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3.0 DESCRIPTION OF THE PROPOSED FACILITY

The Permit Area contains 4,220 acres (**Figure 3.1-1**). The surface area to be affected by the ISR operation is within the Permit Area and will total approximately 285 acres (**Figure 3.1-2**). The mine units, the Plant, the Storage Ponds, and the UIC Class I wells are the significant surface features associated with the uranium ISR operation.

The total area of the pattern areas, e.g., the total area to be used for lixiviant injection and ore recovery over the eight-year mine life, will be approximately 254 acres (**Figure 3.1-2**). The total area of the Plant and related facilities is expected to be less than ten acres, including the two Storage Ponds, each of which will be between two to four acres in size. Two to four UIC Class I wells will be completed; and the total area for those wells and associated pipelines is expected to be less than two acres.

3.1 ISR Process and Equipment

The Project will use techniques and technologies demonstrated at other ISR facilities and incorporate best practices and industry experience. The ISR process is based on extracting ore (in liquid form) from a series of mine units, more than one of which may be in production at a given time, and then processing the ore at the Plant.

The ISR process will be conducted using a carbonate lixiviant, which is pumped from the Plant through buried pipelines to the injection wells in the mine unit(s) in production. After circulation through the ore zone from the injection wells to the production wells, the lixiviant recovered from the production wells will be pumped from the mine unit(s) through buried pipelines to the ion exchange circuit in the Plant. There, the uranium will be removed by solid resin ion exchange. The carbonate lixiviant will then be regenerated and pumped back to the mine units to recover additional uranium. Additional details of the mine units, well construction, and instrumentation and control are provided in **Section 3.2**.

The Plant is designed for the concentration of uranium from dilute solutions by ion exchange. The Plant will house three distinct process circuits: the ion exchange circuit (also called the resin-loading circuit), the elution circuit, and the precipitation/filtration circuit. The final product will be yellowcake slurry with about 40 percent of water by volume. The slurry will be transported from the site via US DOT approved containers to a facility licensed by the NRC or an Agreement State for processing the slurry into dry yellowcake. Additional details on the Plant are provided in **Section 3.3**. Descriptions of other aspects of the ISR process, in particular effluent control (which involves the

Storage Ponds and the UIC Class I wells) and groundwater restoration, are provided in **Section 4** and **Section 6.2** of this report, respectively.

3.1.1 Site Facilities Layout

The approximate location of the Permit Area within the general region was previously shown in **Figure 3.1-1**. The Plant will be located in the central portion of the Permit Area in Section 18, Township 25 North, Range 92 West (**Figure 3.1-2**). It will include all the process circuits, the groundwater restoration facility, administration offices, and shop facilities. A plan view of the Plant is included in **Plate 3.1-1**. The Storage Ponds are adjacent to the Plant, as shown on **Plate 3.1-1**. The mine units will be along an east-west trend through the Permit Area (**Figure 3.1-2**). The UIC Class I wells will be in the southern portion of the Permit Area.

The Plant will be one of the first features constructed in the Permit Area, as noted on the project operation schedule (**Figure 3.1-3**). The primary access road and associated culverts will be constructed when the Plant is built; and the secondary access roads and associated culverts for each mine unit will be constructed prior to and during installation of that mine unit. The anticipated installation schedule for the mine units is shown in **Figure 3.1-3**. Secondary access roads and associated culverts for the Class I UIC wells will be constructed prior to installation of those wells. The primary and secondary roads will be built in accordance with BLM guidelines and standards described in Chapter 3, Section 2(i) of the LQD Rules and Regulations. Topsoil will be stripped based on the soil depths reported in **Section 2.6** and stored in a manner to prevent wind and water erosion, as required per Chapter 3, Section 2(i) of the LQD Rules and Regulations.

The Plant and the pattern area of each mine unit will all be fenced with barbed wire per BLM specifications. As appropriate, areas will be either gated or have cattle guards to minimize livestock access. The Storage Ponds will be fenced with a BLM approved game fence to prohibit large animal access (e.g., deer, elk, wild horses, and cattle). Electrical power will be brought into the site, through an overhead transmission line, from the power line to the west of the site to a transformer at the Plant. The overhead line will be constructed in accordance with BLM guidelines for wildlife protection and to minimize surface disturbance. From the transformer to the header houses and from the header houses to the production and injection wells, power will be transmitted through underground lines that will be located along the same corridors as the pipelines for fluid transmission to and from the wells. Drinking water will be bottled water brought in from off-site; and water needed for other domestic purposes (about ten gpm) will be provided from an on-site well completed in the FG Sand. At this time, LC ISR, LLC has several water supply wells for well drilling and related activities. (**Table 3.1-1**). In the FG horizon, well LC1W will be used for dust suppression and drill water. An additional potable water well (not yet named) is planned for the FG also. Well LC28M is completed in the UKM horizon and will be used for drill water and dust suppression. The M horizon has three drill water and dust suppression wells completed in it; they are LC32W, LC229W and LC606W. The final on-site well for drill water and dust suppression is LC33W, which is completed in the N horizon.

3.1.2 Ore Deposits

As described in **Section 2.6** of this report, the ore deposits in the Permit Area generally occur at depths of 300 to 700 ft bgs in long narrow trends varying from a few hundred to several thousand feet long and 50 to 250 feet wide. The depth depends on the local topography, the dip of the formation, and the stratigraphic horizon. The available geologic and hydrologic data presented in **Sections 2.6** and **2.7** of this report, respectively, identify uranium mineralization in several sandstone layers (e.g., from shallow to deeper, the FG, HJ, and KM Horizons).

The three mineralized Sands in the HJ Horizon, from 350 to 500 ft bgs, are targeted for this permit application. The richest mineralized zone, locally designated as the Middle HJ (MHJ) Sand, is about 30 feet thick at 400 to 450 ft bgs, and is believed to contain over 50 percent of the total resource. Depending on location within the Permit Area, only one or all three of the mineralized Sands may be present at that location.

3.2 Mine Unit Processes, Instrumentation, and Control

The portion of the Permit Area underlain by uranium ore, that is economic to recover, has been divided into mine units for scheduling purposes and for establishing baseline data, monitoring requirements, and restoration criteria. Each mine unit will consist of a reserve block covering about 50 acres and represents an area LC ISR, LLC expects to develop, produce, and restore as a unit. Six or more such units will be required to mine the Permit Area. Typically, two or three mine units may be in production at any one time with additional mine units in various states of development and/or restoration.

The mine units will be subdivided into operational areas referred to as header houses; and, each mine unit may include as many as ten header houses. Each header house will be designed to accommodate the well controls and distribution plumbing for approximately twenty production wells and the associated injection wells (usually about 40 injection wells). With the Plant operating at a nominal flow rate of 6,000 gpm, approximately 180 production wells and 360 injection wells will be in operation.

3.2.1 Mine Unit Chemistry

During operations, barren lixiviant will enter the formation through the injection wells and flow to the production wells. The carbonate lixiviant will be made from varying concentrations and combinations of sodium carbonate, sodium bicarbonate, carbon dioxide, oxygen, and/or hydrogen peroxide added to the native groundwater. The combined carbonate/bicarbonate concentration in the injected solution typically will be maintained at less than five grams per liter (g/L), and the hydrogen peroxide and/or oxygen concentration typically will be less than one g/L. These limits help reduce the possibility of "gas lock" in the formation, which reduces ISR efficiency.

The carbonate/bicarbonate lixiviant is used because of its selectivity for uranium and minor reaction with the gangue minerals. The primary chemical reactions expected in the aquifer are provided in **Figure 3.2-1**. When the lixiviant is injected into the ore zone, the dissolved oxidant reacts with the uranium mineral and brings the uranium to the U^{+6} oxidation state. The uranium then complexes with some of the carbonates in the lixiviant to form a uranyl dicarbonate ion $UO_2(CO_3)_2^{-2}$ and/or a uranyl tricarbonate ion $UO_2(CO_3)_3^{-4}$, both of which are soluble and stable in solution. A small portion of the radium content will also be mobilized along with the uranium. Depending on site conditions, other metals such as arsenic, molybdenum, selenium, and/or vanadium, may also be mobilized.

The chemical reactions which mobilize the uranium will continue as long as the lixiviant is being injected into the orebody. Injection and production at each header house, and eventually each mine unit, will be discontinued once uranium recovery is no longer deemed economical, and restoration will be started (**Section 6.1** of this report).

3.2.2 Mine Unit Design

Delineation drilling in the Permit Area will better define ore resources for design of mine units. A mine unit will consist of interconnected patterns of production and injection wells (e.g. the pattern area) within a ring of monitor wells to detect horizontal excursions of injection or production fluid away from the mineralized zone. Monitor wells will also be completed in overlying and underlying aquifers as necessary to detect vertical excursions. Inside the pattern area, monitor wells (which may double as production or injection wells) will also be completed in the mineralized zone to provide information on the mining process.

The Project proposes relatively small monitor rings, each containing approximately 1.2 million pounds of reserves, within the HJ Horizon. In the simplest scenario, where only one sand is present in a horizon, the production, injection, and monitor wells will be installed in that sand. Where more than one sand is present in the horizon, e.g., the MHJ and LHJ Sands, each sand will be mined concurrently by its own set of wells. The wells in the monitor ring are designed so the open intervals correspond to the depths of the sands adjacent to each well. In instances where multiple sands are being mined concurrently, the monitor ring wells will be selectively completed in the sand that is being mined nearby.

The mine units as currently projected are shown in **Figure 3.1-2**. The size and location of the mine units will be modified as needed based on final delineation of the ore deposit, performance of any prior mine units, and development requirements. Prior to operation of any new mine unit, a Hydrologic Testing Proposal and subsequent Test Report will be submitted to WDEQ-LQD for review and approval; and these documents will detail the aquifer conditions in the mine unit, monitor well locations, pattern areas, and similar information necessary for efficient operation of the mine unit.

Drilling practices, including site preparation/reclamation and drill hole abandonment, currently in use by LC ISR, LLC will continue to be used. Widely adopted industrial practices are followed, and agency consultations were made on drilling site preparation/reclamation and proper drill hole abandonment. LC ISR, LLC has made an effort to research existing information on historic drilling operations in the Permit Area and, if necessary, properly abandon remnant drill holes or wells. If previously unknown drill holes or wells are detected during the mine unit installation and testing, e.g., if communication is detected during a pump test, the drill hole or well will be abandoned in accordance with the procedures currently in use, which are outlined in **Section 3.2.2.1** and **Section 6.3.2**, respectively.

3.2.2.1 Production and Injection Well Patterns

The production and injection well patterns will be based on conventional five-spot patterns, modified as necessary to fit the characteristics of the orebody. The conventional five-spot pattern is four injection wells surrounding a central production well. The cell dimensions will vary depending on the characteristics of the formation and the orebody; but the injection wells are expected to be between 75 and 150 feet apart.

All the production and injection wells will be completed, so they can be used as either a production well or an injection well. This design allows changes in the solution flow patterns to improve uranium recovery and to restore the groundwater in the most efficient manner.

3.2.2.2 Monitor Well Locations

Monitor wells will be located in a perimeter ring around the mine unit, with the completion interval of each well targeted to the mineralized zone(s) adjacent to that well. Distances from the perimeter monitor wells to the injection/production patterns in each mine unit are anticipated to be on the order of 500 feet. The distance between each of the monitor wells in the ring is also anticipated to be on the order of 500 feet. The actual distances will be based on the aquifer characteristics of that mine unit to ensure any excursion can be detected in a timely manner. The adjacent monitor wells will be recompleted to appropriately monitor the adjacent production and injection wells.

The selective completion of the mine unit monitor well ring is a WDEQ requirement. The WDEQ has stated this request at planning meetings with LC ISR, LLC. Results of site pumping tests indicate that the various sand units within the HJ Horizon are hydraulically well connected and respond as a single hydrostatic unit. A mine unit hydrologic test will be completed to demonstrate connection of the monitor ring wells to the production zone. Furthermore, it is unlikely that a horizontal excursion would selectively migrate within a specific sand in the HJ Horizon and not be present within the sand that was being produced. Completion across the entire HJ Horizon would most likely result in collection of samples that are more diluted with respect to any production fluids and would potentially decrease the likelihood of detection of an excursion.

Based on the pumping test results **(Section 2.7)**, it is apparent that the radius of influence of a single pumping well greatly exceeds 500 feet. In fact, the LC19M pump test indicated a response in the HJ Horizon at a distance exceeding 1,000 feet within 5 days. Therefore, an excursion detected at the monitoring ring placed 500 feet from the wellfield could be readily recovered by adjusting extraction and injection rates in nearby well patterns. As noted in TR Section 3.2.2.2 below, the distance for the monitor well spacing (as well as the production and injection well spacing) will be specific for each mine unit, depending on the characteristics of that mine unit. Based on available information, a spacing of 500 feet is anticipated to be appropriate.

Production zone monitor wells will be installed inside the pattern area to provide information on baseline conditions and on progress of recovery and restoration. The completion interval of a production zone monitor well will target the mineralized zone(s) adjacent to that well. The number of production zone monitor wells in a given mine unit will be based on the size of that pattern area and the density of production and injection wells in the pattern area. Most production zone monitor wells are also used as injection and/or production wells.

Overlying and underlying monitor wells will also be completed in the aquifers immediately above and below the uppermost and lowermost mineralized zone, respectively. Overlying and underlying wells will be installed at a density of about one well for each four acres of mine unit area. The actual density will be based on the aquifer characteristics of the mineralized zone and the overlying or underlying aquifer; and specific locations may be targeted depending on the thickness and continuity of the shale separating the mineralized zone from the overlying or underlying aquifer. If conditions are encountered at a prospective mine unit, such that vertical confining layers are very thin or absent, then the local stratigraphy will be evaluated and the mine unit operations and monitoring will be adjusted for the situation. These adjustments may include placement of the overlying or underlying monitor wells in different stratigraphic horizons within the mine unit, rather than in the separate overlying or underlying aquifer. Other adjustments could include additional operational controls, such as localized higher production rates, to help ensure none of the mining fluids migrate from the mineralized zone.

In rare circumstances, a trend well(s) may also be installed to better understand solution movement within a mine unit. These wells will be constructed and tested in the same manner as the monitor wells. Monitoring parameters and frequency will depend on the purpose for which the trend well was installed.

3.2.3 Mine Unit Installation

The projected ISR operation schedule for each of the mine units, along with the anticipated groundwater restoration schedule, is provided in **Figure 3.1-3.** The schedule generally provides two years for development of a mine unit, 1.5 to two years for uranium production, and two years for aquifer restoration. The two years provided for aquifer restoration include approximately: two months for each header house to serve as a buffer area between impacts of production and restoration, nine months for groundwater sweep; nine months for RO, and one month for homogenization. Stability monitoring will follow restoration and is not included in the total time (**Section 6.2** of this report).

The development schedule, provided in **Figure 3.1-3**, will be affected by various factors. These factors typically involve adjustments as necessary to meet production schedules and contractual agreements, longer (or shorter) than predicted mining or restoration times or delays in mine unit installations. **Figure 3.1-2** depicts the mine unit designations as currently projected for the life of the facility. The table and figure are generalized; e.g., if an area designated as undergoing restoration is directly adjacent to an area undergoing mining, all or a portion of the restoration unit could be serving as a buffer zone, or could be in stability monitoring. In addition, the development schedule may be affected by restrictions to protect wildlife such as exclusion from specific areas during nesting seasons. The current schedule reflects existing restrictions on drilling, and LC ISR, LLC will keep in contact with the BLM for updated guidance.

To account for such changes, LC ISR, LLC will include: in the Annual Report to WDEQ and NRC; a map of the Permit Area showing the mine units that are being developed, in production, and in restoration; and areas where restoration has been completed. New areas where production or restoration is expected to begin in the subsequent year will also be identified in the Annual Report. An updated schedule will be supplied with the Annual Report if the ISR operation or restoration schedule varies from **Figure 3.1-3**.

3.2.4 Well Completion

Monitor, production, and injection wells will be drilled to the target completion interval with a rotary drilling unit using native mud and a small amount of commercial drilling fluid additive for viscosity control. The well will then be cased and cemented to isolate the completion interval from all other aquifers. The cement will be placed by pumping it down the casing and forcing it out the bottom of the casing and back up the casing-drill hole annulus.

The well casing will be polyvinyl chloride (PVC) pipe. A typical casing will be CertainTeed's spline-locking standard dimension ratio (SDR) 17 PVC well casing, which has a nominal 4.5 inch diameter, 0.291 inch minimum wall thickness, and is rated for 160 pounds per square inch (psi) burst pressure and 224 psi collapse pressure. The PVC casing joints normally have a length of 20 feet each. Each connection is sealed with an o-ring and spline lock. This configuration provides a seal without the installation of screws to hold each joint together and has been proven effective at other ISR facilities. Casing centralizers, located every 40 feet, are run on the casing to ensure it is centered in the drill hole and that an effective cement seal is provided.

The purpose of the cement is to stabilize and strengthen the casing and seal the well annulus to prevent vertical migration of solutions. The volume of cement used is the calculated volume required to fill the annulus and return cement to the surface. In most cases, the cement returns to the surface, at least initially. However, in some cases, the drilling may result in a larger annulus volume than anticipated and cement may not return to the surface. In these cases, the upper portion of the annulus will be cemented from the surface. In the majority of cases, where the cement fails to return to surface, the reason will be a washout or a casing failure. In the event of a casing problem, the well will not pass the Mechanical Integrity Test (MIT). In all cases, wells are required to pass an MIT test before operations approval. This will ensure that there is sufficient integrity to allow the use of the well in handling lixiviant.

After the cement has set, the well will be completed. This involves under-reaming the desired completion interval to a diameter of 9.5 to 11 inches, depending on the tool configuration and the diameter of the original annulus. The well is then air-lifted for about one hour to remove any remaining drilling mud and/or cuttings. A swabbing tool is frequently run in the well for final clean-up and sampling. If sand production or hole stability problems are expected, a slotted liner, wire-wrapped screen or similar device may be installed across the completion interval to minimize the problem.

Typical well completions are illustrated in **Figures 3.2-2**, **3.2-3**, and **3.2-4**. Completion data for installed wells will be submitted to NRC and WDEQ in the next Annual Report following the completion of the wells.

3.2.5 Well Integrity Testing

After a well (injection, production, or monitor) has been completed and before it is made operational, an MIT of the well casing will be conducted. An MIT will also be conducted on any injection well that has been damaged by surface or subsurface activity or that has had a drill bit or cutting tool inserted in the well. Any well with evidence of suspected subsurface damage will require an MIT prior to the well being returned to service. In addition, an MIT of each injection well will be done once every five years unless an alternate schedule has been reviewed and approved by WDEQ-LQD.

In the integrity test, the bottom of the casing adjacent to or below the confining layer above the zone of interest is sealed with an inflatable packer or other suitable device. The top of the casing is then sealed in a similar manner or with a cap, and a pressure gauge is installed to monitor the pressure inside the casing. The pressure in the sealed casing is then increased to a specified test pressure and will maintain 95 percent of this pressure for ten minutes to pass the test. If any well casing that fails the test cannot be repaired, the well shall be plugged and abandoned.

If there are obvious leaks or the pressure drops by more than five percent during the ten-minute period, the seals and fittings will be reset and/or checked and another test will be conducted. If the pressure drops less than five percent, the well casing is considered to have demonstrated acceptable mechanical integrity.

If a well casing does not meet the mechanical integrity criteria, the casing will be repaired and the well re-tested. If a repaired well passes the MIT, it will be employed in its intended service. Also, if the well defect occurs at depth, the well may be plugged back and re-completed for use in a shallower zone, provided it passes the MIT. If an acceptable test cannot be obtained after repairs, the well will be plugged. The documentation for the MITs will include the well designation, date of the test, test duration, beginning and ending pressures, and the signature of the individual responsible for conducting the test. Results of the integrity tests shall be maintained on-site and will be available for inspection by NRC and WDEQ. A list of wells receiving an MIT, the dates of those MITs, and the designation of whether those wells passed or failed will be reported as part of the Quarterly Report to WDEQ.

3.2.6 Mine Unit Piping and Instrumentation

Each injection well and production well will be connected to a specified injection or production manifold in a header house (**Figure 3.2-5a**). The manifolds will route the leaching solutions to and from the Plant. Flow meters and control valves will be installed in the individual well lines to monitor and control the individual well flow rates and pressures (**Figures 3.2-5b and 3.2-5c**).

Mine unit piping is expected to be high density polyethylene (HDPE) pipe, PVC pipe, stainless steel pipe, or equivalent. The mine unit piping will typically be designed for an operating pressure of 150 pound force per square inch gauge (psig); and it will be operated at pressures equal to or less than the design pressure. The typical pressure rating, for both the PVC and HDPE piping materials used, is between 160 and 200 psig. If a higher design pressure is needed, the pressure rating of the materials will be evaluated and, if necessary, materials with a higher pressure rating will be used.

The individual well lines and the trunk lines to the Plant will be buried to prevent freezing. The use of header houses and buried lines has been proven an effective method of protecting the pipelines at other ISR facilities subject to weather conditions similar to those at the Permit Area. A typical mine unit solution flow pattern is illustrated in **Figure 1.6-1**.

Instrumentation systems will be key to monitoring and maintaining the multiple processes in the field (e.g., the mine units) and in the Plant. Plant and Field Operators will use the data and information provided by the instrumentation systems to better manage the work areas. Operator control of key elements will be maintained; and instrumentation will assist in controlling pump operating levels and valve operation. When operating parameters move outside a specified normal operating range, it will cause an alarm that notifies the operator to initiate corrective action to alleviate the problem. Excessively high or low levels or pressure alarms will initiate automatic shutdown of the related equipment. The key design component of the system will be to minimize the risk of uncontrolled releases of leaching solutions or other solutions and provide maximum safety and protection to the operators, other site personnel and the environment. Additional information on the monitoring and alarm systems is included in **Section 3.2.7.5**.

Radiation detection instruments used to monitor the operation and the specifications on this equipment are included in the Health Physics Manual. The location of monitoring points and monitoring frequency for in-plant radiation safety are discussed in **Section 5** of this report.

3.2.7 Mine Unit Control

The techniques, that will be employed to ensure each mine unit is operating as efficiently as possible, will include monitoring of: production and injection rates and volumes, wellhead pressures, water levels, and water quality. These criteria may be evaluated at more than one level (e.g., by mine unit, by header house, by pattern, or by well) depending on the specific criteria.

The most basic aspect of mine unit control is the bleed system, e.g., overproduction. The bleed system will be used so the volume of injection fluid will be less than the volume of production fluid in a mine unit. The overproduction will result in an inflow of groundwater into the pattern area and help reduce the possibility of an excursion. The anticipated bleed rate is 0.5 to 1.5 percent. Overproduction will be adjusted as necessary to control the distribution of the lixiviant within the mining zone.

3.2.7.1 Header House Control

Within each mine unit, injection and production balance will be monitored in well groupings related to header houses. The production and injection wells within each header house will be monitored individually or by production or injection headers, which are groups of production or injection wells piped together, depending on the monitoring parameter. The instrumentation will allow: balancing of the flow rates in the injection and production wells piped to and from that header house, respectively; monitoring wellhead pressures; and shutdown of flows in the event of a piping failure. Other instrumentation in the header house will include automatic oxygen shut-off and leak detection (**Figures 3.2-5a** through **3.2-5c**).

The hydrologic balance is determined by summing the flow rates of the injection and production wells separately and controlling the rates such that each header house is receiving the same injection volume per unit time as is being produced, minus the bleed volume. In a stable operating mine unit, the well flows observed will only fluctuate minimally from day to day. Appropriately designed flow meters will be used to measure the individual flow rates of each well. As a redundant control measure, flow meters will also be installed on the main pipelines entering and exiting each header house. The individual well flows will be monitored and adjusted daily and the pipeline meter will be monitored continuously with the instrumentation system.

All production wells and each injection header will have pressure gauges; and the pressures will be recorded daily. Pressure switches will be installed on the production wells and injection header in each header house. These switches will be designed to detect a piping failure and to shut down power to the production wells. In normal operation, when one header house has an event that trips the power to that house, the pressure change is noticeable throughout the system and other header houses will alarm the operator and subsequently shutdown.

The pressure information on the injection wells is necessary to help ensure that the injection pressures do not exceed the formation fracture pressure or the rated pressure for the casing. Regional information and historical operational practices indicate that the minimum pressure that could initiate hydraulic fracturing is 0.70 psi per foot of well depth. Further, injection pressures also will be limited to the pressure at which the well was integrity tested. During mine unit operations, injection pressures shall not exceed the MIT pressures (see **Section 3.2.5**) at the injection wellheads. Not withstanding this restriction, the maximum injection operating wellhead pressures shall not exceed 90 percent of the production zone fracture pressure or 95 percent of the American Society for Testing and Materials (ASTM) maximum recommended operating pressure at 75 F for the well casing at the surface, whichever is less.

An example of the determination of the maximum injection pressure would be as follows:

Injection Pressure shall be the lesser of the following:
- Minimum MIT Pressure = 95% of the Manufacturer's Maximum Internal Pressure
- 95% of the ASTM Maximum Operating Casing Pressure
- 90% of the Production Zone Facture Pressure

Well Casing Depth = D in feet
Maximum Casing Pressure from Manufacturer and/or ASTM = P_{max}
Fracture Gradient = G_f = 0.7 psi/ft
Water Gradient = G_w = 0.433 psi/ft

P_{mit} = Maximum Injection Pressure based on Passing MIT Pressure = 0.95 x P_{max}
P_{csg} = Maximum Injection Pressure based on ASTM and/or Manufacturer = 0.95 x P_{max}
P_{Frac} = Maximum Injection Pressure based on Fracture Gradient = 0.9 x D x $(G_f - G_w)$

The oxygen system in each header house will have solenoid operated valves that will close in the event of a power loss or injection flow shutdown. This will prevent the continued delivery of oxygen to the pipeline when the field is not operating. Other operational safety features include, but are not limited to, a set of wet contacts or a conductivity probe installed in the sump in each header house to detect fluids on the floor of the house. If fluids are detected, the shunt will be tripped and electrical power to the production wells will be turned off. An audible and visual alarm system will be activated. Remote shutoffs for power will also be available at each of the header houses.

3.2.7.2 Pattern Control

Balanced patterns are necessary to achieve optimum production and to minimize flare of the lixiviant from the pattern areas. Increased flare from the patterns reduces production efficiencies and increases the effort required to restore the groundwater after production is concluded. Balanced patterns are also necessary to prevent excursions of production fluids from the mine units.

Patterns will be balanced by adjusting the injection and production flow rates to maintain production flow rates equal to injection rates plus the bleed rate. There are two types of operational constraints encountered in mine unit balancing: injection limitations and production limitations. Injection-limited patterns have more available production capacity than the injection wells can accept. This situation usually arises due to plugging of injection wells and can be remediated by servicing the injection wells. Production-limited patterns have a greater injection capacity than the production well can effectively produce. This is more common, as the pattern design typically has a greater number of injection wells than production wells.

The relationship between injector flow rates and producer flow rates is based on whether the pattern is production or injection limited. In the injection-limited scenario, the maximum achievable injection flow rate for a given well is divided by the number of associated recovery wells. The production well flow rate is determined and thus controlled to match the sum of the prorated injection flow rates from its associated injection wells. The determination method is reversed in the production-limited scenario.

3.2.7.3 Projected Water Balance and Water Level Changes

In addition to evaluating the operation of each mine unit individually, the overall water balance and water level changes will be taken into account to ensure all aspects of the operation (e.g., ISR and restoration) are being conducted as efficiently as possible. The overall water balance is based on the potential pumping and injection rates at the mine units and the capacity of the Plant and Class III UIC wells for production and for restoration. The water level changes, including both drawdown and mounding from production and injection, respectively, will be evaluated to minimize interference among the mine units and to determine cumulative drawdown.

Water Balance

Figure 3.2-6 shows the projected water balance of the Project. The liquid waste generated at the Plant will be primarily the production bleed, which, at a maximum scenario, is estimated at 1.5 percent of the production flow. At 6,000 gpm total operational flow, the volume of liquid waste would be 90 gpm (47,304,000 gallons per year). LC ISR, LLC proposes to manage the liquid waste primarily through the UIC Class I well(s) and supplement as necessary with the Storage Ponds.

Mine Unit Interference

Decisions about the order in which mine units will be brought on line and the rates at which they will be developed and restored will depend, in part, on the potential for interference among the mine units. Prior to operation of any new mine unit, a Hydrologic Testing Proposal and subsequent Test Report will be submitted to WDEQ-LQD for review and approval. The Test Report will detail the aquifer conditions in the mine unit, monitor well locations, pattern areas, and similar information necessary for efficient operation of the mine unit.

Water Supply Wells

It is not anticipated that withdrawal from the water supply wells will cause significant drawdown in the HJ Horizon based on the intervening shale(s) between the HJ Horizon and the supply well completion intervals and the low projected pumping rates. It is possible that pumping from the UFG could result in drawdown within the LFG, which is the overlying aquifer to the production zone. If drawdown becomes apparent within the LFG monitor wells inside the Mine Unit, the shallow water supply well (e.g., LC1W) will be temporarily shut-in and the water level response in the LFG monitor wells will be observed. If the water levels recover within the LFG wells once the pumping in the UFG is stopped, then the water supply well would be identified as the cause of water level decreases. If water level recovery does not occur in the LFG, then LC ISR, LLC would act on the assumption that operation of the Mine Unit is causing the drawdown and proceed accordingly with corrective action, if necessary. Similarly, pumping from a UKM completed well (e. g. LC28M) could result in unanticipated drawdown in the KM Horizon, which would be addressed in a comparable manner.

Cumulative Drawdown

As discussed in **Section 2.7** of this report, a regional pump test has been conducted to assess the hydraulic characteristics of the HJ Horizon and overlying and underlying confining units. Pump tests also will be performed for each mine unit in order to demonstrate hydraulic containment above and below the production zone, demonstrate communication between the pattern area and perimeter monitor wells, and to further evaluate the hydrologic properties of the HJ Horizon.

Because the HJ Horizon is a deep confined aquifer, no surface water impacts are expected; and there are no perennial streams in the vicinity of the Permit Area. As discussed in **Section 2.2** of this report, the nearest use of water from the Battle Springs Formation, other than for the Project, is wells located outside the Permit Area. Based on a map measurement, the wells are approximately two to three miles distant from the center of the Permit Area.

Based on a bleed of 0.5 to 1.5 percent, the potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99 percent) of groundwater used in the ISR process will be treated and re-injected (**Figure 3.2-6**). The potential impacts are addressed in more detail in **Section 7.1.5**.

An estimate for the extent of the cone of depression at the point where it intercepts enough of the flow of the aquifer to equal the pumping rate can be determined from the hydraulic conductivity and hydraulic gradient of the HJ Horizon in the Lost Creek Permit Area. Groundwater flux (Q) can be determined from the following equation:

$$Q = k\,i\,A$$

where: k = hydraulic conductivity in ft/d
i = hydraulic gradient in ft/ft
A = area in ft^2 perpendicular to the direction of groundwater flow
(thickness of the aquifer multiplied by the width of the aquifer)

The HJ Horizon is approximately 120 ft thick in the vicinity of the mine units, resulting in a hydraulic conductivity of 1.2 ft/d. The hydraulic gradient in the vicinity of Mine Unit 1 ranges from 0.005 ft/d to 0.009 ft/d/ (Petrotek, 2009). Using a hydraulic gradient of 0.007 ft/d and an aquifer thickness of 120 ft, the width of aquifer required to meet the projected production rate of 89 gpm (17,134 ft^3/d) is approximately 17,000 ft or 3.2 miles. The average flow rate of 89 gpm is based on performing minimal groundwater sweep. Other calculations of drawdown assume one complete pore volume of consumptive water removal from groundwater sweep during restoration. This groundwater flux would be under natural, steady state flow conditions, i.e., without pumping from the aquifer. Pumping will steepen the hydraulic gradient and increase the rate of flow toward the facility, resulting in a decrease in the required width of interception. Once the cone of depression (from the centroid of pumping) reaches approximately 3.2 miles (in the upgradient direction), there should be sufficient groundwater flowing into the aquifer to meet the demands of the ISR operations and the cone of depression should cease to expand. **Figure 3.2-7a** illustrates this concept.

To generally quantify the potential impact of drawdown due to ISR and restoration operations, the following assumptions were used:

- mining/restoration life: eight years;
- average net consumptive use: 174 gpm
  (60 gpm bleed from ISR; 160 gpm from groundwater sweep; 100 gpm from RO);
- location of pumping centroid: center of Section 18;
- observation radius: two and three miles radially from centroid of pumping;
- formation transmissivity 65 ft^2/d (preliminary pump test results);
- formation thickness 120 feet;
- formation hydraulic conductivity 0.54 ft/d;
- formation storativity 1.1×10^{-4} (preliminary pump test results)

The data were used to predict drawdown over time with a Theis semi-steady state analytical solution, which includes the following assumptions.

- The aquifer is confined and has an apparent infinite extent.
- The aquifer is homogeneous and isotropic, and of uniform effective thickness over the area influenced by pumping.
- The piezometric surface is horizontal prior to pumping.
- The well is pumped at a constant rate.
- No recharge to the aquifer occurs.
- The pumping well is fully penetrating.
- The well diameter is small; so well storage is negligible.

Based on these assumptions and results from the Lost Creek Pump Test, the drawdown, after eight years of operation at two-mile and three-mile radial distances from the centroid of pumping, was estimated to be 146 and 114 feet, respectively (**Figure 3.2-7b**). This amount of drawdown is approximately 50 percent of the available drawdown in the HJ Sand. While this amounts to a significant portion of the available drawdown, there is little use of groundwater from the HJ Horizon in the immediate vicinity of the Permit Area (**Section 7.1.5**). In addition, the calculated drawdown is extremely conservative because one of the assumptions is that there is no recharge to the aquifer. It is also conservative because, compared to the estimate illustrated in **Figure 3.2-7a**, this estimate is based on a greater number of pore volumes during ground water sweep (1.0 rather than 0.3), resulting in a higher average net consumptive use (174 gpm rather than 89 gpm).

These calculations also neglect the impact of the Lost Creek Fault, which as noted above, limits groundwater flow to a significant degree. The calculated drawdowns from ISR and restoration are based on the assumption of an infinite radial system, resulting in less drawdown as compared to a system bisected by the Fault. However, it is anticipated that ISR and restoration activities will progress on alternating sides of the fault to manage the impact, so the duration of ISR and restoration on each side of the Fault would be less than the eight-year period used in these calculations. In addition, it is anticipated that LC ISR, LLC will apply for a license amendment to conduct ISR in the overlying FG and underlying KM Sands, increasing the options for management of the effects of the Fault. The drilling to refine the delineation of each mine unit and the testing performed as part of the Hydrologic Testing Proposal and Report for each mine unit will provide information on the extent of the Fault and its impact on the hydrologic characteristics of each mine unit and will allow for refinement of the drawdown calculations.

3.2.7.4 Excursion Monitoring and Control

The groundwater monitoring program is designed to: establish baseline water quality prior to mining, detect excursions of lixiviant horizontally and/or vertically from the production zone, and determine when the production zone aquifer has been adequately restored following mining. During operation, the primary purpose of the monitoring program will be to detect and correct conditions that could lead to an excursion of lixiviant or detect such an excursion, should one occur.

Water levels will be measured at the same frequency as the monitor well sampling. Sudden changes in water levels may indicate that the mine unit flow is out of balance. Increases in water levels in the overlying or underlying aquifers may be an indication of fluid migration from the production zone. Flow rates would be adjusted to correct this situation. Adjustments to well flow rates or complete shutdown of individual wells may be required to correct this situation. Increases in water levels in the overlying or underlying aquifers may also be an indication of casing failure in a production, injection or monitor well. Isolation and shutdown of individual wells can be used to determine the well causing the water level increases.

To ensure the leach solutions are contained within the designated area of the aquifer being mined, the production zone and overlying/underlying aquifer monitor wells will be sampled semimonthly during mining as discussed in **Section 5.7** of this report.

In the event that an excursion is detected, then verified by confirmation samples, excursion control would be initiated in accordance with the procedures in **Section 5.7**. With regard to the overall water balance, it is anticipated that the following procedures would be implemented to achieve control and remediation of the excursion.

If an excursion is verified, the following methods of corrective action will be instituted (not necessarily in the order given) dependent upon the circumstances.

- Conduct sampling/analysis to verify an excursion has occurred.
- Complete a preliminary investigation to determine the probable cause(s).
- Adjust production and/or injection rates in the vicinity of the monitor well(s) as necessary to increase the net process bleed; thus, forming a hydraulic gradient toward the production zone.
- Pump individual production/injection or monitor wells (and trend wells, if available) to enhance the recovery of ISR solutions.
- Suspend injection into the mine unit area adjacent to the monitor well.
- Continue recovery operations; thus, increasing the overall bleed rate and the recovery of mine unit solutions.

Assuming a total mine unit flow of 6,000 gpm, with approximately 180 production wells, the groundwater extraction per production well is 30 to 35 gpm. Conversely, the injection rate for each well pattern is also approximately 30 to 35 gpm (minus the one percent bleed). Shutting off the injection from two to four well patterns near the monitor well that has a verified excursion would result in approximately 60 to 140 gpm of additional net extraction in the area of the excursion. Based on results from the 2007 pump test, corrective pumping on the order of 60 to 140 gpm would be sufficient to quickly and efficiently control an excursion.

3.2.7.5 Spill Prevention and Detection

Several methods will be used for timely detection of leaks in the wellfield, including 'on-the-ground' inspections, instrumentation (including process and mine unit instrumentation), and fluid detection systems. Cleanup methods will include measures to stop the leak and reconnaissance to determine the extent of cleanup and required safety measures, as well as treatment, removal, and/or disposal needs.

'On-the-Ground' Inspections

The first and foremost method for timely detection of leaks is a regular presence of Operators in the wellfields. The Operators will be responsible for taking measurements (i.e., double checking instrument readings) and looking for leaks and problems at the header houses. In addition, their regular routine will include checking each of the wellheads for fluids or salts from evaporated fluids and repairing them as needed. They will also be required to drive the pipeline rights-of-way and check the valve stations for fluids or salts.

Instrumentation

Several types of instruments, described in more detail below under Process Instrumentation and Mine Unit Instrumentation, will be used in several ways to detect leaks. Flow and pressure data will be continuously transmitted to the Operations Center in the Plant for review by Operators. In addition, algorithms are being developed to alarm in the event of changes against previous data and set points. In the event that an alarm sounds, Operators will be notified and the well/line will be checked for an upset condition.

Fluid Detection Systems

These systems will be used in the header houses and at the wellheads to alarm the Operators of potential upset conditions. The first component of these systems is typically based on the leaking fluid completing an electrical circuit which initiates an audible/visible alarm locally and/or transmits an alarm to the Operations Center. The second component of these systems is typically a shutdown switch, which is triggered if there is an accumulation of fluids in a header house sump, and an alarm transmitted to the Operations Center.

Process Instrumentation

There will be three layers of protection associated with the process instrumentation:

I) Automated Monitoring and Data Output;
II) Alarm; and
III) Control.

I) Process Automated Monitoring and Data Output

a) Piping will typically be monitored for flow and pressure. Some of the readings will normally be taken to the operator's computer for continuous monitoring and data recording. The others will typically be local readouts to give the operator an idea of what is going on in the plant. For example, the total flow rates on the IC and PC lines may be monitored and recorded by the computer. The individual flow rates for each column may be local readouts so the operator can monitor the system's effectiveness.
b) Tanks: All process tanks will typically be monitored for fluid level. The level

readout will typically be brought back to the plant operator's computer for continuous monitoring. Some tanks (precipitation) may be monitored for pH. In that case, pH data will also be brought back to the computer for continuous monitoring. Additional data monitoring will normally be brought back to the operator's computer as well.

c) Processes: Processes that are set to run automatically after the operator turns them on will typically be monitored continuously by the computer. These processes will monitor the flow, pressure, pH, level and all necessary indicators to ensure proper operation. In the event of an upset condition (operating parameters outside preset levels), alarms will typically occur to notify the operator.

II) Process Alarms

a) Piping: High and low set points will typically be set for plant piping with continuous monitoring. If the pressures or flow rates fall outside the set points, alarms will typically notify the operator.
b) Tanks: High and low set points will typically be set for the key tank process indicators such as level, pH, and temperature. If the indicators fall outside the set points, alarms will typically notify the operator.
c) Processes: If programmed processes are not operating as within the preset operating conditions, the operator will typically be notified audibly and on the control screen.

III) Process Control

a) Piping: Control valves will typically be utilized where applicable to shut down flow in the event of a piping failure or over pressurization.
b) Tanks: Control valves will typically be utilized for level control. As the levels change, valves will normally be used to maintain normal tank operating conditions.
c) Processes: Control valves may be used in automating and controlling some of the processes. They will turn open and close as needed to keep the process moving.

Mine Unit Instrumentation

There will be three layers of protection associated with the mine unit instrumentation on the pipelines and header houses. The same three layers of protection associated with the wellfield instrumentation will also be associated with the plant instrumentation:

I) Mine Unit Automated Monitoring and Data Output;
II) Mine Unit Alarm; and
III) Mine Unit Control.

I) Mine Unit Automated Monitoring and Data Output

a) Pipelines: Pressures will be monitored and sent to the Plant for Operator review. Flow algorithms may be used to review differential flow status to determine if there is a potential problem. Monitoring points will be at pump discharges and at header house entrances. Also, if booster stations are used, the inlet and outlet pressures at those stations will also be monitored.
b) Header Houses:
   1) Oxygen: Oxygen pressures will be monitored for abnormal operating conditions.
   2) Production Systems: The main header pressure and flow rate will be monitored as well as the flow rate of each of the production wells for abnormal operating conditions. The On/Off status of each of the pumps will also be monitored.
   3) Injection Systems: The main header pressure and flow rate will be monitored as well as the flow rate of each of the injection wells for abnormal operating conditions.
   4) Header House Sumps: Sump levels and the operating status of the sump pumps in the header house basements will be monitored and transmitted to the Plant for review/alarm.

II) Mine Unit Alarm

a) Pipelines: High and low set points will be set for pipeline data. If pressures are outside the set points, Operators will be notified via alarm and Wellfield Operators will address the upset condition.
b) Header Houses:
   1) Oxygen: High and low data points will be set for oxygen injection piping within the header houses. If pressures are outside the set points, Operators will be notified via alarm and Wellfield Operators will address the upset condition.
   2) Production Systems: The main header pressure and flow rate will have high and low set points. If there is an upset condition, Operators will be notified via alarm and Wellfield Operators will address the upset condition. The same is true for individual production well flow rates as well as the On/Off status of the pumps. Flow algorithms may be utilized to review differential flow status to determine if there is a potential problem. Production wellheads will have fluid detection systems to alarm

of the presence of a leak. The fluid will close a circuit that will generate an alarm either locally, at the plant, or both.

3) Injection Systems: The main header pressure and flow rate will have high and low set points. If there is an upset condition, Operators will be notified via alarm and Wellfield Operators will address the upset condition. The same is true for individual injection well flow rates. Flow algorithms may be utilized to review differential flow status to determine if there is a potential problem. Injection wellheads will have fluid detection systems to alarm of the presence of a leak. The fluid will close a circuit that will generate an alarm either locally, at the plant, or both.

4) Header House Sumps: If sumps have fluid in them, the sumps will be activated and the fluid pumped into the production header. Anytime the sumps are activated, the Plant Operator will receive an indication. If a high level in the sump is received, the Operator will receive an alarm and the Wellfield Operator will address the upset condition.

III) Mine Unit Control

a) Pipelines: Where applicable, control valves will be used to moderate flow and pressure.

b) Header Houses:

1) Oxygen: Pressure switches and interlocks with the injection system will be utilized to insure that oxygen injection cannot occur without adequate flow and pressure in the injection header. The concept being that if oxygen is only allowed to enter the injection header when water is present, then dangerous concentrations cannot build up in the piping.

2) Production Systems: There are several levels of control and shutdown within the production system. The PLC will be connected to the Plant and will allow for shutdown/startup of all production wells in upset conditions. The main valve will be capable of being shut based on operating conditions, i.e., sump overflow, ruptured flowline, etc. The motor control center (MCC) will typically be interlocked with the sump high level shutoff to shut down operating pumps. The wellheads will typically utilize any leaking fluid to complete a circuit and initiate an alarm in the form of either an audible/visible alarm locally or by transmitting an alarm to the operations center. Simple systems included in the piping include check valves to insure that pipeline production fluid cannot enter shutdown sections of pipe.

3) Injection Systems: Control of this system begins with the control valve where the injection fluid enters the header house. This valve will maintain the appropriate pressure and flow for the local operating conditions as well as allow for complete shutdown of injection. Data from the main flow line

and the individual injection wells will be transmitted to the Plant for review. If there is an upset condition, operators will be notified and the suspect area will be shut down for maintenance. The wellheads will typically utilize any leaking fluid to complete a circuit and initiate an alarm in the form of either an audible/visible alarm locally or by transmitting an alarm to the operations center.

4) Header House Sumps: High sump levels will initiate a shutdown in the production wells and alarm the Operators.

Cleanup

If an Operator has an indication of a leak, the affected system will immediately be shut down and repaired. Prior to repair, the leak or spill will be reported internally (as required) and to the appropriate agency (if required). The Site RSO or HPT will evaluate the nature of the leak/spill, obtain soil samples as necessary, and determine the appropriate method of remediation. If fluid is present when the event is noted, the Operator and/or designated personnel will collect and dispose of the material properly.

3.3 Plant Processes, Instrumentation, and Control

The Plant is designed for the concentration of uranium from dilute solutions by ion exchange. The Plant will house three distinct process circuits: the ion exchange circuit (also called the resin-loading circuit), the elution circuit, and the precipitation/filtration circuit. The final product will be yellowcake slurry. The slurry will be transported from the Permit Area via DOT-approved tankers to a facility licensed by NRC for processing the slurry into dry yellowcake.

The Plant will be designed to process up to 6,000 gpm of lixiviant through the ion exchange circuit. All of the uranium-laden resin will be transferred via pipe to the elution circuit. The elution circuit will be designed to accept loaded resins from satellite facilities operated by LC ISR, LLC or its affiliates and/or from third-party facilities. (If the decision is made to accept resins from third-party facilities, LC ISR, LLC will inform NRC of any contracts with third party loaded resin suppliers, when those contracts are in place.) The elution and precipitation/filtration circuits will be designed on the basis of a two million pound-per-year processing rate, with an initial nominal operating rate of one million pounds per year to match the projected production rate from the Permit Area.

The Plant building will house all auxiliary equipment and systems required to support an operation of this type. In addition, the Plant will contain equipment and facilities capable of treating up to 1,000 gpm of groundwater from mine units that are in both production and restoration (**Figure 3.2-6**).

3.3.1 Ion Exchange (Resin-Loading) Circuit

Uranium concentrations averaging 40 to 50 parts per million (ppm) U_3O_8, are expected in the production fluid. Standard, commercially available ion exchange resins have been demonstrated to function well under conditions such as those at the Project. The ion exchange resins preferentially remove the uranyl dicarbonate or uranyl tricarbonate from the solution. The ion exchange circuit will consist of pressurized, "down-flow" vessels that are internally screened to maintain the resin in place but allow the lixiviant to flow through the vessel. Once the resin becomes loaded, the vessel is isolated from the normal process flow and the resin is transferred via piping to a separate vessel for elution.

Approximately 200 gpm of the barren lixiviant (IC fluid) will be routed through an RO unit prior to leaving the Plant. RO, at this point, allows approximately one percent of the total flow required for bleed to exit as waste brine instead of injection fluid. The RO permeate is added back to the injection stream. The solution leaving the ion exchange circuit will normally contain less than five ppm of uranium. Sodium carbonate, sodium bicarbonate, oxidants, and carbon dioxide will be added to the barren solution, as required, prior to re-injection. The resin-loading circuit is graphically represented in **Figure 1.5-2a**.

3.3.2 Elution Circuit

When resin in an ion exchange vessel is fully loaded and/or removing very little additional uranium, the vessel will be isolated from the normal process flow. The loaded resin will be transferred in 500 cubic foot lots from the ion exchange vessel to the elution circuit. In this circuit, the loaded resin will first be passed over vibrating screens with wash water to remove entrained sand particles and other fine trash. The loaded resin will then move by gravity from the screens into down-flow elution vessels for uranium recovery and resin regeneration. The Plant will also have the capability to receive loaded resin from other operations via bulk transport for processing in the elution circuit.

Once in the elution vessel, the loaded resin will be contacted with an eluate composed of approximately 90 g/L sodium chloride and 20 g/L sodium carbonate (soda ash). The eluted resin is subsequently rinsed with fresh water and returned to an empty ion exchange vessel or bulk trailer (**Figure 1.5-2b**).

In a three-stage batch elution process, a total of 45,000 gallons of eluant contact the 500 cubic feet of resin. The process generates 15,000 gallons of rich eluate with a concentration of ten to 20 g/L U_3O_8. Each elution produces 30,000 gallons of eluate that is re-used in the next elution. Likewise, 15,000 gallons of fresh eluate will be required per elution. The fresh eluate is prepared by mixing the proper quantities of a saturated sodium chloride (salt) solution, a saturated sodium carbonate (soda ash) solution, and water. The saturated salt solution is generated in commercially available salt saturators (brine generators). Saturated soda ash solution is prepared by passing warm water (greater than 105° F) through a bed of soda ash.

3.3.3 Precipitation/Filtration Circuit

From the elution circuit, the uranium-rich eluate will be sent to an agitator tank for batch precipitation. To initiate the precipitation cycle, hydrochloric or sulfuric acid will be added to the eluate to breakdown the uranyl carbonate present in the solution (**Figure 1.5-2b**). Hydrogen peroxide will then be added to the eluate to effect precipitation of the uranium as uranyl peroxide. Caustic soda solution will then be added to elevate the pH, which promotes growth of uranyl peroxide crystals and makes the slurry safer to handle in the subsequent process steps.

After precipitation, the precipitated uranium will be washed, to remove excess chlorides and other soluble contaminants, and then de-watered and filtered to form the yellowcake slurry. This slurry will then be stored in holding tanks or in transport tanks parked in a secure area in the Plant. The holding and transport tanks will be used solely for yellowcake slurry. On-site inventory of U_3O_8 in the slurry form will typically be less than 100,000 pounds. However, in periods of inclement weather or other interruptions to product shipments, there will be capacity for up to 200,000 pounds of slurry within the Plant. The yellowcake slurry will be shipped by exclusive-use, authorized transport to a facility licensed by NRC for processing the slurry into dry yellowcake.

3.3.4 Major Process Equipment and Instrumentation

The major process equipment in the Plant will include: ion exchange vessels; elution vessels; precipitation tanks; filter presses; slurry storage tanks; and the piping, pumps, valves, filters, and associated equipment required to control and move the solutions through the various process circuits. The process equipment will be installed as needed to meet the required flow rates and production levels. The ion exchange, elution, and precipitation/filtration circuits will have instrumentation designed to monitor key fluid levels, flow rates and pressures. In addition to monitoring, there will be varying levels of control, such as automatic shut-offs, for pumps, valves, and operating systems.

The Plant will be equipped with the appropriate instrumentation to monitor flow, pressure, level, pH, and temperature where needed. This instrumentation will normally alert the operator to possible problems both on the Plant computer and audibly. If necessary, the instrumentation may shut the process down depending on the nature of the problem.

The main injection/production lines coming from the field will typically have automated valves. If there is a loss of power, pressure or flow, the change will alarm the operator on the computer and audibly in the Plant. In the case of power loss or problems in the Plant, the automated valves are designed to open a by-pass loop and the fluids will return to the field. This will keep the mine units operational while isolating the Plant to complete repairs.

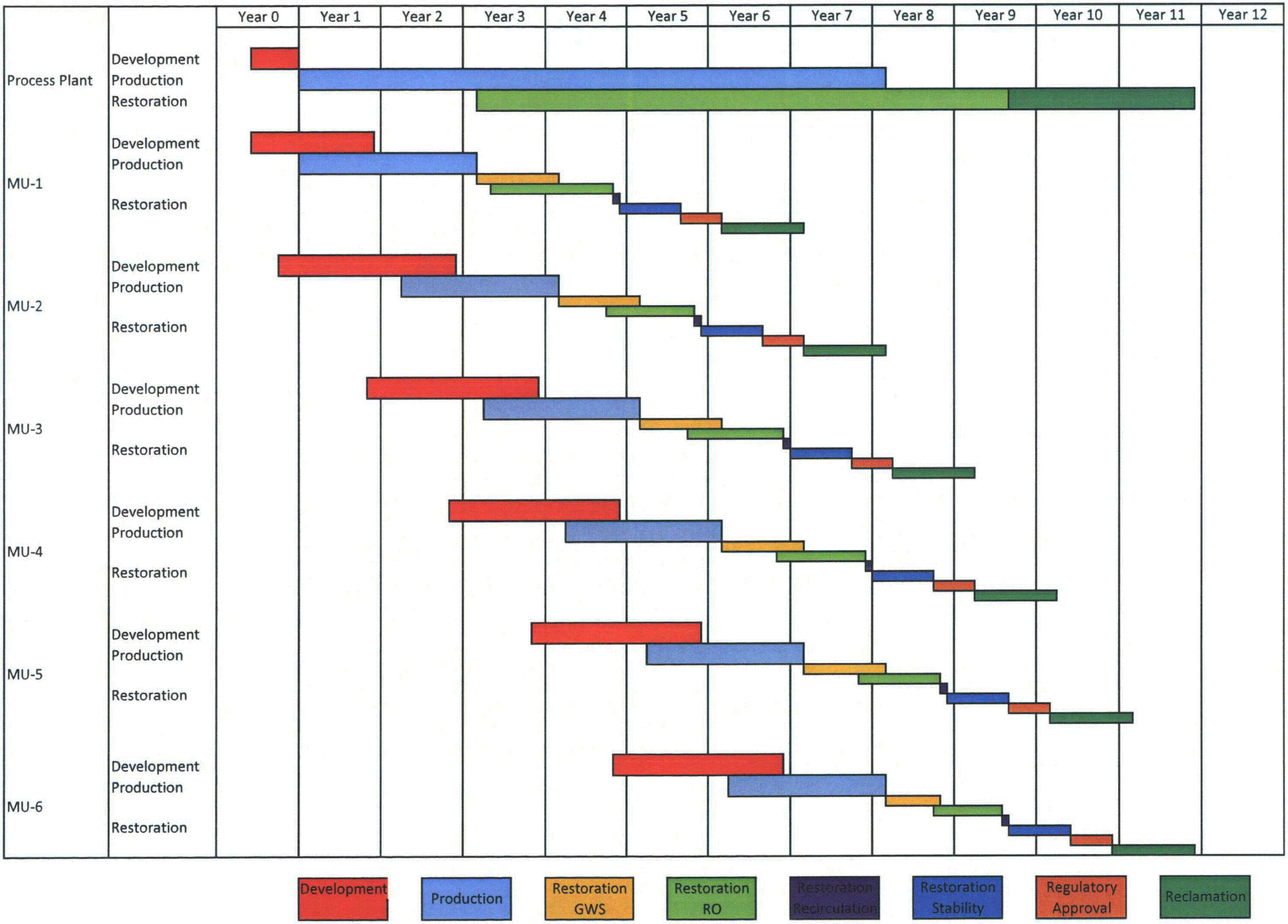
In the case of an upset condition in the chemical area, the operator will normally be alerted on the computer and audibly to the problem. Instrumentation will shut down the process if it is resulting in a release (piping break or tank overfill). Also, there will be a chemical area emergency stop. If failures occur in the chemical area during operation (or loading), the operator (or chemical delivery driver) could hit the emergency stop button. This action will stop all pumps and close all valves in the chemical area. Instrumentation will stay active, but there will be no movement of chemical until the area is restarted.

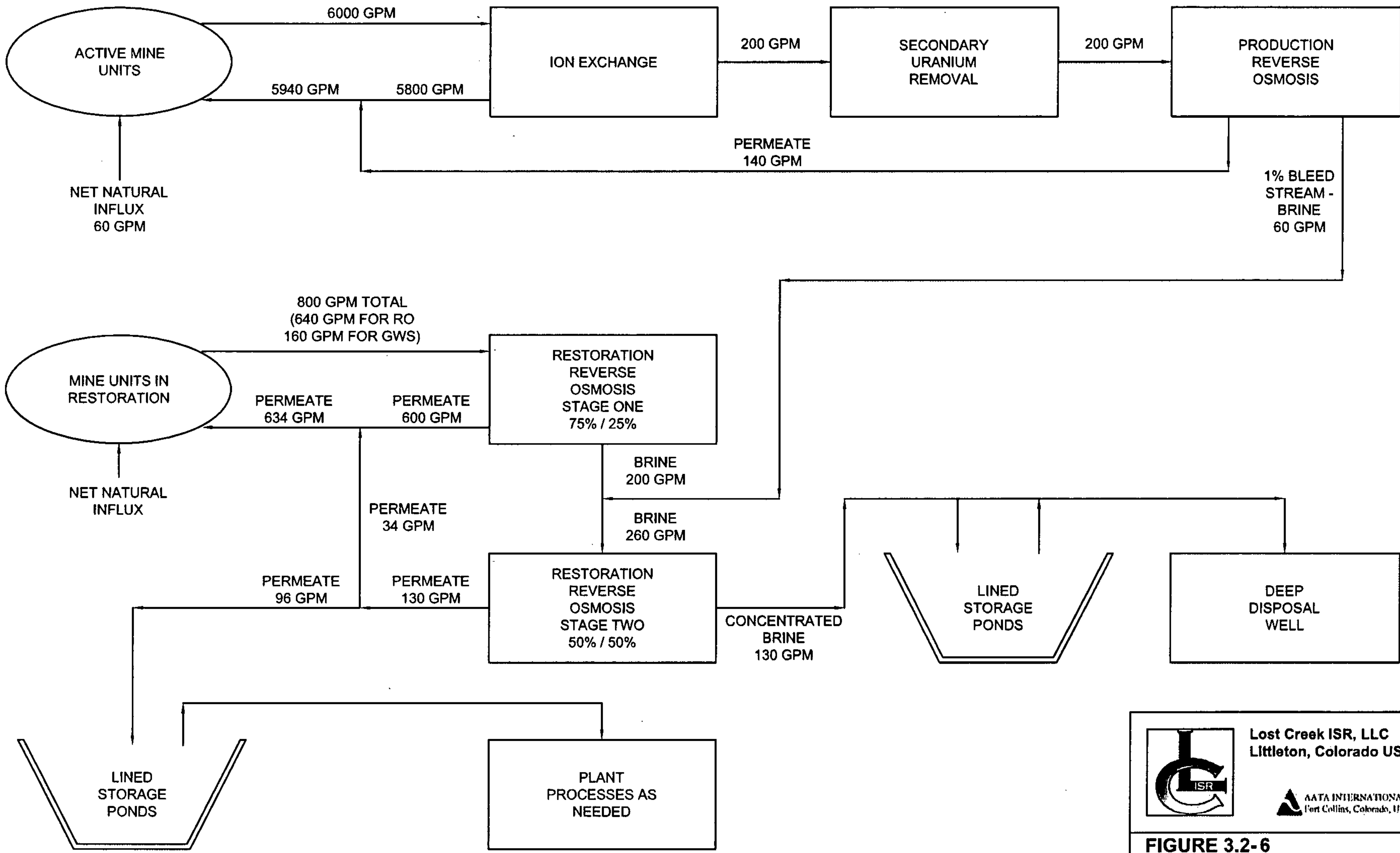
In the case of an upset condition in the other systems (elution, precipitation, and restoration), the instrumentation will normally alert the operator on the computer screen and audibly. If necessary, the instrumentation will shut the process down.

An additional safety aspect/control point will be the installation of two plant emergency stops outside the building. One will be located outside the office main entrance door and one outside the rear plant entrance door. If either of these buttons is pushed, the entire Plant will shut down and valves will close; only instrumentation and ventilation will remain operational. In the event of a total power failure, mine units will shut down until power is restored. Only the emergency and critical systems in the plant will remain operational.

The Plant will include internal berms, as well as a perimeter berm, as described in **Section 7.4.1**, and other facilities will also be bermed, as described in **Section 7.3.2**. The primary purpose of the berms is for containment of accidental releases, but they will also function to divert surface water flow, if any, around the Plant. The primary drainage is ephemeral and east of the Plant **(Section 2.7.1.1)**, and the chance of flooding at the Plant is remote. Additional information on the effects of accidents, the design of the chemical processes and on assessment and mitigation of accidents involving chemicals is provided in **Sections 7.4** through **7.6**.

Figure 3.1-3
Project Development, Production and Restoration Schedule





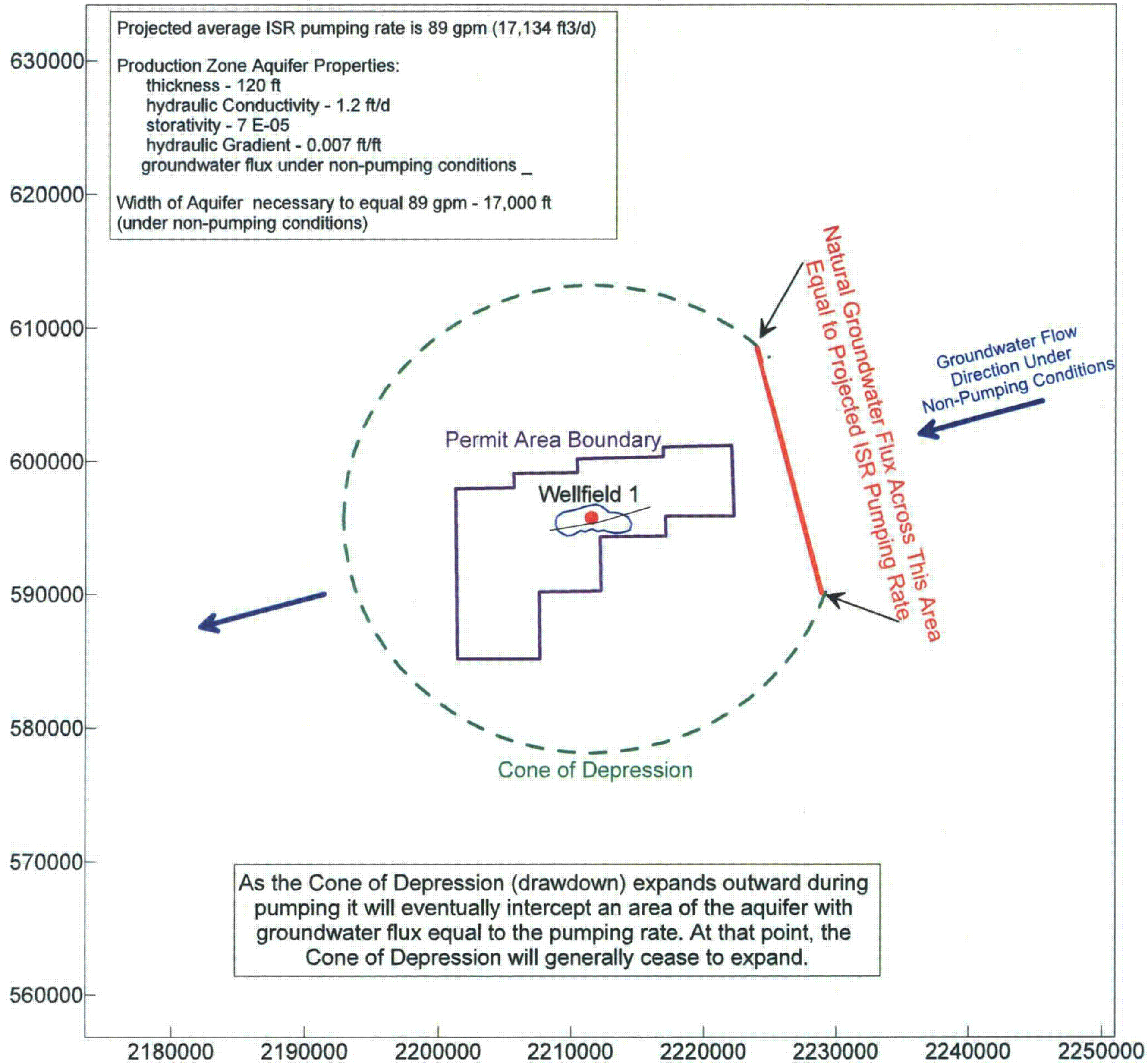
MINE UNIT OPERATIONS AT 6,000 GPM
WITH A 1% BLEED (60 GPM)

Lost Creek ISR, LLC
Littleton, Colorado USA

AATA INTERNATIONAL, INC.
Fort Collins, Colorado, USA

FIGURE 3.2-6
Project Water Balance
Lost Creek Permit Area

Issued For: NRC TR 1.0 Drawn By: SMH
Issued / Revised: 10.12.2007
Drawing No. NRCTR 1.0 FIG 3.2-5 10.12.2007 SMH



Lost Creek ISR, LLC
Littleton, Colorado, USA

Petrotek
www.petrotek.com
Littleton, CO, USA

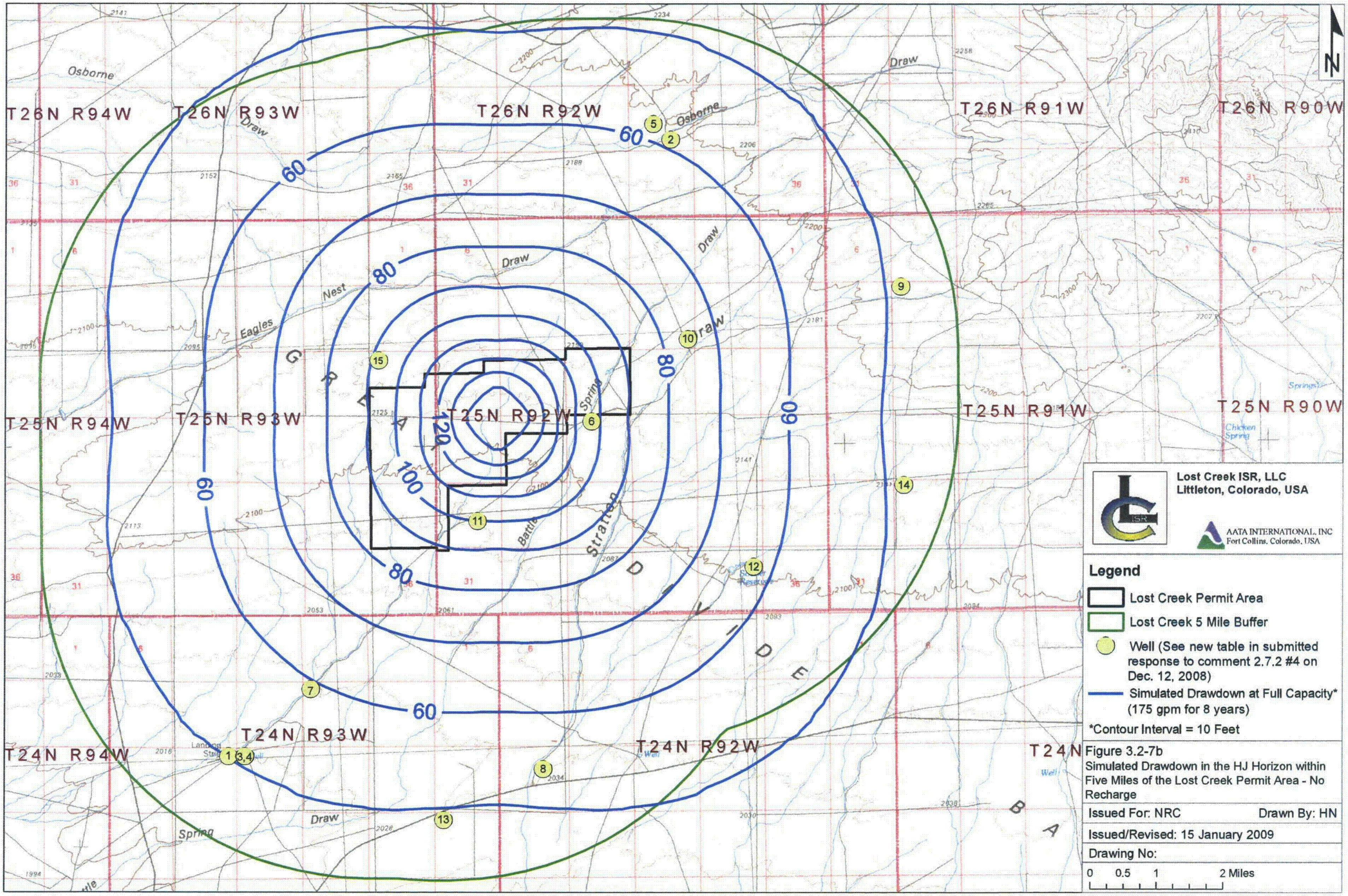
FIGURE 3.2-7a

Conceptualization of the Limit of the Cone of Depression During ISR Operations

Lost Creek Permit Area

Issued For: WDEQ LQD	Drawn By: EPL
Issued /Revised: 02.10.10	
Drawing No.: Figure WDEQOP10a	

0 1 2 3 4 5 Miles



Lost Creek ISR, LLC
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AATA INTERNATIONAL, INC
Fort Collins, Colorado, USA

Figure 3.2-7b
Simulated Drawdown in the HJ Horizon within Five Miles of the Lost Creek Permit Area - No Recharge

Issued For: NRC | Drawn By: HN

Issued/Revised: 15 January 2009

Drawing No:

Table 3.1-1 Lost Creek Water Supply Wells

Well #	Date Completed	Completion Interval(s)	Horizon	Map Coordinates (NAD 83)		Comments
				Easting	Northing	
LC1W	09/30/05	300-360	Upper FG	2203585	595463	Completion interval is about 115 feet above Lost Creek Shale (LCS), with 2 aquicludes between LCS and completion interval. [1]
--	--	--	FG	--	--	Planned for but not yet installed.
LC28M	08/30/06	502-557	UKM	2201671	585142	Completion interval is directly below the Sagebrush Shale (SBS), which is 12' thick in this well. This well is located approximately 2.4 miles southwest of the southwestern edge of MU1.
LC32W	05/01/07	737-845	M	2215385	597511	Completion interval is 240 ft below Sagebrush Shale (SBS), with 6 aquicludes between SBS and completion interval.
LC33W	07/17/07	800-895	N	2216487	595018	Completed interval is 330 ft below SBS, with 6 clay aquicludes between SBS and completion interval.
LC229W	06/03/08	863-888 915-945 955-985	M	2209390	598293	Completed interval is 310 ft below SBS, with 7 aquicludes between SBS and completion interval.
LC606W	10/09/08	670-685 690-715 735-740	M	2202739	586368	Completed interval is 190 ft below SBS, with 4 aquicludes between SBS and completion interval.

[1] Aquicludes imply predominantly clay lithology at least 5 feet thick.

Drilling Water Needs

Assumptions

500	drill hole & wells per year (300 Delineation + 200 Wells)
650	average depth per hole
325,000	avg feet per year of drilling

Calculation

0.52	avg # water loads per 100' of drilling (all hole types) Lost Creek - 2008 average
1690	# loads of water per year (total project)
135,200	# bbls of water per year (total project)
5,678,400	# gal of water per year (total project)
3	# of water wells used as supply
1,892,800	# gal of water per year per well
3.6	= avg gpm /per well [24:7 operation]