Recommendations" as determined by the auditor. Findings are deficiencies involving the apparent non conformance of the operation to meet required standards. These standards may include the requirements of the Strata Radiation Protection Program (RPP) or NRC regulatory or license requirements. Findings usually require formal corrective action. Recommendations typically do not indicate non conformance of required standards, but constitute "best industry practices" or improvement to exiting procedures. Recommendations may not result in corrective actions.

2.0 Ross ISR Project and ALARA Activities

The Ross Project is a relatively new uranium ISR operation that was constructed during 2014 and 2015. It is licensed by the US NRC under License Number SUA-1601. This license permits the construction of a full Central Processing Plant (CPP) facility, ISR wellfields, waste water storage ponds and deep disposal wells. Due to uranium market considerations the facilities constructed at the site, and currently in operation, are limited to a scaled back CPP that only includes ion exchange (IX) columns and related facilities. No uranium elution, precipitation circuits or yellowcake drying facilities are in place. The uranium loaded IX resin is currently transported by trailer 110 miles to the Uranium One Irigaray/Christensen Ranch ISR facility (NRC License Number SUA-1341) for resin elution, uranium precipitation and yellowcake drying. All dried yellowcake product is shipped from the Irigaray/Christensen Ranch ISR facility to the purchaser or conversion facility.

Uranium production from the first wellfield (Mine Unit 1) started in December 2015. As of December 31, 2017 uranium production was occurring from Mine Unit 1 (four Headerhouses) and Mine Unit 2 (five Headerhouses). Uranium production started in Mine Unit 2 in February 2017. Development activities at Mine Unit 2 will continue through 2018. Approximately one shipment of uranium loaded resin is transported each week to the Irigaray/Christensen Ranch ISR facility for processing.

At the time of the audit the workforce at the Ross Project totaled 38 personnel with about 17 workers assigned to the CPP and wellfields, 8 workers assigned to construction, and 13 office workers (geologists, management, environmental, safety and radiation protection staff). This

ALARA Audit covers the period January 1, 2017 thru December 31, 2017. This period coincides with the second complete year of uranium production operations. Bill Kearney, Radiation Protection Specialist, conducted the full audit. Bill Kearney reviewed NRC license documents, site radiological monitoring data (both health physics and environmental monitoring site data) and numerous Standard Operating Procedures. A "walk-through" inspection of the CPP and wellfield areas was conducted on January 30, 2018. In summary, the following relevant documents were reviewed:

- NRC License No. SUA-1601, Amendment 7
- NRC License Application Technical Report (emphasis on Section 5- "Operational Organization, Management, Programs and Training")
- Applicable NRC Regulatory Guides including, but not limited to nos. 4.14, 8.15,8.22, 8.25, 8.29 8.30, 8.31
- 10 CFR Parts 20 and 40
- Monthly Radiation Safety Summary Reports
- Miscellaneous site records and reports generated by the Radiation Safety staff
- Safety and Environmental Review Panel (SERP) reports
- NRC Inspection Report 040-09091/2017-002 and Notice of Violation, dated March 2, 2017
- NRC Inspection Report 040-09091/2017-003 dated September 21, 2017
- Laboratory Audit Report completed dated May 17, 2017 by Inter-Mountain Laboratories Inc.

In addition to the review of the above documents, the site RSO, RST and VP-PREC were consulted and they provided details concerning their working knowledge of the Radiation Protection Program and the various files and databases containing the data and records supporting the program.

3.0 Review of Radiation Program Data

3.1 Employee Exposure Records

The Employee Exposure Monitoring Program is described in Section J of the Radiation Protection Program (RPP). A review of the employee exposure records was completed. The review of the records covered the period January 1, 2017 thru December 31, 2017. Previously, during the first full year of uranium production operations (2016), the RSO maintained employee exposure records by determining the Total Effective Dose Equivalent (TEDE) for all employees.

In accordance with recommendations from the last ALARA Audit, due to the very low conservative estimates for the annual dose to personnel, the RSO modified the employee exposure monitoring program to discontinue maintaining individual exposure records for all employees. Accordingly, in 2017, the RSO modified the computer program (Excel spreadsheet) such that the routine air monitoring data (uranium particulates and radon) is used to estimate the CEDE to two generic work groups (CPP Operator and Wellfield Operator). These work groups were chosen as they have the greatest potential of any workers at the site to be exposed to radioactive materials.

In summary, the program utilizes the particulate uranium and radon daughters (radon) routine air monitoring data obtained on at least a monthly basis at selected locations in the CPP and wellfield (headerhouses). This data is averaged for the CPP or Wellfield for the particular month and the normal work hours per month are used by the program to estimate the monthly CEDE. At the end of each quarter when the DDE data is available for the OSL badges the RSO adds these to the program. This resulted in the calculation of the TEDE on a quarterly and an annual basis. Therefore, the CEDE for these work groups is estimated on a quarterly and annual basis to maintain an estimate of the TEDE at the Ross Uranium Project and show that estimated exposures from radioactive materials remain very low, and well below the NRC required employee exposure monitoring requirement (500 mrem per year).

It was noted that the computer program used by the RSO to estimate employee exposures permits the entry of non-routine exposures and doses calculated from uranium bioassay results. The RSO was knowledgeable that these functions of the employee exposure program will be potentially utilized when uranium processing and yellowcake drying operations commence at the Project at some future time.

The Deep Dose Equivalent (DDE) was determined for gamma radiation exposure from Optically Stimulated Luminescence (OSL) personnel dosimeter badges that are exchanged every three months. In accordance with recommendations from the previous ALARA Audit, the RSO reduced the number of workers monitored with OSL badges and limited this monitoring to personnel that routinely work in the CPP or wellfields.

In summary, a review of the results for 2017 showed all doses to both generic work groups to be very minimal. Consistent with last year's dose estimates this is expected as there is no yellowcake precipitation or drying operations being conducted, which basically negates the potential exposure to any significant quantity of airborne uranium.

It was estimated that the annual TEDE for the generic Wellfield Operator was 102 mrem and 162 mrem for the generic CPP Operator. These TEDE dose estimates equate to approximately 2% and 3%, respectively, of the annual limit of 5000 mrem and less than one- half of the 500 mrem annual dose that require exposure monitoring (10% of the 5000 mrem annual limit). Additionally, it should be noted that the majority of the estimated TEDE dose (over 90%) is attributed to radon. Therefore, these estimates are very conservative as the natural background concentration of radon is not subtracted from the air monitoring data. The CPP and headerhouses contain ventilation systems that ensure that radon does not increase to significant levels thereby limiting the worker exposure to radon.

3.2 Uranium Bioassay Results

A detailed review of the uranium bioassay program and records for calendar year 2017 was completed. The Uranium Bioassay Program is contained in the Section F of the RPP which follows NRC Regulatory Guides 8.9, 8.11 and 8.22. Uranium bioassay samples were obtained on a monthly basis from workers representing all the work groups at the Ross Project. Urinalysis for U-nat comprises the bioassay method.

Since there is currently no uranium elution, precipitation circuits or yellowcake drying facilities at the Ross Project the potential uptake of a significant amount of uranium by a worker is very limited. As such, the program is used to document that workers are not ingesting or inhaling in uranium. It was determined that 92 bioassay results were analyzed, not including quality control samples. It was determined that no bioassay samples exceeded the detection limit is 5.0 ug/L. As expected, due to the lack of uranium elution, precipitation circuits or yellowcake drying facilities, the lack of any positive bioassays shows that workers are not being exposed to any significant amounts of uranium at the Ross Project. Even though the levels of uranium surface contamination on equipment is very low, this also shows workers are following good hygiene practices.

The review of the bioassay records also showed that the laboratory results were available within 20 days of specimen collection. It was verified with the RSO that the current contract laboratory (IML Sheridan, WY) provides very quick turnaround of the required uranium analyses and notifies the RSO or RST immediately (within the same day the analyses are completed) via phone and email of the detection of any positive results (including spikes). Notification is typically received at the Ross Project within 3-4 business days of receipt of the samples by the lab.

The in-house QA/QC blank and spike bioassay samples for 2017 were also reviewed in detail (approximately 39 samples). It was determined that blank and spike samples were included as required by Section F of the RPP. The review showed that the contract lab results were in close agreement with the spiked concentrations (typically within 5% of the known concentration) except for one spiked sample that was slightly outside the acceptable range for the spike. An additional spike sample was submitted to the lab and a new spike solution was procured. No concerns were noted with the contract lab results.

NRC guidance requires the RSO to investigate and document the cause for any bioassay results that exceed 15 ug/L. Since all the bioassay results were below the detection limit the RSO did not need to complete any investigations.

Section F.3.1 of the RPP specifies that "baseline" bioassay samples should be obtained for all new employees and "termination" samples should be "requested" from employees terminating employment at the facility. It appeared that this protocol was not consistently practiced as the RSO was not always obtaining bioassay samples from administrative new hires. This was discussed at length during the Closeout Meeting and it was determined that efforts would be increased to obtain these samples for all company employees. Therefore, the following Finding is included:

- The RSO should ensure that "baseline" and "termination" bioassay samples be obtained when possible.

3.3 Daily and Weekly Inspections

A spot check of the Daily CPP Facility Inspection and the Weekly Facility Inspection reports completed in 2017 was conducted. In accordance with Section 5.3.1.1 of the TR the Daily CPP Facility Inspection is routinely conducted at the beginning of the shift by the RSO or RST. A qualified designee completes the Daily CPP Facility Inspection on weekends and holidays or on infrequent occurrences when the RSO or RST is not at the site. In accordance with Section 5.3.1.2 of the TR the Weekly Facility Inspection is routinely conducted by the RSO each calendar week. This inspection is also conducted with the assistance of the Production Superintendent or equivalent position.

The review of the records showed that the required inspections had been completed as required to assist in promoting the ALARA concept and the Weekly Facility Inspections were reviewed by the VP- PREC and the VP-Operations. During the previous audit it was observed that the forms for both the daily and weekly inspections are redundant in the items they cover and it was recommended that the RSO consider revising these forms. It was observed that the RSO did complete draft revisions to these forms in 2017 but they were not finalized at the time of the audit. However, the new forms for both inspections were finalized just after the audit and went into effect on February 3, 2018.

3.4 Documented Training Program Activities

Records documenting Radiation Protection Training and DOT Training were reviewed. It was observed that the records were well organized. Radiation Protection Training was provided by the Manager HSE/RSO 11 new hire employees and 89 contractors during the period. For new company employees the Radiation Protection Training included the use of a detailed Power Point slideshow presented by the RSO and a quiz to demonstrate that trainees understand the key concepts. Contractors were provided training at levels commensurate with the work they were doing at the operation. Most of the contractor training involved work not directly associated with any significant potential for exposure to radiation (such as computer and electrical work in the CPP).

A review of the training records showed that, the Manager HSE/RSO updated the Annual Radiation Safety Refresher PPT and presented it to a total of 42 Strata employees and contractor rig crews on four dates between March 31 and April 18, 2017.

A review of the training records for the current RSO (Royal Pond) and the RST (Charlie Harless) showed that they both last attended "Uranium RSO Refresher" training on April 4-8, 2016. The RSO conveyed that they are scheduled to attend RSO training in 2018. The records showed that Mike Griffin, VP-PREC (Alternate RSO) attended RSO refresher training in December 2017.

The records also showed that DOT training for the handling of hazardous materials was completed by the appropriate employees on September 28, 2017. The training was provided by R&D Enterprises, Inc. This training is required every three years.

In summary, the review showed that employees and contractors had been appropriately trained for the activities they were tasked to complete at the Ross Project.

3.5 Radiation Safety Monthly Reports

The RSO completes a Monthly Radiation Safety report that is forwarded to Ross Project management and the VP-PREC. The report summarizes the results of the daily and weekly inspections, radiation surveys and monitoring, radiation safety training, Radiation Work Permits (RWPs) completed and other pertinent information. The report also summarizes any compliance concerns and the need for corrective actions. A review of the 2017 reports shows them to be detailed and they include the information required by NRC regulatory guidance. The review also showed that the RSO is completing the reports in a timely manner and no significant radiation protection concerns were identified.

3.6 **Radiological Survey and Sampling Data**

The radiological survey and sampling data used to support the ALARA program as it relates to the protection of personnel from exposure to uranium and its daughters was reviewed. The following radiological survey and monitoring data for the radiation protection program were reviewed; airborne uranium and radon daughter monitoring (sampling) data, gamma (TLD) personnel monitoring, "clean" area contamination surveys, personnel contamination survey data and the surveying (screening) of materials for unrestricted release.

Airborne Uranium Monitoring Data

In accordance with the RPP and Section 5.7.3.1 of the TR, airborne uranium (particulates) was initially monitored at the beginning of production operations on a weekly frequency at three locations in the CPP. The weekly monitoring was conducted for three months (December 2015 thru February 2016) with all results less than 1% of the DAC. The RSO determined (see memo dated March 8, 2016) that the lack of any particulate uranium within air samples from the CPP justified a lesser monitoring frequency and therefore the frequency was revised to monthly in March 2016. It was observed that the monthly monitoring frequency continued through 2017.

A "spot- check" review of the airborne uranium monitoring results for 2017 was completed. It was noted that the air samples are collected with a high volume sampler for a period of 5-10 minutes. Records showed that the volume of air pumped was sufficient to meet LLD requirements. It was determined that all results were at zero or less than 1% DAC, and representative of background levels. This is expected, as there is no yellowcake processing occurring at the CPP. Given the limited operations at the CPP there is a minimal chance that airborne uranium could be detected above, or near, the detection limit unless there was a very large release of production fluid that is then allowed to dry and the residues of uranium became airborne.

The 2017 ALARA Audit recommended that due to the lack of any airborne uranium at the CPP and the fact that personnel are not being exposed to airborne uranium, that consideration should be given to changing the frequency of airborne uranium monitoring in the CPP from a monthly to a quarterly basis. It was observed that the RSO maintained the monthly frequency for airborne uranium monitoring in the CPP but he switched hi volume air samplers in order that the monitoring could be completed in considerably less time.

Airborne uranium monitoring is also conducted at each operational Headerhouse on a monthly basis. The airborne uranium monitoring results for the 2017 were reviewed. It was noted that the air samples are collected with a high volume sample. It was determined that all results were at zero or less than 1% DAC, and representative of background levels. This is expected, as there is a very limited potential for airborne uranium within headerhouses as mining fluids are contained within piping. Additionally, the ventilation system (two exhaust fans) that continuously operates at headerhouses to minimize the potential accumulation of radon prevents the potential for any significant airborne uranium in headerhouses.

Radon Air Monitoring Data

In accordance with the RPP and Section 5.7.3.2 of the TR, radon (radon daughters) is monitored on a monthly basis at the CPP plant area, CPP office area, headerhouses and the Admin Office. Radon daughter concentrations are determined using the Modified Kusnetz method. The radon monitoring data for 2017 year was reviewed. In summary, the review showed that radon concentrations in all normally occupied areas was low and well below any action levels. The review showed that the CPP typically contains average radon concentrations of less than 1% to 6% DAC. This shows that the tank ventilation system and building ventilation system is adequately preventing the buildup of radon.

The review showed that the radon concentrations in headerhouses are typically less than 1% to 5% DAC. This shows that the ventilation system at the headerhouses is adequately preventing the buildup of radon. The review showed that the radon concentrations at the Admin Office building are typically less than 1% DAC. The review showed that the average radon concentrations for all monitored locations are typically 2% to 4% DAC. It should be noted that the airborne radon monitoring data is conservatively estimated as background levels are not subtracted from the estimates.

As in the previous ALARA Audit it was observed that a Bladewerx Sabre Alert continuous air monitor (CAM) is installed at the CPP. It is used to continuously estimate radon daughter concentrations and permits trend analysis of radon levels in the CPP, if desired. It also has an alarm feature that can be set alert workers to the increased presence of radon. This type of monitoring equipment is not required by any NRC regulations or the Ross Technical Report and the monitoring data from it is not used to estimate the exposure of employees to radon. The use of this equipment is not discussed in the RPP. Therefore, the following Recommendation is included:

- Section 6.6 of the RPP should be revised to discuss how and for what purpose the Bladewerx Sabre Alert continuous air monitor (CAM) installed at the CPP is used.

Gamma Dosimetry Data

In accordance with the RPP and Section 5.7.2.3 of the TR, at the start of operations, all fulltime personnel at the Ross Project were issued optically stimulated luminescence (OSL) personnel dosimeter badges to monitor their exposure to gamma radiation. The badges are supplied by a vendor and they are exchanged on a quarterly basis.

During the fourth quarter 2016 the RSO assessed the external gamma exposure data from the OSL badge program. The RSO verified the lack of any, or very low, gamma radiation exposure by all the work groups, including the long term contractors (drill rigs) at the Ross Project. Accordingly, it was decided in accordance with in NRC regulations (10 CFR 20.1201(a)) to reduce the number of personnel who will be issued personnel gamma dosimeters starting in 2017 to personnel that worked in the CPP or wellfield areas or frequented these areas on more than an infrequent basis. Depending on the period (quarter) 12-15 employees were issued badges in 2017.

The dosimetry results for calendar year 2017 were reviewed. It was determined that most employees were not exposed to any gamma radiation discernable from background with a corresponding DDE of 0 to 2 mrem. As expected, the highest gamma exposures were to CPP Operators and the RST that incurred an exposure of less than 10 mrem for the entire year. This is less than 1% of the allowable annual limit of 5000 mrem. The greatest annual DDE was for the RST and was only 9 mrem.

The review of the OSL data and the routine gamma survey data for 2017 show the very low external occupational gamma exposure to personnel at the Ross Project and supports the decision by the RSO limit the number of employees issued OSL badges. Based on the above the following Recommendation is included:

- Although gamma radiation levels and worker exposure to gamma radiation is very low the monitoring of a select number of workers with OSL badges should continue.

Gamma Survey Data

In accordance with the RPP and Section 5.7.2.1 of the TR, gamma radiation surveys are completed on a monthly basis to measure gamma radiation levels at various locations in the CPP, Admin Office and wellfield headerhouses. This is primarily done to ensure that filter pods, tanks, IX vessels or other equipment do not become a significant gamma radiation source that could require posting as a “Radiation Area” (greater than 5 mR/hr) or as a “Restricted Area” (greater than 2 mR/hr).

A “spot check” of the monthly gamma survey data for calendar year 2017 was completed. It was noted that although the background levels at the time of surveying are recorded on the survey forms the background is not subtracted. Therefore, the survey results on the form reflect the gross gamma radiation exposure rates in uR/hr. The review showed that gamma levels in the

CPP continue to be relatively low compared to other uranium ISR processing facilities. This observation is likely due to the newness of the CPP and the lack of accumulation of radioactive solids in the tanks and IX vessels as well as the levels of uranium and daughter products (principally radium-226 and radon) in the production fluids. The survey data shows that the gamma exposure rates generally ranged from approximately 20 to 80 uR/hr throughout the CPP. The survey data has effectively identified the highest gamma radiation producing areas in the CPP which include the filter pods, RO, and tanks that hold wastewater and IX transfer water. These areas typically have gamma exposure rates of 100 to 500 uR/hr. A review of the gamma survey data for 2017 showed a decrease in gamma levels near the filter pods, RO, and tanks that hold wastewater and IX transfer water. The decrease is attributed to the transient nature of fluids and/or solids containing radioactive material in the tanks and the periodic cleaning or emptying of tanks.

It was noted in 2016 that the RSO had identified from these surveys that several office areas, the Break Room and the Lab at the CPP had levels of gamma radiation slightly above background. As part of an ALARA action the RSO moved the table at the Lunch Room away from the wall closest to the CPP process area such that gamma radiation levels at the table were lessened further.

Area OSL Dosimeter Data

In accordance with the RPP and Section 5.7.2.1 of the TR, the RSO emplaced fixed OSL dosimeters at three locations in the CPP (Lab, Upstairs Office, Break Room wall) and one location at the Admin Office (Maintenance Bay). Similar to the personal dosimeters these dosimeters are exchanged on a quarterly basis. A review of the data for calendar year 2017 shows that the three dosimeters located in the CPP did record gamma exposure rates above background. This was expected as the gamma survey data showed increased gamma radiation at these areas resulting from their proximity to the wastewater tank and related equipment in the northwest part of the CPP. The review also showed that dosimeter located at the Lab had only about 30-40 mrem DDE per quarter. The results for this monitoring also showed that the DDE exposure at the CPP Break Room, which historically ran about 200 to 250 mrem per quarter lessened to only about 60 mrem during the fourth quarter 2017. The results for the fixed OSL dosimeter in the Admin Office (Maintenance Bay) show that it is measuring background conditions. A comparison of the area OSL dosimeter data with the gamma survey results show that they compare favorably.

Personnel Contamination Surveys

Personnel contamination surveys (scanning) are conducted at two locations at the CPP (Main Survey Station next to the Control Room and the Southwest Door). The surveys are conducted for alpha/beta activity with a Ludlum Model 2360 meter equipped with a 43-93 probe. The RST periodically sets the acceptable limit for the alpha/beta activity based on the meter efficiency for alpha and for beta and background beta activity. Records of the surveys were observed at the survey stations. A spot check of the personnel contamination survey records showed the records to be complete.

3.7 Reports on Over Exposure of Workers

There were no instances of over-exposure of any worker to radioactive materials. Therefore, no reports of this nature were reviewed.

3.8 Annual Review of Standard Operating Procedures (SOPs)

Section 5.2.1 of the TR requires that the Radiation Protection Program (RPP) contain of written SOPs for all process activities involving radioactive materials as well as record keeping, document control, quality assurance, environmental and health physics monitoring and emergency procedures. It was observed that all SOPs and the Radiation Protection Program and Emergency Response Plan are maintained on the Strata intranet site. Hard copies of the SOPs and programs are maintained at the Admin Building Conference Room and the RSO's office. A hard copy of the CPP and Wellfield Operations SOPs and all programs are maintained in the CPP Control Room for ease of use.

It was observed that the SOPs are reviewed and approved by the RSO. It was noted that the required annual review of the SOPs by the RSO was completed by in December 2017.

4.0 Review of the Radiologic Environmental Monitoring Program

In accordance with TR Section 5.7.7.1.1 Strata maintains the operational radiological environmental monitoring program used for the pre-operational baseline monitoring program. In response to a recommendation in the 2017 ALARA Audit monitoring at the South monitoring station was discontinued in early 2017. The locations of the five monitoring sites are shown on TR Figure 2.9.24- "Air Particulate Sampling Locations". Air particulates, passive radon and passive gamma radiation are monitored at each station. The air particulates monitored include uranium (U-nat), radium-226, thorium-230, and lead 210. The environmental radiologic monitoring data was reviewed to determine if there are any trends in the data and if any changes are warranted to the program.

4.1 Radiological Particulate Air Monitoring Data

The air particulates monitored at each station include uranium (U-nat), radium-226, thorium-230, and lead 210. The air particulates monitoring data is obtained from continuously operated air samplers. A technician changes out the filters on a weekly or every two week frequency depending on dust loading to the filters. In accordance with NRC guidance, the filters are composited and analyzed on a quarterly basis (every 3 months) for the concentration of radionuclide's in order that concentrations can be compared with the 10 CFR 20 Appendix B Table 2 Effluent Concentration Limit values.

Spreadsheets and graphs for uranium (U-nat), radium-226, thorium-230, and lead- 210 at the air monitoring stations obtained from 2010 through 2017 were reviewed. This information showed both the background (baseline) concentration data from Q1 2010 thru Q3 2015 and the operational concentration data from Q1 2016 thru Q4 2017. The data and graphs for (U-nat), radium-226, and thorium-230 show that most of the data for both the "baseline" and "operations" periods is at, or very near, the applicable detection limit and there is no determinable impact from operations. In part, this is expected since there is no significant release of radioactive materials and there is no yellowcake processing occurring at the site. The review also showed that all the data for (U-nat), radium-226, and thorium-230 obtained from all the monitoring stations in 2017 (based on the average for the four quarters of 2017) approaches zero percent of the 10 CFR 20 Appendix B Table 2 Effluent Concentration Limit values.

The data and graphs show that lead-210 is typically above the detection limit at all monitoring stations. This is expected as lead-210 is related to the natural occurrence of radon in the air. There is no apparent difference between data for the "baseline" and "operations" periods. In summary, if this data shows anything it is the natural baseline occurrence of lead-210 in the area. The review also showed that all the data for lead-210 obtained from all the monitoring stations during 2017 (based on the average for the four quarters of 2017) approaches 2.0 to 2.4 percent of the 10 CFR 20 Appendix B Table 2 Effluent Concentration Limit value.

4.2 Passive Radon Monitoring Data

Passive radon is monitored with fixed radon Track Etch type dosimeters that are exchanged each quarter (every 3 months). A spreadsheet and graphs for the radon at all five (5) air monitoring stations obtained from 2010 through 2017 was reviewed. This information showed both the background (baseline) concentration data from Q1 2010 thru Q3 2015 compared to the operational concentration data from Q1 2016 thru Q4 2017.

The data and graphs show that radon is typically above the detection limit at all monitoring stations. This is expected as radon naturally occurs in the air. There is no apparent difference between data for the "baseline" and "operations" periods.

4.3 **Passive Gamma Radiation Monitoring Data**

Passive gamma radiation is monitored with environmental OSL dosimeters that are located at the five (5) air monitoring stations. The dosimeters are exchanged each quarter (every 3 months). A spreadsheet and graphs of gamma radiation (mrem) radon at all air monitoring stations obtained from 2010 through 2016 was reviewed. This information showed both the background (baseline) concentration data from Q1 2010 thru Q3 2015 compared to the operational concentration data from Q1 2016 thru Q4 2017.

A review of the graphs show that the East Station has a lower passive gamma radiation compared the other stations. There appears to be no significant trend in gamma radiation at all stations. In 2017 the passive gamma radiation recorded at all sites averaged about 35 mrem per quarter. As expected the there is no discernable impact to passive gamma radiation levels from the operations.

5.0 Trends in Personnel Exposures

Section 3.1 "Employee Exposure Records" reviews and discusses the exposure of personnel at the Ross Project to radioactive materials (uranium, radon daughters and gamma radiation) including the estimates of the TEDE determinations. As discussed in Section 3.1 the review of the program showed all estimated internal and external radiation doses to employees to be very minimal. This was expected as there is no yellowcake precipitation or drying operations being conducted which greatly limits the potential exposure of personnel to any significant quantity of uranium. The CPP and headerhouses contain ventilation systems that ensure that radon does not increase to significant levels thereby limiting worker exposure to radon. Given the very low personnel exposure to radioactive materials, no significant trends in personnel exposures were determined.

6.0 Equipment Used for Exposure Control

Due to the lack of yellowcake processing at the CPP the equipment used to control the exposure of workers to airborne radioactive materials (radon and particulate uranium) basically controls exposure to only radon. The primary method of radon control at the CPP is by venting tanks, IX columns and the resin shaker deck through piping and exhaust fans to the outside ("local ventilation"). The general plant area ventilation system also circulates air within the CPP by exhausting air outside the building, forcing fresh air in. Passive ventilation (open doors) is also used during the warmer months.

A review of the routine radon monitoring data (see Section 3.6) showed that the CPP typically contains average radon concentrations of less than 2% to 4% DAC (without background subtracted). This shows that the tank ventilation system, building ventilation system and passive ventilation is adequately preventing the buildup of radon.

The major concern for exposure of workers to airborne radioactive materials at headerhouses is also limited to exposure to radon. The primary method of radon control at headerhouses is accomplished by the continuous operation of two exhaust fans. One fan pulls from the basement area of the building and exhausts outside while the second fan exhausts through the wall approximately six feet from the floor. A review of the routine radon monitoring data (see Section 3.6) shows that the radon concentrations in headerhouses are typically less than 1% to 5% DAC. This shows that the ventilation system at the headerhouses is adequately preventing the buildup of radon.

7.0 Review of NRC Inspections

There were two NRC inspections conducted during the period. The first inspection took place on January 31 thru February 2, 2017. Three NRC personnel conducted a routine team inspection. One individual from the WDEQ-LQD Uranium Recovery Program accompanied the inspection. As described in the NRC Inspection Report 040-09091/2017-002 and Notice of Violation, dated March 2, 2017 one Notice of Violation was issued. Based on the results of this inspection, the NRC determined that one Severity Level IV violation of NRC requirements occurred. The violation involved failure to provide shipping papers for two return shipments of 11e.(2) byproduct material containers as required by NRC regulations.

In summary, the violation involved the lack of shipping papers for the return shipment of the empty 11e.(2) by-product dumpster from the disposal site to the Ross Project. Strata's corrective action to the violation included the determination that Strata was the "shipper" for the return by-product dumpster shipment and the appropriate shipping papers were included with subsequent shipments. The NRC evaluated the corrective actions at the next NRC inspection, found them acceptable, and closed out the violation. During the 2018 ALARA Audit, W. Kearney reviewed the shipping papers and observed that the correct shipping papers were included for all by-product waste and resin shipments.

The second NRC inspection occurred on August 29-31, 2017. Two NRC personnel conducted the routine inspection. An individual from the Republic of South Africa accompanied the NRC. No violations were cited as a result of this inspection and the previous inspection's Notice of Violation was closed out.

The inspection report contained one follow up item that was concerned with the issuance of Radiation Work Permits (RWPs). More specifically, the inspectors identified that all individuals that worked under an RWP may not have signed it. This was contrary to Section D.11.5 of the RPP that requires all workers to read and sign RWP requirements.

After the inspection the RSO revised the RWP form to include more area for signatures and he provided training to employees on the changes to the procedure. It should be noted that the NRC reviewed the RSO's corrective action to this follow up item in a subsequent inspection that occurred January 31 to February 2, 2017. The NRC determined that the RSO's corrective actions where adequate.

8.0 On-Site Walk-Thru Audit

On January 30, 2017 a formal walk-thru of the CPP and wellfields was conducted by Bill Kearney. He was accompanied by Royal Pond, Manager HSE/RSO, Charlie Harless (RST) and Jay Douthit Vice President-Operations (VP-OPS) . It was confirmed that no yellowcake processing is occurring at the CPP and activities in the CPP are basically limited to the loading of uranium on the resin in the IX columns, the transfer of resin to and from the resin trailer to the IX columns, the reconstituting of the injection fluid, and the handling of wastewater.

It was observed that the CPP was clean and orderly and all required signage was in place. It was noted that no areas were identified as an "Airborne Radioactivity Area". It was observed that workers had recently begun an apparent routine activity that involves washing bag filters with a pressure washer in order that the filters can be reused at the headerhouse filter pods. This work takes place at the Resin Bay and a steel frame was recently constructed to hold the filters. It was observed that PPE (rain suit, rubber gloves, and face shield) was located at the area and is used by workers.

It was determined that no SOP was in place for this activity nor was an RWP being utilized. This condition is an apparent non-conformance with NRC License Condition 10.4 which in part conveys that " *The licensee shall develop and implement written standard operating procedures (SOPs) prior to operation for:A) All routine operational activities involving radioactive and non-radioactive materials associated with licensed activities that are handled, processed, stored, or transported by employees;...* ".Therefore the following Finding is included:

- In accordance with NRC License Condition 10.4 an SOP should be developed for washing bag filters at the Resin Bay.

No other areas of concern were noted in the CPP.

The walk-thru of the wellfield showed that there are currently four headerhouses in Mine Unit 1, which is completely installed and operating. It was observed that five headerhouses are operating in Mine Unit 2 with other portions of this wellfield in various stages of development. It was observed that the radon fans were operational in the headerhouses entered and required signage was in place at the headerhouses and entrances to the wellfield areas. No areas of concern were noted.

9.0 Review of Radiation Work Permits (RWP's)

The Radiation Work Permits (RWPs) for calendar year 2017 were reviewed for completeness and agreement with RPP Section D.11. It was observed that 28 RWPs were issued by the RSO during the period. In accordance with RPP Section D.11 most of the RWPs resulted from the need to conduct work activities where there was potential exposure to radioactive materials and there was not a specific SOP in place that addressed the particular job and protection for the radioactive materials. Due to the lack of yellowcake processing at the facility, the RWPs were mostly for activities, such as replacing pipes or valves, that had minimal risk of airborne uranium and the major concern was for contamination on workers hands and clothes. The RSO specified the proper PPE to mitigate these conditions.

In accordance with Section D.11 of the RPP it was determined that the RSO ensured that a Confined Space Entry permit was also issued for RWPs that required entry into a tank or IX column. The RSO identified that the main radiological hazard associated with tank entries was the presence of radon. The RSO required the tanks to be ventilated prior to entry and at least one radon daughter air sample was obtained from within the tank prior to entry to assess levels of radon and allow the dose to the employee to be estimated.

A review of RWP's showed that although the RSO had the air sample data attached to the particular RWP there was not always a dose assessment included with the RWP when air monitoring for particulate uranium and/or radon was required. This was discussed with the RSO during the audit and he conveyed that a revised RWP form was in the process of being finalized. Therefore, the following Recommendation is included:

- Consideration should be given to modifying the RWP form such that it includes the calculation of the dose (DAC hours or mrems) to uranium and/or radon estimated for the RWP participants when air monitoring is required. This should also take into account the protection factor afforded by any respiratory protection. This modification to the form would assist having all the required information for an RWP together in one location.

10.0 Review of Resin Shipment Records

The shipment records for the transport of loaded IX resin from the Ross Project CPP to the Uranium One Irigaray facility and the return shipments of barren resin were reviewed. There were 51 roundtrip shipments for 2017. Kissack Water & Oil Service transports the Strata owned resin trailer (221 miles round trip). There were no significant incidents with any of these shipments. The records completed by both Strata and Uranium One were found to be complete and well organized. It should be noted that the NRC also reviewed these records during their inspections and found them acceptable.

11.0 Review of 11E.2 Byproduct Shipment Records

The shipment records for the 11E.2 Byproduct shipments that occurred in 2017 were reviewed. There were nine (9) round trip shipments. These shipments consisted of a 20 yd3 covered steel roll off dumpster. Material to be disposed was transported by Kissack Water & Oil Service to the NRC- licensed Pathfinder Shirley Basin 11E.2 Byproduct Disposal Facility located approximately 234 miles from the Ross Project. Records showed that the material disposed was mostly comprised of sock and other filter media, contaminated pipe and pumps, and some laboratory waste. A total of 171 yd3 (4617 ft3) was disposed.

A review of the records showed that, as a result of the NRC Notice of Violation in early 2017 shipping papers were included with all 2017 return shipments of the empty shipping container from the disposal site to the Ross Project. It should be noted that the NRC also reviewed these records during their inspections and found them acceptable.

12.0 Review of Calibration Records for Radiation Detection and Survey Instruments

The calibration records for all radiation detection and survey instruments were reviewed. The RSO maintains a spreadsheet that contains all survey instruments and the date of the last calibration and the date of the next required calibration. The records were determined to be complete and in good order. A spot check of individual survey meters that were in use was conducted and they were observed to be in good order.

13.0 Review of Respirator User Medical Evaluations, Fit Test Results and Training Records

Due to the lack of yellowcake processing at the Ross Project the need for respiratory protection is very limited. On an infrequent basis select personnel are required to utilize respiratory protection when the need arises to enter IX columns or tanks in the CPP, primarily for protection from radon.

The RSO maintains a spreadsheet that contains all the required elements for respirator users. A review of the spreadsheet showed that it was up to date and it listed dates that required medical evaluations, fit tests and training were completed for each individual. This activity resolves concerns from the previous ALARA Audit.

14.0 Recommendations to Further Reduce Personnel Exposure to Uranium and Daughters

As discussed in Section 3 the exposure of personnel at the Ross Project to uranium and radon is very limited due to the lack of yellowcake processing and estimated doses are minimal and well below NRC requirements. Nonetheless, in the spirit of ALARA, the following recommendations are included to further lessen personnel exposure or ensure that it does not substantially increase:

- Maintain ventilation systems at the CPP and headerhouses.
- Continue to assess gamma radiation levels at tanks in the CPP and periodically clean solids out of them to minimize the potential buildup of gamma radiation levels.
- Continue to assess gamma radiation levels at filters in headerhouses to ensure that they do not substantially increase to levels of concern.

15.0 Safety and Environmental Review Panel (SERP) Reviews

The SERP reviews completed in 2017 were reviewed. In addition to an electronic file, a file (3-ring binder) of all SERP reviews is maintained in the RSO's office. It was determined that 11 SERP reviews were completed in 2017. It was observed that the more critical SERP reviews involved the approval of a new RSO (Royal Pond), the start up of headerhouses and revisions to the Ross Project Technical Report with "as-built" equipment design information. The review of the SERPs showed that they contained sufficient detail and were completed in accordance with NRC Licensee Condition 9.4.

16.0 Contract Laboratory Assessment Report

Strata contracted with Inter-Mountain Laboratories Inc. to complete a laboratory audit of the Ross Project site laboratory ("Lab"). The Lab performs analytical laboratory operations for the environmental monitoring program and the ISR process analyses. The report for the May 17, 2017 audit completed by Tom Patten of Inter-Mountain Laboratories Inc. was reviewed. This laboratory audit was completed to fulfill the requirements of Section C of NRC Regulatory Guide 4.15, Strata Energy, Inc. Quality Assurance Plan Revisions 30 Aug 15, and internal standard operating procedures.

A review of the audit report shows that the Lab is functioning properly. The report contained several findings and recommendations that mostly involved quality control procedures with chemical spikes and duplicate samples as well as opportunities to automate several aspects of data entry that could assist in avoiding data transcription errors. According to the Lab Tech the most important findings and recommendations have been resolved at this time (January 30, 2018).

17.0 Analysis of Annual Dose to Individual Members of the Public

In accordance with License Condition 11.2 and 10 CFR 20.1301 and 10 CFR 20.1302 the analysis of the annual estimated dose to the public was determined by assessing the data obtained from the approved airborne radiologic monitoring program established around the outside of the CPP. It was determined that the greatest potential dose from radiation to a member of the public would potentially result from releases of particulate uranium and radon gas from the CPP to members of the public, such as contractors and delivery persons in close proximity to the CPP and the associated restricted area. Therefore, the monitoring program assessed the concentrations of particulate uranium and radon in all cardinal directions around the CPP.

To demonstrate compliance with 10 CFR 20.1301 Strata used option 1 which requires the licensee to show by actual measurement or calculation that the TEDE to the public does not exceed 100 mrem. The TEDE is estimated by summing the CEDE for particulate uranium and radon and adding the DDE for gamma radiation exposure. Strata monitored particulate uranium around the outside of the CPP at the four compass directions. Air samples were obtained every month in 2017(48 samples in total) and the average uranium concentration was determined each month for the four sample locations. In summary, all sample results were reflective of background conditions. This was expected as there is no uranium processing (yellowcake precipitation and drying) at the facility. Additionally, over 50 particulate uranium samples routinely obtained within the CPP in 2017confirm that no uranium was present in the air within the CPP that could be discharged outside the facility. Therefore, it is concluded that a member of the public was not exposed to any detectable concentration of airborne uranium, within, or near the CPP.

Strata monitored radon around the outside of the CPP at the eight compass directions using radon track etch detectors. These detectors were exchanged on a quarterly basis and analyzed by a qualified laboratory. It was assumed that Radon-222 is in equilibrium with its associated progeny. In accordance with the approved monitoring program and the previous assessment for 2016, which has been reviewed by the NRC, the average concentration of radon was determined for 2017 for each compass location and the background radon concentration was subtracted from each. The average radon concentration from the background environmental monitoring station (Southwest Station) was used. In summary, the assessment shows that the average radon concentrations at all eight locations were reflective of background concentrations. Therefore, it is concluded that a member of the public was not exposed to any detectable concentration of radon above background near the CPP.

In respect to an estimate of the DDE that a member of the public could incur near the CPP and associated restricted area, the routine gamma survey data from the CPP was analyzed. It was determined that the average gamma level at the CPP ranged from approximately 20 to 50 uR/hr through 2017. The highest gamma reading in the CPP was 1000 uR/hr at a wastewater tank. This was a transient reading as the gamma radiation level at this tank varies according to the fluid amount and contents which is in it.

If it is assumed that a member of the public most likely to be near the CPP is a contractor or a delivery person and they are there for 100 hours in the year (conservative) and could be subject to 50 uR/hr (very conservative) they would incur a DDE of 5 mrem for the year. It should be noted that the CPP Operators typically only receive approximately 10 mrem per year working at the facility as reflected in the OSL dosimetry data. Additionally, in accordance with 10 CFR 20.1301 limit for external gamma dose to an individual continuously present in an unrestricted area cannot exceed 2 mrem/hr. The facility has no areas that exceed this dose rate.

In summary, since it has been determined by both measurement and calculation there is no internal CEDE dose to a member of the public, the TEDE is limited to the conservative DDE dose maximum of 5 mrem per year which is 5 percent of the 100 mrem annual limit.

Based on the lack of radioactive effluents at the Ross Project, and the fact that drying and processing of uranium is not currently occurring at the CPP, the following Recommendation is included:

- Strata should assess if the radon monitoring completed at the eight locations around the CPP can be discontinued until process operations change at the CPP. Accordingly, Strata could assess if the routine radon monitoring results for the CPP and/or monthly radon samples (Kusnetz) outside the CPP could be used to document that there is no discernible radon above background. This information could be used for the annual assessment of the dose to the public.