Question 2.5.2 No. 2 Reasonable Alternatives – Liquid Effluent Disposal

RAI Question:

More physical details (size, location, operations) or other information (cost, logistics, technology, etc.) on the three liquid effluent disposal alternatives (overland application, evaporation ponds, and deep well injection).

Answer:

In 2008, Uranium One performed additional alternatives analysis for potential waste water treatment and disposal options. The results of this alternatives analysis were not available at the time the Moore Ranch NRC application was prepared and submitted. As a result of the initial screening analysis, a detailed analysis of deep well disposal, mechanical evaporation, chemical precipitation and reverse osmosis, and spray/solar evaporation was performed. In response to this RAI question, section 2.5.1.3 of the Environmental Report will be revised.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

2.5.1.3 Waste Management

Liquid wastes generated from production and restoration activities are generally managed at ISR facilities by solar evaporation ponds, deep well injection, and/or land application. The use of deep waste disposal well(s) is considered by EMC to be the best alternative to dispose of these types of wastes. The Moore Ranch deep well(s) will isolate liquid wastes generated by the project from any underground source of drinking water (USDW). These wells must be authorized by the State of Wyoming under a Class I UIC Permit.

EMC has considered ~~and rejected using solar evaporation ponds and land application as a~~a wide range of liquid treatment/–disposal methods for use at Moore Ranch. The alternatives analysis considered three primary waste streams from ISR operation:

- *Plant eluant;*
- *Wellfield purge water; and*
- *RO reject produced during wellfield restoration.*

A "design basis influent" was developed for the three typical ISR wastewater streams to be managed as well as the projected water quality characterization for blending the waste streams. The alternatives analysis was completed stepwise

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with the development of a common evaluation basis, screening of potentially applicable treatment technologies, development of candidate treatment trains, and technical and cost evaluation of the treatment trains. The initial screening of treatment technologies included evaluation of each technology for implementability, flexibility, maintainability, and relative capital and operating costs. The retained technologies were developed into treatment options and then the comparative evaluation of each option was conducted in parallel for each waste stream. Both capital and annual operating costs were developed for each option in order to calculate a net present value. The costs developed were comparative order-of-magnitude estimates intended for comparison purposes and were based on an ISR model case that could then be scaled to a particular operation. Costs that were common to all options such as regulatory reporting, project management, and administrative costs were not included.

Land application is feasible and has been historically used at some ISR facilities as a wastewater treatment/disposal method, generally in conjunction with deep well disposal and/or spray/solar evaporation. However, discharges through land application may be required to meet surface water quality standards. If land-applied water is not treated to stringent standards there is a potential for future environmental liability due to accumulation of contaminants in the soil or groundwater below the land application surface area. For this reason land application was not retained in the screening process for further consideration.

The following discussion provides a description of each treatment/disposal method considered and the relevant characteristics that led to the selection of deep well injection as the preferred alternative.

Deep well disposal

On any site where geologic and hydrogeologic conditions would allow, deep well injection is the current preferred method for wastewater disposal. Deep well injection is permitted primarily on the condition that potential sources of drinking water cannot be adversely impacted by the deep well operation, rather than by the quality and characteristics of the wastewater injected. Deep well "discharge standards" as incorporated into a permit are based on the mine operator's characterization of the waste stream. This method was considered potentially suitable for all ISR waste streams.

Mechanical Evaporation

Mechanical evaporation utilizing equipment that requires either gas or electric power was considered. Evaporation is energy-intensive, but produces the smallest possible volume of waste for disposal. Disposal costs per unit volume can be evaluated against the evaporator operations cost to determine the economic viability of evaporation as a post-treatment step. For this evaluation it is assumed *that a volume reduction of approximately 95% is achieved. This method was considered potentially suitable for all ISR waste streams.*

Chemical Precipitation and Reverse Osmosis

Chemical precipitation and reverse osmosis which can utilize the chemical precipitation step to either pretreat the wastewater for more efficient operation of the reverse osmosis system or use the chemical precipitation step to treat the brine was considered. Both a brine residual and a sludge are formed. This method was considered potentially suitable for all ISR waste streams.

Spray/solar evaporation

Spray/solar evaporation utilizing natural evaporation and enhancing the rate by spraying water to increase the surface area, which was assumed to provide a 95% volume reduction for this evaluation, was considered. While solar evaporation is technically feasible, the evaporation rate and length of the evaporation season must be considered in parallel with the flow rate of water to be treated. Pond size may become infeasibly large if the evaporation rate is low. If sprayers are used for evaporation enhancement, overspray due to high winds must be controlled. Additional issues with ponds include dust and dirt blown in, and the eventual need to remove salts and accumulated solids.

Table 2.5-1 provides a summary of the technical and cost evaluation of candidate water treatment and management options for a combination of the process wastewaters. For each of the alternatives considered, the table lists the advantages and disadvantages, the chemicals required, residues storage capacity, required offsite shipments, power requirements, labor requirements, environmental and safety considerations, capital cost, and 20-yr Net Present Value. For capital cost and 20-yr NPV, the deep disposal well alternative is considered the base case and the capital cost and 20-year NPV for the other alternatives are scaled from it.

As shown by Table 2.5-1, the NPV for the Deep Well Option and the Spray/Solar Evaporation Option were the most favorable (lowest estimated life cycle cost), with the Deep Well Option as the lowest overall cost. The Deep Well option presents additional environmental, safety and health benefits including the following:

- *Minimize worker exposure to concentrated brine streams that may contain uranium and byproduct material;*
- *Minimize the required footprint and therefore land disturbed by the system;*
- *Minimize the residual, either solid or liquid, stored onsite and also shipped offsite. There is no offsite transportation of residual required with a deep well; and*

- *Minimize the requirement for chemicals and other commodities.*

Based on this comparative evaluation the deep well water management option for ISR wastewater provides clear economic and environmental advantages.

~~*due to required treatment, monitoring and reclamation costs, and the potential environmental impacts from a surface discharge.*~~

All solid wastes will be properly managed. Non-contaminated solid waste will be disposed in an off site solid waste landfill permitted by the county in which it is located. Contaminated wastes will be shipped to a NRC or Agreement State-~~approved~~licensed facility for disposal.

Insert New Table 2.5-1.

ALTERNATIVES

Question ER 2.5 No.1 Reasonable Alternatives – Alternate Plant Site

RAI Question:

Information on other sites that were evaluated prior to picking the site where the project is to be accomplished. Also include information on the footprint, such as alternative plant locations, routes for roads, and building locations.

Answer:

The Central Plant was initially proposed at a location which was situated approximately 700 feet to the west of the current proposed location, shown in Figure 1.2-4 of the Environmental Report. Since preparation of the Environmental Report, additional siting evaluations have been performed and a better location has been identified compared to the original proposed Central Plant site location. The current preferred Plant site is deemed the most suitable location primarily due to the existing topography and the minimal topographic changes required for the proposed layout of the plant infrastructure. Additional information on this evaluation and alternate site information including a new Figure 2.5-1 will be included in the revised Section 2.5 of this Environmental Report.

In addition, Section 4.12.2 of the Environmental Report will be revised to reflect updated radiological impacts due to relocation of the plant site. EMC has revised the dose impacts analysis using the MILDOS-Area code, resulting in an increase in the maximum annual dose at the site boundary from 0.8 mrem/year to 1.5 mrem/year. This change is reflected in Table 2.6-1 in response to RAI Question 2.5 Number 4.

Proposed Revisions to License Application

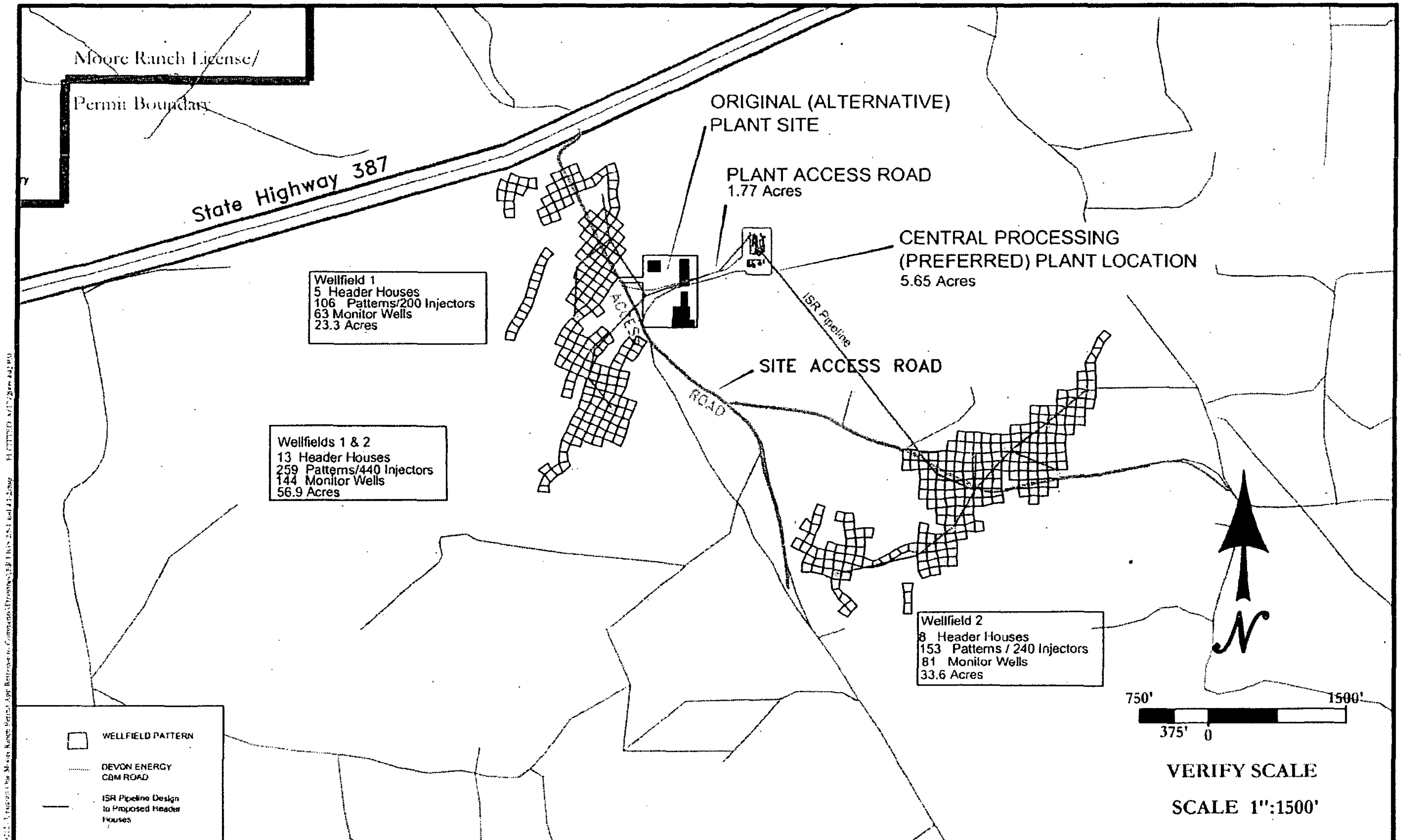
The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

2.5 REASONABLE ALTERNATIVES

2.5.2 Plant Location Alternatives

The site of the Moore Ranch Central Plant was initially planned at a location which was situated approximately 700 feet to the west of the current preferred location, shown in Figure 2.5-1. The current proposed plant site was deemed the more suitable location primarily due to existing topography, and the minimal topographic changes that would be required for the proposed layout to the plant infrastructure. The new proposed site location minimizes cut and fill, thereby minimizing the disturbance of natural ground. The revised site location, as with the alternate site location, is located to minimize environmental impacts in that it *will be in close proximity to the primary access road, it will avoid existing utilities, and its visibility from Highway 387 will be minimized.*

Insert New Figure 2.5-1



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SCALE 1":1500'

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DRAWN BY: WB

CHECKED BY: JS

APPROVED BY:

MOORE RANCH
CPP
Site Road Plan

REV. #	DESCRIPTION	BY	DATE
0	INITIAL DRAFT	WB	05/19/09
1	UPDATE	KLW	06/17/09

Figure
2.5-1

Question 2.5.2 Number 2 Reasonable Alternatives – Liquid Effluent Disposal

RAI Question:

More physical details (size, location, operations) or other information (cost, logistics, technology, etc.) on the three liquid effluent disposal alternatives (overland application, evaporation ponds, and deep well injection).

Answer:

In 2008, Uranium One performed additional alternatives analysis for potential waste water treatment and disposal options. The results of this alternatives analysis were not available at the time the Moore Ranch NRC application was prepared and submitted. As a result of the initial screening analysis, a detailed analysis of deep well disposal, mechanical evaporation, chemical precipitation and reverse osmosis, and spray/solar evaporation was performed. In response to this RAI question, section 2.5.1.3 of the Environmental Report will be revised.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

2.5.1.3 Waste Management

Liquid wastes generated from production and restoration activities are generally managed at ISR facilities by solar evaporation ponds, deep well injection, and/or land application. The use of deep waste disposal well(s) is considered by EMC to be the best alternative to dispose of these types of wastes. The Moore Ranch deep well(s) will isolate liquid wastes generated by the project from any underground source of drinking water (USDW). These wells must be authorized by the State of Wyoming under a Class I UIC Permit.

EMC has considered a wide range of liquid treatment/disposal methods for use at Moore Ranch. The alternatives analysis considered three primary waste streams from ISR operation:

Deleted: *and rejected using solar evaporation ponds and land application as a*

Deleted:

- *Plant eluant;*
- *Wellfield purge water; and*
- *RO reject produced during wellfield restoration.*

A "design basis influent" was developed for the three typical ISR wastewater streams to be managed as well as the projected water quality characterization for blending the waste streams. The alternatives analysis was completed stepwise with the development of a common evaluation basis, screening of potentially *applicable treatment technologies, development of candidate treatment trains, and technical and cost evaluation of the treatment trains. The initial screening of treatment technologies included evaluation of each technology for implementability, flexibility, maintainability, and relative capital and operating costs. The retained technologies were developed into treatment options and then the comparative evaluation of each option was conducted in parallel for each waste stream. Both capital and annual operating costs were developed for each option in order to calculate a net present value. The costs developed were comparative order-of-magnitude estimates intended for comparison purposes and were based on an ISR model case that could then be scaled to a particular operation. Costs that were common to all options such as regulatory reporting, project management, and administrative costs were not included.*

Land application is feasible and has been historically used at some ISR facilities as a wastewater treatment/disposal method, generally in conjunction with deep well disposal and/or spray/solar evaporation. However, discharges through land application may be required to meet surface water quality standards. If land-applied water is not treated to stringent standards there is a potential for future environmental liability due to accumulation of contaminants in the soil or groundwater below the land application surface area. For this reason land application was not retained in the screening process for further consideration.

The following discussion provides a description of each treatment/disposal method considered and the relevant characteristics that led to the selection of deep well injection as the preferred alternative.

Deep well disposal

On any site where geologic and hydrogeologic conditions would allow, deep well injection is the current preferred method for wastewater disposal. Deep well injection is permitted primarily on the condition that potential sources of drinking water cannot be adversely impacted by the deep well operation, rather than by the quality and characteristics of the wastewater injected. Deep well "discharge standards" as incorporated into a permit are based on the mine operator's characterization of the waste stream. This method was considered potentially suitable for all ISR waste streams.

Mechanical Evaporation

Mechanical evaporation utilizing equipment that requires either gas or electric power was considered. Evaporation is energy-intensive, but produces the smallest possible volume of waste for disposal. Disposal costs per unit volume can be evaluated against the evaporator operations cost to determine the economic viability of evaporation as a post-treatment step. For this evaluation it is assumed that a volume reduction of approximately 95% is achieved. This method was considered potentially suitable for all ISR waste streams.

Chemical Precipitation and Reverse Osmosis

Chemical precipitation and reverse osmosis which can utilize the chemical precipitation step to either pretreat the wastewater for more efficient operation of the reverse osmosis system or use the chemical precipitation step to treat the brine was considered. Both a brine residual and a sludge are formed. This method was considered potentially suitable for all ISR waste streams.

Spray/solar evaporation

Spray/solar evaporation utilizing natural evaporation and enhancing the rate by spraying water to increase the surface area, which was assumed to provide a 95% volume reduction for this evaluation, was considered. While solar evaporation is technically feasible, the evaporation rate and length of the evaporation season must be considered in parallel with the flow rate of water to be treated. Pond size may become infeasibly large if the evaporation rate is low. If sprayers are used for evaporation enhancement, overspray due to high winds must be controlled. Additional issues with ponds include dust and dirt blown in, and the eventual need to remove salts and accumulated solids.

Table 2.5-1 provides a summary of the technical and cost evaluation of candidate water treatment and management options for a combination of the process wastewaters. For each of the alternatives considered, the table lists the advantages and disadvantages, the chemicals required, residues storage capacity, required offsite shipments, power requirements, labor requirements, environmental and safety considerations, capital cost, and 20-yr Net Present Value. For capital cost and 20-yr NPV, the deep disposal well alternative is considered the base case and the capital cost and 20-year NPV for the other alternatives are scaled from it.

As shown by Table 2.5-1, the NPV for the Deep Well Option and the Spray/Solar Evaporation Option were the most favorable (lowest estimated life cycle cost), with the Deep Well Option as the lowest overall cost. The Deep Well option presents additional environmental, safety and health benefits including the following:

- *Minimize worker exposure to concentrated brine streams that may contain uranium and byproduct material;*
- *Minimize the required footprint and therefore land disturbed by the system;*
- *Minimize the residual, either solid or liquid, stored onsite and also shipped offsite. There is no offsite transportation of residual required with a deep well; and*

* *Minimize the requirement for chemicals and other commodities.*

Based on this comparative evaluation the deep well water management option for ISR wastewater provides clear economic and environmental advantages.

All solid wastes will be properly managed. Non-contaminated solid waste will be disposed in an off site solid waste landfill permitted by the county in which it is located. Contaminated wastes will be shipped to a NRC or Agreement State licensed facility for disposal.

Insert New Table 2.5-1.

Deleted: *due to required treatment, monitoring and reclamation costs, and the potential environmental impacts from a surface discharge.*

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Table 2.5-1

Treatment Alternatives Comparative Evaluation Matrix – 150 gpm ISL Wastewater

Evaluation Factor	Deep Well	Mechanical Evaporation	Chemical Precipitation/RO	Spray/Solar Evaporation
Advantages	Economical, no residuals so no onsite storage or offsite transport required, no concentrated chemicals required, minimal operating requirements, minimal space requirements, flexible with regard to water quality and disposal rate.	Produces very low volume brine for disposal or further processing by solidification or to dry salt for zero liquid discharge, produces treated water with essentially zero contaminants (distilled water), can be operated campaign style.	Broadly applicable to metals and common anion contaminants, chemical precipitation pretreatment allows operation of RO system to produce less brine, produces high quality treated water stream for reuse or discharge.	Primary treatment is simple system consisting of ponds, pumps, piping and nozzles. No complicated equipment, low capital cost. Commonly used for management of brine in arid climates. Can allow complete evaporation to dryness or remove low volume brine for solidification and offsite disposal.
Disadvantages	Site geology will dictate feasible disposal flow rate. Site hydrogeology (presence of potential drinking water aquifers) will dictate disposal well depth. Permitting process may be lengthy. Attention to water chemistry and need for antiscalent is required to minimize wellscreen scaling and fouling issues. Changes in water chemistry may require re-permitting. No recovery of treated water.	Long equipment lead, distillate is corrosive and would need conditioning for reuse or discharge, high capital and power cost, concentrates radionuclides into the evaporator brine by 20 times or more.	Produces both liquid and solids residues with higher volume liquid residues that other options. Highest labor. Requires bulk concentrated chemicals. Highest truck traffic of options evaluated for chemical deliveries and residuals transport.	Treatment rate dependent upon weather. "Overdesign" required to account for weather shutdowns. Potential for birds and other wildlife to drink and contact water. Treatment time affected by wind with high potential for overspray. Reduced efficiency and operating difficulty due to freezing in winter so large storage capacity required. Windborne dust and dirt reduce efficiency and increase maintenance (cleanouts). Large quantities of chemicals required for solidification and large quantities of solidified brine produced for offsite disposal.
Chemicals Required	None to minimal. Antiscalent may be required depending on water characteristics.	Minimal for evaporator and limited to antiscalent compounds and some cleaning products. Lime, soda ash, and polymer required for solidification.	Lime Concentrated acid Polymer, antiscalent and RO cleaning chemicals. Lime, soda ash and polymer for solidification.	Lime, soda ash, and polymer for solidification.
Residues Storage Capacity	Small feed tank – 10,000 gal storing regular strength wastewater	60,000 gal brine storage – approximately 5 days of storage for feed to solidification system. 100 yd^3 solidified brine (3-4 days)	200,000 gal brine storage – (4 days) 80 yd^3 sludge (20% solids by weight) from chemical precipitation storage 500 yd^3 solidified brine (3-4 days)	40,000,000 gal storage for low evaporation months 60,000 gal brine storage for low evaporation months 100 yd^3 solidified brine (3-4 days)
Offsite Shipments	None	Approximately 10 trucks per week with solidified brine.	Approximately 43 trucks per week with solidified brine and dewaterered sludge.	Approximately 10 trucks per week with solidified brine.
Other Considerations	None	Brine is concentrated waste (20X feed), potentially characterized as hazardous or mixed waste	Brine is concentrated waste (6X feed) potentially characterized as hazardous or mixed waste	Brine is concentrated waste (20X feed) potentially characterized as hazardous or mixed waste
Power	710,000 kwh/yr	11,008,000 kwh/yr	2,912, 000 kwh/yr	8,822,000 kwh/yr
Labor	Minimal	3 – 4 FTE	6 FTE	3 – 4 FTE
Environmental /Safety	Safest and lowest environmental impact of options. Smallest carbon footprint with low operating power requirement and no truck traffic. No residuals stored onsite, no potential for wildlife exposure to holding ponds. No requirement for chemicals. No potential exposure to concentrated residues.	Large carbon footprint with over 10 times the power requirement of a deep well and 20 times the power requirement of the RO/precipitation option. Requires high operating temperatures and pressures. Low to moderate footprint primarily for brine storage tanks. Requires storage of brine as feed to solidification system and offsite transportation of solidified brine stream. High chemical requirements for solidification chemicals. High operating temperature and pressure.	Moderate carbon footprint with the lowest operating power requirement but the most truck traffic of any option evaluated. Handling of highest quantity of residues required including onsite storage and offsite disposal. Higher labor requirements with more potential for exposure to chemicals and residuals during sludge dewatering operations and residuals management.	Moderate carbon footprint with greater the power required of a deep well and some truck traffic for offsite brine disposal. Greatest risk to wildlife due to large volume ponds. Greatest potential for release of salts from overspray. Potential for exposure to labor from the sprays.
Capital cost estimate	Base Case	3.56 times base case	1.79 times base case	4.21 times base case
20 Year NPV	Base Case	17.6 times base case	68.9 times base case	17.9 times base case

Question 2.5 No. 3 Reasonable Alternatives - Alternative Lixiviants and Mining Methods

RAI Question:

Information on other lixiviants considered, as well as other technologies for underground uranium recovery.

Answer:

Section 2.5.1.1 of the Environmental Report provided a short discussion of alternate lixiviants that were considered by EMC during preparation of the License Application. Section 2.6.1 of the Environmental Report provided a discussion of mining alternatives that were considered but eliminated by EMC during preparation of the License Application. In response to this RAI question, sections 2.5.1.1 and 2.6.1 of the Environmental Report will be revised.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

2.5.1.1 Lixiviant Chemistry

EMC proposes to use a sodium bicarbonate lixiviant that is an alkaline solution. Where the groundwater contains carbonate, an alkaline lixiviant will mobilize fewer hazardous elements from the ore body and will require less chemical addition than an acidic lixiviant. Also, test results at other projects indicate only limited success with acidic lixiviants, while the sodium bicarbonate has proven highly successful at commercial mining operations in the Powder River Basin to date. Alternate leach solutions include ammonium carbonate solutions and acidic leach solutions.

Acidic Leach Solutions

Acid-based lixiviants, such as sulfuric acid, have been used in the United States and are widely used internationally. Acid leach has historically produced a majority of the world's ISL production. Acid-based lixiviants generally achieve a higher degree of recovery (70 to 90%), better leaching kinetics, and a shorter leaching period. However, acid-based lixiviants dissolve heavy metals and other solids associated with uranium in the host rock and other chemical constituents that required additional remediation (International Atomic Energy Agency, 2001).

In the United States, acid-based lixiviants have been used only for small-scale research and development operations. At the Nine Mile test site in Wyoming, test patterns were developed using acid-based and carbonate-based lixiviants. The acid-based pattern *developed two significant problems. During uranium recovery operations, gypsum precipitated on well screens and within the aquifer, plugging wells and reducing the efficiency of wellfield circulation. Restoration efforts had limited success, apparently due to gradual dissolution of the precipitated gypsum following restoration, resulting in increased salinity and sulfate levels in the affected groundwater (Mudd, 2000).*

Acid-based lixiviants were not found to be more cost effective than alkaline lixiviants, particularly in light of difficulties in achieving acceptable groundwater restoration results. The commercial use of alkaline lixiviants in the United States has been related to the need to restore affected groundwater and alkaline mine sites are recognized to be technically easier to restore. For this reason, a commercial ISR facility using an acid-based lixiviant has not been developed in the United States and EMC determined an acid-based lixiviant was not a suitable alternative for Moore Ranch.

Ammonia-based Lixiviants

Ammonia-based lixiviants have been used in the United States, including in Texas and Wyoming. The ammonia tended to adsorb onto clay minerals in the subsurface. The ammonia desorbs slowly from the clay during restoration, and therefore the aquifer requires that a much larger amount of groundwater be removed and processed during aquifer restoration (Mudd, 2000). In addition, concerns arose in the early 1980s over the potential post mining oxidation of ammonia in the groundwater to form nitrate and nitrite species. This potential difficulty in addition to the slow desorbtion of ammonia from clays resulted in a movement away from ammonia based lixiviants and an outright ban on their use in Texas. Due to this additional consumptive use of groundwater to meet groundwater restoration requirements, EMC determined that an ammonia-based lixiviant was not a suitable alternative for Moore Ranch.

Other Lixiviants

Other lixiviants which have been evaluated in laboratory scale and limited field tests include potassium based lixiviants, a range of oxidants including air, iodine, potassium permanganate, and a variety of trace additives such as clay stabilizing agents to increase the selective oxidation and mobilization of uranium minerals. To date, these alternatives have consistently proven to be far less economical than the planned oxygen – sodium bicarbonate system.

2.6.1 Mining Alternatives

Underground and open pit mining represent the two currently available alternatives to solution mining for the uranium deposits in the Moore Ranch project area. In the southern Powder River Basin uranium ore has been mined with open pits in the past. This activity occurred from 1970 to 1984 at the Exxon Highland facility and from the mid-1970s to 1986 at Union Pacific Resources Bear Creek site, both located south of the Moore Ranch site. A limited quantity of ore was also mined with underground mining at the Exxon Highland site, in addition to the open pit method. However, the underground

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mine was uneconomical and plagued by poor ground conditions. Kerr McGee operated a test underground mine at the Bill Smith (now Smith Ranch) Project in the late 1970's with similar results. Subsequent work by Kerr McGee and its successor, Rio Algom Mining Corp, shifted to ISR methods. Likewise, Exxon recognized the inherent advantages of ISR and was in the process of amending the Highland NRC license for conversion of the project to an ISR operation when Highland was sold to Everest Minerals Corp. in 1983. Subsequently, Everest reconfigured the Highland Project into an ISR operation.

The Moore Ranch project was originally investigated by Conoco in the late 1970's as an open pit mine. Neither of these methods is economically viable for producing the Moore Ranch reserves at this time. The following sections discuss each mining alternative in relation to the Moore Ranch site.

2.6.1.1 Open Pit Mining

Open pit mining requires the removal of all material covering the orebody. This overburden must be removed and stockpiled to allow removal of the uranium-bearing ore. Once removed, the ore must be transported to a conventional uranium mill for further processing and uranium extraction.

Open pit mining of the relatively low grade Moore Ranch ore would require a capital investment that is not supported by the current uranium market. The nearest conventional mill with an operating license that could receive uranium ore for toll milling is the Denison Mines White Mesa Mill located in Blanding, Utah. The combination of capital costs to develop an open pit mine at Moore Ranch, the operating and maintenance costs to mine the ore, and the transportation costs to Blanding, Utah far exceed the current value of the ore as a feedstock for White Mesa. The nearest conventional uranium mill, Kennecott Uranium Corporation's Sweetwater Mill, located in the Great Divide Basin in Wyoming, is not licensed for operations. However, if the Sweetwater Uranium Mill was currently licensed for operation, similar economic factors would preclude mining the Moore Ranch deposit under current uranium market conditions.

Environmental factors must also be considered in addition to the economic factors for open pit mining. Open pit mining would produce large piles of waste rock that would permanently alter the topography of the Moore Ranch site. In addition, substantial dewatering of the pit on the order of several thousand gallons per minute would be required to depress the potentiometric surface. Large quantities of groundwater with naturally elevated radium-226 and uranium would be discharged requiring treatment and subsequent disposal of a radioactive solid waste.

2.6.1.2 Underground Mining

Underground mining of the Moore Ranch deposit would involve sinking mine shafts to the vicinity of the orebodies, horizontally driving crosscuts and drifts to the orebodies at different levels, physically removing the ore and transporting the mined ore to the conventional uranium mill for further processing. The economic factors involved with this alternative are identical to those for ores mined from an open pit.

From an environmental perspective, open pit mining or underground mining and the associated milling process involve higher risks to employees, the public, and the environment. Radiological exposure to the personnel in these processes is increased not only from the mining process but also from milling and the resultant mill tailings. The milling process generates a significant amount of waste relative to the amount of ore processed. Extensive mill tailings ponds are needed for the disposal of these wastes. The environmental impacts associated with open pit and underground mining are generally recognized as being considerably greater than those associated with in-situ recovery mining.

In a comparison of the overall impacts of ISR mining of uranium compared with conventional mining, an NRC evaluation concluded that environmental and socioeconomic advantages of in situ recovery include the following:

1. *Significantly less surface area is disturbed than in surface mining, and the degree of disruption is much less. In addition, this disturbance is temporary in nature, being limited to the period of construction, operations, and decommissioning.*

2. *No mill tailings are produced and the volume of solid wastes is reduced significantly. The gross quantity of solid wastes produced by ISR methods is generally less than 1% of that produced by conventional milling methods (more than 948 kg (2090 lb) of tailings usually result from processing each metric ton (2200 lb) of ore).*

3. *Because no ore and overburden stockpiles or tailings pile(s) are created and the crushing and grinding ore-processing operations are not needed, the air exposure problems caused by windblown dusts from these sources, both on site and during transportation, are eliminated.*

4. *The tailings produced by conventional mills contain essentially all of the uranium daughter products including radium-226 that are originally present in the ore. By comparison, less than 5% of the radium in an ore body is brought to the surface when ISR methods are used. Consequently, operating personnel are not exposed to the radionuclides present in and emanating from the ore and tailings and the potential for radiation exposure is significantly less than that associated with conventional mining and milling.*

5. *By removing the solid wastes from the site to a licensed waste disposal site and otherwise restricting them from contaminating the surface and subsurface environment, the entire mine site can be returned to unrestricted use within a relatively short time.*

6. *Solution mining results in significantly less water consumption than conventional mining and milling.*

7. *The socioeconomic advantages of ISR include:*

   - *The ability to mine a lower grade ore,*
   - *A lower capital investment,*
   - *Less risk to the miner,*
   - *Shorter lead time before production begins, and*
   - *Lower manpower requirements.*

Additional References:

International Atomic Energy Agency. "Manual of Acid In Situ Leach Uranium Mining Technology," IAEA-TECDOC-1239, Vienna, Austria, August 2001.

Mudd, G.M. "Acid In Situ Leach Uranium Mining : 1 - USA and Australia." Tailings & Mine Waste 2000, Fort Collins, CO. January 2000.

Question ER 2.5 No.4 Reasonable Alternatives – Quantitative and Qualitative Support

RAI Question:

Quantitative and qualitative support for the assessments that are made in Table 2.6-1.

Answer:

The information presented in Table 2.6-1 Comparison of Predicted Environmental Impacts, is supported by the qualitative and quantitative analysis found in Section 4 (Environmental Impact) of this Environmental Report. Additional quantitative information for the Preferred Alternative category has been incorporated into Table 2.6-1 including data for Land Surface Impacts, Land Use Impacts, Geology and Soil Impacts, Groundwater Impacts, Noise Impacts, Radiological Health Impacts, and Waste Management Impacts. Also, the corresponding subsection numbers have been referenced for the Preferred Alternative information.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI. Changes to the original text, as previously submitted to NRC, are noted in red-line/strikeout method.

Insert Revised Table 2.6-1