Evaporation Pond Design Report
Piñon Ridge Project
Montrose County, Colorado

Prepared for:

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EXECUTIVE SUMMARY

Energy Fuels Resources Corporation (EFRC) is in the process of completing designs for a uranium mill, termed the Piñon Ridge Project, located in Montrose County, Colorado. Golder Associates Inc. (Golder) was contracted to provide geotechnical design for construction of the tailings cells, evaporation ponds and ore pads at the Piñon Ridge Project. Golder's evaporation pond design scope of work includes:

- Conducting a geotechnical field and laboratory test investigation of the proposed evaporation pond area (Golder, 2008a);
- Reviewing available data and regulatory requirements, and development of project design criteria;
- Conducting engineering analyses and design for the evaporation ponds, including probabilistic water balance modeling, design of liner systems, design of leak collection and recovery systems, and water fowl protection design; and
- Development of design drawings and specifications for potential two-phased construction of the evaporation ponds, with the first phase designed for 500 ton per day (tpd) operations, with potential for expansion to an ultimate capacity of 1,000 tpd.

The plan area of the lined portion of each evaporation pond is 4.13 acres, with a total Phase I lined area of 41.3 acres and a total combined Phase I/Phase II lined area of 82.6 acres. The evaporation ponds have been designed with measures to enhance evaporation, including installation of black geomembrane liner and operation of sprinklers.

The evaporation ponds are each designed with a primary and secondary liner system and an intervening leak collection and recovery system (LCRS). The LCRS design provides for capture and conveyance of the seepage through the upper primary liner to a collection sump. LCRS sumps have been included in the design of each evaporation pond cell. Solution collected in the LCRS sumps will be pumped using a mobile pump, and returned to the evaporation ponds.

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1.0 INTRODUCTION

Energy Fuels Resources Corporation (EFRC) is in the process of completing designs for a new uranium mill, termed the Piñon Ridge Project, located in Montrose County, Colorado. Golder Associates Inc. (Golder) was contracted to provide geotechnical design for construction of the tailings cells, evaporation ponds and ore pads at the Piñon Ridge Project.

1.1 Scope of Work

Golder's evaporation pond design scope of work includes:

- Conducting a geotechnical field and laboratory test investigation of the proposed evaporation pond area (Golder, 2008a);
- Reviewing available data and regulatory requirements, and development of project design criteria;
- Conducting engineering analyses and design for the evaporation ponds, including probabilistic water balance modeling, design of liner systems, design of leak collection and recovery systems, and water fowl protection design; and
- Development of design drawings and specifications for potential two-phased construction of the evaporation ponds, with the first phase designed for 500 ton per day (tpd) operations, with potential for expansion to an ultimate production rate of 1,000 tpd.

The plan area of the lined portion of each evaporation pond is 4.13 acres, with a total Phase I lined area of 41.3 acres and a total combined Phase I/Phase II lined area of 82.6 acres.

1.2 Property Location

The Piñon Ridge Project is located in Montrose County, Colorado in the Paradox Valley, approximately 15 miles northwest of the town of Naturita on Highway 90. The physical address of the site is 16910 Highway 90; Bedrock, Colorado. The approximate site location is: latitude 38° 15' N, longitude 108° 46' W; and elevation 5,500 feet above mean sea level (amsl). The property is located within Sections 5, 8, and 17, Township 46 North, and Range 17 West. The site lies in the gently sloping base of the northwest-trending Paradox Valley with steep ridges on either side. Drawing 1 presents a general location map for the Piñon Ridge property.

2.0 GENERAL SITE CONDITIONS

The site terrain is gently sloping toward the north, with shallow to moderately incised arroyos across the property. The northern half of the site is generally covered in dense sagebrush while the southern half is sparsely vegetated with grass and cacti.

The Paradox Valley was formed by an anticline heavy in evaporites. As the evaporites began to dissolve, part of the anticline sank forming the Paradox Valley. The bedrock underlying the site primarily consists of claystone and gypsum of the Hermosa Formation. The gypsum generally shows a massive texture, whereas the claystone is typically highly fractured. Less significant zones of sandstone, siltstone and claystone of the Cutler and Moenkopi Formations were also found across the Piñon Ridge Project site during the field investigation. Groundwater in the vicinity of the evaporation ponds is greater than 600 feet below the ground surface, as the prevalence of the Hermosa Formation increases toward the northern portion of the site, and hence the thickness of the non-water-bearing gypsum unit.

2.1 Climate

The macro-climate of the Piñon Ridge Project area is classified by the Koppen Climate Classification System as a BSk, which indicates a semi-arid steppe with much of the characteristics of a desert (Kleinfelder, 2007a).

Meteorological towers have been installed on-site to provide baseline site data; however, on-site climatic data is not yet available. Golder conducted a review of climatic data obtained from the Western Regional Climate Center for the Uravan, Nucla, Grand Junction (Airport and 6 ESE), and Montrose weather stations. The evaluation of climate data for these nearby weather stations indicates that the Uravan weather station is likely to provide reasonable precipitation estimates for the site (see Appendix A-1). Climatic data available for the Uravan weather station included precipitation, air temperature, and snow cover for the years of record of 1960 through 2007. The Hargreaves (1985) method was used to estimate monthly evaporation values at the Piñon Ridge site, using the available climate data from Uravan. The calculated evaporation values were scaled by a factor of 0.7 to represent lake evaporation. The average monthly climatic data used for design of the Piñon Ridge facilities is summarized in Table 1. Considering this climatic data, the annual evaporation exceeds annual precipitation on average by about three times.

The predominant wind directions for the site are east and east-southeast, with an average annual wind speed of 5.3 miles per hour (mph) (Kleinfelder, 2007b). The maximum wind speed used for facility design is 23.4 mph, which was recorded at the Grand Junction weather station (see Appendix A-1).

2.2 Geotechnical Conditions

A geotechnical investigation was conducted by Kleinfelder West Inc. (Kleinfelder) and Golder in accordance with Criterion 5(G)(2), 6 CCR 1007 Part 18. Phase 1 of the investigation was directed by Kleinfelder to develop general characterization of the site. Phase 2 was conducted jointly by Kleinfelder and Golder to support geotechnical design work for the site, including the evaporation ponds.

As part of the Phase 1 geotechnical investigations, Kleinfelder drilled twenty (20) geotechnical boreholes (PR1-1 to PR-20) spaced across the site to depths ranging from 30.3 to 98.8 feet below the ground surface, installed six monitoring wells (MW-1 to MW-6) at depths of 100 to 600 feet below the ground surface, and completed three seismic reflection/refraction geophysical lines trending north-south across the site.

The Phase 2 geotechnical field investigation conducted by Golder (2008a) consisted of 48 drill holes and 11 test pits within the proposed tailings cells, evaporation pond, and ore pad areas. The geotechnical conditions encountered in the 17 drill holes (GA-BH-01 through GA-BH-17) completed in the evaporation pond area consisted of bedrock depths ranging from 14.5 feet to 67 feet. Bedrock was not encountered in several borings at exploration depths ranging from 50 to 70 feet. The overburden soils generally consist of windblown loess (i.e., ML, SM, SW, CL) with occasional layers of alluvium (i.e., GM, SM). Bedrock generally consisted of claystone, gypsum, and siltstone of the Hermosa Formation. Blowcounts in the overburden materials underlying the evaporation pond area ranged from 3 to refusal (i.e., greater than 50 blows per 6 inches).

Findings from the geotechnical investigations reveal the following general site characteristics:

- Groundwater was encountered in a few monitoring wells (MW-6, MW-7, MW-8 and MW-9) on the southern portion of the site, with no groundwater encountered to the north of these wells. The depth to groundwater was between 340 and 400 feet below the ground surface in these wells. The groundwater has a high sulfur content. Holes drilled within the evaporation pond area at the northern end of the property went as deep as 600 feet without encountering groundwater.

- The site is underlain by a number of aquitards. Additionally, evaporite rock of the Hermosa Group, which does not host any measurable amount of water, underlies the proposed location of the evaporation ponds. This geological feature significantly reduces any potential impact to groundwater during the Mill's "Active Life" (as defined in Criterion 5A of Appendix A to include the closure period).

- While the geophysical investigation identified some possible fault traces underlying the proposed evaporation pond area, trenching and mapping confirmed that these features are overlain by a minimum of 20 feet of undisturbed alluvial/colluvial soil. Accordingly, this data confirms that the potential faults are at least 10 million years old and can be classified as "non capable faults" as defined in section III(g) of Appendix A of 10 CFR Part 100.

3.0 EVAPORATION POND DESIGN

This section provides the engineering analyses and technical details to support design of the evaporation ponds for the Piñon Ridge Project.

3.1 Design Criteria

3.1.1 Design Regulations

Regulations relevant to the design of the evaporation ponds presented here in Section 3.0 are summarized below.

Key Regulatory Agencies and Documents:

Colorado Department of Public Health and Environment (CDPHE): 6 CCR 1007-1, Part 18 – "*State Board of Health Licensing Requirements for Uranium and Thorium Processing*", specifically Appendix A (Criteria relating to the operation of mills and the disposition of the tailings or wastes from these operations).

Environmental Protection Agency (EPA): 40 CFR Part 264 – "*Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*", Subpart K (Surface Impoundments); and 40 CFR Part 192 – "*Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*", Subpart D (Standards for management of uranium byproduct materials pursuant to section 84 of the Atomic Energy Act of 1954, as amended).

Note: Per Rule 17 (Exempt Structures) of the State of Colorado, Department of Natural Resources, Division of Water Resources (Office of the State Engineer [OSE], 2007) "Rules and Regulations for Dam Safety and Dam Construction", uranium mill tailing and liquid impoundment dams are exempt from these rules with permitting authority provided by the Colorado Department of Public Health and Environment (CDPHE).

3.1.2 Project Design Criteria

Design criteria relevant to the analyses presented here in Section 3.0 are summarized below.

Geometry:

Milling Operations: Design capacity of 500 tons per day (tpd) of tailings disposal, with potential expansion capacity to 1,000 tpd.

Evaporation Pond Storage Capacity: 256 acre-feet for Phase I (i.e., 25.6 acre-feet per cell), with potential expansion to 512 acre-feet (see Figure 1).

Maximum Evaporative Surface Area: 41.3 acres for Phase I (i.e., 4.1 acres per cell), with potential expansion to 82.6 acres.

Mill Design Life: 40 years (dependent upon milling rate).

Raffinate Stream Properties:

Design Volumetric Flow Rate: 63 gallons per minute (gpm) at a milling capacity of 500 tpd, with 126 gpm at an ultimate milling capacity of 1000 tpd.

System Requirements:

Evaporation Pond Liner System: Double layer liner system as follows (top to bottom): (1) upper (primary) geomembrane liner; (2) leak collection and recovery system; (3) lower (secondary) geomembrane liner; underlain by (4) minimum three feet of low permeability soil liner with a hydraulic conductivity no more than $1x10^{-7}$ centimeters per second (cm/sec), or approved equivalent (per 40 CFR 264.221 by reference from 10 CFR 40 and 6 CCR 1007-1, Part 18).

Leak Collection and Recovery System: Per 40 CFR 264.221 (by reference from 10 CFR 40 and 6 CCR 1007-1, Part 18), the leak detection system shall meet the following requirements: (1) constructed with a bottom slope of one percent or more; (2) constructed of granular drainage materials with a hydraulic conductivity of $1x10^{-1}$ cm/sec or greater and a thickness of 12 inches or more, or constructed of a synthetic or geonet drainage material with a transmissivity of $3x10^{-4}$ square meters per second (m^2/sec) or more; (3) constructed of materials that are chemically resistant to the waste and leachate; (4) designed and operated to minimize clogging during the active life and post-closure care period; and (5) constructed with sumps and liquid removal methods (i.e., pumps).

3.2 Design Concepts

This section presents the general evaporation pond design concepts with the technical details for these concepts discussed in detail in the following sections.

3.2.1 General Evaporation Pond Design Concepts

The Piñon Ridge Mill is designed for start-up operations at 500 tons per day (tpd), with a potential to expand to 1,000 tpd. The design raffinate flows from the process circuit (CH2M Hill, 2008), which includes water collected from the tailings cells in excess of that needed for re-circulation to the mill, will be discharged to the evaporation ponds. The design flow rates associated with the start-up and ultimate production rates are 63 and 126 gallons per minute (gpm), respectively. The average volumetric flow rate to the evaporation ponds for the 1,000 tpd scenario is somewhat less at 117 gpm.

The evaporation pond system is designed for construction in two phases. Phase I includes 10 ponds (or cells), each with a surface dimension of 300 feet by 600 feet (i.e., 4.13 acres), designed to evaporate the inflows associated with the 500 tpd production schedule. Similarly, Phase II includes an additional 10 ponds with the same dimensions designed to evaporate the flows associated with the 1,000 tpd production schedule. Both phases of construction are designed to provide contingency storage for the 1,000-year storm event acting over the respective pond area, with an additional one foot of freeboard (above the required design capacities). Pond berms with a minimum crest width of 15 feet are designed between ponds to allow access from all sides of the cells, as well as installation of bird netting supports. All of the evaporation ponds are designed at the same elevation, allowing for gravity flow of the raffinate from the inlet pond (i.e., the southeastern-most pond cell) to all other ponds. Consequently, the water depth in each pond will be similar, maximizing the evaporative surface area. Leak collection and recovery system (LCRS) sumps have been included in the design of each evaporation pond cell. Solution collected in the LCRS sumps will be pumped using a mobile pump, and returned to the evaporation ponds.

In order to improve performance of the evaporation pond system (i.e., enhance the evaporative capabilities), the design includes implementation of a sprinkler system. The sprinklers will be placed and sized to maximize evaporation and minimize the potential for wind-drift beyond the extents of the lined evaporation pond area. A continuous liner is designed over the entire evaporation pond area, including over the separation berms. A textured geomembrane will be extrusion welded on top of the berms between pond cells to facilitate access (i.e., pedestrian or ATV).

Measures taken to limit water fowl from accessing the evaporation ponds included design of a bird netting system. The individual pond cell dimensions of 300 feet by 600 feet were selected based on the maximum practical span for the bird netting system. The bird netting system will consist of wooden support poles spaced approximately 48 feet apart along the 15-foot wide pond divider berms, designed to elevate and support the primary cable system. A secondary cable system will link the primary cables, creating a cable grid over which the netting can then be placed. The base of each wooden support pole will be sealed to prevent raffinate infiltration around the liner at the pole locations. The bird netting is designed with two-inch openings to prevent access from water fowl. Drawings 6 and 7 provide details for installation of the bird netting system for both Phases I and II. Bird netting system design details are discussed in greater detail in Section 3.6.

3.2.2 Surface Water Control Design Concepts

Site-wide surface water design was conducted by Kleinfelder, and will be presented under separate cover. Surface water run-on into the evaporation ponds includes surface water run-off from the perimeter berms, direct precipitation onto the evaporation pond area, and stormwater overflow via a spillway and channel (or pipe) from the West Stormwater Pond. The West Stormwater Pond is designed to contain the 100-year storm event, with runoff in excess of the 100-year storm event (up to the 1,000-year storm event) reporting to the evaporation pond system.

3.2.3 Closure Design Concepts

The closure plan for the evaporation ponds at the Piñon Ridge Project has been designed and integrated with the closure plan for the tailings cells. Closure of the evaporation ponds includes excavation and disposal of geosynthetic materials into the tailings cells as well as removal and disposal of the upper 12 inches of soil below the liner system. After excavation and disposal of the aforementioned materials into the tailings cells, the evaporation pond area will be regraded and revegetated to tie in with the natural landscape.

More detailed information on the tailings cells closure and the evaporation ponds disposal can be found in the Tailings Cell Design Report (Golder, 2008d).

3.3 Liner System Design

As noted previously, investigative drilling to depths of up to 600 feet below the ground surface did not encounter any groundwater under the planned location of the evaporation ponds. The nearest discovery of groundwater was 3,200 feet south of the evaporation pond location. Additionally, a number of aquitards were identified during the geotechnical field investigation, further limiting any potential impacts to the groundwater regime during the “Active Life” of the Mill. However, as noted in Golder (2008a), the evaporation pond area is underlain by varying thicknesses of collapsible soils and therefore the evaporation ponds were conservatively designed applying the same standards as those required for the tailings cells (i.e., 40 CFR 264.221, by reference from 10 CFR 40 and 6 CCR 1007-1 [Part 18]). The evaporation pond design utilizes a double liner system with an intervening Leak Collection and Recovery System (LCRS) for groundwater protection and enhanced seepage protection, as follows (from top to bottom):

- 60-mil high density polyethylene (HDPE) upper (primary) geomembrane;
- LCRS consisting of HDPE geonet;
- 60-mil HDPE lower (secondary) geomembrane;
- Reinforced geosynthetic clay liner (GCL) as the underliner component of the secondary composite liner system; and
- Prepared subgrade.

Liner system details for the evaporation ponds are provided on Drawing 8.

3.3.1 Upper (Primary) Liner

The upper primary liner will consist of a conductive smooth 60-mil HDPE geomembrane. An HDPE liner was chosen for its long term performance due to its chemical resistance properties (see Chemical Resistance Charts in Appendix D), resistance to ultraviolet radiation, high tensile strength, and high stress-crack resistance (Lupo & Morrison, 2005). The evaporation pond liner will be exposed for the life of the mine (i.e., 20 to 40 years), and was therefore designed for long-term solar radiation exposure (see Section 4.1 and Golder, 2008b). To facilitate quality assurance during installation of the liner system, the upper primary geomembrane liner will be conductive to facilitate spark testing of the liner surface upon completion of the installation (see Section 4.2). A standard black HDPE geomembrane will be employed as the upper (primary) liner for increased heat retention to enhance evaporation potential.

3.3.2 Leak Collection and Recovery System

An important feature of the evaporation pond liner system is the Leak Collection and Recovery System (LCRS) layer, designed per 40 CFR 264.221 (by reference from 10 CFR 40 and 6 CCR 1007-1, Part 18). If a leak occurs in the upper primary geomembrane, the LCRS is designed to minimize the hydraulic heads on the lower geomembrane liner by utilization of HDPE geonet.

In the event that leakage occurs through the upper geomembrane liner, it will be collected in the LCRS layer and routed (via gravity flow) to a LCRS sump located in each evaporation pond cell. The LCRS design is discussed in greater detail in Section 3.4.

3.3.3 Lower (Secondary) Composite Liner System

Beneath the LCRS layer is a 60 mil smooth HDPE secondary geomembrane liner. This liner provides secondary containment of process solutions should leakage occur through the upper primary geomembrane liner.

The lower secondary geomembrane liner will be underlain by a GCL, which consists of a layer of sodium bentonite encapsulated between two geotextiles with an upper woven geotextile and lower nonwoven geotextile which is subsequently needle-punched together to form a hydraulic barrier material (i.e., CETCO Bentomat ST, or equivalent). The GCL is approximately 0.4 inches thick with a reported hydraulic conductivity of $5x10^{-9}$ centimeters per second (cm/sec). Since the mid-1980s, GCLs have been increasingly used as an alternative to compacted clay liners on containment projects due to ease of construction/installation, resistance to freeze-thaw and wet-dry cycles, and low cost.

Golder (2008d) presents an analysis conducted for the tailings cell liner system using the method proposed by Giroud et al. (1997) to demonstrate that the secondary composite liner system consisting of a 60-mil HDPE geomembrane overlying a GCL has equivalent or improved fluid migration characteristics when compared to a secondary composite liner system consisting of a 60-mil HDPE geomembrane overlying the prescriptive compacted clay liner (i.e., 3 feet of 10^{-7} cm/sec soil, per 40 CFR 264.221). This site-specific analysis is relevant to design of the evaporation pond liner system, and accounts for a potential increase in the GCL hydraulic conductivity in the unlikely event that leakage through both the primary and secondary geomembrane liners occurs in sufficient quantities to saturate the GCL with raffinate. The amount of flow through the secondary liner system with the prescriptive compacted clay liner was evaluated to be nearly 5 times greater than the flow through the secondary liner system with a standard GCL underliner, and more than 8 times greater that the flow through a secondary liner system with a polymer-treated GCL underliner. Therefore, in terms of limiting fluid flow through the composite secondary liner system, the secondary liner system containing a standard GCL performs better than the secondary liner system containing the prescriptive clay liner, and the use of a polymer-treated bentonite within the GCL is not warranted.

Compatibility testing of the proposed GCL with the anticipated tailings solution chemistry provided by the process designers (CH2M Hill, 2008) was conducted by TRI/Environmental, Inc. (TRI) under contract to CETCO Lining Technologies (CETCO), the manufacturer of the proposed GCL material. The raffinate chemistry is very similar to the tailings solution chemistry, and therefore GCL compatibility testing with the tailings solution chemistry is considered relevant for design of the

evaporation ponds. For reference, Table 2 summarizes the chemistry of the two solutions. Results of this testing program indicate that the anticipated tailings leachate may result in an increase to the permeability of the standard GCL from $5x10^{-9}$ cm/sec to approximately $1.1x10^{-8}$ cm/sec. Testing of a polymer-treated GCL in contact with the anticipated tailings leachate indicates negligible change in GCL permeability. A more detailed description of the GCL compatibility testing program is provided in Golder (2008d).

3.4 Leak Collection and Recovery System Design

As part of the evaporation pond design, a leak collection and recovery system (LCRS) has been incorporated to meet the requirements of the regulations. If a leak occurs in the upper primary geomembrane, the LCRS is designed to minimize the hydraulic heads on the lower geomembrane liner. Details of the LCRS system are shown on Drawing 9.

The LCRS layer has been designed as an HDPE geonet with a minimum transmissivity of $2x10^{-3}$ square meters per second (m^2/sec), which exceeds the minimum transmissivity requirement of $3x10^{-4}$ m^2/sec (per 40 CFR 264.221). The drainage layer is designed with a thickness of 200 mil.

In the event that leakage occurs through the upper geomembrane liner, it will be collected in the LCRS layer and routed (via gravity flow) to a LCRS sump located in each evaporation pond cell. The LCRS sumps were conservatively sized using a minimum base dimension of 10 feet for constructability. The sump for each evaporation pond cell is designed to have base dimensions of 10 feet by 30 feet, 3H:1V side slopes, and a 5-foot depth based on the designed grading for the pond cells (i.e., flat portions of the cell are underlain by the LCRS sump). The LCRS sump provides capacity for approximately 14 days of anticipated leakage (see LCRS sump sizing calculation in Appendix E), which facilitates use of a mobile pump for removal of leak solution, and return to the evaporation ponds.

Two LCRS riser pipes are provided within each sump to add redundancy to the system. The risers consist of 10-inch diameter, SDR-17 HDPE pipes. The lower ends of the pipes are slotted in the sump area to provide solution access into the risers. Solution is recovered via a mobile submersible pump (designed by others) which will be installed in the riser as needed. The LCRS risers will be instrumented and fully-automated to report to the mill control system with an alarm in the mill. Recovered solutions will be returned to the evaporation pond system.

Action Leakage Rates (ALRs) were evaluated for the LCRS sump using the guidelines published by the U.S. Environmental Protection Agency (EPA, 1992). The ALR is defined in 40 CFR 264.222 as "*the maximum design flow rate that the leak detection system (LDS) can remove without the fluid head on the bottom liner exceeding 1 foot*." The ALR calculations are provided in Appendix B. Based on these calculations, the ALR for the LCRS sump contained within each evaporation pond cell is 12,000 gallons per acre per day (gpad).

3.5 Water Balance Modeling

Golder developed a probabilistic water balance to assist in sizing of the evaporation pond system (i.e., required evaporative surface area). Water balance calculations were performed using the computer program Goldsim™, and are presented in detail in Appendix A.

The following water balance components were considered: (1) the amount of raffinate water entering the pond system from the mill (CH2M Hill, 2008), (2) water entering the system through meteoric precipitation, and (3) the amount of water released to the atmosphere through evaporation. Precipitation values are likely to exhibit largest variations, and were therefore treated as stochastic inputs (i.e., probabilistic), while the other parameters were treated as deterministic variables. Figure 2 presents the process flow diagram for the evaporation pond water balance.

Preliminary analyses revealed a prohibitively large evaporation area for extreme precipitation events when considering evaporation losses solely from the pond surface. To reduce the required evaporative area, subsequent analyses included a sprinkler system resulting in enhanced evaporation losses. All sprinkler heads will be located a minimum of 300 feet from the edge of the lined evaporation pond area to minimize the probability of wind-drift blowing the raffinate beyond the lined evaporation pond area.

The results of the water balance were calculated assuming a four percent (4%) chance of exceedance (requiring mill shutdown) over the maximum anticipated mill life of 40 years, which is the probability that the 1,000-year storm event will occur during the operational period. Based on this assumption, the required evaporative areas for milling operations of 500 and 1,000 tons per day were calculated to be 45.5 and 82.6 acres, respectively. The Phase I evaporation pond design provides 41.3 acres of pond surface area, a reduction from the calculated 45.5 acres. This deviation from the calculated value is based on the assumption that mill expansion to 1,000 tpd will occur by the end of year 10 of operations (see Table A-7 in Appendix A). However, field measurements during the early years of

milling will assist in optimization of the required evaporation pond area, and an additional cell (or cells) will be added for the designed 500 tpd milling rate as needed to accommodate actual site conditions.

The influence of potential bird netting and the presence of dissolved solids in the process flow to the evaporation ponds are both likely to affect pond evaporation. Thus, the need to provide field evaporation measurements during the early years of milling operations is warranted. These field measurements will assist in refining expansion design of the evaporation ponds for an increase to 1,000 tpd operations.

3.6 Bird Netting Design

The acidic solution contained within the evaporation ponds represents a potential threat to endangered birds and migratory waterfowl. Birds view these ponds as an opportunity to rest and feed. If allowed to land, the birds may become poisoned by getting into contact with chemicals present in the evaporation ponds. This situation creates a liability under the Migratory Bird Treaty Act (U.S. Congress, 1976). In order to limit bird mortality, a bird netting system was designed to reduce water fowl access to the evaporation ponds. Design of the water fowl protection system is presented in detail in Appendix C. Details of the bird netting system are illustrated in Drawings 6 and 7.

4.0 CONSTRUCTION CONSIDERATIONS

This section presents considerations for construction of the evaporation pond system. A number of these items were developed as a result of project meetings with the Colorado Department of Public Health and Environment (CDPHE) during the course of the design, particularly those that relate to Construction Quality Assurance (CQA) and addressing CDPHE concerns regarding long-term exposure of the pond liner system.

4.1 Geomembrane Exposure

The evaporation pond liner system will remain exposed during the active life of the mine (i.e., 20 to 40 years), with disposal of the evaporation pond liner system in the tailings cells during mill closure. High density polyethylene (HDPE) geomembrane has been selected as the primary geomembrane liner. The HDPE's resistance to ultraviolet (UV) radiation is one of the primary reasons that it was selected as the geomembrane for evaporation pond construction at the Piñon Ridge Project. Refer to Golder (2008b) for a literature review and presentation of results supporting the use of HDPE geomembrane for the Piñon Ridge Project. Major points from Golder (2008b) are summarized in the following sections.

When exposed to atmospheric conditions, plastic materials containing impurities can absorb UV energy which can excite photons and create free radicals within the plastic (Zeus, 2005). These free radicals then proceed to degrade the plastic by causing a chain reaction of molecule damage that can accelerate breakdown of the material (Layfield, 2008). However, a variety of methods are available to both limit the production of free radicals and inhibit the chain reaction of molecule degradation in plastics, including use of stabilizers, absorbers or blockers (Zeus, 2005).

HDPE geomembrane is manufactured with 2 to 3 percent carbon black, a material produced by the incomplete combustion of petroleum products, which provides protection to the geomembrane structure by blocking the degradation process (Layfield, 2008). The chemical properties of carbon black further act to absorb molecular-damaging free radicals, preventing them from causing additional damage. Carbon black is universally accepted as being resistant to significant deterioration caused by weathering for 50 years or more (GSE, 2003). In addition to carbon black, many HDPE manufacturers, such as GSE, utilize highly effective chemical UV stabilizers that further extend the life of the material to which it is added (GSE, 2003). Properly formulated and compounded

polyethylenes, achieved through the use of carbon black and chemical stabilizers, have an estimated projected life in excess of 100 years for resistance to weathering due to exposure (GSE, 2003).

Evaluations of HDPE geomembrane from field performance and laboratory test data presented in Golder (2008b) provide evidence that exposure of a 60-mil HDPE geomembrane to UV for 20 or more years will not result in significant degradation of the geomembrane. The results of field tests of actual operating facilities utilizing HDPE geomembrane (Golder, 2008b) support the conclusion that the use of HDPE geomembrane as designed for the evaporation ponds will maintain sufficient integrity despite UV exposure during their estimated lifetimes. Laboratory test results presented in Golder (2008b) predict an even longer life and improved UV resistance for HDPE geomembrane, even when stabilized only with the standard percentages of carbon black (i.e., no additional antioxidants or UV stabilizers).

4.2 GCL Underliner Construction Considerations

Due in part to the lack of locally-available low permeability soil sources for underliner, geosynthetic clay liner (GCL) has been designed as the underliner component of the secondary composite liner system for the evaporation ponds (see Section 3.3.3). Where geomembrane composite-lined slopes underlain by compacted clay liner materials have been exposed for long periods of time, desiccation and cracking of the clay component often occurs (Giroud, 2005). The use of GCL as the underliner component prevents the issue of clay desiccation, but shrinkage has been documented to occur due to long-term exposure (i.e., numerous drying [i.e., day] and hydration [i.e., night] cycles) of the liner system (Giroud, 2005). The design drawings and Technical Specifications (Golder, 2008c) include increasing the manufacturer-recommended longitudinal overlap of the GCL (from 6 to 12 inches) and increasing the manufacturer-recommended end-of-roll overlaps (from 2 to 4 feet) to limit effects of GCL shrinkage within the evaporation pond liner system.

In addition to the construction considerations discussed previously, pre-hydration of the GCL is provided during the construction process to enhance the permeability characteristics of the GCL. The reader is referred to Shackelford et al. (2000) for the benefits of prehydration of the GCL with regard to the resulting permeability. Prior to GCL placement, the subgrade soils will be moisture-conditioned and compacted to a minimum 95 percent of the standard Proctor (ASTM D 698) maximum dry density at optimum to plus 4 percent of the optimum moisture content. This recommended specification is based on the results of a study conducted by Bonaparte et al. (2002) which shows that prehydration of the GCL is obtained via subgrade moisture absorption.

4.3 Electrical Leak Integrity Survey

An electrical leak integrity survey will be conducted after completion of evaporation pond liner installation, prior to start-up of operations. Requirements of the electrical leak detection survey have been incorporated into the Geosynthetics CQA Plan (Section 1400.2 of the Technical Specifications; Golder, 2008c).

At present, there are many ways of conducting electrical leak detection surveys of geomembranes. Some of these methods involve filling the lined area with water prior to testing, while others are only applicable to specific liner configurations (such as single liner systems and liners covered with soil). Based on the available methods (ASTM D 6747) and considering the lack of locally-available water as well as the expansive nature of the evaporation ponds, the most appropriate method involves installation of an electrically conductive geomembrane as the primary geomembrane in the system.

Electrically conductive geomembrane is constructed with a thin conductive layer adhered to and underneath a polyethylene geomembrane, which is naturally non-conductive. Once installed, the exposed geomembrane is tested for leak paths according to ASTM D 7240 (Conductive Geomembrane Spark Test) in the following manner:

- The conductive (under) side of the geomembrane is charged; and
- A conductive element is swept over the upper surface of the geomembrane, creating a spark where potential leak paths exist. An alarm is built into the system to sound each time a spark is detected.

This system is capable of detecting leak paths smaller than one millimeter (1 mm) in diameter and repairs can be made immediately upon leak path detection. Due to the nature of the test and the fact that the conductive layers of adjacent rolls are not necessarily in good contact, traditional non-destructive seam testing is still needed. This test does not require the use of any water.

5.0 USE OF THIS REPORT

This report has been prepared exclusively for the use of Energy Fuels Resources Corporation (EFRC) for the specific application to the Piñon Ridge Project. The engineering analyses reported herein were performed in accordance with accepted engineering practices. No third-party engineer or consultant shall be entitled to rely on any of the information, conclusions, or opinions contained in this report without the written approval of Golder and EFRC.

The site investigation reported herein was performed in general accordance with generally accepted Standard of Care practices for this level of investigation. It should be noted that special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing program implemented in accordance with a professional Standard of Care may fail to detect certain subsurface conditions. As a result, variability in subsurface conditions should be anticipated and it is recommended that a contingency for unanticipated conditions be included in budgets and schedules.

Golder sincerely appreciates the opportunity to support EFRC on the Piñon Ridge Project. Please contact the undersigned with any questions or comments on the information contained in this report.

Respectfully submitted,

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6.0 REFERENCES

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10 CFR Part 40 – "*Domestic Licensing of Source Material*", Appendix A to Part 40 (Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for their Source Material Content).

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