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^{o} 15' N, longitude 108^{o} 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,

GOLDER ASSOCIATES INC.

Kimberly Finke Morrison, P.E., R.G.
Senior Project Manager

James M. Johnson, P.E.
Principal, Project Director

6.0 REFERENCES

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).

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).

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).

40 CFR Part 264 – "*Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*", Subpart K (Surface Impoundments).

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TABLES

TABLE 1

MONTHLY PRECIPITATION AND EVAPORATION VALUES

Month	Average* Precipitation (inches)	Calculated Lake Evaporation (inches)
January	0.9	0.8
February	0.8	1.2
March	1.0	2.2
April	1.0	3.3
May	0.9	4.8
June	0.5	5.8
July	1.2	6.3
August	1.4	5.4
September	1.5	3.8
October	1.5	2.5
November	1.1	1.2
December	0.9	0.7
Total	12.7	38.0

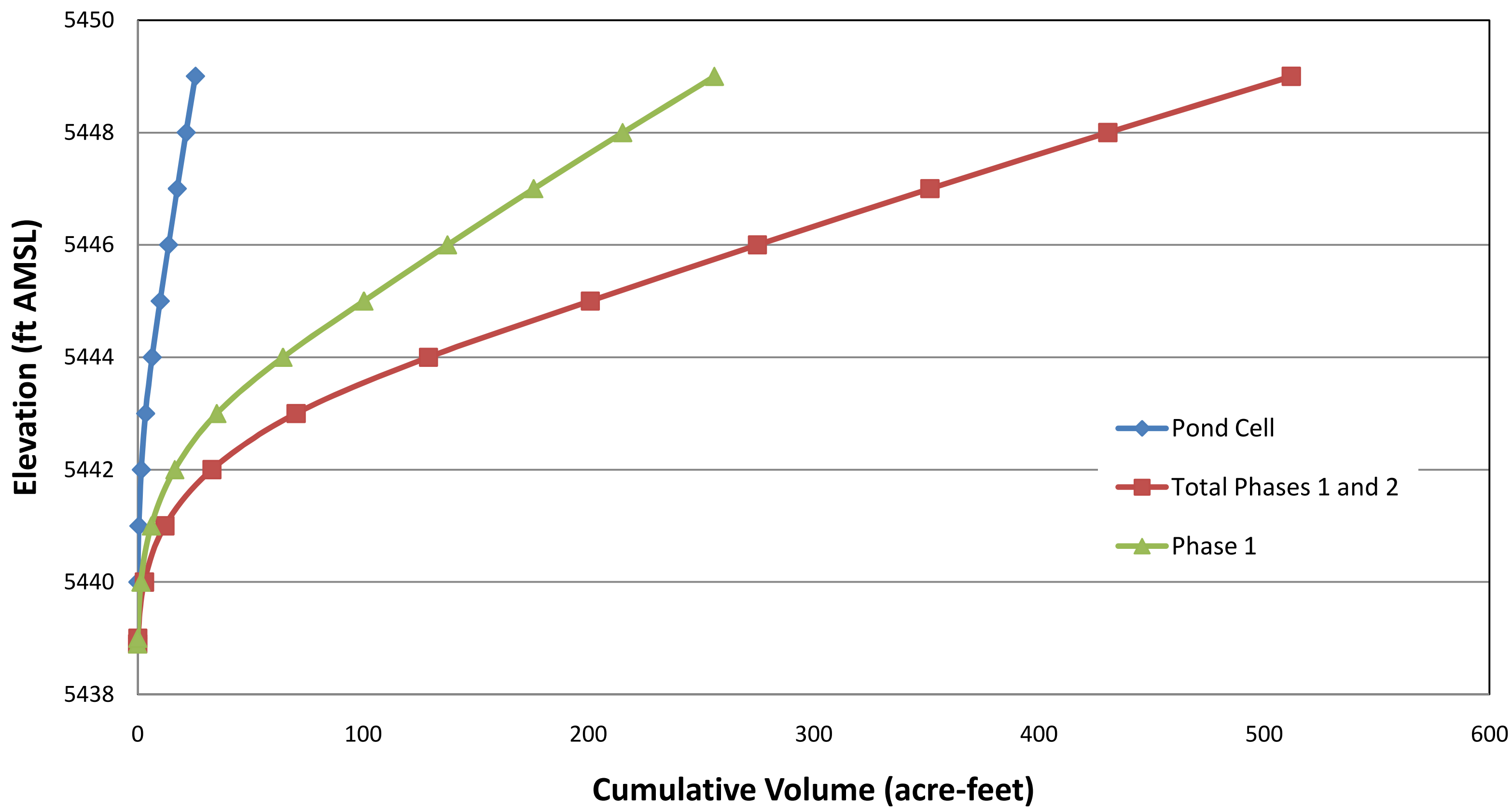
Precipitation values obtained for Uravan weather station from 1961 to 2007

TABLE 2

DESIGNED LEACHATE COMPOSITIONS

Reagent	Raffinate (CH2M Hill, 2008) (g/L)	Tailings Leachate (CH2M Hill, 2008) (g/L)
H_2SO_4	0.01	0.084
$FeSO_4$	0	0.014
$Fe_2(SO_4)_3$	36.00	35.99
$(NH_4)_2SO_4$	34.9	34.9
Na_2SO_4	3.916	3.917

FIGURES



Golder Associates | Denver, Colorado

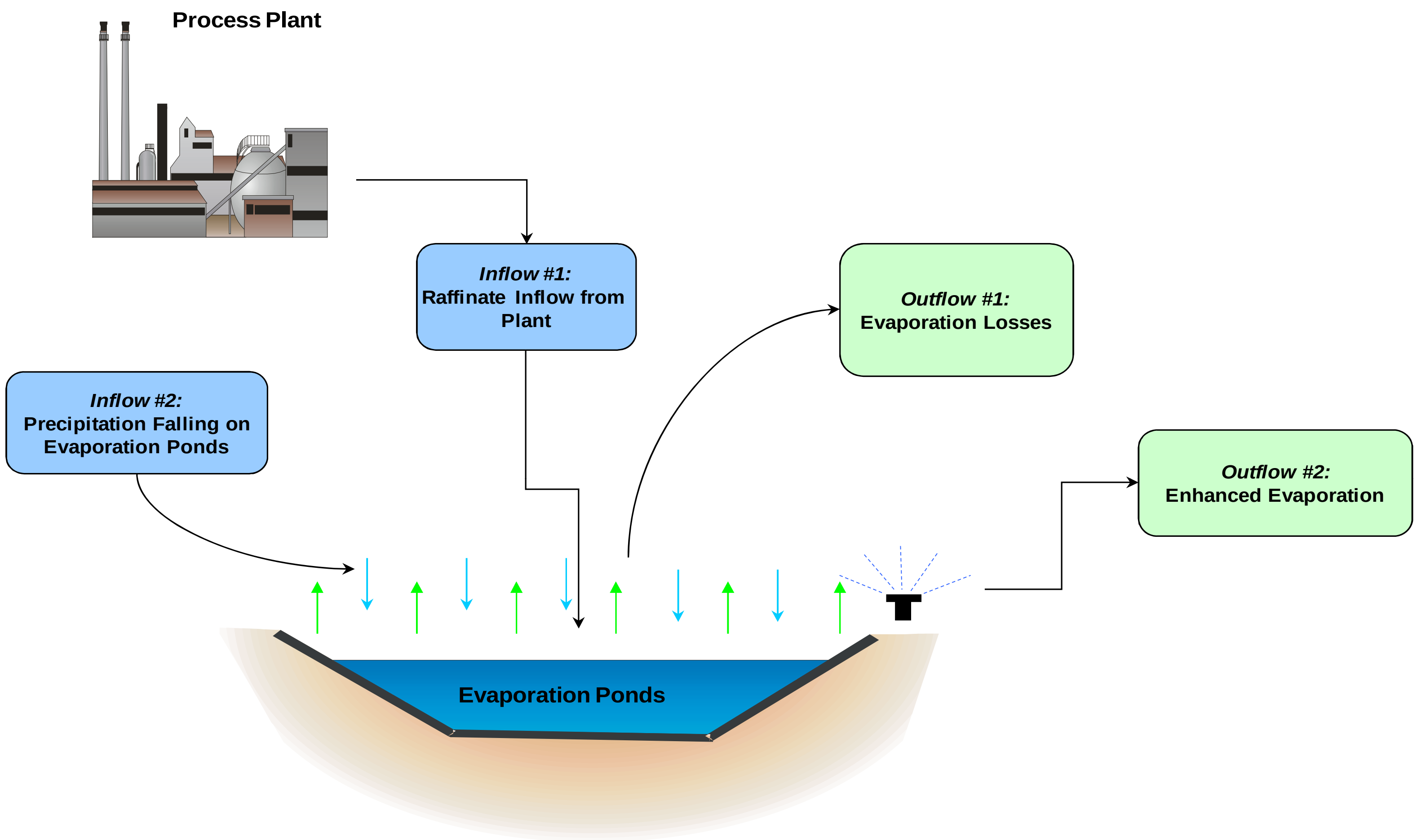
TITLE

EVAPORATION POND STAGE-STORAGE DATA

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	KFM	DATE	Oct-08	JOB NO.	073-81694.0004
CHECKED	KFM	SCALE	AS SHOWN	DWG. NO.	NA
REVIEWED	JMJ	FILE NO.	single-cell-ss-evap-ponds.xls	FIGURE NO.	1



Golder Associates

Denver, Colorado

TITLE

Water Balance Flow Sheet

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	KFM	DATE	May-08	JOB NO.	073-81694.0004
CHECKED	KFM	SCALE	NTS	DWG. NO.	NA
REVIEWED	JMJ	FILE NO.	Figure-H2OBal.xls	FIGURE NO.	2

DRAWINGS

PIÑON RIDGE PROJECT
EVAPORATION POND DESIGN

DRAWING NUMBER	REVISION	DRAWING TITLE
1	A	TITLE SHEET WITH DRAWING LIST AND LOCATION MAP
2	A	GENERAL PROJECT LAYOUT AND LOCATIONS OF GEOTECHNICAL INVESTIGATIONS
3	A	PHASE I EXCAVATION GRADING PLAN AND ISOPACH
4	A	PHASE II EXCAVATION GRADING PLAN AND ISOPACH
5	A	EVAPORATION POND TYPICAL SECTIONS
6	A	BIRD NETTING PLAN AND DETAILS
7	A	BIRD NETTING DETAILS
8	A	EVAPORATION POND LINER DETAILS
9	A	LEAK COLLECTION AND RECOVERY SYSTEM SECTIONS AND DETAILS

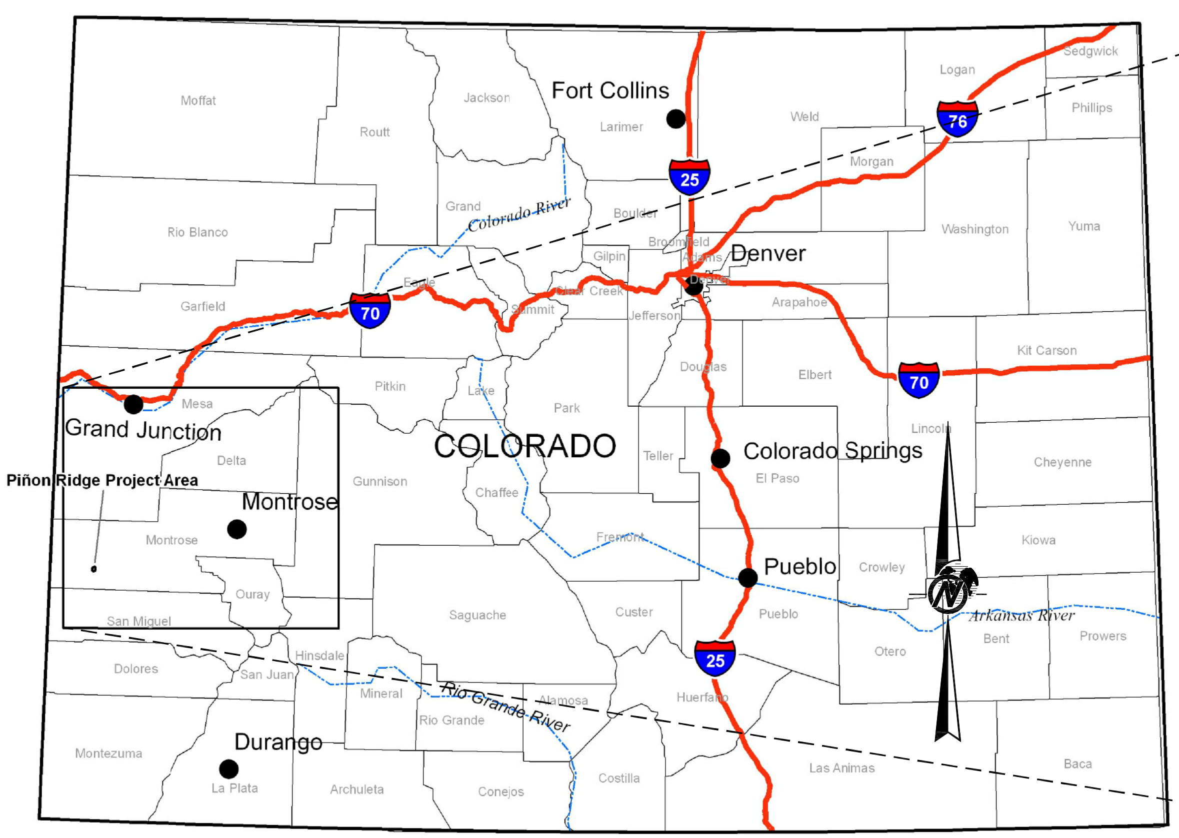
DESIGN DRAWINGS PREPARED BY
GOLDER ASSOCIATES INC.
FOR
ENERGY FUELS RESOURCES CORPORATION
MONTROSE COUNTY, COLORADO

GENERAL NOTES

1. THIS DRAWING SET ILLUSTRATES THE DESIGN REQUIREMENTS FOR CONSTRUCTION OF EVAPORATION PONDS IN UP TO TWO PHASES FOR THE PIÑON RIDGE PROJECT.
2. THE PROPOSED FACILITY IS LOCATED IN SECTIONS 5, 8, AND 17, TOWNSHIP 46 NORTH, RANGE 17 WEST, MONTROSE COUNTY, COLORADO.
3. GOLDER ASSOCIATES INC. (GOLDER) HAS PREPARED THIS DESIGN PACKAGE CONSISTENT WITH THE REQUIREMENTS OF THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT (CDPHE) RULES AND REGULATIONS PERTAINING TO RADIATION CONTROL 6 CCR 1007–1, PART 18.

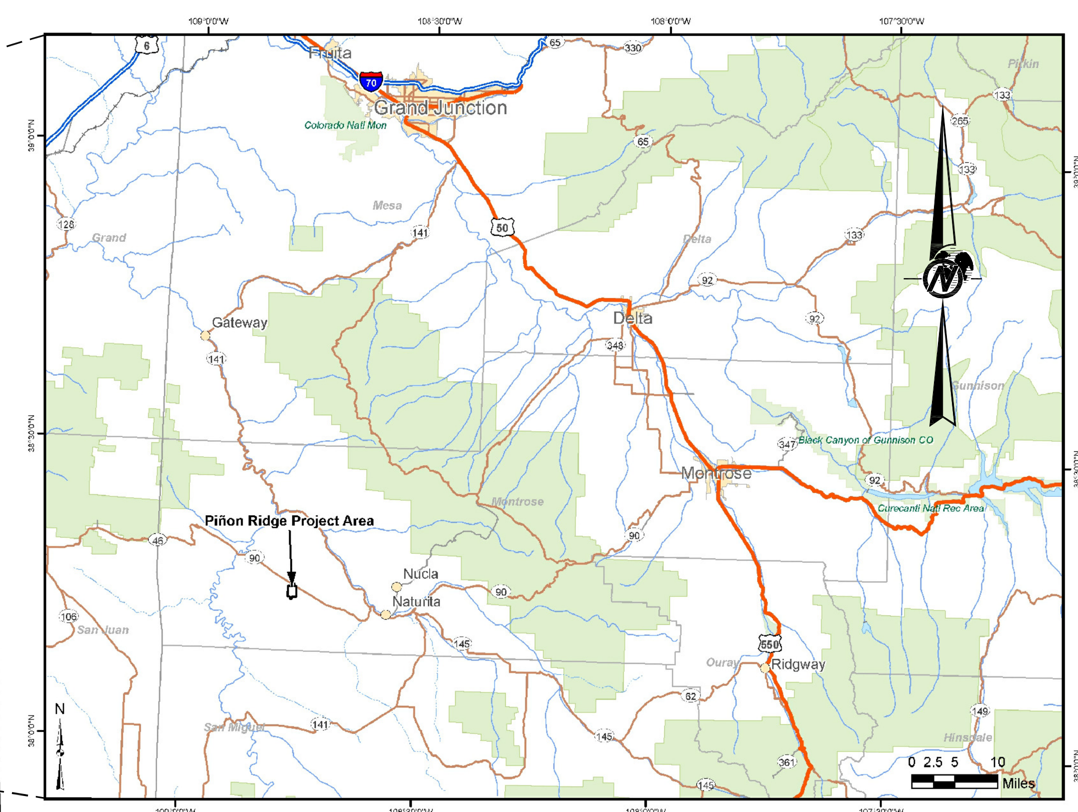
CONSTRUCTION SEQUENCING

1. PERFORM GENERAL SITE GRADING FOR PHASE I ACCORDING TO THE GENERAL GRADING PLAN.
2. INSTALL WOODEN POLES FOR BIRD NETTING PER THE DESIGN DRAWINGS.
3. PREPARE SUBGRADE WITHIN THE POND CELLS AND INSTALL LINER SYSTEM AS INDICATED.
4. INSTALL BIRD NETTING PER THE DRAWING DETAILS, (SEE DRAWINGS 6 AND 7).
5. IF NECESSITATED BY OPERATIONS WHICH INCLUDES AN INCREASE IN THE MILLING CAPACITY UP TO 1000 TONS PER DAY (TPD) FROM 500 TPD, REPEAT THE ABOVE SEQUENCING FOR PHASE II EXPANSION OF THE EVAPORATION POND SYSTEM.



VICINITY MAP

30 0 30
SCALE MILES



LOCATION SITE MAP

10 0 10
SCALE MILES

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/8/08	KFM	ISSUED FOR DESIGN REPORT	JDE	KFM	JMJ

PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION PONDS
MONTROSE COUNTY, COLORADO

TITLE
TITLE SHEET WITH DRAWING LIST AND LOCATION MAP

Golder Associates
DENVER, COLORADO

PROJECT No.		073–81694	FILE No.	07381694A031
DESIGN	KFM	2/08	SCALE AS SHOWN	REV. A
CADD	MTM	2/08	DRAWING	1
CHECK	KFM	2/08		
REVIEW	JMJ	2/08		

Plot Time: 10/07/08 08:41

Table 2-1 Phase 2 Testpit Locations			
I.D.	Northing	Easting	Elevation
GA-TP-01	1596508.7	2060410.5	5425.1
GA-TP-02	1596555.9	2062587.4	5444.3
GA-TP-03	1595901.2	2060958.5	5439.9
GA-TP-04	1595889.0	2062566.9	5445.8
GA-TP-05	1594959.4	2061470.7	5467.1
GA-TP-06	1594887.2	2062632.2	5456.6
GA-TP-07	1593460.0	2061496.2	5498.2
GA-TP-08	1592971.3	2062039.9	5508.4
GA-TP-09	1591630.0	2061943.2	5542.5
GA-TP-10	1591765.7	2062391.3	5536.1
GA-TP-11	1593903.6	2062412.6	5483.8

Table 2-2 Phase 2 Drillhole Locations			
I.D.	Northing	Easting	Elevation
GA-BH-01	1596809.5	2060098.5	5419.8
GA-BH-02	1596809.4	2060648.6	5430.7
GA-BH-03	1596809.4	2061198.8	5442.3
GA-BH-04	1596809.4	2061749.0	5441.2
GA-BH-05	1596809.5	2062299.1	5432.7
GA-BH-06	1596809.4	2062849.3	5443.9
GA-BH-07	1596186.8	2060098.5	5430.5
GA-BH-08	1596186.8	2060648.7	5433.0
GA-BH-09	1596186.8	2061198.8	5448.9
GA-BH-10	1596186.8	2061749.0	5453.3
GA-BH-11	1596186.8	2062849.3	5443.9
GA-BH-12	1595564.1	2060148.5	5444.4
GA-BH-13	1595564.1	2060698.7	5446.3
GA-BH-14	1595564.1	2061248.8	5459.6
GA-BH-15	1595564.1	2061799.0	5459.3
GA-BH-16	1595564.1	2062349.2	5451.2
GA-BH-17	1595564.1	2062899.4	5446.7
GA-BH-18	1595159.0	2060648.7	5453.5
GA-BH-19	1595158.9	2061198.8	5456.2
GA-BH-20	1595159.0	2062299.2	5458.0
GA-BH-21	1595159.0	2062849.3	5449.5
GA-BH-22	1594658.9	2061198.8	5467.7
GA-BH-23	1594658.9	2061749.0	5476.9
GA-BH-24	1594658.8	2062299.1	5465.7
GA-BH-25	1594658.8	2062849.4	5458.6
GA-BH-26	1594158.7	2060648.7	5472.6
GA-BH-27	1594158.7	2061749.0	5484.4
GA-BH-28	1594158.7	2062299.2	5482.3
GA-BH-29	1594158.7	2062849.3	5473.8
GA-BH-30	1593658.6	2060648.7	5492.3
GA-BH-31	1593658.5	2061198.8	5494.2
GA-BH-32	1593658.5	2061749.0	5491.4
GA-BH-33	1593658.6	2062299.2	5490.7
GA-BH-34	1593658.5	2062849.3	5493.0
GA-BH-35	1593158.4	2061198.8	5506.9
GA-BH-36	1593158.4	2061749.0	5505.3
GA-BH-37	1593158.4	2062299.1	5504.2
GA-BH-38	1593158.4	2062849.3	5500.4
GA-BH-39	1592658.3	2060648.7	5515.8
GA-BH-40	1592658.2	2061198.8	5520.5
GA-BH-41	1592658.3	2061749.0	5517.0
GA-BH-42	1592658.2	2062299.2	5515.4
GA-BH-43	1592658.2	2062849.3	5512.1
GA-BH-44	1591993.8	2062619.9	5531.0
GA-BH-45	1591533.7	2062620.0	5538.8
GA-BH-46	1591533.6	2062159.8	5545.0
GA-BH-47	1591301	2061116	5558
GA-BH-48	1591262	2061811	5556
TB-01	1592383.1	2061089.0	5529.8
TB-02	1592345.1	2061329.2	5530.2
TB-03	1592286.4	2061605.6	5528.5
TB-04	1592228.4	2061863.5	5528.1
TB-05	1592172.2	2062129.9	5528.6
TB-06	1592130.7	2061064.0	5534.2
TB-07	1592093.6	2061309.1	5537.1
TB-08	1592055.3	2061581.3	5536.4
TB-09	1592033.5	2061801.0	5533.1
TB-10	1591994.2	2062062.5	5532.9
TB-11	1591973.6	2061069.1	5538.4
TB-12	1591922.9	2061313.4	5540.6
TB-13	1591810.9	2061522.9	5543.6
TB-14	1591791.3	2061733.9	5540.0
TB-15	1591729.8	2061977.1	5539.5
TB-16	1591740.8	2061024.6	5543.7
TB-17	1591703.0	2061276.2	5547.1
TB-18	1591664.8	2061491.4	5547.3
TB-19	1591639.0	2061662.5	5544.6
TB-20	1591580.9	2061923.1	5543.8
PB-01	1595665.3	2063972.7	5457.5
PB-02	1594878.7	2063676.3	5470.1
PB-03	1594100.2	2063616.5	5486.4
PB-04	1592683.7	2063259.2	5509.7
PB-05	1591673.0	2062844.7	5531.8

Table 2-3 Phase 1 Borehole Locations			
I.D.	Northing	Easting	Elevation
PR1-1	1597859.9	2061661.5	5452
PR1-2	1597335.7	2059249.5	5417
PR1-3	1595950.5	2060110.2	5436
PR1-4	1596313.6	2062461.3	5448
PR1-5	1596763.4	2063490.6	5426
PR1-6	1594993.8	2058978.2	5456
PR1-7	1594770.9	2060386.1	5461
PR1-8	1595232.8	2061816.9	5466
PR1-9	1594698.5	2062045.7	5471
PR1-10	1594329.5	2063839.4	5487
PR1-11	1594197.1	2061358.2	5481
PR1-12	1593384.0	2060405.0	5495
PR1-13	1593400.8	2062173.2	5497
PR1-14	1593338.1	2063190.8	5496
PR1-15	1592361.9	2058840.1	5551
PR1-16	1592065.8	2060628.5	5530
PR1-17	1591874.2	2061530.4	5543
PR1-18	1592020.5	2062213.4	5533
PR1-19	1590853.4	2061719.5	5571
PR1-20	1591043.5	2063607.1	5545

Table 2-4 Phase 1 Monitoring Well Locations			
I.D.	Northing	Easting	Elevation
MW1	1597208.6	2060295.0	5423
MW2	1597132.0	2062819.0	5432
MW3	1595226.9	2059204.8	5448
MW4	1594834.3	2063802.6	5477
MW5	1591190.9	2060280.6	5570
MW6	1591044.0	2062551.0	5553
MW7	1589982.8	2060959.6	5287
MW8	1591822.2	2062942.1	5149
MW9	1592244.1	2060677.5	5122

LEGEND

- PR1-20 — KLEINFELDER 2007 GEOTECHNICAL PHASE 1 BORING LOCATIONS
- GA-BH-44 — GOLDER 2007 GEOTECHNICAL PHASE 2 BORING LOCATIONS
- PB-4, TB-15 — KLEINFELDER 2007 GEOTECHNICAL PHASE 2 BORING LOCATIONS
- GA-TP-10 — GOLDER 2007 GEOTECHNICAL PHASE 2 TEST PIT LOCATIONS
- MW5 — KLEINFELDER MONITORING WELL BORING LOCATIONS
- METEOROLOGICAL TOWER / AIR MONITORING STATION
- EFR PROPERTY BOUNDARY
- SEISMIC REFLECTION / REFRACTION LINES
- PROPOSED APPROXIMATE FACILITY AREAS
- EXISTING FENCE LINES

NOTES

1. THE PHASE 1 INVESTIGATION CONDUCTED BY KLEINFELDER INCLUDED INSTALLATION OF MONITORING WELLS (MW-1 THROUGH MW-6), GEOTECHNICAL BOREHOLES (PR-1 THROUGH PR-20), AND THREE GEOPHYSICAL SURVEY LINES. ADDITIONAL MONITORING WELLS (MW-7 THROUGH MW-9) WERE INSTALLED IN 2008.
2. DRILLHOLES GA-BH-1 THROUGH GA-BH-48, TB-1 THROUGH TB-20, AND PB-1 THROUGH PB-5 WERE ADVANCED BY DAKOTA DRILLING OF DENVER, COLORADO, FROM OCTOBER 23 THROUGH DECEMBER 15, 2007. AUGER DRILLING FOR SHALLOW SOIL BORINGS WAS CONDUCTED USING EITHER A CME-55 OR A DIEDRICH 50 DRILL RIG. A DIEDRICH 120 DRILL RIG WAS USED FOR THE DRILLHOLES REQUIRING CORING CAPABILITIES.
3. FOR DRILLHOLES GA-BH-1 THROUGH GA-BH-48, A GOLDER FIELD REPRESENTATIVE LOGGED THE SOIL AND ROCK MATERIALS ENCOUNTERED, COLLECTED SAMPLES OF MATERIALS FOR LABORATORY TESTING, AND OBSERVED AND/OR CONDUCTED IN-SITU TESTING. OTHER PHASE 2 DRILLING WAS OBSERVED BY A KLEINFELDER FIELD REPRESENTATIVE.
4. TEST PITS GA-TP-1 THROUGH GA-TP-11 WERE EXCAVATED ON 11/1/2007 AND 11/2/2007, USING A CATERPILLAR MODEL 430D BACKHOE OPERATED BY HIGH DESERT CONSTRUCTION. A GOLDER FIELD REPRESENTATIVE LOGGED THE TEST PITS AND COLLECTED SAMPLES OF MATERIALS FOR LABORATORY TESTING.

REFERENCES

1. TWO-FOOT CONTOUR BASE MAP PROVIDED BY KLEINFELDER IN JUNE 2008, CREATED FROM DRAWING BY ACCURATE SURVEY & ENGINEERING DATED 9/6/2007.
2. COORDINATES ARE PROVIDED IN A SCALED VERSION (ADJUSTED TO GROUND) OF THE COLORADO STATE PLANE (SOUTH ZONE) COORDINATE SYSTEM USING NAD83 AS THE HORIZONTAL DATUM.
3. ELEVATIONS PROVIDED ARE IN FEET ABOVE MEAN SEA LEVEL USING NAV88 AS THE VERTICAL DATUM.
4. TABLES 2-1 AND 2-2 REFLECT THE PROPOSED DRILLING LOCATIONS. ACTUAL DRILLING LOCATIONS TYPICALLY VARY BY 5 FEET LATERALLY. THE COORDINATES AND ELEVATIONS LISTED FOR GA-BH-47 AND GA-BH-48 ARE ESTIMATIONS AS THEIR PROPOSED LOCATIONS WERE NOT SURVEYED.
5. ELEVATIONS LISTED IN TABLES 2-3 AND 2-4 ARE ESTIMATED BASED ON THE TOPOGRAPHY AT THE I.D. LOCATION.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/8/08	KFM	ISSUED FOR DESIGN REPORT	JWR	KFM	JMJ

PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION PONDS
MONTROSE COUNTY, COLORADO

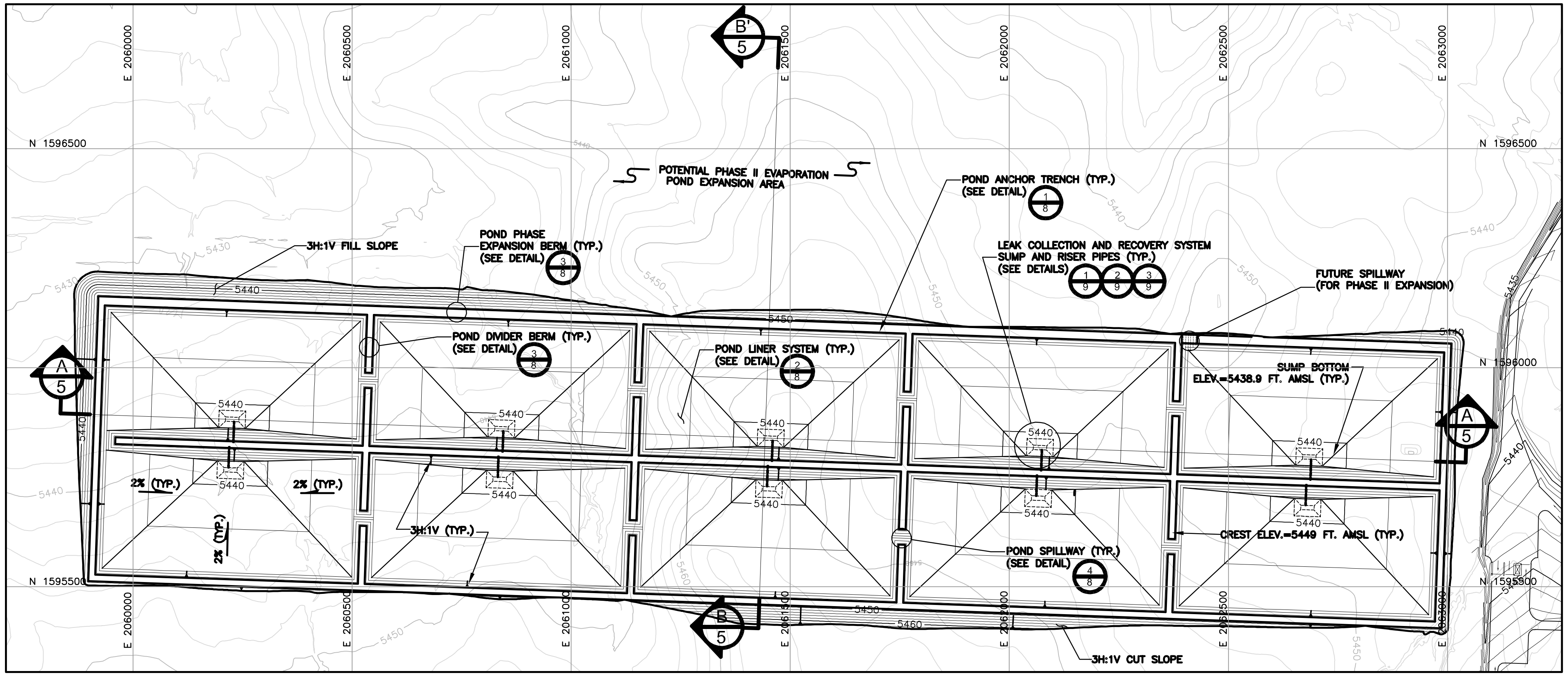
TITLE
GENERAL PROJECT LAYOUT AND LOCATIONS OF GEOTECHNICAL INVESTIGATIONS

Golder Associates
DENVER, COLORADO

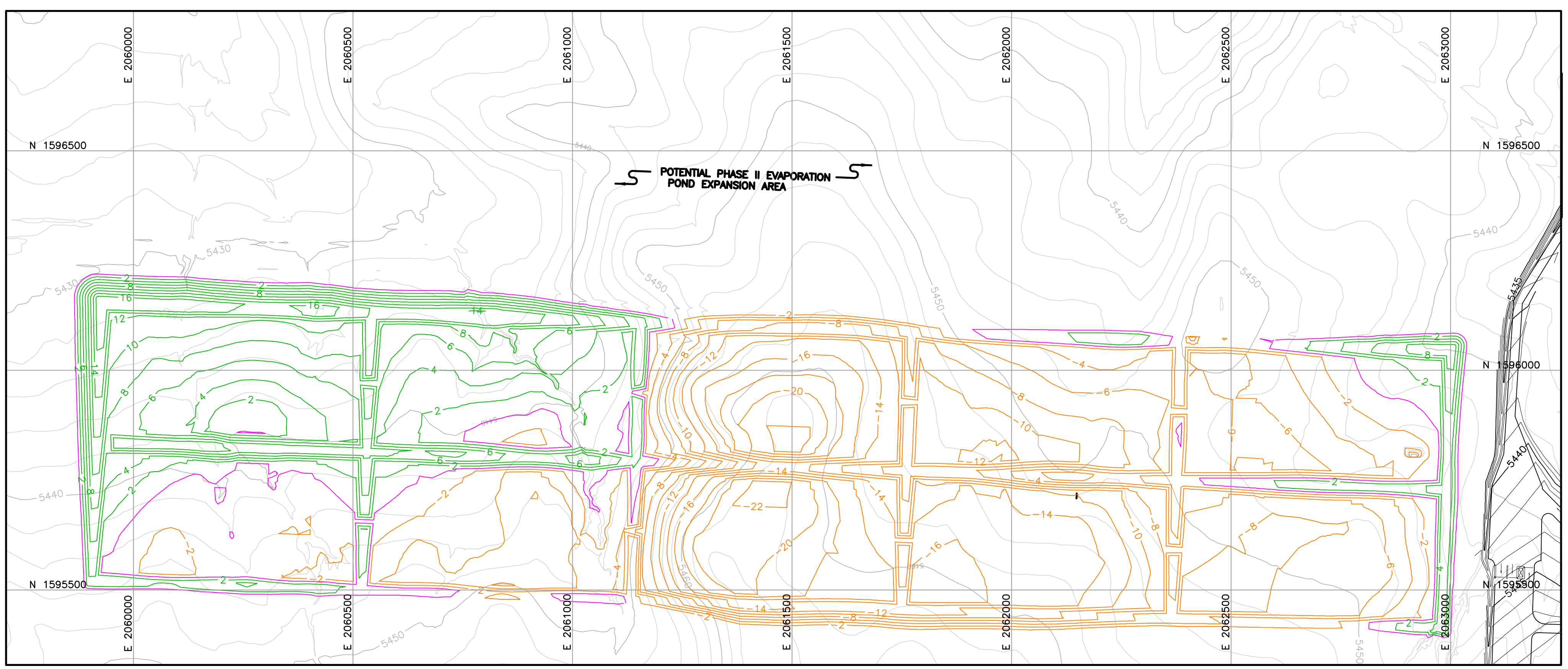
PROJECT No.	073-81694	FILE No.	07381694A045
DESIGN	JDE	02/08	SCALE AS SHOWN REV. A
CADD	JDE	02/08	DRAWING
CHECK	KFM	02/08	2
REVIEW	JMJ	02/08	

Plot Time:10/07/08 08:45

Dwg Name: N:\07\073-81694\07381694A045.dwg
Layout Name: 24x36 Landscape Machine: DEN1-L-JELLIOTT
Last Update: Oct 02, 2008 09:02 By: JElliott
Last Plot: Oct 07, 2008 08:45 By: JElliott



1/3 PHASE I EVAPORATION POND GRADING PLAN
SCALE: 1 IN.= 150 FT.



2/3 PHASE I EVAPORATION POND ISOPACH PLAN
SCALE: 1 IN.= 150 FT.

LEGEND

- EXISTING GROUND TOPOGRAPHY (SEE REFERENCE 1)
- PROPOSED FINISHED GRADE TOPOGRAPHY
- SLOPE DIRECTION
- ISOPACH CUT CONTOUR
- ISOPACH FILL CONTOUR
- ISOPACH ZERO CONTOUR
- EXISTING FENCE LINE
- LCRS RISER PIPES
- LCRS SUMP BASE GRADING
- CROSS SECTION IDENTIFIER
- SHEET WHERE SECTION IS LOCATED

QUANTITIES

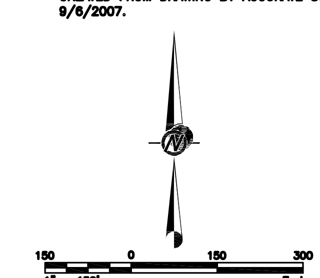
	CUT (CU. YDS.)	FILL (CU. YDS.)
EVAPORATION PONDS PHASE I GRADING	460,000	139,000

NOTES

1. GRADING PLAN CONTOURS REPRESENT TOP OF GEOMEMBRANE WITHIN THE EVAPORATION PONDS AND TOP OF STRUCTURAL FILL OUTSIDE THESE LIMITS.

REFERENCES

1. TWO-FOOT CONTOUR BASE MAP PROVIDED BY KLEINFELDER IN JUNE 2008, CREATED FROM DRAWING BY ACCURATE SURVEY & ENGINEERING DATED 9/6/2007.



REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/8/08	KFM	ISSUED FOR DESIGN REPORT	JWR	KFM	JMJ

PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION PONDS
MONTROSE COUNTY, COLORADO

TITLE
PHASE I EXCAVATION GRADING PLAN AND ISOPACH

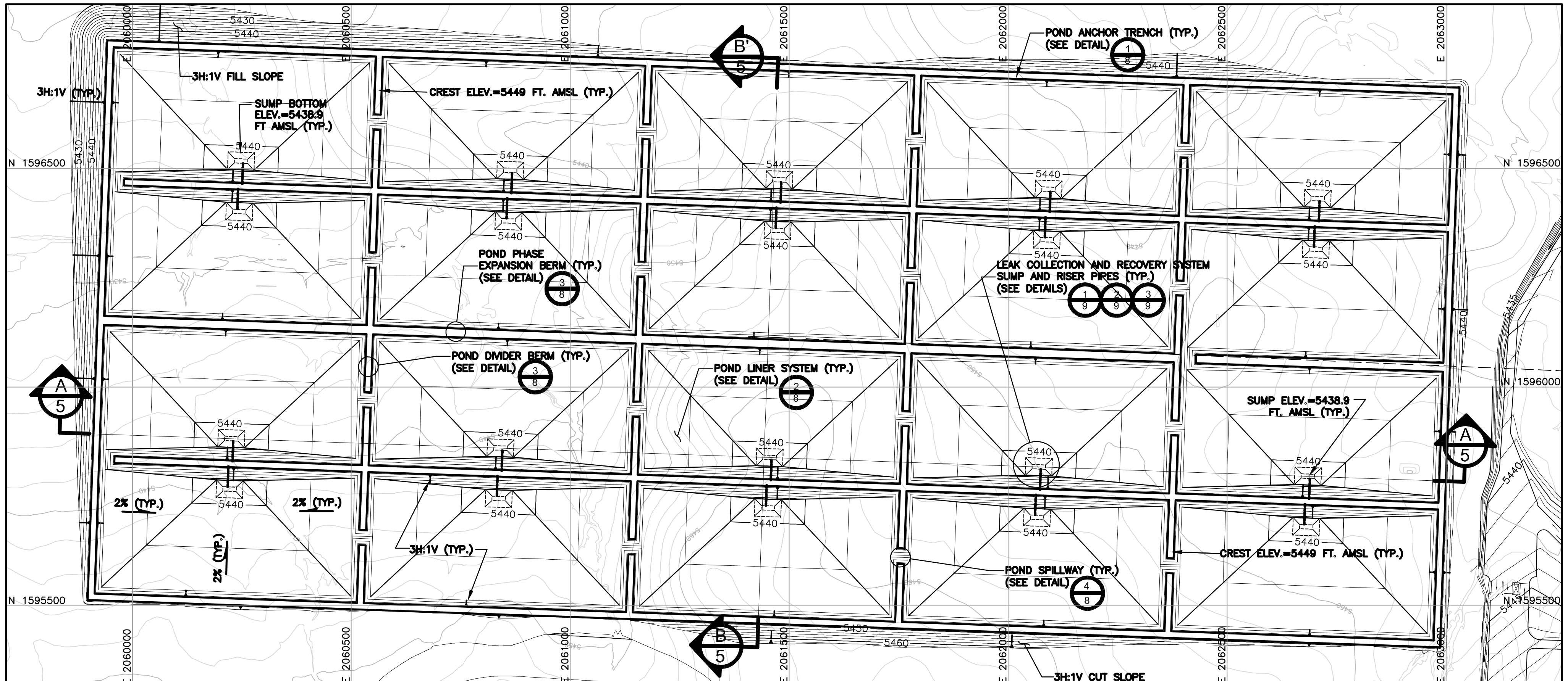
Golder Associates
DENVER, COLORADO

PROJECT No.	073-81694	
DESIGN	GG	03/08
CADD	JWR	03/08
CHECK	KFM	03/08
REVIEW	JMJ	03/08

FILE No. 07381694A057
SCALE AS SHOWN REV. A
DRAWING 3

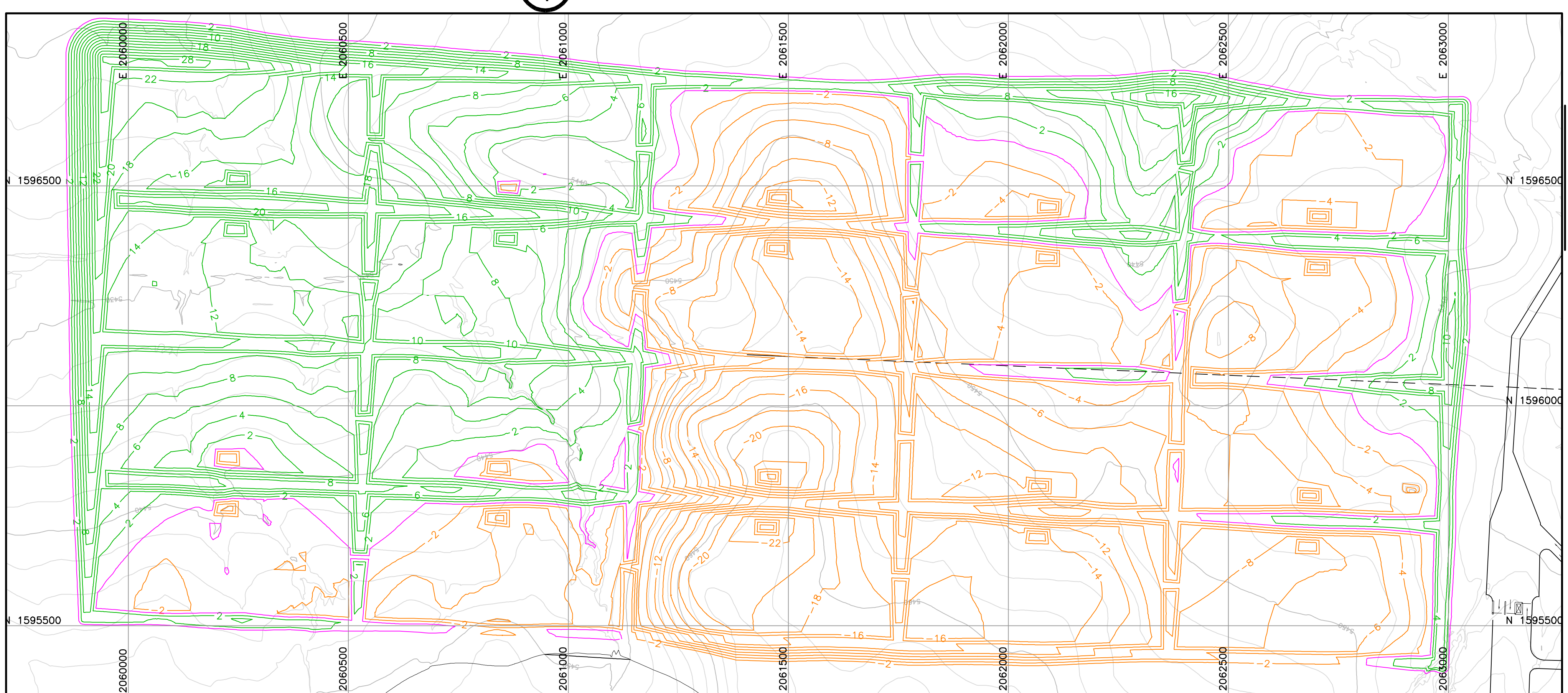
Plot Time: 10/07/08 08:50

Dwg Name: N:\07\073-81694\07381694A057.dwg
Layout Name: 24x36 Landscape Machine: DEN1-L-JELLIOT1
Last Update: Sep 30, 2008 16:56 By: jroberts
Last Plot: Oct 07, 2008 08:50 By: JElliott



1/4 **PHASE I AND II EVAPORATION POND GRADING PLAN**

SCALE: 1 IN.= 150 FT.



2/4 **PHASE I AND II EVAPORATION POND ISOPACH PLAN**

SCALE: 1 IN.= 150 FT.

LEGEND

- EXISTING GROUND TOPOGRAPHY (SEE REFERENCE 1)
- PROPOSED FINISHED GRADE TOPOGRAPHY
- SLOPE DIRECTION (TOE / CREST)
- ISOPACH CUT CONTOUR
- ISOPACH FILL CONTOUR
- ISOPACH ZERO CONTOUR
- EXISTING FENCE LINE
- LCRS RISER PIPES
- LCRS SUMP BASE GRADING
- CROSS SECTION IDENTIFIER (A)
- SHEET WHERE SECTION IS LOCATED (8)

NOTES

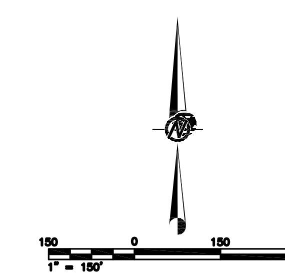
1. GRADING PLAN CONTOURS REPRESENT TOP OF GEOMEMBRANE WITHIN THE EVAPORATION PONDS AND TOP OF STRUCTURAL FILL OUTSIDE THESE LIMITS.

REFERENCES

1. TWO-FOOT CONTOUR BASE MAP PROVIDED BY KLEINFELDER IN JUNE 2008, CREATED FROM DRAWING BY ACCURATE SURVEY & ENGINEERING DATED 9/6/2007.

QUANTITIES

	CUT (CU. YDS.)	FILL (CU. YDS.)
EVAPORATION PONDS PHASE I GRADING	460,000	139,000
EVAPORATION PONDS PHASE II GRADING	174,000	426,000



REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/8/08	KFM	ISSUED FOR DESIGN REPORT	JWR	KFM	JMJ

PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION PONDS
MONTROSE COUNTY, COLORADO

TITLE

PHASE II EXCAVATION GRADING PLAN AND ISOPACH

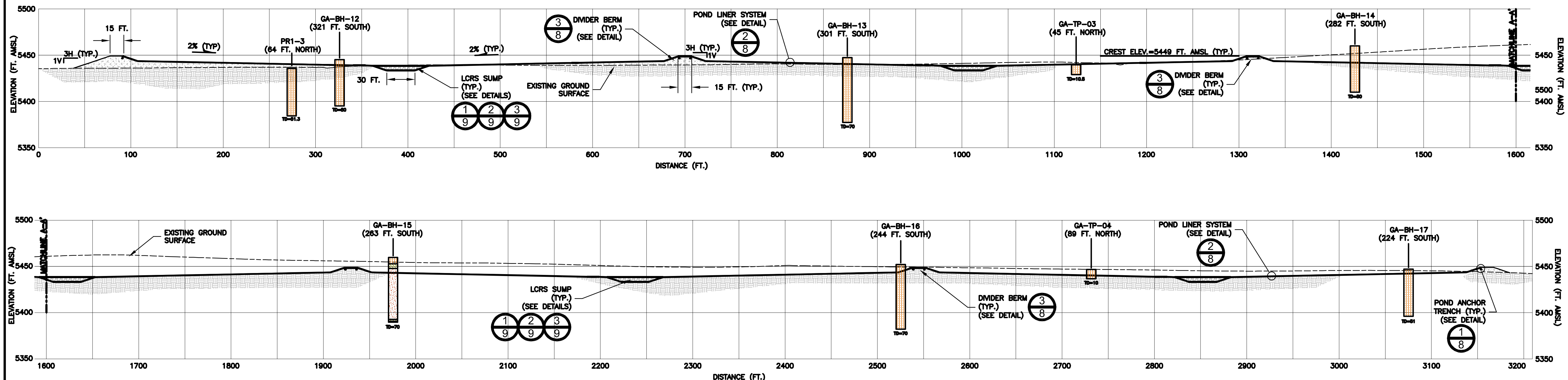
Golder Associates
DENVER, COLORADO

PROJECT No.	073-81694	
DESIGN	GG	03/08
CADD	JWR	03/08
CHECK	KFM	03/08
REVIEW	JMJ	03/08

FILE No. 07381694A056
SCALE AS SHOWN REV. A
DRAWING 4

Plot Time:10/07/08 08:52

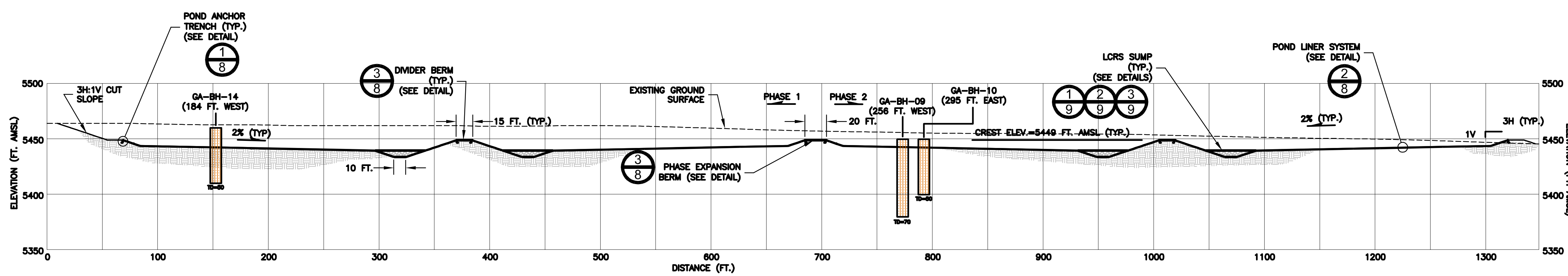
Dwg Name: N:\07\073-81694\07381694A056.dwg
Layout Name: 24x36 Landscape Machine: DEN1-L-JELLIOT1
Last Update: Sep 30, 2008 16:46 By: jroberts
Last Plot: Oct 07, 2008 08:52 By: JElliott



A / 5 EVAPORATION POND CROSS SECTION A-A'

SCALE: 1 IN.= 50 FT.

50 0 50
1" = 50' Feet



B / 5 EVAPORATION POND CROSS SECTION B-B'

SCALE: 1 IN.= 50 FT.

50 0 50
1" = 50' Feet

LEGEND

- EXISTING GROUND SURFACE
- REGRADED SURFACE
- LINER SURFACE
- 2/8 — DETAIL IDENTIFIER / SHEET WHERE DETAIL IS LOCATED
- PREPARED SUBGRADE OR EXISTING SUBGRADE
- STRUCTURAL FILL
- LEAK DETECTION FILL
- GA-BH-14 — BORING/TEST PIT DESIGNATION
- (184 FT. WEST) — OFFSET FROM SECTION LINE
- SIMPLIFIED GEOLOGY
- TD=100 — TOTAL DEPTH OF INVESTIGATION (FEET)
- OVERBURDEN SOILS: CONSISTING PRIMARILY OF LOESS, SOIL CLASSIFIES AS SILTY SAND (SM) AND LEAN SILT (ML) WITH OCCASIONAL LAYERS OF LEAN CLAY (CL), CLAYEY SAND (SC), AND SILTY GRAVEL (GM). BLOW COUNTS FOR 12 INCHES OF PENETRATION TYPICALLY RANGED FROM 10 TO 50 NEAR THE SURFACE (0–10 FT.) AND GREATER THAN 50 BELOW 10 FEET DUE TO SOIL CEMENTATION.
- CLAYSTONE: PREDOMINATELY HERMOSA FORMATION, OCCASIONAL MOENKOPI FORMATION – MODERATELY TO HIGHLY WEATHERED, VERY STIFF TO HARD, OLIVE COLORED, TYPICALLY INTENSELY AND IRREGULARLY FRACTURED.
- GYPSUM: HERMOSA FORMATION, PARADOX MEMBER – FRESH TO SLIGHTLY WEATHERED, VERY WEAK TO WEAK, MOTTLED IN COLOR (BLACK, GRAY, AND WHITE).
- SANDSTONE/SILTSTONE: MOENKOPI AND CUTLER FORMATIONS – SLIGHTLY TO HIGHLY WEATHERED, VERY WEAK TO MEDIUM STRONG, FINE TO VERY FINE GRAINED SAND.

REFERENCES

1. TWO-FOOT CONTOUR BASE MAP PROVIDED BY KLEINFELDER IN JUNE 2008, CREATED FROM DRAWING BY ACCURATE SURVEY & ENGINEERING DATED 9/6/2007.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/8/08	KFM	ISSUED FOR DESIGN REPORT	JWR	KFM	JMJ

PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION PONDS
MONTROSE COUNTY, COLORADO

TITLE

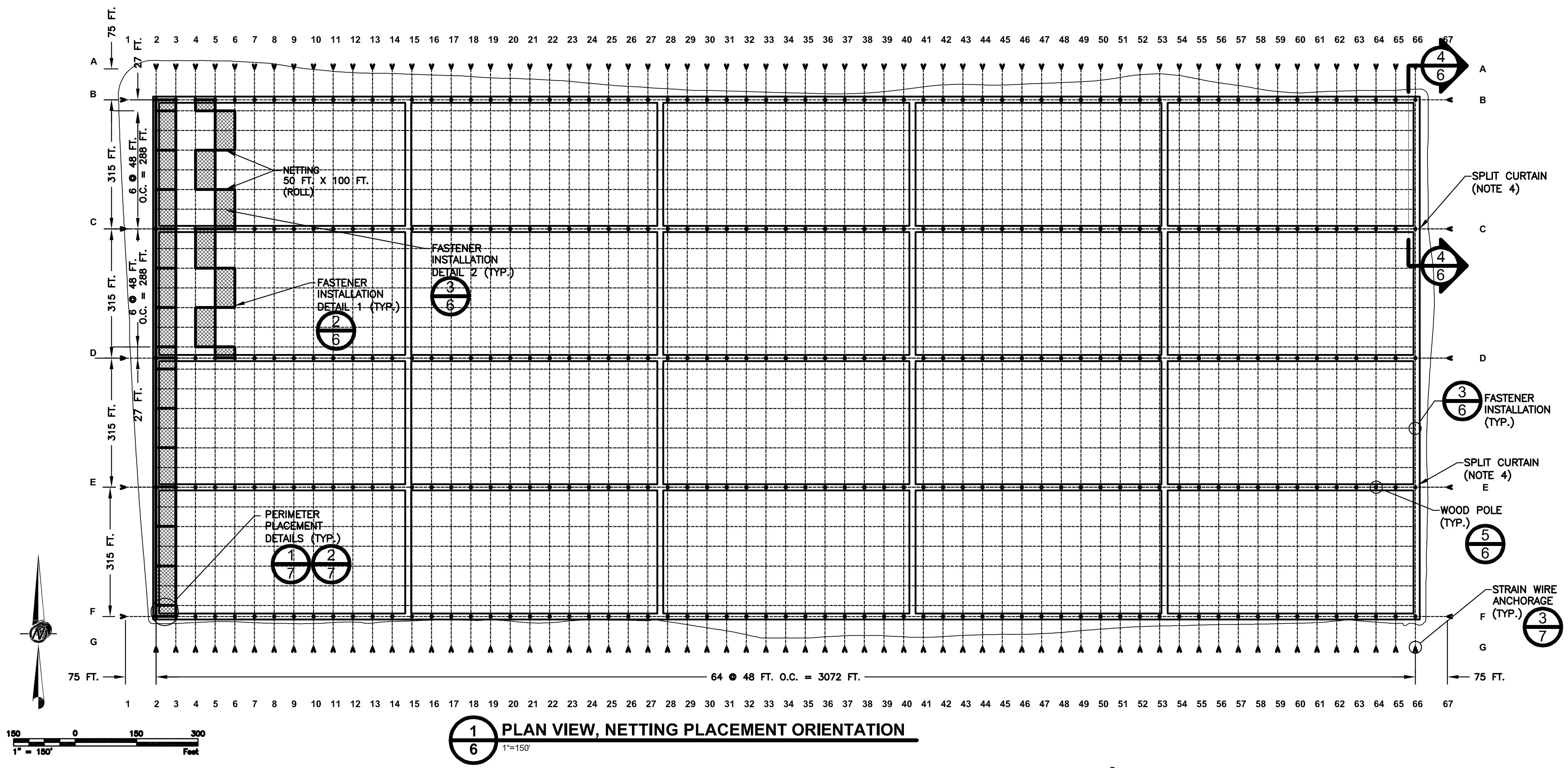
EVAPORATION POND TYPICAL SECTIONS

Golder Associates
DENVER, COLORADO

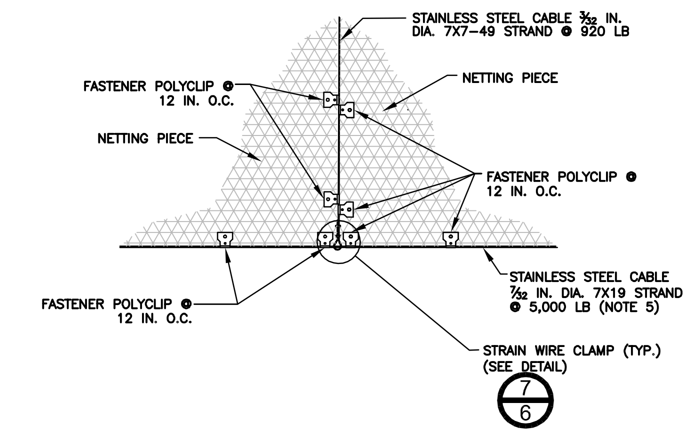
PROJECT No.	073-81694	
DESIGN	GG	03/08
CADD	JWR	03/08
CHECK	KFM	03/08
REVIEW	JMJ	03/08

FILE No. 07381694A067
SCALE AS SHOWN | REV. A
DRAWING 5

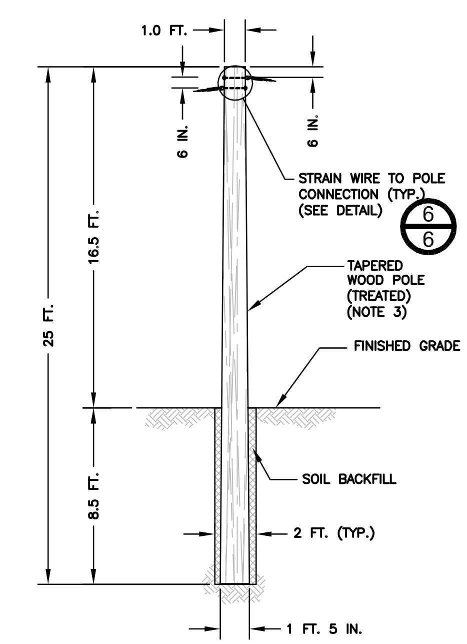
Plot Time:10/07/08 08:55



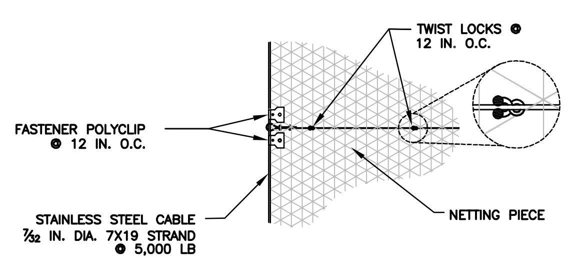
1/6 **PLAN VIEW, NETTING PLACEMENT ORIENTATION**
1"=150'



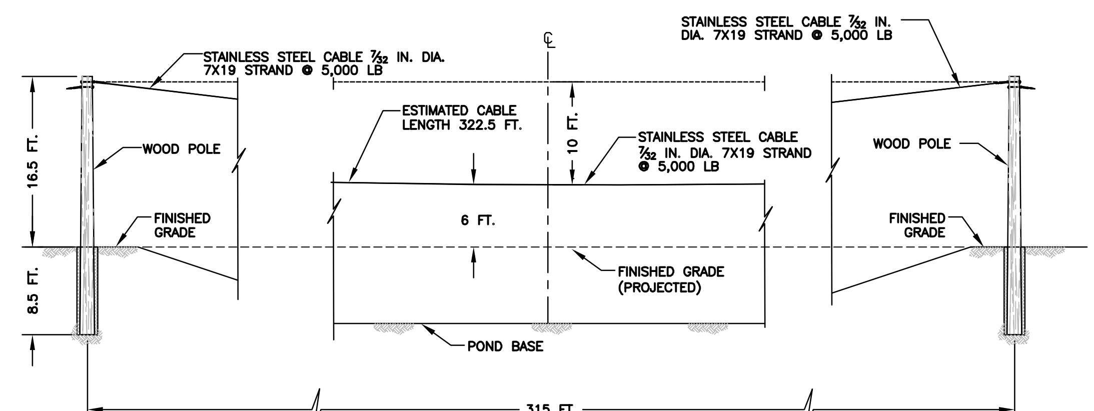
2/6 **FASTENER INSTALLATION DETAIL 1**
N.T.S.



5/6 **WOOD POLE DETAIL**
N.T.S.



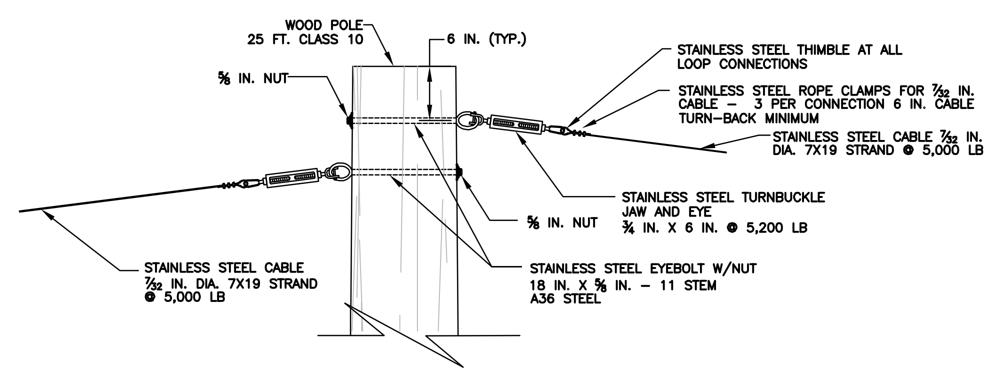
3/6 **FASTENER INSTALLATION DETAIL 2**
N.T.S.



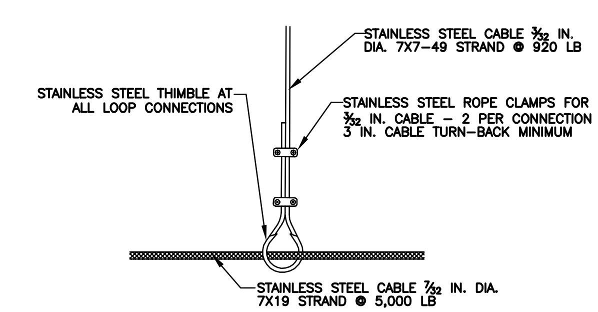
4/6 **STRAIN WIRE DISPLACEMENT**
N.T.S.

NOTES

1. THE EDGES OF THE NETTING SHALL BE ROLLED AT LEAST 2 TIMES TO ALLOW POLYCLIP TEETH TO GRIP SUFFICIENT NETTING.
2. NETTING PROVIDED WITH 2-INCH OPENINGS.
3. WOOD POLES TO BE TREATED PER THE PROJECT SPECIFICATIONS.
4. PROVIDE SPLIT CURTAINS AT OUTSIDE PERIMETER OF CENTRAL BERMS TO FACILITATE ATV ACCESS.
5. EPOXY-COAT STAINLESS STEEL SUPPORT CABLES.



6/6 **STRAIN WIRE TO POLE CONNECTION DETAIL**
N.T.S.



7/6 **STRAIN WIRE CLAMPING DETAIL**
N.T.S.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/8/08	KFM	ISSUED FOR DESIGN REPORT	JWR	KFM	JMJ

PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION PONDS
MONTROSE COUNTY, COLORADO

TITLE
BIRD NETTING PLAN AND DETAILS

Golder Associates
DENVER, COLORADO

PROJECT No.	073-81694	
DESIGN	EF	04/08
CADD	EF	04/08
CHECK	KFM	04/08
REVIEW	JMJ	04/08

FILE No. 07381694A066
SCALE AS SHOWN
REV. A

6

Plot Time: 10/07/08 08:58

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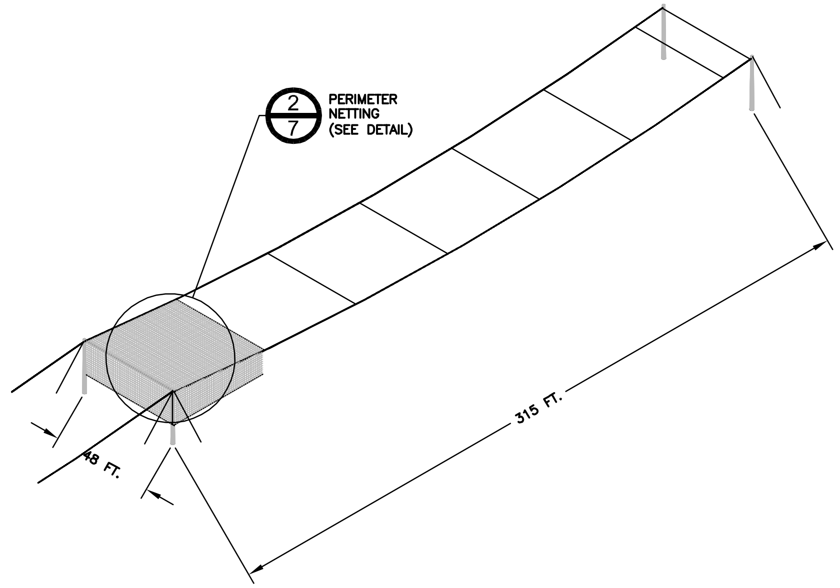
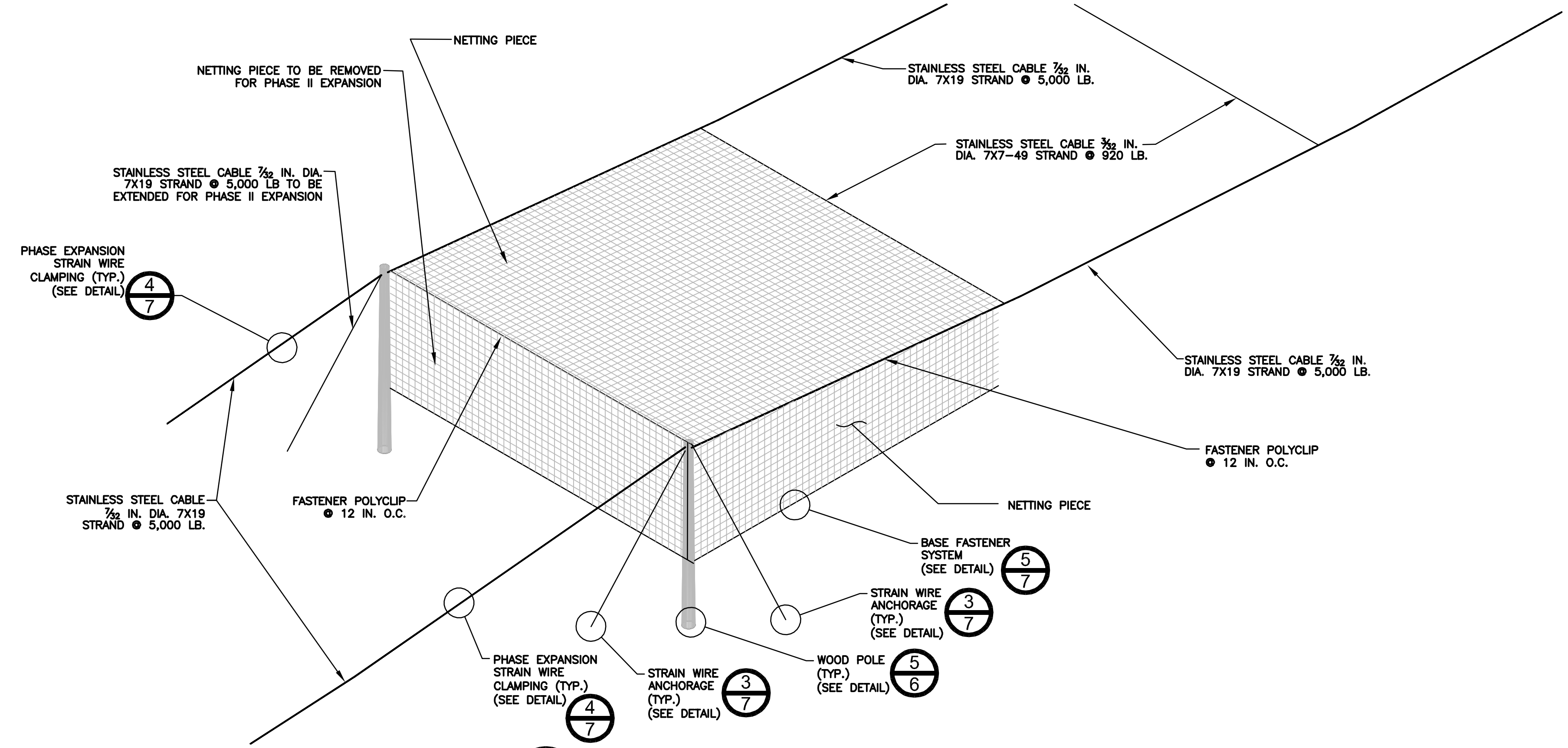
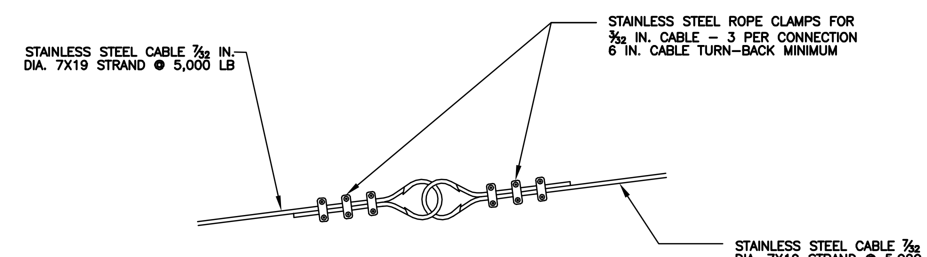
Last Update: Oct 01, 2008 16:18 By: jroberts
Last Plot: Oct 07, 2008 08:58 By: JElliott



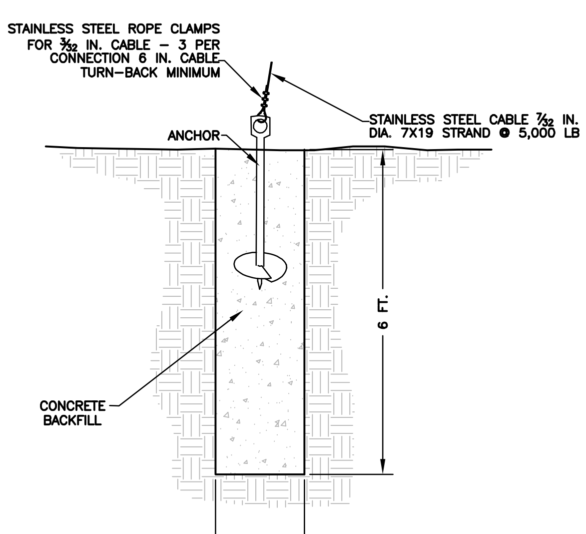
1/7 WOOD POLE LOCATION AND NETTING PLACEMENT PARTIAL VIEW
N.T.S.



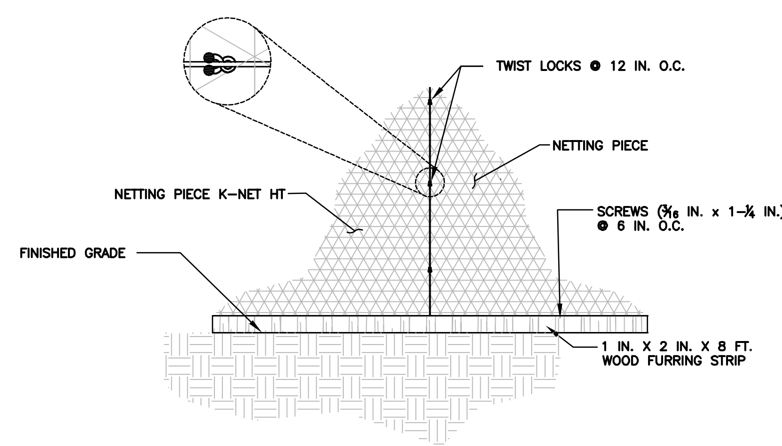
2/7 PERIMETER NETTING PLACEMENT DETAIL
N.T.S.



4/7 STRAIN WIRE CLAMPING DETAIL FOR PHASE II EXPANSION
N.T.S.



3/7 STRAIN WIRE ANCHORAGE
N.T.S.



5/7 BIRDNET BASE FASTENER SYSTEM
N.T.S.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/8/08	KFM	ISSUED FOR DESIGN REPORT	JWR	KFM	JMJ

PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION PONDS
MONTROSE COUNTY, COLORADO

TITLE
BIRD NETTING DETAILS

Golder Associates
DENVER, COLORADO

PROJECT No.	073-81694	FILE No.	07381694A066
DESIGN	EF	04/08	SCALE AS SHOWN REV. A
CADD	EF	04/08	7
CHECK	KFM	04/08	
REVIEW	JMJ	04/08	

Plot Time:10/07/08 08:57

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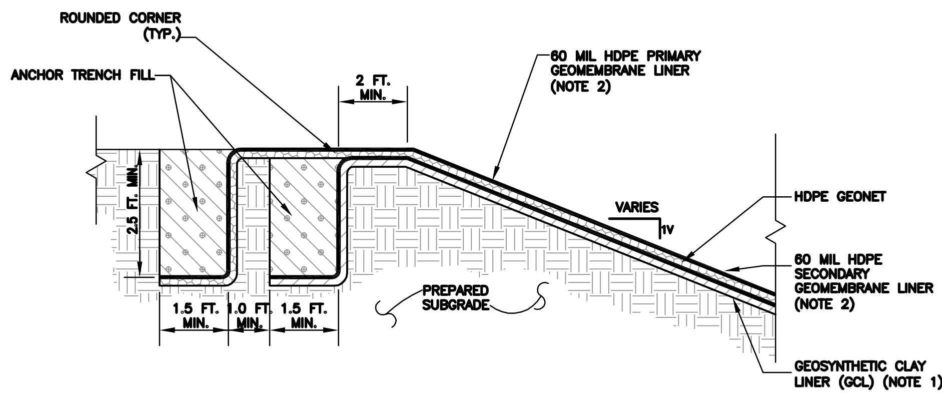
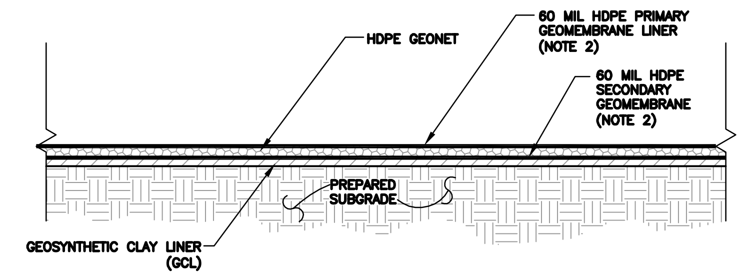
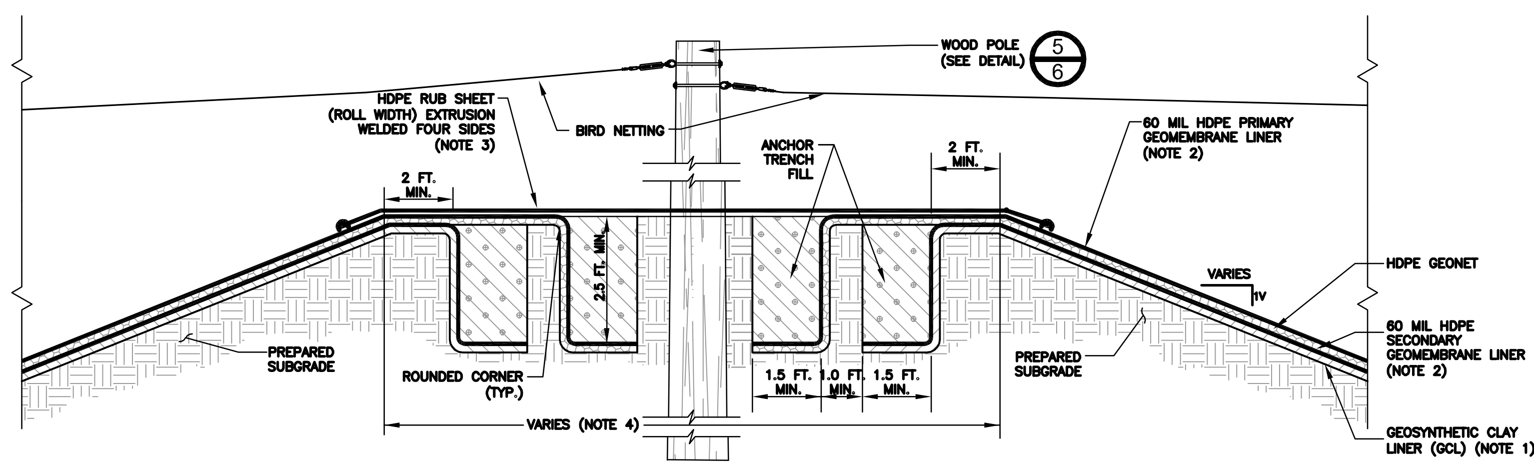
Last Plot: Oct 07, 2008 08:57 By: kElliott



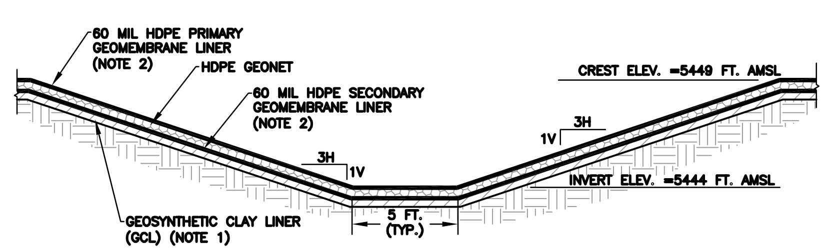
1/8 POND LINER ANCHOR TRENCH DETAIL
N.T.S.



2/8 POND LINER DETAIL
N.T.S.



3/8 DIVIDER BERM DETAIL
N.T.S.



4/8 POND SPILLWAY DETAIL
N.T.S.

NOTES

1. USE BENTOMAT ST OR APPROVED EQUIVALENT REINFORCED GCL AS THE UNDERLINER COMPONENT OF THE SECONDARY COMPOSITE LINER, WOVEN SIDE UP.
2. PRIMARY AND SECONDARY GEOMEMBRANE LINERS SHALL CONSIST OF SMOOTH BLACK HIGH DENSITY POLYETHYLENE GEOMEMBRANE. PRIMARY GEOMEMBRANE SHALL BE CONDUCTIVE TO FACILITATE SPARK TESTING.
3. RUBSHEET SHALL CONSIST OF SINGLE-SIDED TEXTURED HDPE GEOMEMBRANE (TEXTURED SIDE UP). GEOMEMBRANE SHALL BE BOOTED (I.E. SEALED) AT THE BASE OF THE WOOD POLE SUPPORTS.
4. DIVIDER BERM SHALL BE CONSTRUCTED WITH A MINIMUM WIDTH OF 15 FT. EXCEPT AT THE NORTHERN PERIMETER OF PHASE I WHICH SHALL BE CONSTRUCTED WITH A MINIMUM WIDTH OF 20 FT.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/8/08	KFM	ISSUED FOR DESIGN REPORT	JWR	KFM	JMJ

PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION PONDS
MONTROSE COUNTY, COLORADO

TITLE

EVAPORATION POND LINER DETAILS

Golder Associates
DENVER, COLORADO

PROJECT No.		073-81694	FILE No.	07381694A059
DESIGN	JDE	10/07	SCALE AS SHOWN	REV. A
CADD	JDE	10/07	DRAWING	
CHECK	KFM	10/07	8	
REVIEW	JMJ	10/07		

Plot Time: 10/07/08 09:00

Dwg Name: N:\07\073-81694\07381694A059.dwg
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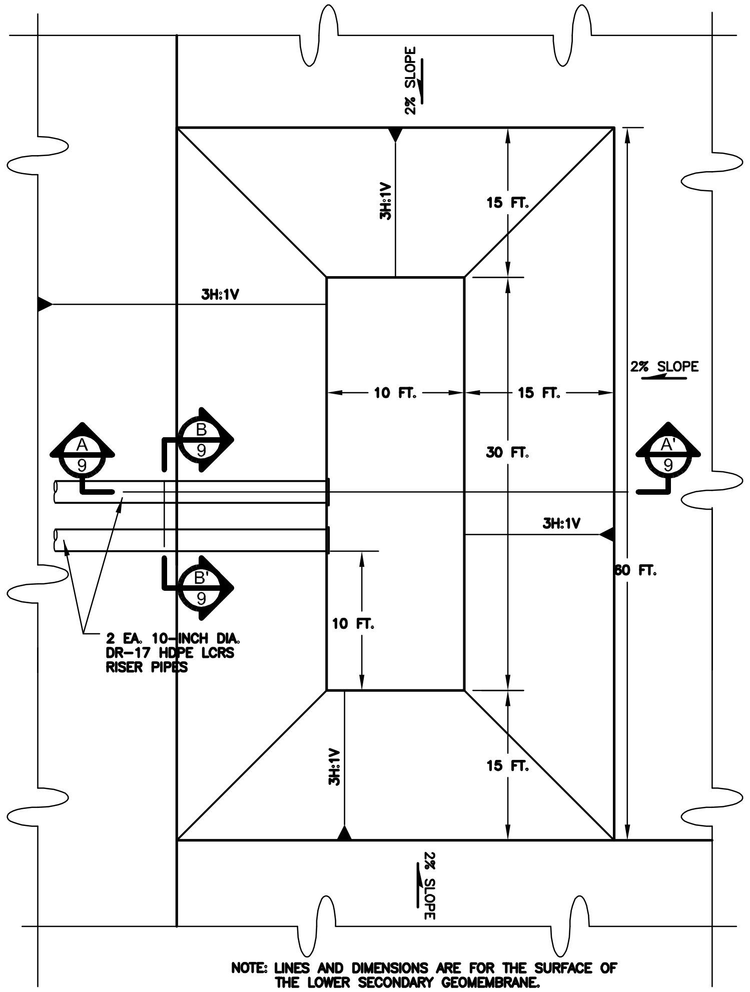
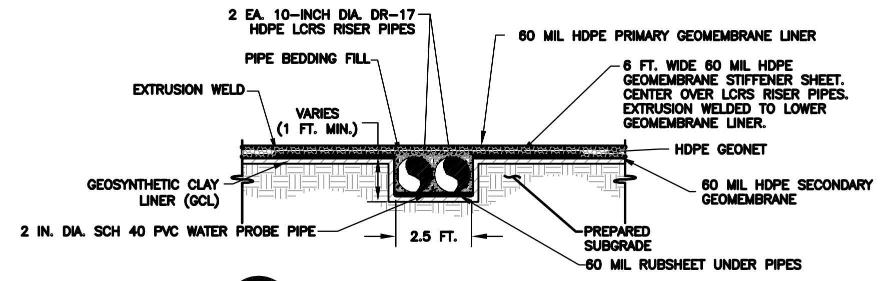
Last Update: Sep 30, 2008 16:54 By: jroberts
Last Plot: Oct 07, 2008 09:00 By: JElliott

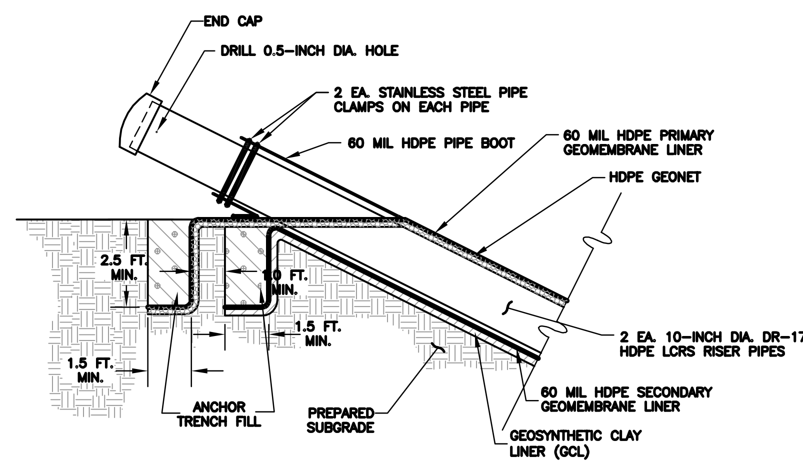


NOTE: LINES AND DIMENSIONS ARE FOR THE SURFACE OF THE LOWER SECONDARY GEOMEMBRANE.

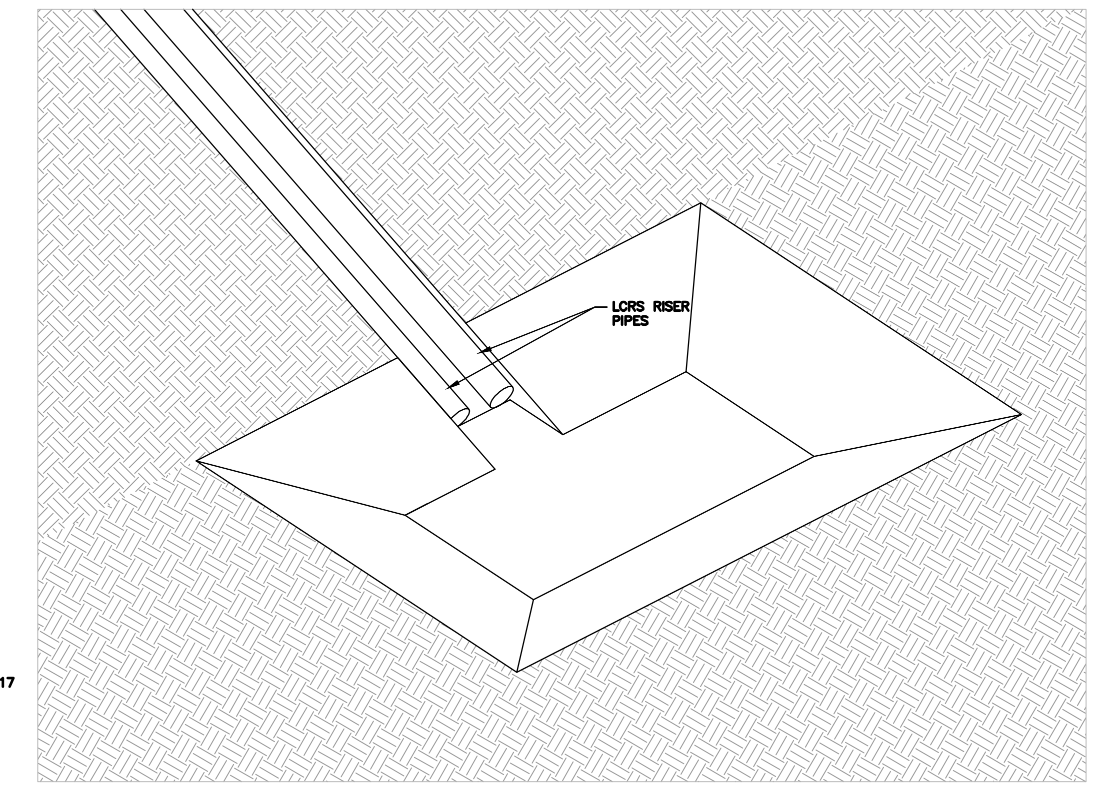
1/9 LCRS SUMP PLAN
N.T.S.



B/9 LCRS RISER PIPE SECTION B-B'
N.T.S.



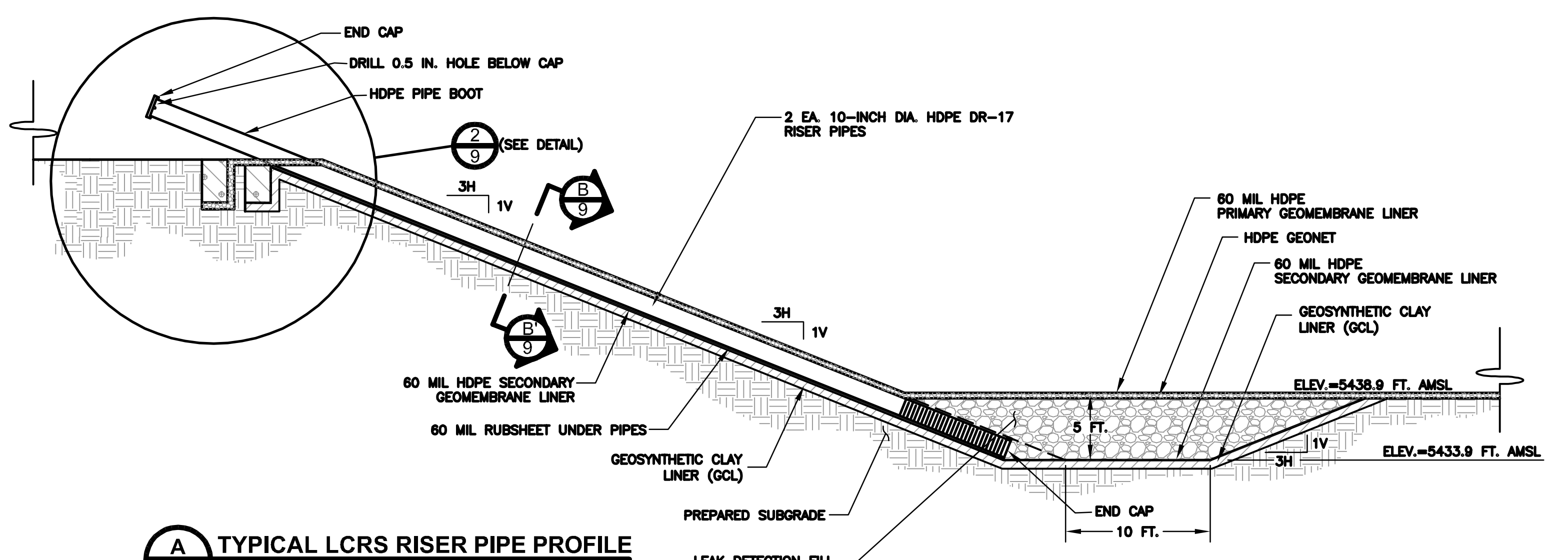
2/9 LCRS RISER OUTLET DETAIL
N.T.S.



3/9 LCRS SUMP ISOMETRIC VIEW
N.T.S.

NOTES

1. MOBILE PUMP FOR LEAK COLLECTION AND RECOVERY SYSTEM TO BE SUPPLIED BY OTHERS.



A/9 TYPICAL LCRS RISER PIPE PROFILE
N.T.S.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/08/08	KFM	ISSUED FOR DESIGN REPORT	JWR	KFM	JMJ

PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION PONDS
MONTROSE COUNTY, COLORADO

TITLE
LEAK COLLECTION AND RECOVERY SYSTEM SECTIONS AND DETAILS

Golder Associates
DENVER, COLORADO

PROJECT No.		073-81694	FILE No.	07381694A060
DESIGN	JDE	02/08	SCALE AS SHOWN	REV. A
CADD	JDE	02/08	DRAWING	
CHECK	KFM	02/08	9	
REVIEW	JMJ	02/08		

Plot Time: 10/07/08 09:02

Dwg Name: N:\07\073-81694\07381694A060.dwg
Layout Name: 24x36 Landscape Machine: DEN1-L-JELLIOT1
Last Update: Sep 30, 2008 16:56 By: jroberts
Last Plot: Oct 07, 2008 09:02 By: JElliott

APPENDIX A

WATER BALANCE EVALUATION

APPENDIX A

WATER BALANCE EVALUATION

A probabilistic water balance has been developed for the purpose of sizing the evaporation ponds for the Piñon Ridge Project. The water balance evaluation was conducted assuming that the evaporation ponds will be constructed in phases, with Phase 1 accommodating a milling rate of 500 tons per day (tpd), and Phase 2 allowing for an ultimate milling capacity of 1,000 tpd.

MODEL DEVELOPMENT

For the purpose of sizing the evaporation ponds, 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. Water balance calculations were performed using the computer program *Goldsim*™.

The water balance model was based on the following equation:

$$\Delta S = (Q + P) - (E + E_{SP})$$

where:

ΔS	=	change in stored solution volume
Q	=	raffinate inflow from the mill
P	=	precipitation collected within the evaporation pond footprint
E	=	evaporation loss from the pond surface
E_{SP}	=	water loss due to enhanced evaporation

AVAILABLE DATA

Water balance assumptions and sources of input data are summarized in Table A-1. The evaluation of climate data conducted by Golder for nearby weather stations indicates that the Uravan weather station is likely to provide reasonable precipitation estimates (See Appendix A-1). The average monthly precipitation values for the Uravan weather station are summarized in Table A-2.

The Hargreaves (1985) method was used to estimate monthly evaporation values at the Piñon Ridge site, using the available climate data from the Uravan weather station (i.e., precipitation, air temperature, etc.). The calculated evaporation values were scaled by a factor of 0.7 to represent lake evaporation. Monthly evaporation values used for the water balance calculations are summarized in Table A-2. The extreme climate data used for water balance modeling to simulate average, dry, and wet climatic conditions are summarized in Table A-3.

Based on design-level process water balance information provided by CH2M Hill (2008), the design process water inflow (raffinate from the mill) to the evaporation ponds was predicted to range from 63 gallons per minute (gpm) for 500 tons per day (tpd) milling operations, up to 126 gpm for 1,000 tpd milling operation.

DEVELOPMENT OF STOCHASTIC PRECIPITATION PARAMETERS

In order to develop stochastic precipitation input for the *Goldsim* model, continuous probability distributions were calibrated against the available monthly precipitation data from the Uravan weather station. The Weibull distribution was selected due to its flexibility to represent a wide range of values. The distribution is truncated at its lower end and has a long tail to the upper end, making it well-suited to modeling extreme positive values, such as precipitation events with longer return periods. Separate Weibull distributions were fitted to non-zero precipitation records collected for each month. A moment estimation method was used to determine distribution parameters resulting in fitting coefficients summarized in Table A-4. Minimum monthly precipitation was set to 0.1 inches per month for all *Goldsim* simulations.

MODEL VALIDATION

To verify the adopted probability distributions, a precipitation model was constructed in *Goldsim*™ and allowed to run for a 1-year period using Monte-Carlo sampling with 1,000 realizations. *Goldsim* results are compared against recorded values for the Uravan weather station in Figures A-2 to A-13 for the months of January through December, respectively, with annual totals in Figure A-14. *Goldsim* results show favorable agreement between the measured and calculated extreme values on both monthly and annual basis.

ENHANCED EVAPORATION

Enhanced evaporation values were evaluated from the estimated monthly vapor pressure deficit (e_{sat}-e_{air}) where:

e_{sat} = saturated vapor pressure (kPa)
e_{air} = actual vapor pressure (kPa)

Both saturated and actual vapor pressures were calculated based on the quarterly values for relative humidities for Grand Junction reported by Schroeder et al. (1994), and monthly temperature records for Uravan as summarized in Table A-5.

Enhanced evaporation losses summarized in Table A-5 were calculated using the methodology proposed by Ortega et al. (2000), who proposed the following equation for sprinkling irrigation losses:

$$Evap\_Losses = 7.63 * (e_{sat} - e_{air})^{0.5} + 1.62 * W$$

where W is the wind speed in meters per second (m/s), and e_{sat} and e_{air} were defined above. Assuming negligible evaporation losses caused by wind drift, as the sprinklers will be placed internal to the ponds such that drift is not a concern from a regulatory standpoint, the wind speed influence was neglected for the enhanced evaporation calculations. Total sprinkler output was evaluated by assuming installation of low impact sprinklers with a nominal outflow of 2 gallons per minute (gpm) per sprinkler head. The adopted sprinkler influence diameter was 30 feet. It was assumed that the sprinklers are uniformly spaced along the evaporation pond perimeters, with the distance between two adjacent sprinklers equal to the influence diameter. *Note that to prevent irrigation beyond the outer edge of the ponds, no sprinklers were installed within 100 feet from the evaporation pond boundaries*.

WATER BALANCE RESULTS

Preliminary Estimates

In order to provide initial estimates for the evaporation pond sizing calculation, the following general expression may be used:

$$RequiredEvapArea\,(L^2) = \frac{ProcessWaterInflows\left(L^3/T\right) - EnhancedEvaporation\left(L^3/T\right)}{Evaporation(L/T) - Precipitation(L/T)(1 - EnhEvapCoef.)}.,$$

Enhanced evaporation losses were calculated assuming a sprinkler application rate of 1,000 gpm for the raffinate inflow of 63 gpm, and a sprinkler application rate of 2,000 gpm for the raffinate inflow of 126 gpm. For these preliminary calculations, the average annual enhanced evaporation loss of 7.4 percent was applied assuming that the sprinklers were activated 33 percent of the time (i.e., 8 hours per day).

For the annual precipitation values presented in Table A-3, preliminary estimates for the pond evaporation areas are summarized in Table A-6. Table A-6 indicates the need of increasing pond sizes to provide contingency for precipitation events of larger magnitude. Probabilistic analyses were conducted to provide estimates which consider variations in the climate during the milling period.

Probabilistic Estimates

The evaporation pond areas were evaluated at different stages of the facility development assuming a maximum time of operation of 40 years. *Goldsim* calculations were based on the stochastic monthly precipitation records generated by using Weibull's distribution parameters presented in Table A-4, and illustrated in Figures A-2 through A-13. The acceptable probability of unscheduled shutdown was selected based on the 1 in 1000 year reoccurrence interval, or a 0.001 probability in any given year. The probability of the unscheduled shutdown occurring once during the 40-year operation period can be calculated as follows:

$$Cumulative\ probability = 1 - (1 - p)^n,$$

where

p = annual probability of occurence
n = number of years to evaluate

Thus, the allowable probability of exceedence for the entire 40 year period is approximately 4 percent. The calculated evaporative area was considered adequate if greater than 96 percent (100% minus 4%) of the simulations did not trigger an unscheduled shutdown during the entire 40 year simulation. A Monte-Carlo simulation with 1,000 realizations was used to evaluate the probability of exceeding the evaporation pond storage capacity (i.e. probability of unscheduled shut down) after 5, 10, 20 and 40 years of operation. For the 1-year simulation, the evaporative area was considered adequate if 99.9 percent of simulations did not trigger an unscheduled shutdown. Due to relatively high target probabilities in Monte Carlo simulations for 1- and 2-year periods, these simulations required a larger number of realizations. Results from the probabilistic analyses are summarized in Tables A-7 and A-8 and Figures A-15 through A-18.

SUMMARY

The stochastic water balance model for a continuous raffinate inflow of 126 gpm corresponding to 1000 tpd operations indicates that the evaporation pond area of approximately 83 acres is required for the operating period of 40 years with the probability of emergency shut-down below four percent. For the raffinate inflow of 63 gpm based on the design milling capacity of 500 tpd, the required evaporation pond area reduces to 45.5 acres, also assuming approximately four percent chance of emergency shutdown during 40 years of milling operations. It should be noted that a potential reduction in evaporation pond size due to pumping water to the tailings cells for dust control has not been considered, as this flow rate is assumed to be negligible.

For the above analyses, a reduction in evaporation of 30 percent was assumed based on the difference between calculated and actual shallow lake or pond evaporation. The evaporation ponds are expected to be protected from water fowl using ultraviolet (UV) stabilized knotted polyethylene netting. As the netting may influence the wind speed and radiation exposure, the proposed evaporation rates should be verified in-situ, and possibly revised upon initial construction of the evaporation ponds for the 500 tpd milling rate. The influence of netting and the presence of total dissolved solids (TDS) 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 to assist in refining the design of the evaporation ponds and allow modifications to operations as warranted, which may include construction of an additional cell (or cells) if milling continues at the 500 tpd rate for the entire mine life. Further, field evaporation measurements will assist in refining expansion design of the evaporation ponds for an increase in the milling capacity (i.e., to 1,000 tpd or more).

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TABLE A-1

WATER BALANCE MODEL ASSUMPTIONS

Property	**Value**	**Source**	**Comment/Assumptions**
Number of evaporation ponds	Varies	Calculated variable	Calculated from water balance requirements
Dimensions for a single evaporation pond	300 ft x 600 ft	See Figure A-1	Pond constructed with a 3H:1V upper portion over the vertical distance of 5 ft for containment purposes.
Sprinkler outflow	2 gpm	Rain Bird and Senninger specifications	Assume low impact sprinkler to minimize wind drift
Sprinkler diameter of influence	30 ft	Rain Bird and Senninger specifications	Use diameter of influence to determine required distance between adjacent sprinklers
Raffinate inflow	63 or 126 gpm	CH2M Hill (2008)	Design flow of 63 gpm corresponds to a milling rate of 500 tpd. Design flow of 126 gpm corresponds to a potential expansion milling rate of 1000 tpd.
Climate data	Varies	See Appendix A-1	Use climate date for Uravan
Annual Pan Evaporation	55 to 60 inches	wrcc.dri.edu/climmaps/panevap.gif	Use pan factor of 0.7 to estimate lake (pond) evaporation
Enhanced evaporation loss	Varies	Ortega et al. (2000)	Neglect wind influence in calculations

Notes:

1. Tailings and evaporation pond stream analysis for project design provided by CH2M Hill (2008).

TABLE A-2

MONTHLY PRECIPITATION AND EVAPORATION VALUES

Month	Average* Precipitation (inches)	Minimum* Precipitation (inches)	Maximum* Precipitation (inches)	Calculated Lake Evaporation (inches)
January	0.88	0	3.19	0.8
February	0.76	0	2.05	1.2
March	1.03	0	3.43	2.2
April	1.01	0.03	2.68	3.3
May	0.94	0	2.85	4.8
June	0.48	0	1.65	5.8
July	1.19	0.09	3.54	6.3
August	1.36	0.18	3.32	5.4
September	1.5	0.06	4.78	3.8
October	1.51	0	5.89	2.5
November	1.05	0	2.39	1.2
December	0.88	0.03	3.55	0.7

* Precipitation values obtained for Uravan weather station from 1961 to 2007

TABLE A-3

EXTREME ANNUAL PRECIPITATION AND AVERAGE EVAPORATION VALUES

Average* Precipitation (inch)	Min.* Precipitation (inch)	Max.* Precipitation (inch)	Estimated Lake Evaporation (inch)
12.5	7.13	21.4	38.0

* Precipitation values obtained for Uravan weather station from 1961 to 2007

TABLE A-4

WEIBULL DISTRIBUTION PARAMETERS

Month	Slope Parameter (-)	Mean Minus Minimum* (inch/month)
January	1.49	0.78
February	1.35	0.71
March	1.27	0.97
April	1.32	0.93
May	1.13	0.89
June	0.98	0.44
July	1.57	1.09
August	1.51	1.28
September	1.28	1.39
October	1.25	1.46
November	1.75	0.98
December	1.48	0.76

*****Minimum monthly precipitation was set to 0.1 inches per month for all *Goldsim* simulations.

TABLE A-5

CALCULATED ENHANCED EVAPORATION LOSSES

Month	Min. Temperature T_{min} (^oF)	Max. Temperature T_{max} (^oF)	Avg. Temperature T_{avg} (^oF)	Relative Humidity (%)	e_{sat} (kPa)	e_{air} (kPa)	Evaporation Losses (no wind) (%)
January	15.6	42.7	29.2	60	0.62	0.37	3.8
February	22.4	49.9	36.3	60	0.82	0.49	4.4
March	29.2	58.7	43.9	60	1.12	0.67	5.1
April	35.7	67.6	51.7	36	1.51	0.54	7.5
May	44.5	78.6	61.5	36	2.17	0.78	9.0
June	52.4	89.5	70.9	36	3.04	1.09	10.6
July	59.4	95.5	77.4	36	3.72	1.34	11.8
August	58.2	92.2	75.2	36	3.41	1.23	11.3
September	48.3	83.5	65.8	36	2.53	0.91	9.7
October	36.9	71.4	54.2	57	1.68	0.96	6.5
November	26.5	54.7	40.6	57	0.97	0.56	4.9
December	17.8	43.4	30.6	57	0.65	0.37	4.0

TABLE A-6

PRELIMINARY EVAPORATION POND AREA ESTIMATES

Climatic Condition	Annual Precipitation (inch)	Pond Area for Raffinate Inflow of 63 gpm (acre)	Pond Area for Raffinate Inflow of 126 gpm (acre)
Dry Conditions	7.13	26	55
Average Conditions	12.5	32	69
Wet Conditions	21.4	54	117

TABLE A-7

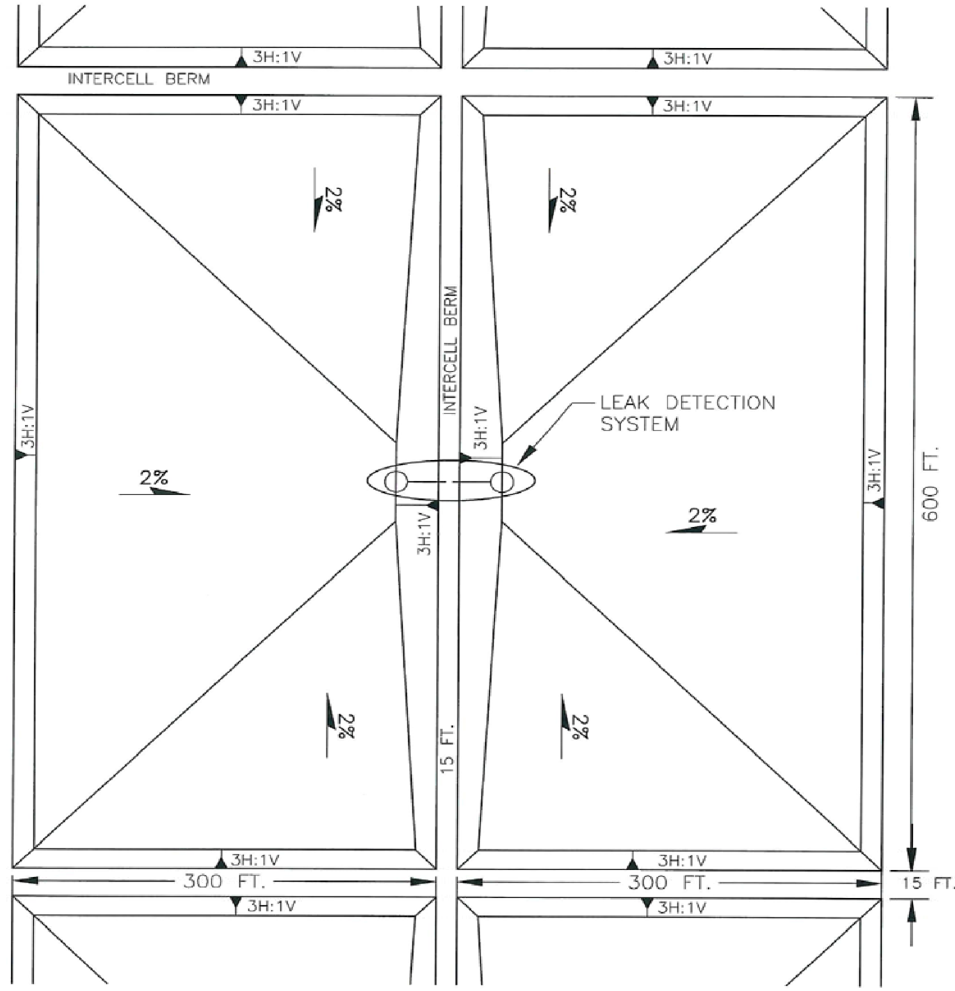
PROBABILISTIC EVAPORATION POND AREAS FOR RAFFINATE INFLOW OF 63 GPM

Design Storm	Pond Areas at Different Times of Operation (t=1, 2, 5, 10, 20 and 40 yrs) (acres)					
	1 yr	2 yr	5 yr	10 yr	20 yr	40 yr
1/1000 yrs	16.5	24.8	37.2	41.3	45.5	45.5

TABLE A-8

PROBABILISTIC EVAPORATION POND AREAS FOR RAFFINATE INFLOW OF 126 GPM

Design Storm	Pond Areas at Different Times of Operation (t=1, 2, 5, 10, 20 and 40 yrs) (acres)					
	1 yr	2 yr	5 yr	10 yr	20 yr	40 yr
1/1000 yrs	33.1	49.6	70.2	78.5	82.6	82.6



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TITLE
TYPICAL EVAPORATION POND CELL LAYOUT

CLIENT/PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	GG	DATE	Oct-08	JOB NO.	073-81694
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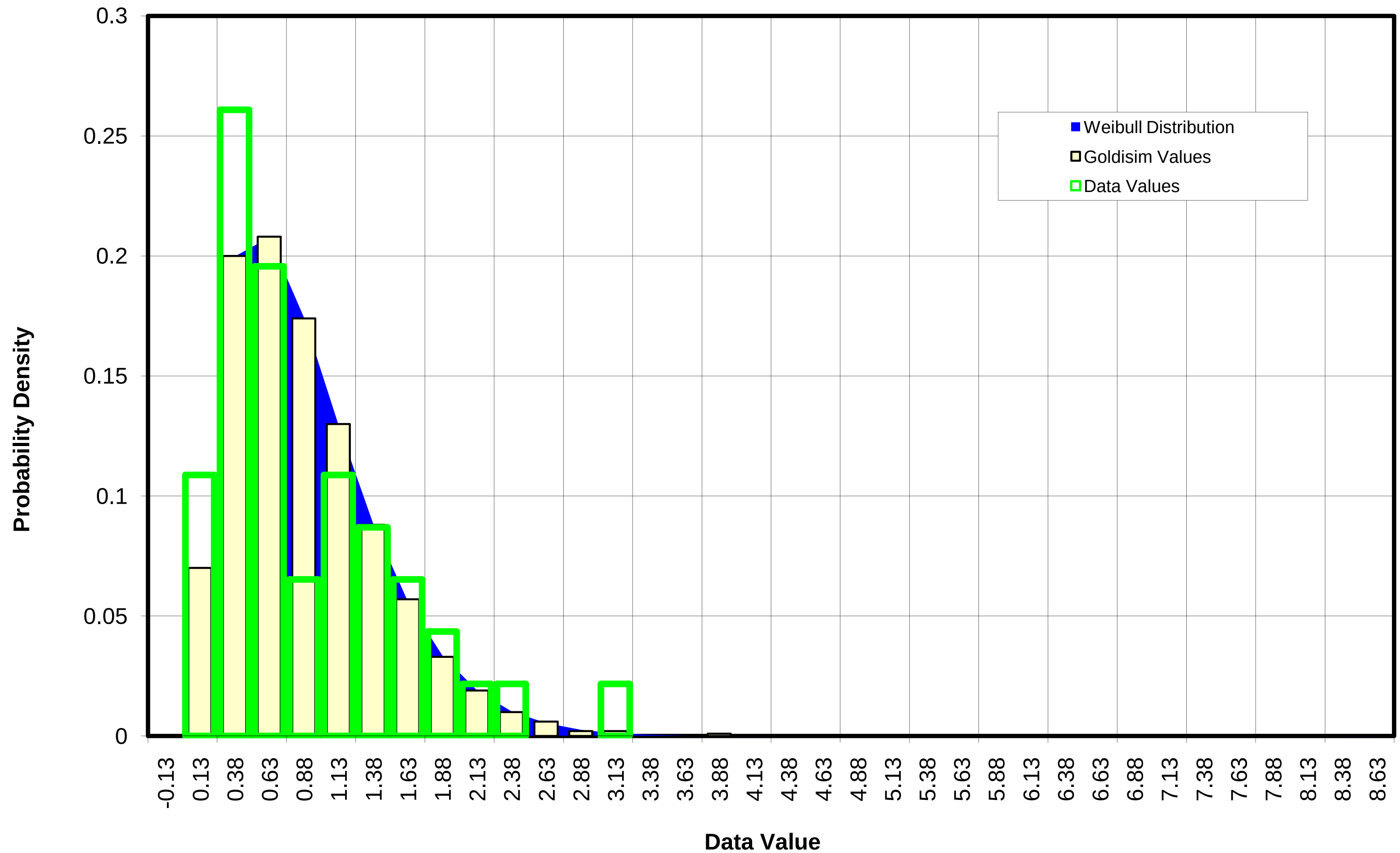

Golder Associates — Denver, Colorado		TITLE: **URAVAN DATA GOLDSIM RESULTS AND WEIBULL DISTRIBUTION FOR JANUARY**			
CLIENT/PROJECT: **ENERGY FUELS RESOURCES CORPORATION PIÑON RIDGE PROJECT**	DRAWN	GG	DATE	Oct-08	JOB NO. 073-81694
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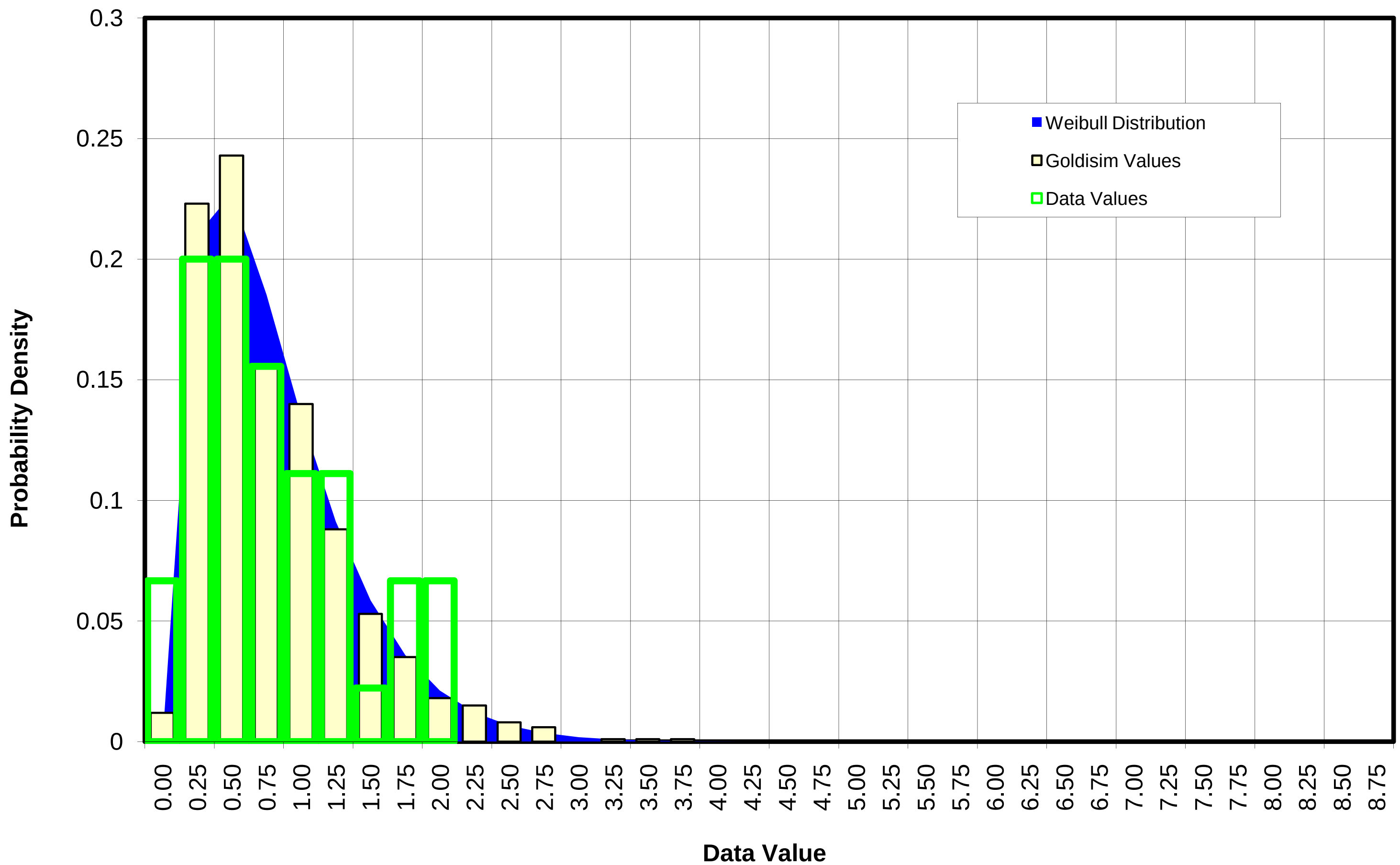

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URAVAN DATA
GOLDSIM RESULTS AND WEIBULL DISTRIBUTION FOR FEBRUARY

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORP.
PIÑON RIDGE PROJECT

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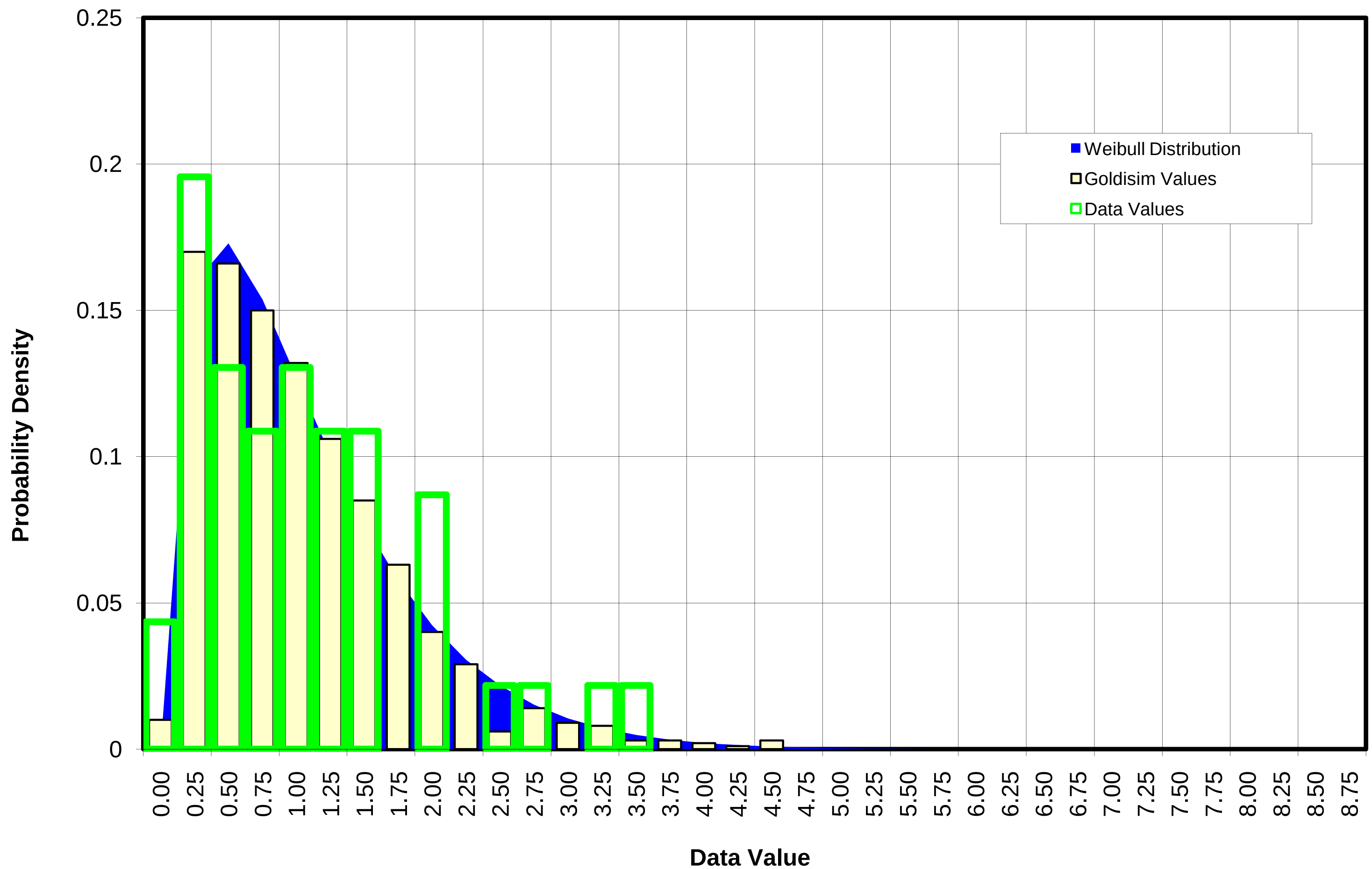

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URAVAN DATA
GOLDSIM RESULTS AND WEIBULL DISTRIBUTION FOR MARCH

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORP.
PIÑON RIDGE PROJECT

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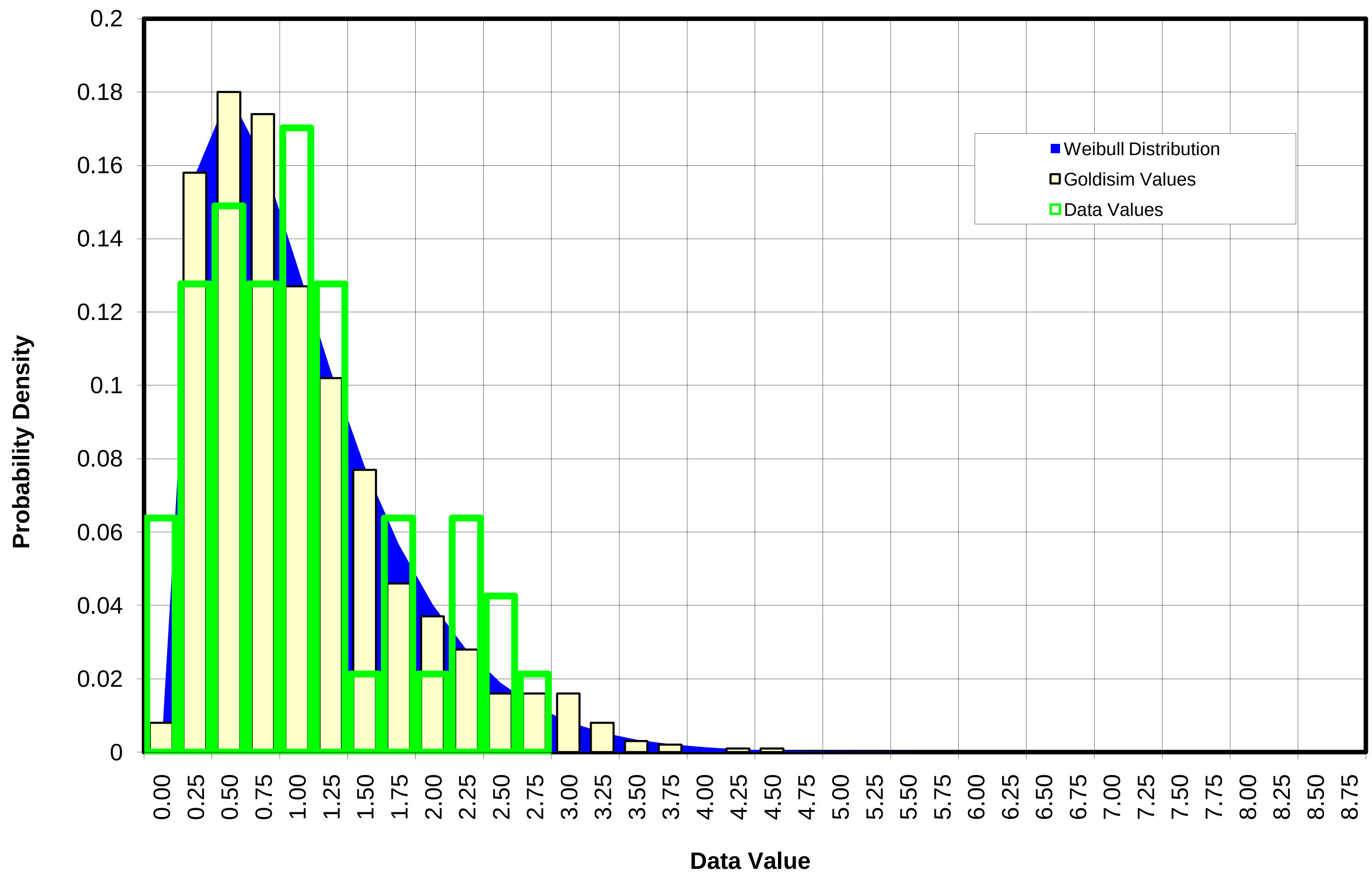

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URAVAN DATA
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CLIENT/PROJECT
ENERGY FUELS RESOURCES CORP.
PIÑON RIDGE PROJECT

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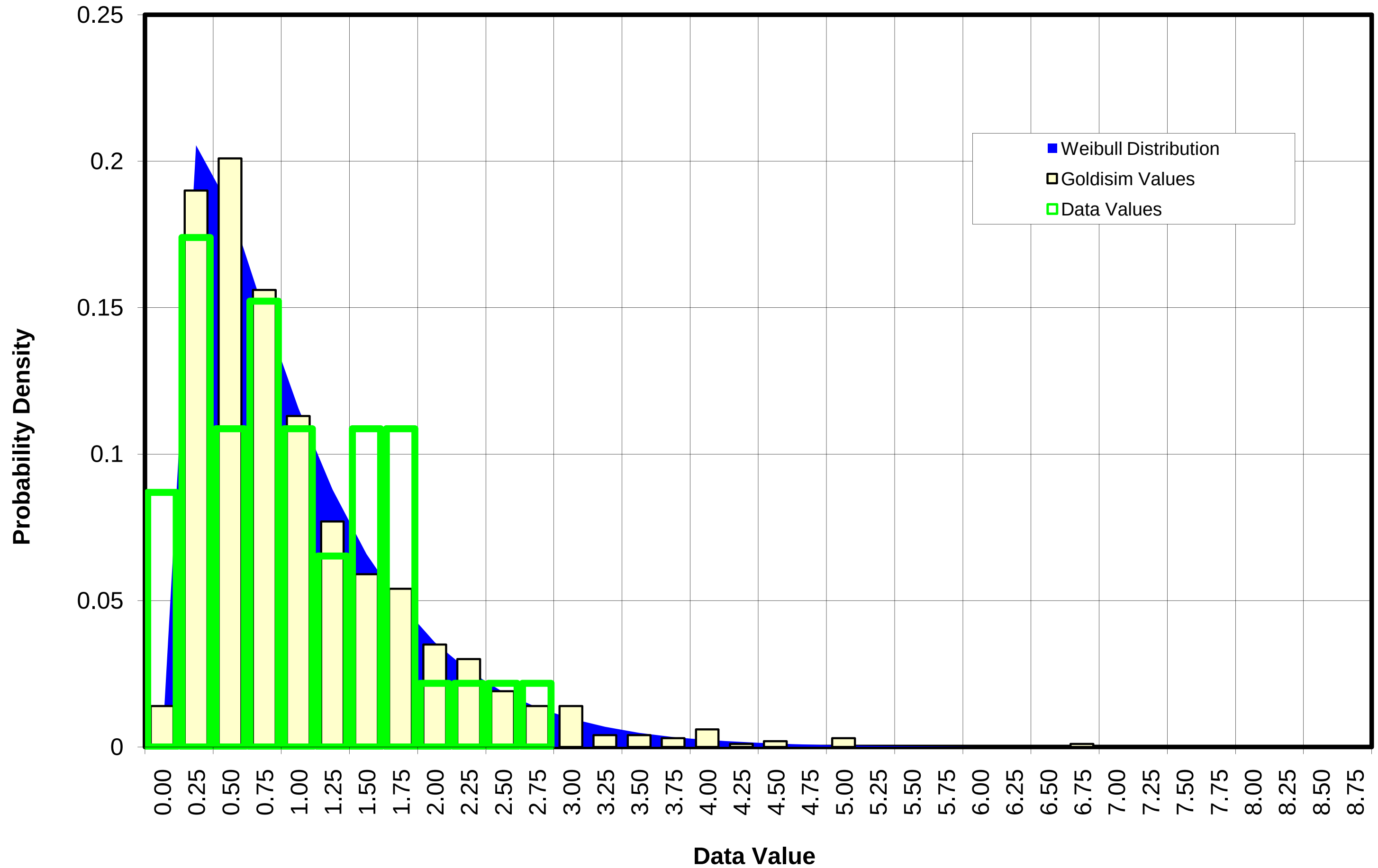

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URAVAN DATA
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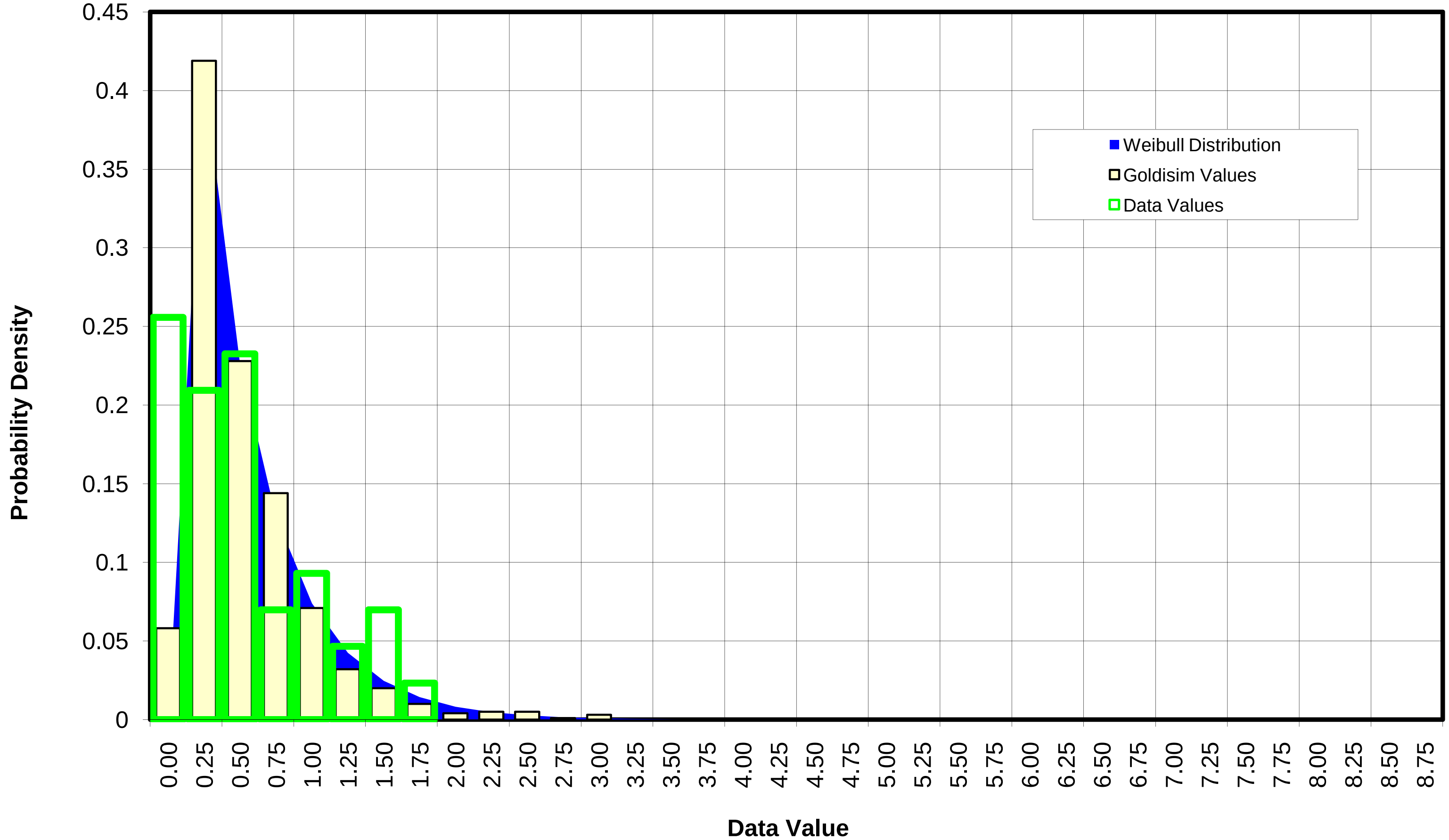

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URAVAN DATA
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CLIENT/PROJECT
ENERGY FUELS RESOURCES CORP.
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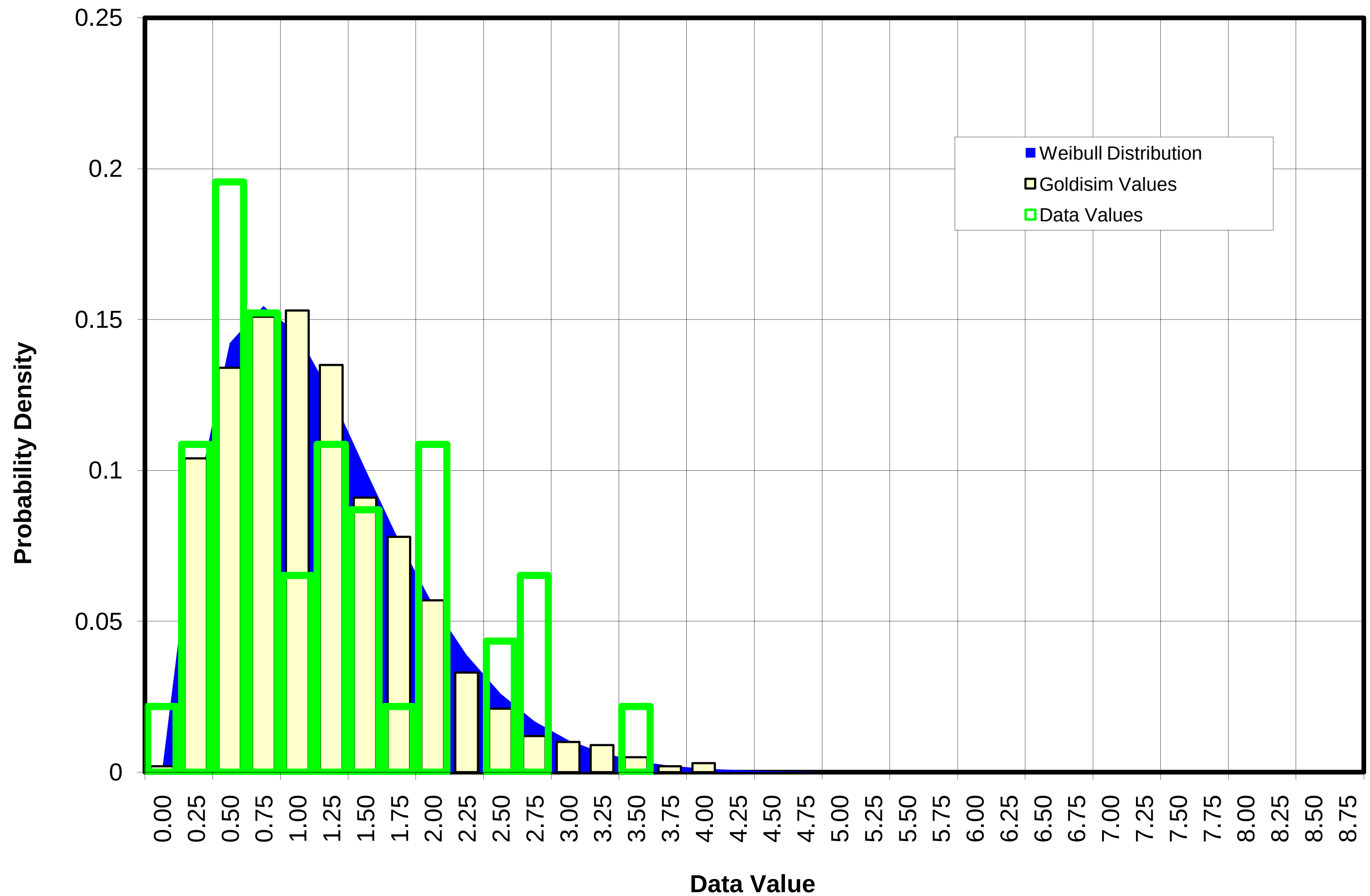

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URAVAN DATA
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ENERGY FUELS RESOURCES CORP.
PIÑON RIDGE PROJECT

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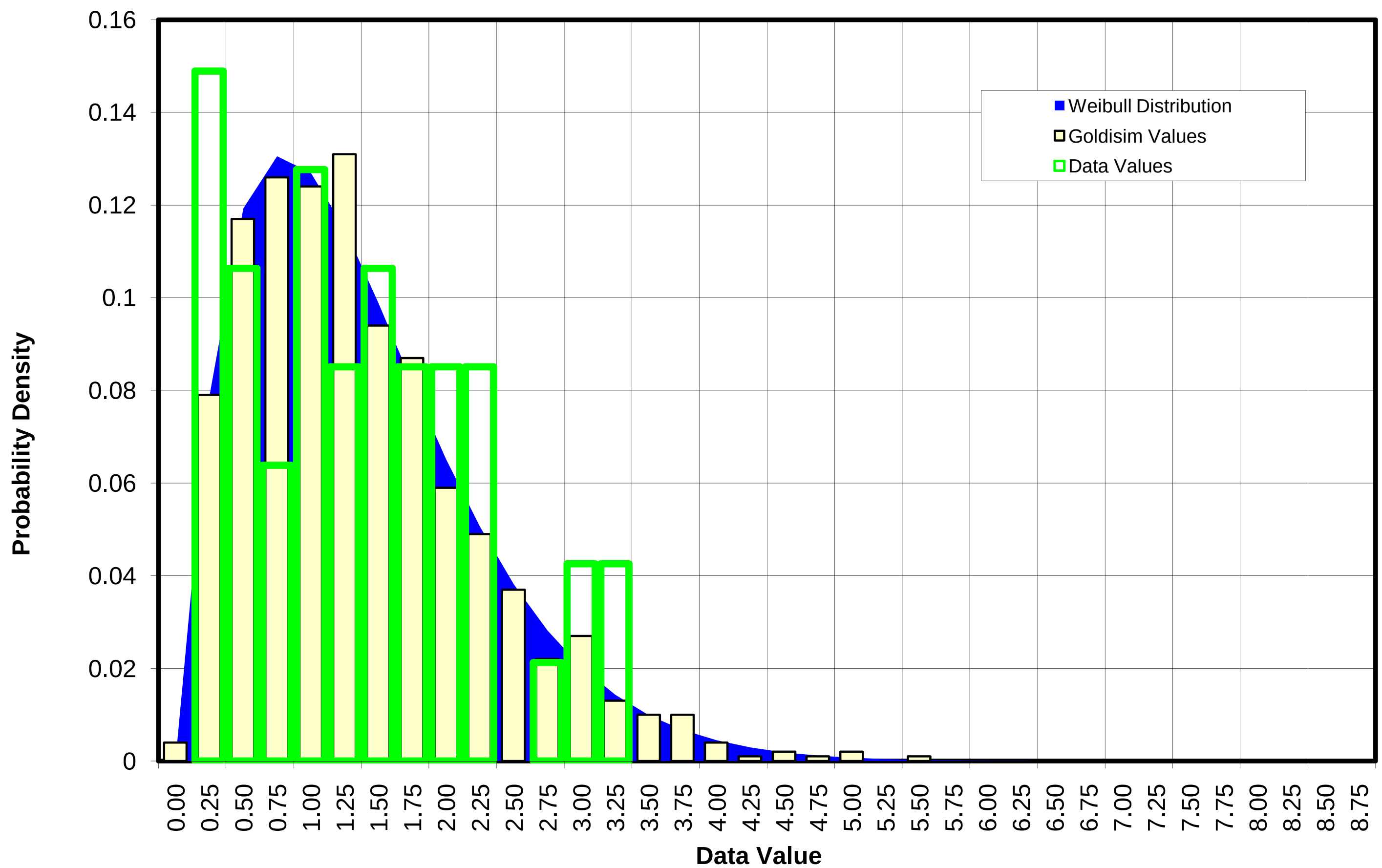

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TITLE

URAVAN DATA
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CLIENT/PROJECT
ENERGY FUELS RESOURCES CORP.
PIÑON RIDGE PROJECT

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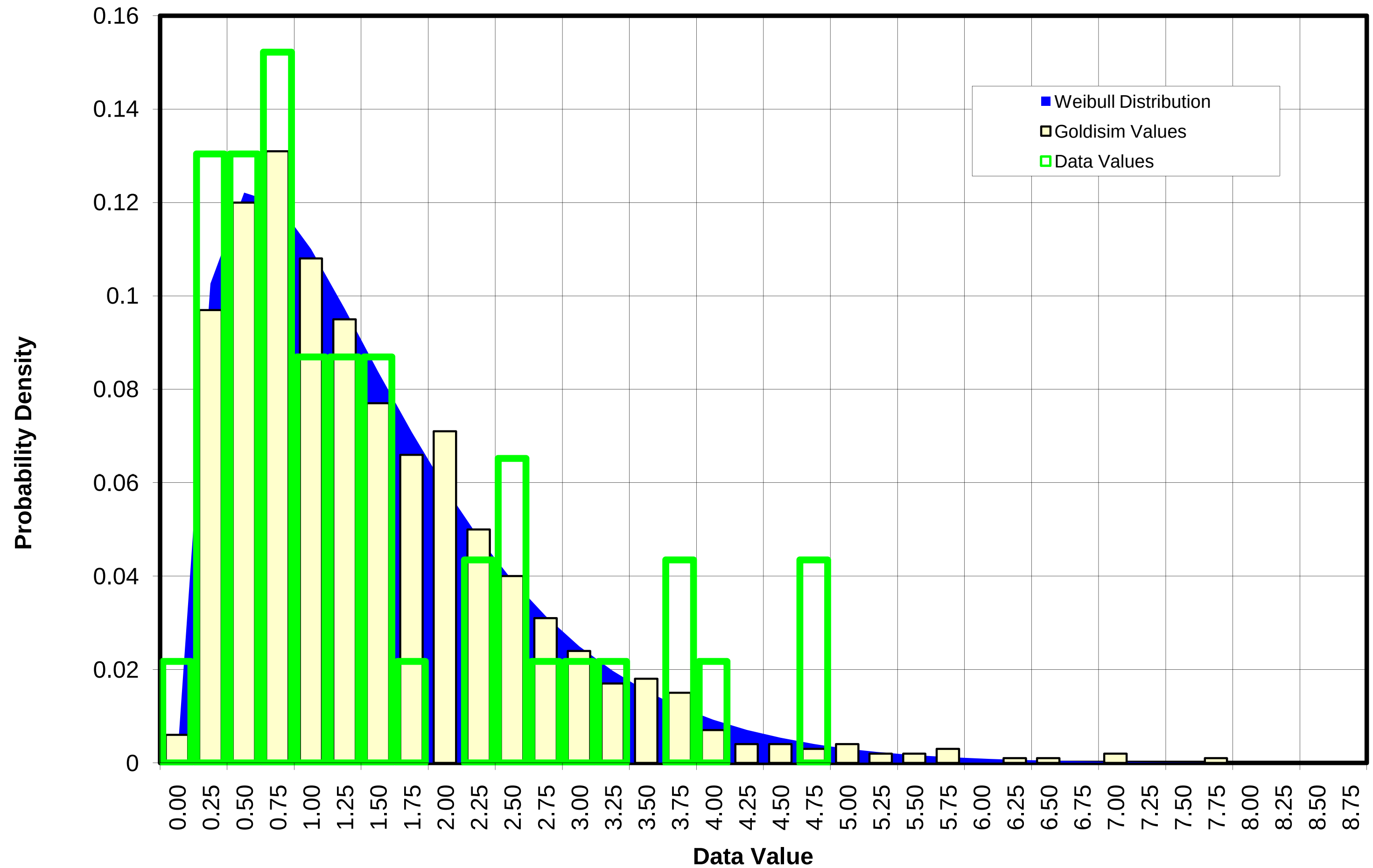

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URAVAN DATA

GOLDSIM RESULTS AND WEIBULL DISTRIBUTION FOR SEPTEMBER

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ENERGY FUELS RESOURCES CORP.
PIÑON RIDGE PROJECT

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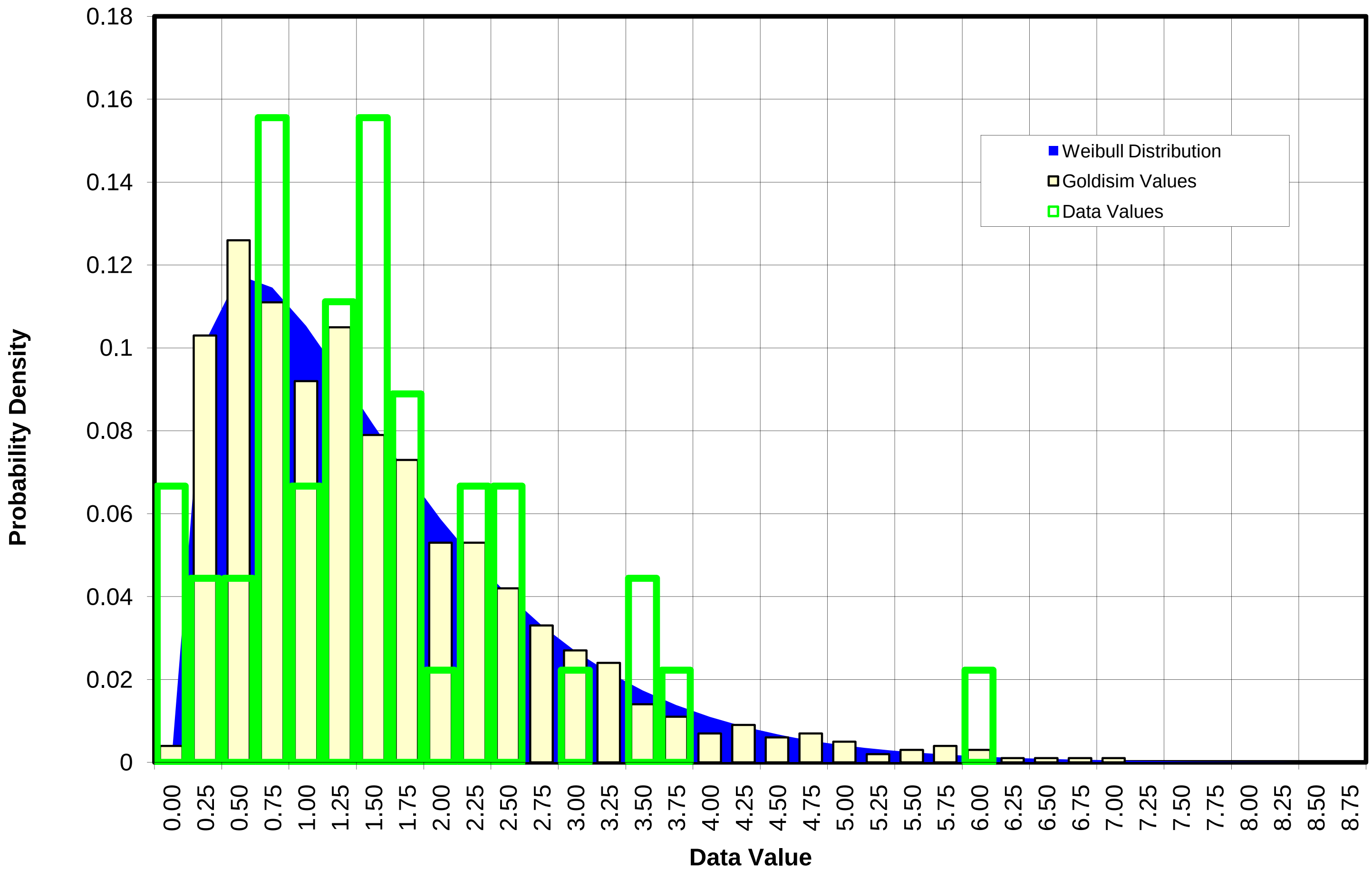

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URAVAN DATA
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CLIENT/PROJECT

ENERGY FUELS RESOURCES CORP.
PIÑON RIDGE PROJECT

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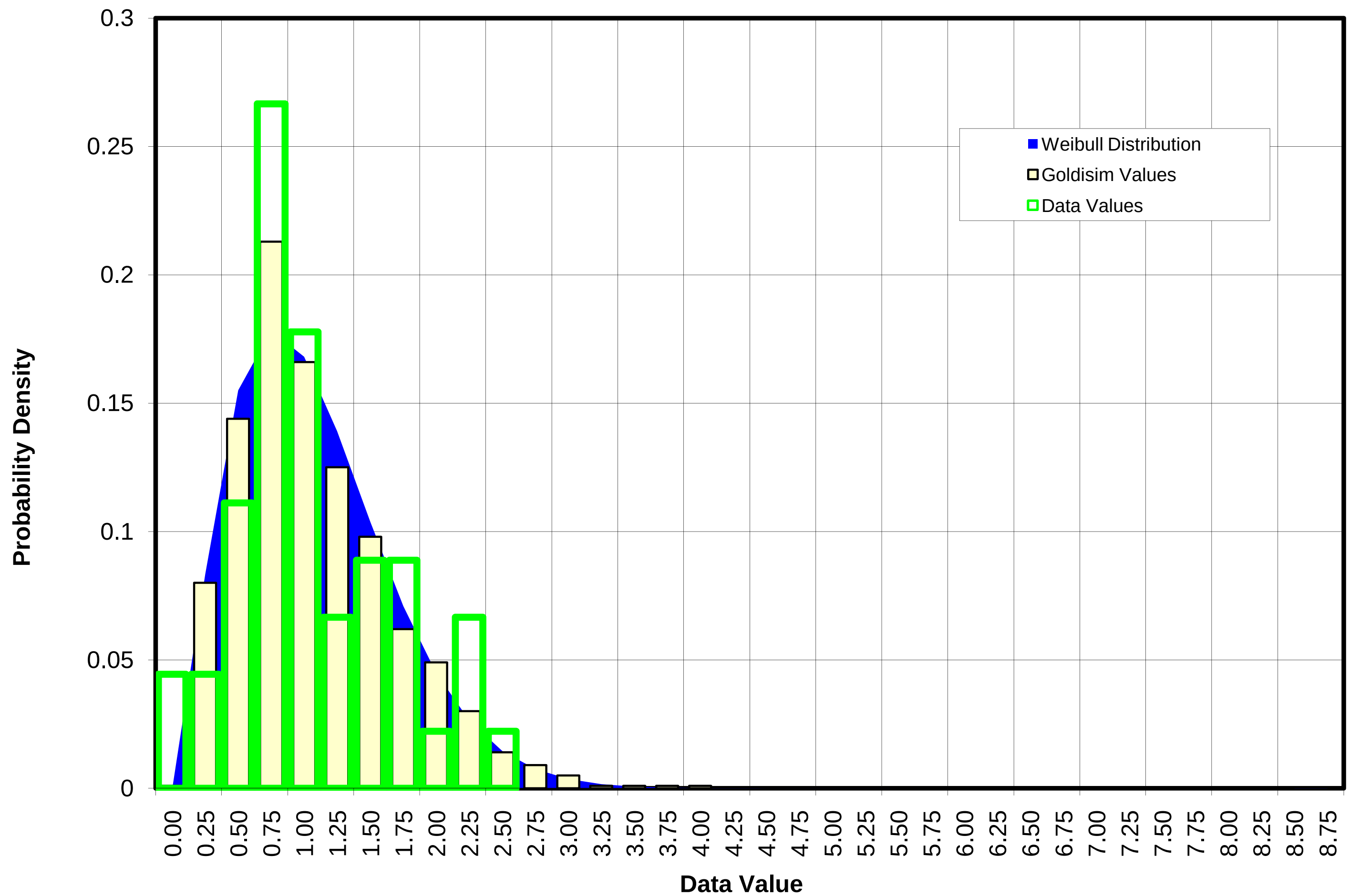

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URAVAN DATA
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ENERGY FUELS RESOURCES CORP.
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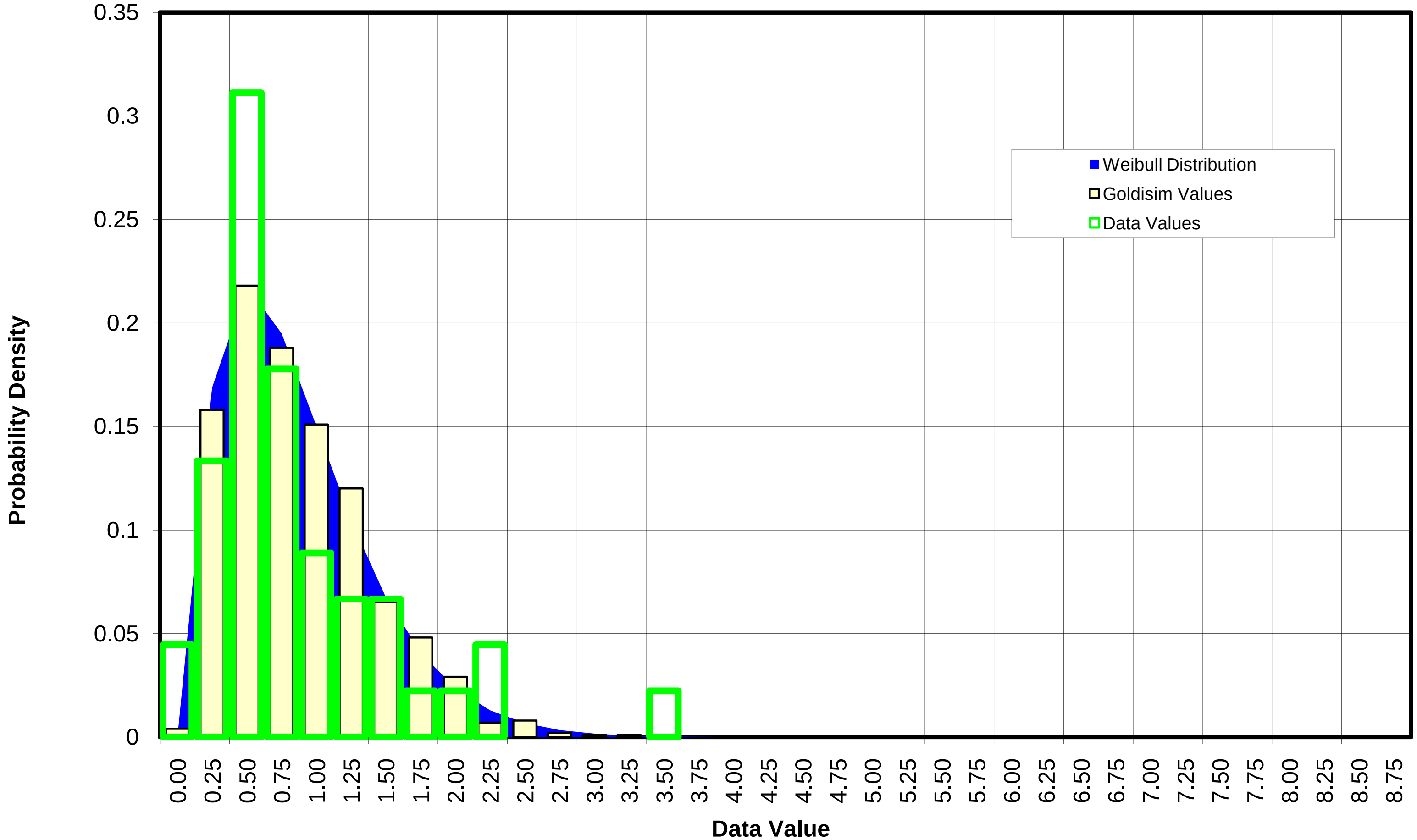

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URAVAN DATA
GOLDSIM RESULTS AND WEIBULL DISTRIBUTION FOR DECEMBER

CLIENT/PROJECT
ENERGY FUELS RESOURCES CORP.
PIÑON RIDGE PROJECT

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CHECKED	DPH	SCALE	AS SHOWN	DWG. NO.	NA
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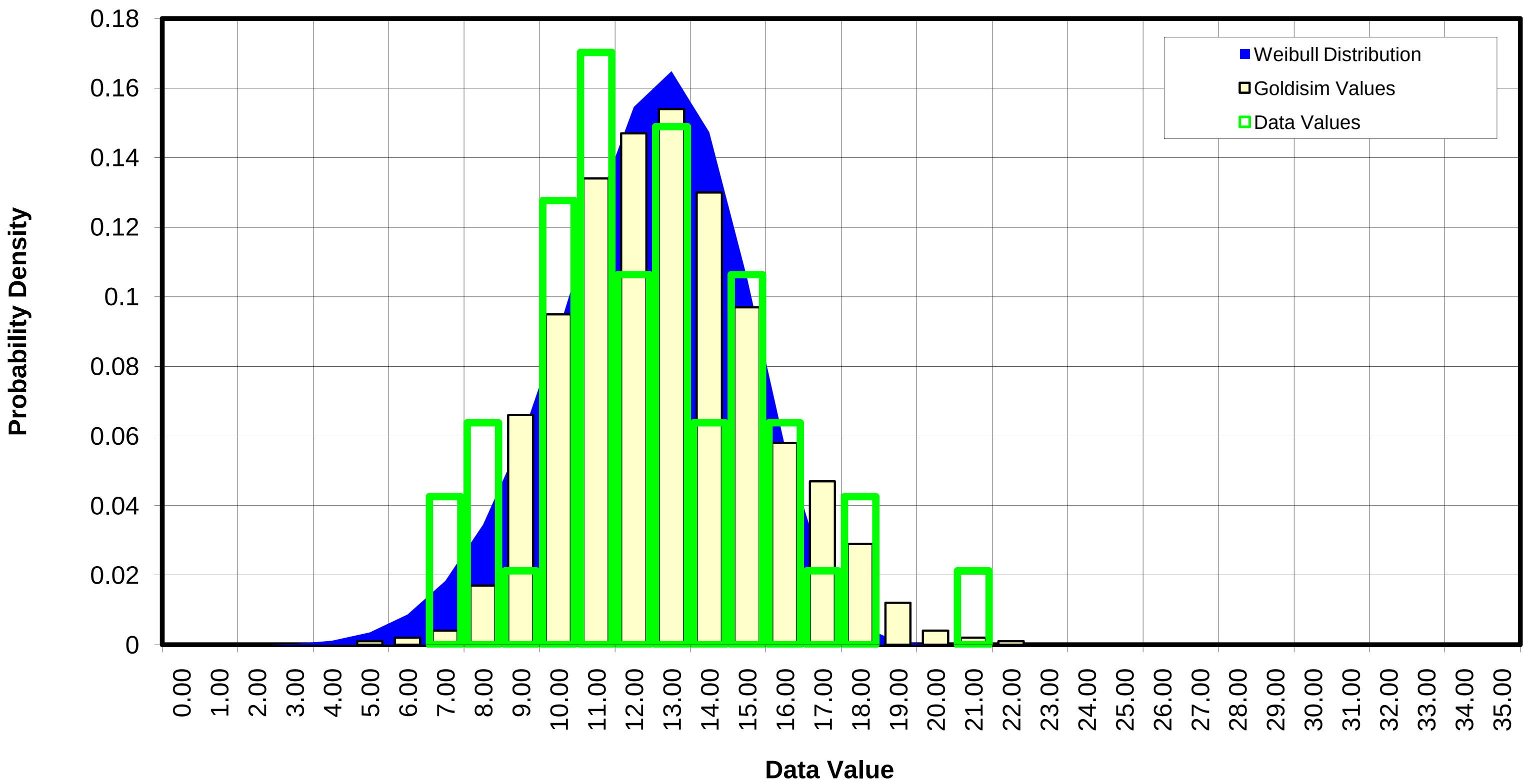
Annual Data Histograms with Weibull Distribution Fit to Uravan Historical Precipitation Data



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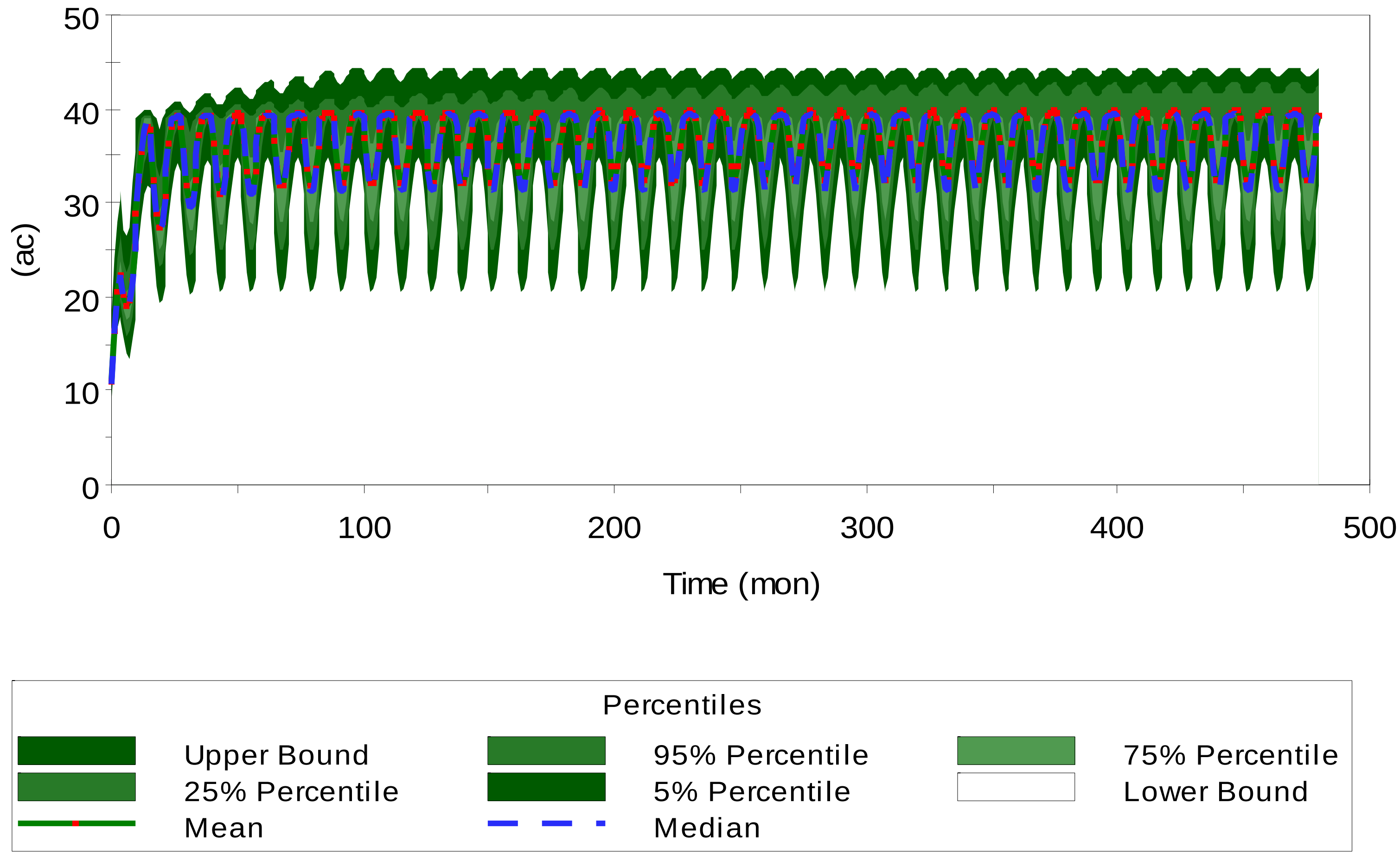

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EVAPORATION POND AREA FOR 63 GPM INFLOW

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
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DRAWN	GG	DATE	Oct-08	JOB NO.	073-81694
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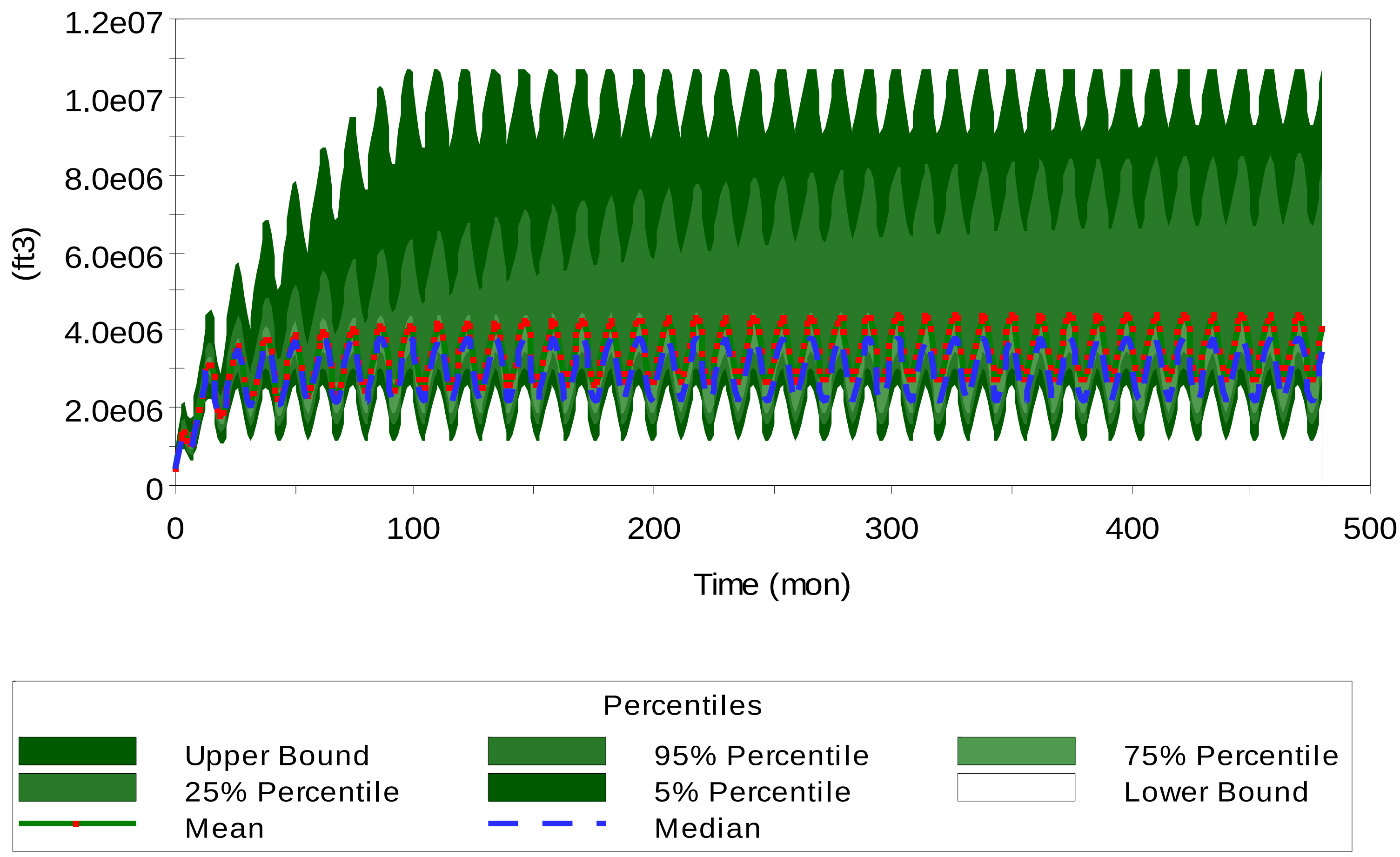
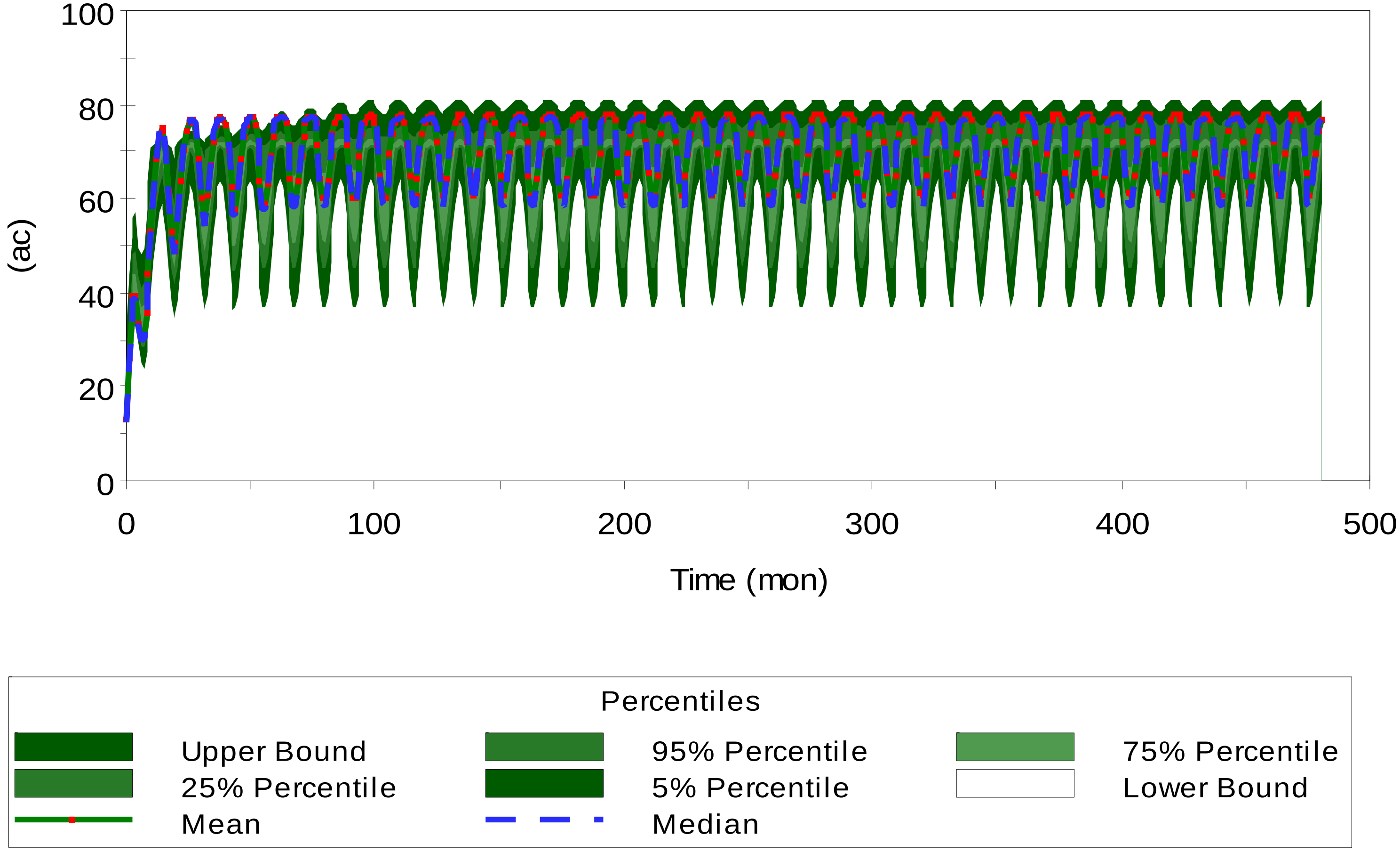


Golder Associates
Denver, Colorado

TITLE	EVAPORATION POND VOLUME FOR 63 GPM INFLOW				
DRAWN	GG	DATE	Oct-08	JOB NO.	073-81694
CHECKED	DPH	SCALE	AS SHOWN	DWG. NO.	NA
REVIEWED	KFM	FILE NO.	EvapPondWatBal-Figures.xls	FIGURE NO.	A-16

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT



Golder Associates
Denver, Colorado

TITLE
EVAPORATION POND AREA FOR 126 GPM INFLOW

CLIENT/PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	GG	DATE	Oct-08	JOB NO.	073-81694
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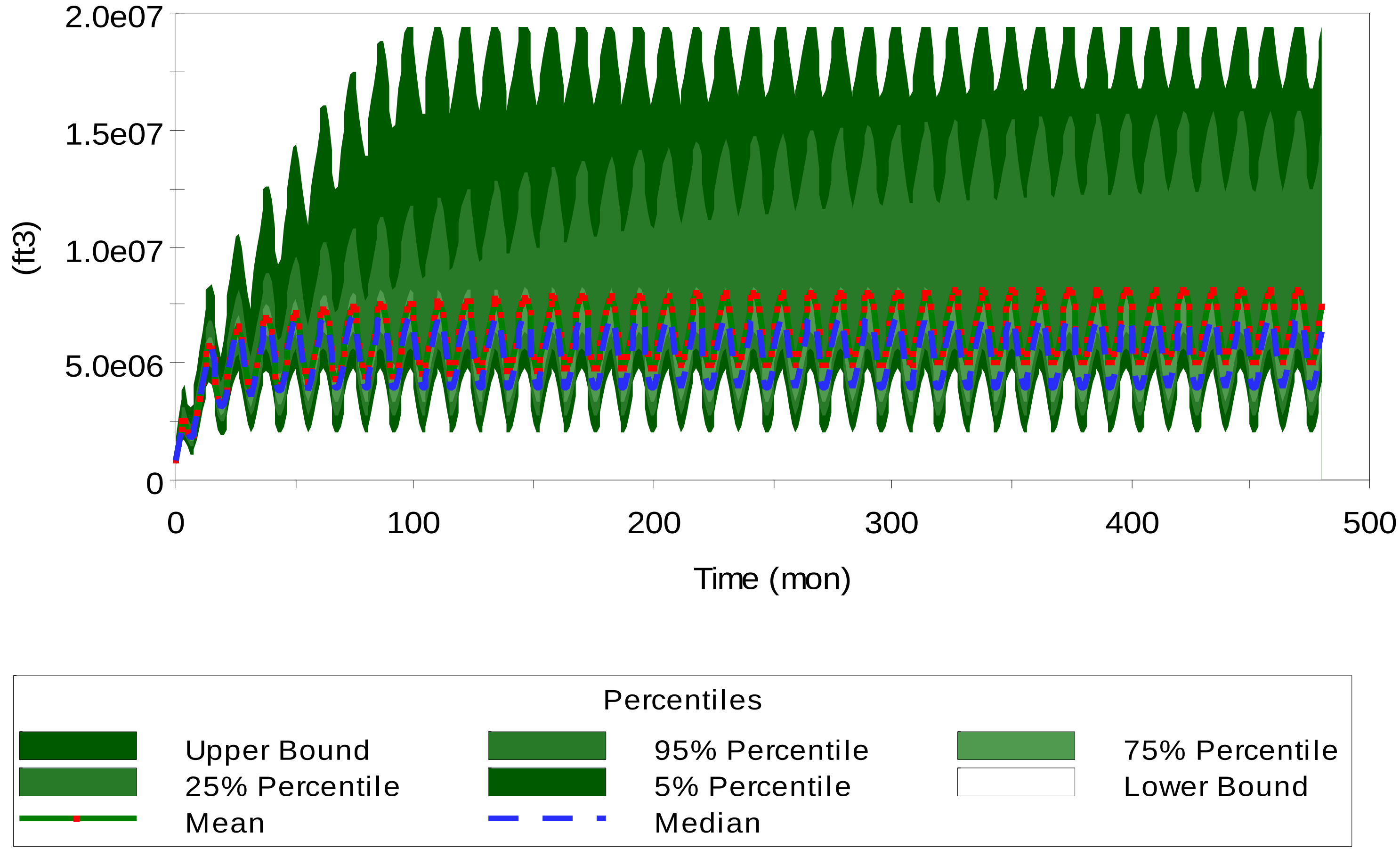
REVIEWED	KFM	FILE NO.	EvapPondWatBal-Figures.xls	FIGURE NO.	A-17



Golder Associates

Denver, Colorado

TITLE

EVAPORATION POND VOLUME FOR 126 GPM INFLOW

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	GG	DATE	Oct-08	JOB NO.	073-81694
CHECKED	DPH	SCALE	AS SHOWN	DWG. NO.	NA
REVIEWED	KFM	FILE NO.	EvapPondWatBal-Figures.xls	FIGURE NO.	A-18

APPENDIX A-1

CLIMATE DATA ANALYSIS

OBJECTIVE:

Evaluate the available weather data for the Piñon Ridge site and select a data set to be used in the design of facilities for the project.

GIVEN:

- Daily weather data obtained from the Western Regional Climate Center from the following locations:
  - Uravan
  - Nucla
  - Grand Junction
  - Montrose

ANALYSIS:

Site-Specific Data

Piñon Ridge site is located at 38°15' latitude, 108°45' longitude, elevation 5,480 feet. The site rests in the middle of a narrow valley near Monogram Mesa (see Figure A-1-1). Due to the limitations of obtaining site specific weather data, nearby weather stations are used to estimate or approximate the climatic conditions for the Piñon Ridge site.

Regional Data

The weather data from the following weather stations are considered due to proximity to the investigated site, and the available data inventory:

- *Uravan* (NCDC No. 058560)
- *Nucla* (NCDC No. 053807)
- *Grand Junction* (NCDC No. 053488)
- *Grand Junction 6 ESE* (NCDC No. 053489)
- *Montrose 1* (NCDC No. 055717)
- *Montrose 2* (NCDC No. 055722)

Data for above sites were obtained from the Western Regional Climate Center. The locations of the nearby weather stations and the Piñon Ridge site are illustrated in Figure A-1-2. In the following section, a brief description is presented for each weather station.

Uravan

Uravan is located at 38°22' latitude 108°45' longitude, elevation 5,010 feet, about 8.5 miles North of the Piñon Ridge site. The difference in elevation between the sites is 470 feet. This weather station provides the following daily weather data between the years of 1960 to 2007:

- Precipitation
- Air temperature
- Snow cover

The average total annual precipitation is equal to 12.6 inches. The months of September and October are generally the wettest months of the year. The maximum total annual precipitation of 21.4 in was recorded in 1965. The driest year was 1989 with a total annual rainfall equal to 7.3 inches. The average annual temperature is equal to 53.1 °F, and the average total annual snowfall is equal to 9.4 inches. The maximum snowfall was recorded during 1978-1979 with a total 40.4 in. Table A-1-1 shows the average monthly and annual data for this weather station.

Nucla

Nucla is located at 38°13' latitude 108°33' longitude, elevation 5,860 feet, about 11 miles East of the Piñon Ridge site. The difference in elevation between the sites is 380 feet. This weather station provides the following daily weather data for the years 1999 to 2007:

- Air temperature
- Solar radiation
- Wind velocity
- Relative humidity
- Precipitation

The average annual temperature at the Nucla site is 53 °F. The solar radiation has been increasing during the period of record (i.e., 1999 to 2007) from 746 langleys (ly) in 1999 to 827 ly in 2007. The maximum solar radiation was collected during June 2007 at 828 ly. The average relative humidity (RH) for this site is equal to 42%, where the driest season corresponds to summer time (RH =31 %) . The average total annual precipitation for this location is 9.3 inches. The wettest month is September with an average accumulated precipitation of 1.8 inches. The driest month corresponds to January with 0.3 inches of precipitation. The wettest year correspond to 2006 with a total accumulated precipitation equal to 10.4 inches. Table A-1-2 shows the average monthly and annual data for this weather station.

Grand Junction Airport

Grand Junction Airport is located at 39° 8' latitude 108°32' longitude, elevation 4,840 feet, about 62 miles North of the Piñon Ridge site. The difference in elevation between the sites is 640 feet. This weather station provides the following daily weather data for the years 1900 to 2007:

- Air temperature
- Precipitation
- Snow cover
- PAN evaporation
- Relative humidity
- Cloud cover
- Wind velocity

PAN evaporation data is available only for years 1948 to 1960 for this location, with an average total annual PAN evaporation equal to 82.4 inches. The annual average relative humidity is equal to 53.1%. An annual average of 22 inches of snowfall was recorded at Grand Junction airport, with a maximum snowfall of 6.3 inches recorded in December of 1998. The wettest year was in 1957 with 15.7 in of total precipitation. Grand Junction airport average annual precipitation is 8.8 in. The average cloud cover is 6%. The average annual data for Grand Junction are summarized in Table A-1-3.

Grand Junction 6ESE

Grand Junction 6ESE weather station is located at 39° 2' latitude 108°27' longitude, and elevation of 4,760 feet. The weather station is located 7.8 miles south of the Grand Junction Airport weather station. This weather station complements the data provided by the Grand Junction airport weather station. The Grand Junction 6ESE weather station provides the following daily weather data for the years 1962 to 2007:

- Air temperature
- Precipitation
- PAN evaporation
- Snow cover

The total average annual PAN evaporation is equal to 57.9 inches. The average annual precipitation is equal to 8.9 inches. The wettest year was in 1957 with 16 inches of total precipitation. The average annual snowfall for this station is 12.3 inches with a maximum snow fall recorded in December of 1978. Table A-1-4 shows the average annual data for this weather station.

Montrose

Two weather stations are used to obtain climate data for this location: one located at 38°28' latitude 107°52' longitude, elevation 5,786 feet and the second located at 38°29' latitude 107°52' longitude, elevation 5,785 feet. The first weather station provides data from 1905 to 1982; the second weather station provides data from 1895 to 2007. Montrose is located 50 miles southeast from the Piñon Ridge site. These weather stations provide the following daily weather data:

- Air temperature
- Precipitation
- Snow cover
- Average monthly PAN evaporation

The average total annual snowfall recorded at this location is 25.9 inches. With a maximum snowfall of 72 inches recorded in 1918. Montrose records show that the average annual precipitation is 9.6 in. The maximum precipitation was in 1941 with 17 inches of rainfall. The annual average PAN evaporation is 55.8 inches. Table A-1-5 shows the average monthly annual data for this weather station.

Data Analysis

Precipitation Data

Figure A-1-3 shows a comparison in total annual precipitation for years 1999 through 2007. Note that the Uravan weather station exhibits higher average annual precipitation than the rest of the sites. Table 1 compares the accumulated precipitation from 1999 to 2007 for all sites. Uravan weather station, which is the closest station to the Piñon Ridge site, provides the maximum precipitation. Also, historical data shows that the Uravan weather station provides the most critical rainfall event (year 1965). For reference purposes, Figure A-1-4 presents the annual precipitation as a function of station elevation for all regional stations considered in this report. Note that there is no clear correlation between elevation and precipitation for the considered weather stations. Figure A-1-5 shows the monthly precipitation for the driest and wettest years for the Uravan weather station. A comparison of monthly precipitation between Uravan and Grand Junction airport weather stations for the years 1965 (wettest year) and 1989 (driest year), show that these sites present different precipitation events (Figure A-1-6 and Figure A-1-7).

Table 1. General statistics for selected weather stations.

	Elevation (ft)	Difference in Elevation (ft)[1]	Distance to Piñon Ridge (miles)	Accumulated Precipitation (in) from 1999-2007	Average Max. Temp (°F)	Average Min. Temp (°F)
Uravan	5010	-470	8.5	100	69	37
Nucla	5860	380	11	74	68	39
Grand Junction	4840	-640	62	81	67	41
Montrose	5786	306	49.5	87	63	35

[1]Compared to Piñon Ridge site, EL. 5,480 ft

Temperature Data

A comparison between different weather stations is shown is Figure A-1-8. Correlation between elevation and temperature is shown in Figure A-1-9. A summary of temperature data is presented in Table 1.

Evaporation/Evapotranspiration data

Due to the limitation of weather data, the potential evapotranspiration (PET) for the Uravan weather station was calculated using the Hargreaves (1985) method as discussed by Allen et al. (1998). The estimated PET was then scaled by a factor of 0.7, to meet the average annual evaporation from shallow lakes for the Piñon Ridge site (Figure A-1-10). Figure A-1-11 shows a comparison between PAN evaporation and analytical PET estimates for different sites. Table 2 summarizes the scaled monthly PET for the Uravan weather station.

Table 2. Scaled Average monthly PET evaporation for the Uravan weather station

	Avg. PET (in)
January	0.8
February	1.2
March	2.2
April	3.2
May	4.6
June	5.5
July	5.9
August	5.0
September	3.7
October	2.5
November	1.2
December	0.7
Total Annual	35.8

Wind data

Table A-1-6 shows the maximum annual wind speed for various years for the Grand Junction airport and Nucla weather stations. The maximum wind speed was recorded in Grand Junction weather station at 23.4 miles per hour (mph) in the year 2007. The average wind speed for this weather station is 7.8 mph. The prevalent wind direction is ESE for Grand Junction, SE for Montrose and E for the Nucla station.

CONCLUSIONS:

A review of available climate records for nearby weather stations indicates that Uravan weather station is likely to represent conservative precipitation estimates for the Piñon Ridge site.

REFERENCES:

Western Regional Climate Center online data source: http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?coCNUC

Kleinfelder (2007). "Climatological Report, Piñon Ridge Mill Site Montrose County, Colorado." Kleinfelder project no. 83088

Allen, R. G., Pereira, L. S., Raes, D., and Smith, M. (1998). "Crop evapotranspiration - Guidelines for computing crop water requirements." Irrigation and drainage paper 56, FAO, Rome.

TABLES

TABLE A-1-1. Uravan weather station data

Period of record : 11/17/1960 to 6/30/2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	42.7	49.9	58.7	67.6	78.6	89.4	95.4	92.2	83.5	71.4	54.7	43.4	69
Average Min. Temperature (F)	15.6	22.4	29.2	35.7	44.5	52.4	59.3	58.1	48.3	36.9	26.5	17.8	37.2
Average Total Precipitation (in.)	0.88	0.76	1.03	1.01	0.94	0.48	1.2	1.35	1.5	1.51	1.05	0.88	12.6
Average Total SnowFall (in.)	3.8	0.8	0.5	0.2	0	0	0	0	0	0.1	0.6	3.5	9.4

TABLE A-1-2. Nucla weather station data

Period of Record : 1/ 1/1999 to 12/31/2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	44.8	48.5	57.4	65.3	76.5	87.3	93.5	88.4	79.8	67.7	54.2	43.3	67.4
Average Min. Temperature (F)	19.7	23.2	29.6	37.1	45.3	53.7	60.6	58.0	18.6	38.3	26.9	18.6	38.4
Average Total Precipitation (in.)	0.3	0.5	0.6	0.8	0.5	0.4	0.8	1.1	1.8	1.5	0.4	0.5	9.3

TABLE A-1-3. Grand Junction weather station data

Period of Record : 1/ 1/1900 to 12/31/2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	36.7	44.7	55.1	65.2	75.6	86.9	92.8	89.4	80.5	67.3	51.2	38.9	65.5
Average Min. Temperature (F)	16.0	23.3	31.2	39.3	4826.0	54.2	64.1	62.0	53.0	41.1	28.3	18.7	40.4
Average Total Precipitation (in.)	0.6	0.6	0.8	0.8	0.8	0.4	0.6	1.0	1.0	0.9	0.7	0.6	8.8
Average Total SnowFall (in.)	6.1	4.0	3.2	0.9	0.1	0.0	0.0	0.0	0.0	0.4	2.5	4.9	22.0

TABLE A-1-4. Grand Junction 6ESE weather station data

Period of Record : 3/26/1962 to 6/30/2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	38.6	46.3	56.6	65.6	75.9	86.8	92.7	89.7	80.7	67.8	51.9	40.4	66.1
Average Min. Temperature (F)	17.5	23.9	32.3	39.5	48.4	57.2	63.5	61.3	52.4	40.8	29.2	19.7	40.5
Average Total Precipitation (in.)	0.48	0.45	0.87	0.84	0.94	0.5	0.75	0.83	0.97	0.98	0.76	0.55	8.93
Average Total SnowFall (in.)	3.4	1.8	1.6	0.3	0.1	0	0	0	0	0.3	1.4	3.5	12.3

TABLE A-1-5. Montrose weather station data

Period of Record : 1/ 1/1895 to 6/30/2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	38	43.9	52.9	62.4	72.4	83.1	88.6	85.7	77.9	65.7	50.3	39.3	63.3
Average Min. Temperature (F)	13.7	19.7	26.6	34	42.1	49.7	55.6	53.9	45.6	35	23.9	15.3	34.6
Average Total Precipitation (in.)	0.57	0.48	0.7	0.86	0.88	0.53	0.86	1.26	1.1	1.04	0.66	0.62	9.56
Average Total SnowFall (in.)	6.5	4.3	3.5	1.8	0.1	0	0	0	0	0.6	2.7	6.4	25.9

TABLE A-1-6. Maximum annual wind speed

	Grand Junction Airport	Nucla
year	wind speed (mph)	
1984	16.3	-
1985	18.3	-
1986	22.0	-
1987	14.8	-
1988	18.6	-
1989	17.3	-
1990	17.8	-
1991	18.1	-
1992	17.1	-
1993	17.2	-
1994	19.4	-
1995	16.8	-
1996	17.7	-
1997	18.1	-
1998	18.0	16.4
1999	17.1	18.2
2000	18.8	18.6
2001	19.7	14.6
2002	21.2	17.2
2003	19.8	16.8
2004	19.9	14.3
2005	18.0	14.0
2006	21.9	14.8
2007	23.4	15.1
Maximum W(mph)	**23.4**	**18.6**

FIGURES

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TITLE

SITE VIEW PIÑON RIDGE

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	EF	DATE	1/16/2008	JOB NO.	073-81694
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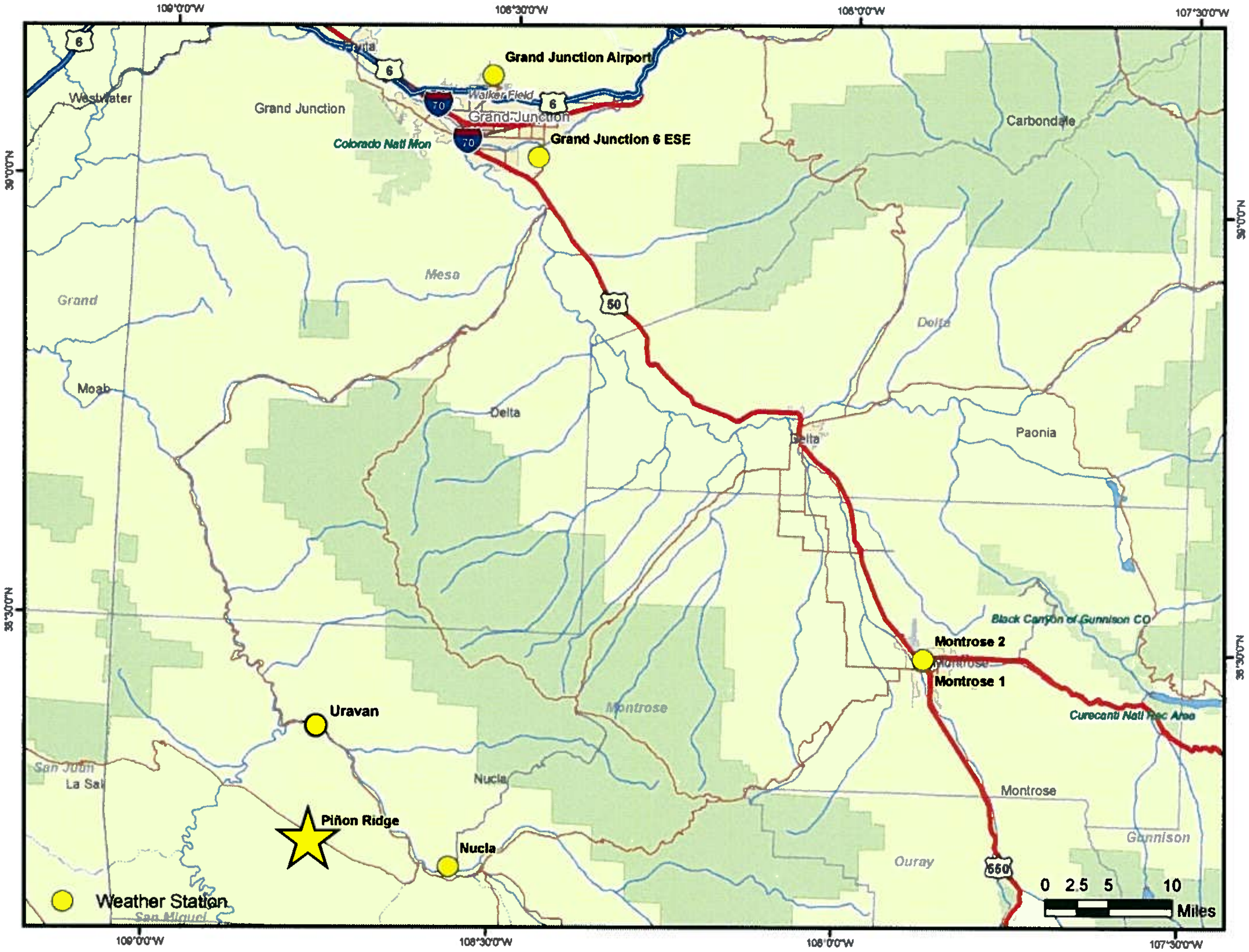

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TITLE
WEATHER STATION LOCATIONS

CLIENT/PROJECT
ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	EF	DATE	1/16/2008	JOB NO.	073-81694
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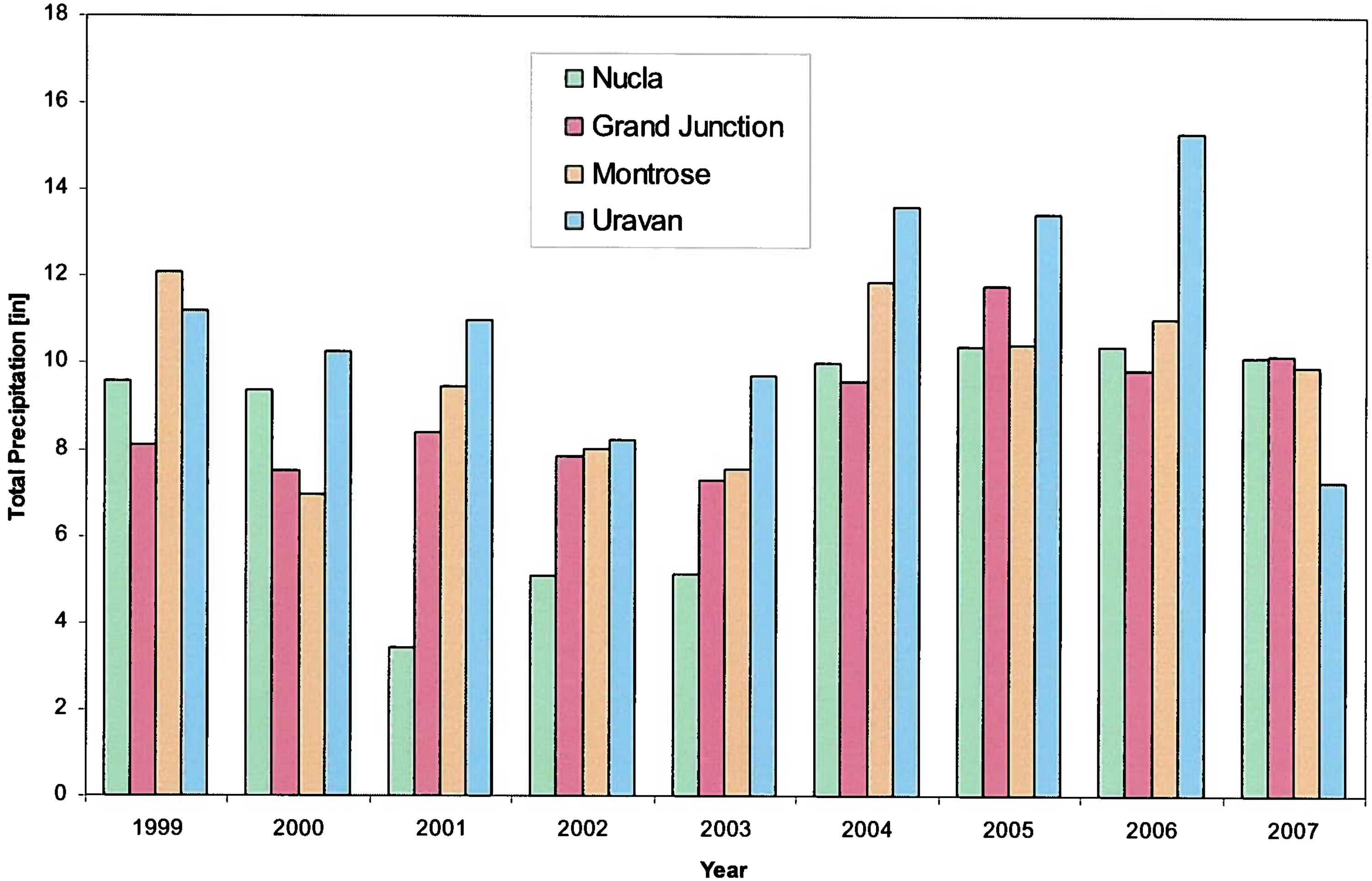

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TITLE

TOTAL ANNUAL PRECIPITATION

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	EF	DATE	1/16/2008	JOB NO.	073-81694
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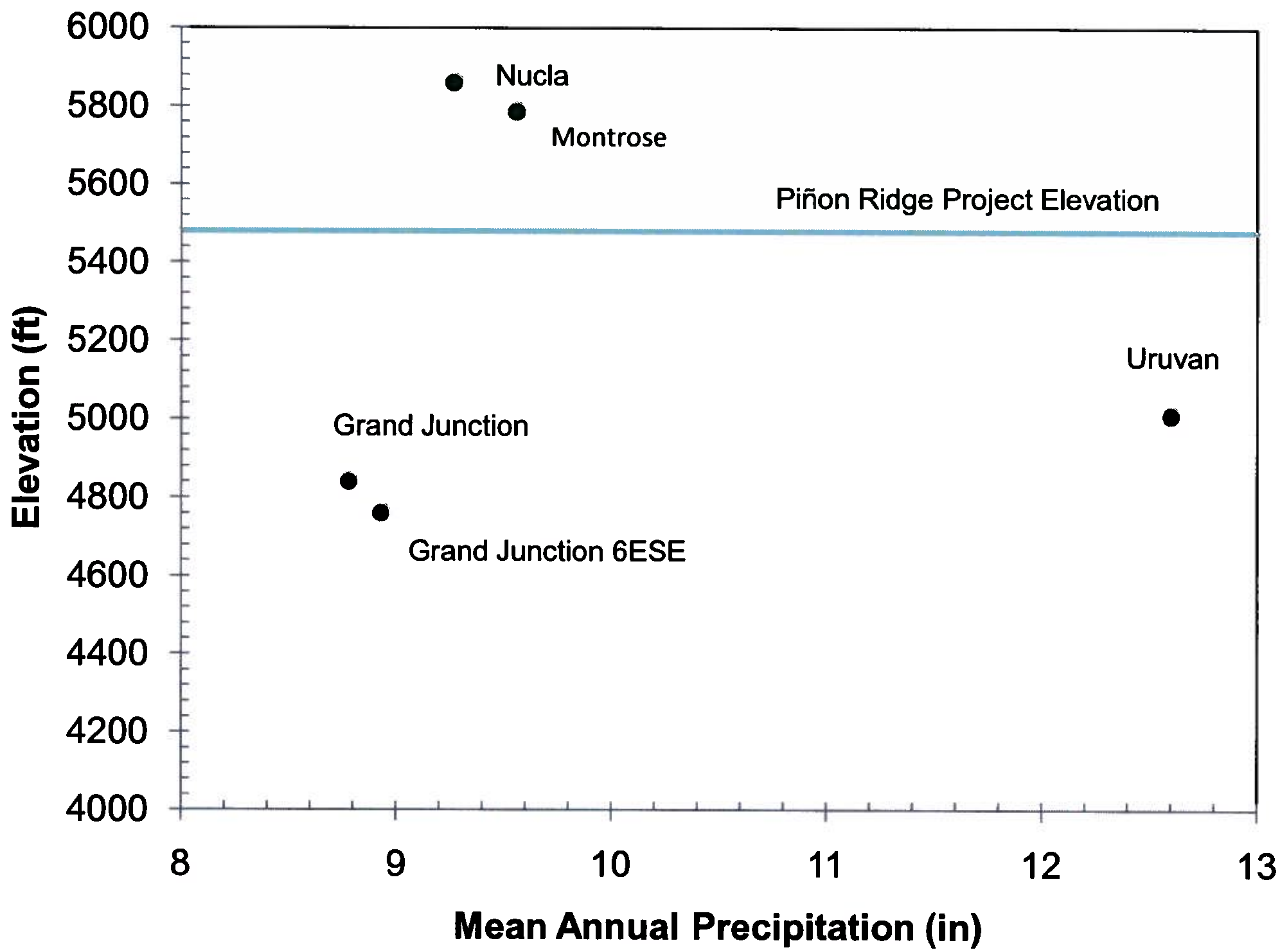

Golder Associates
Denver, Colorado

TITLE

VARIATION IN ANNUAL PRECIPITATION vs. ELEVATION FOR REGIONAL METEOROLOGICLA STATIONS

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	EF	DATE	1/16/2008	JOB NO.	073-81694
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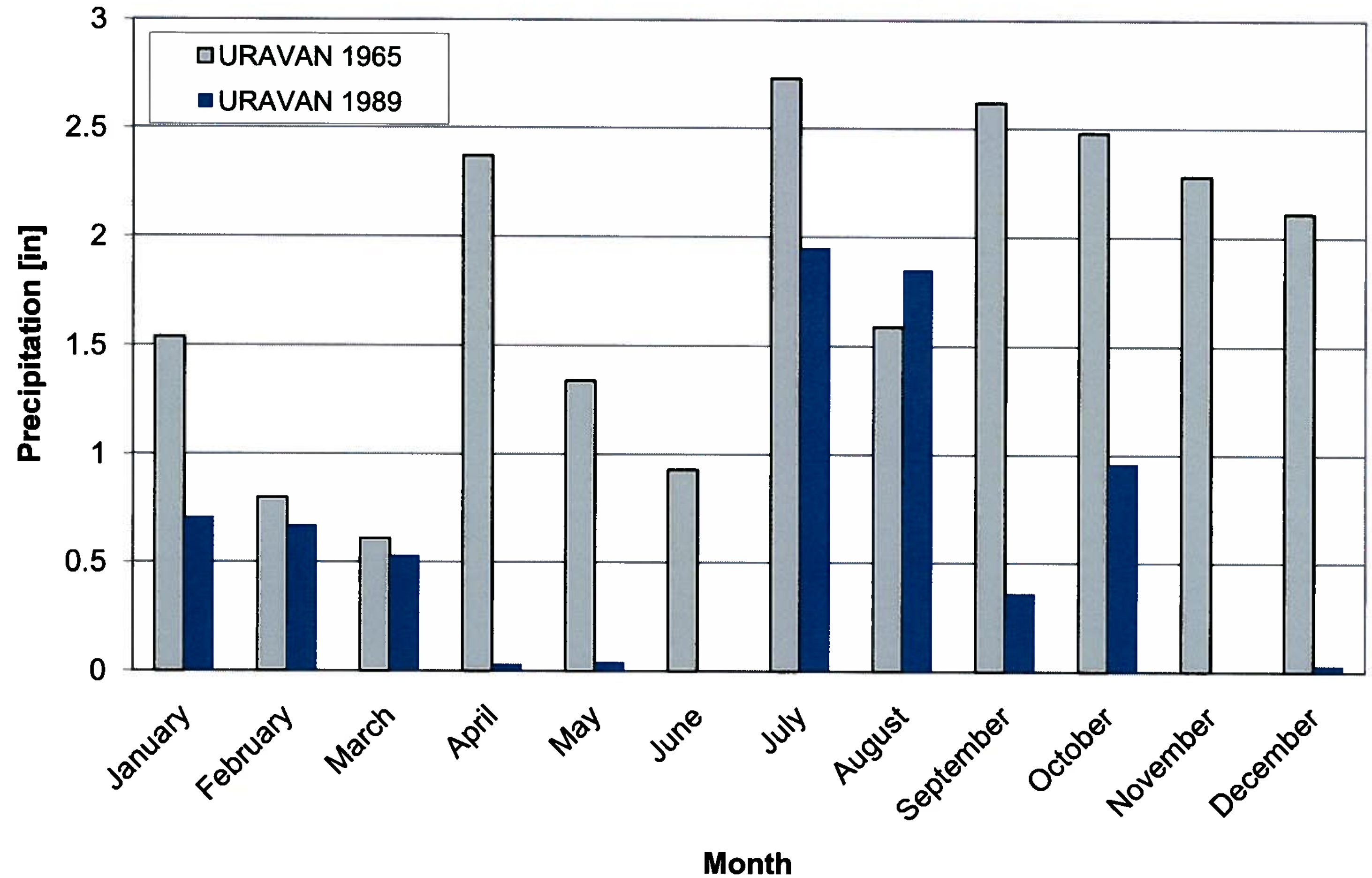

Golder Associates

Denver, Colorado

TITLE

MONTLY PRECIPITATION FOR DRIEST AND WETTEST YEAR FOR URAVAN SITE

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	EF	DATE	1/16/2008	JOB NO.	073-81694
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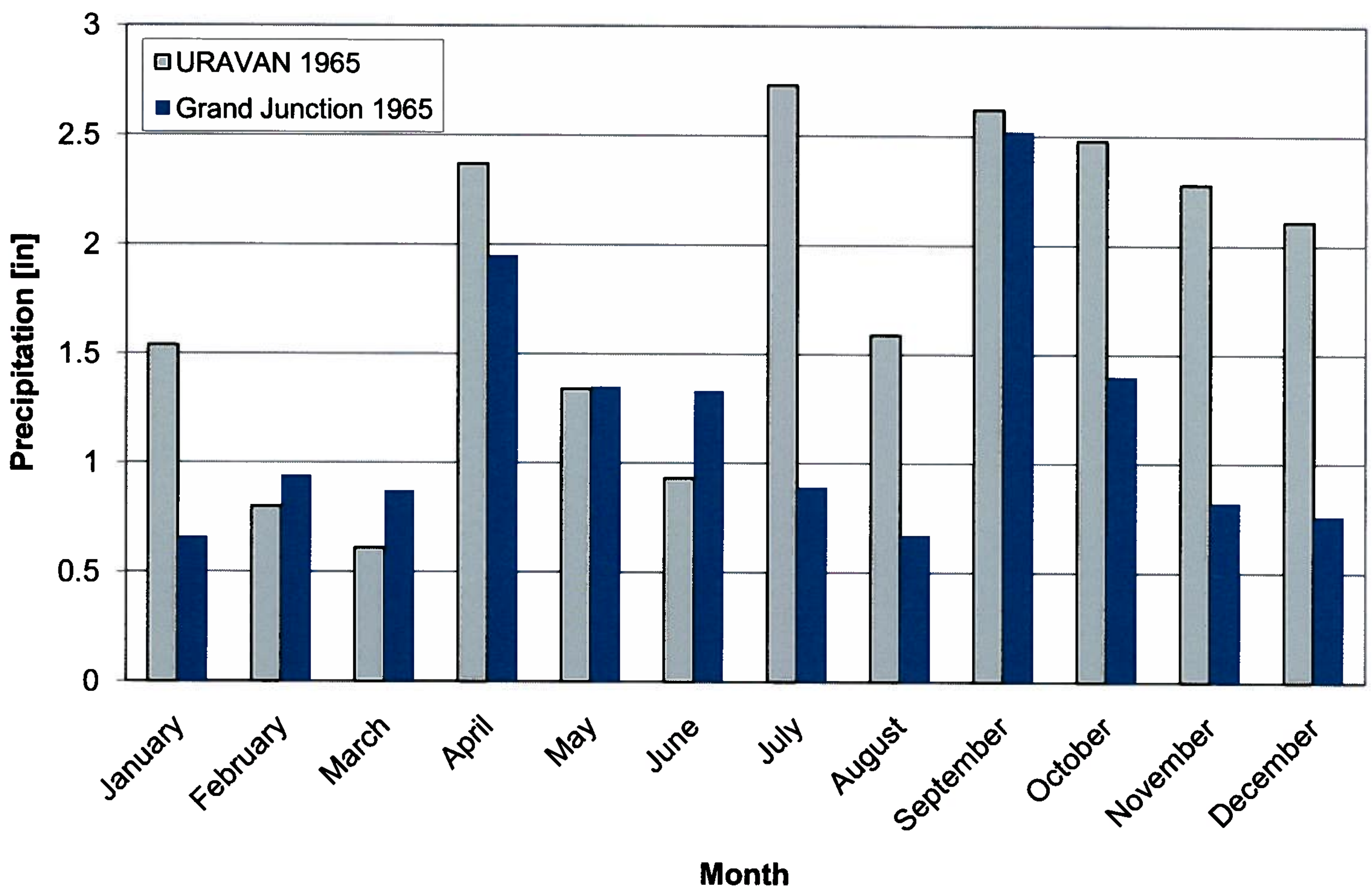

Golder Associates — Denver, Colorado

TITLE

ANNUAL PRECIPITATION URAVAN AND GRAND JUNCTION FOR YEAR 1965

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	EF	DATE	1/16/2008	JOB NO.	073-81694
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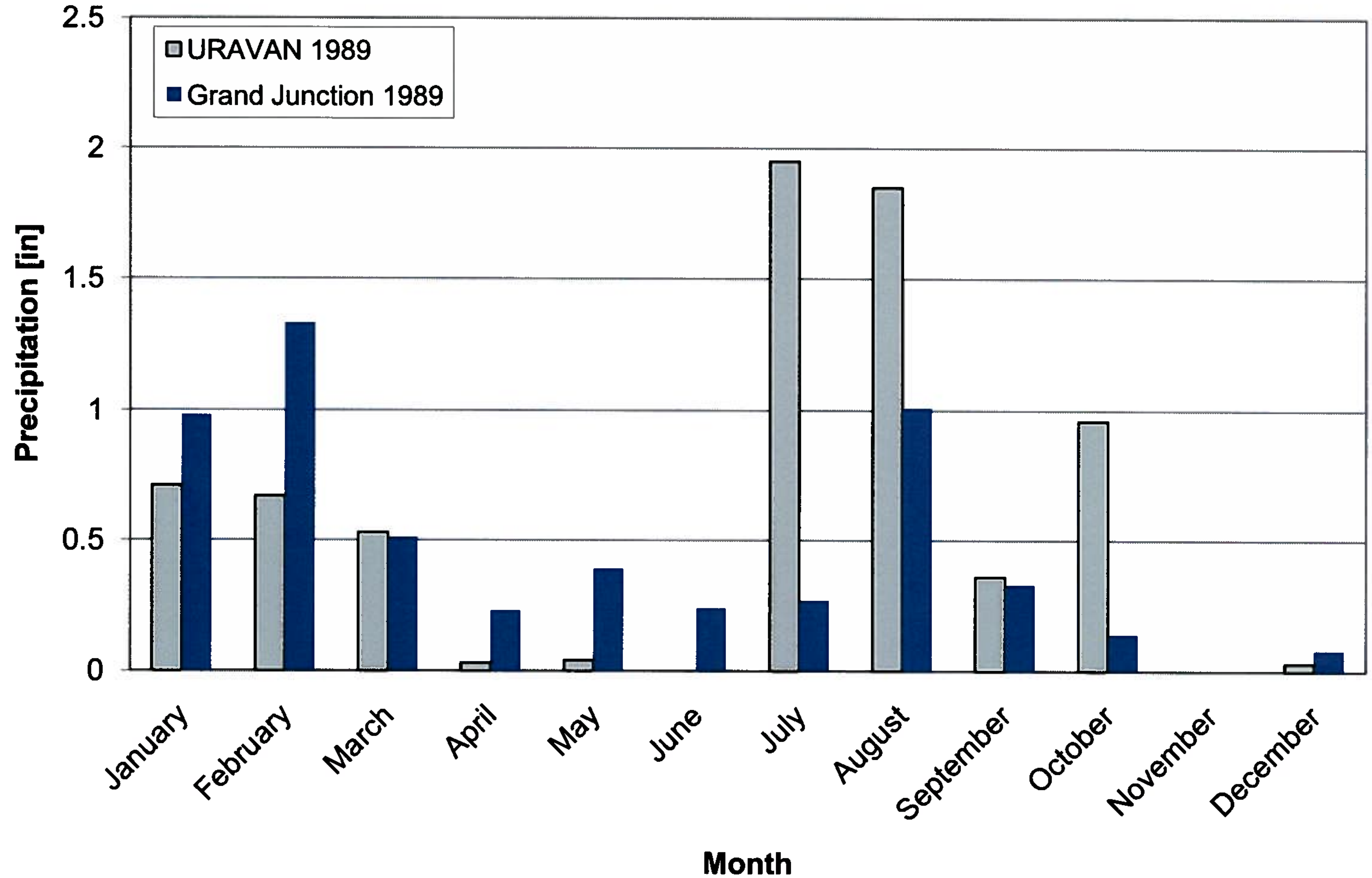

Golder Associates
Denver, Colorado

TITLE

MONTHLY MAXIMUM TEMPERATURE FOR URAVAN AND GRAND JUNCTION

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	EF	DATE	1/16/2008	JOB NO.	073-81694
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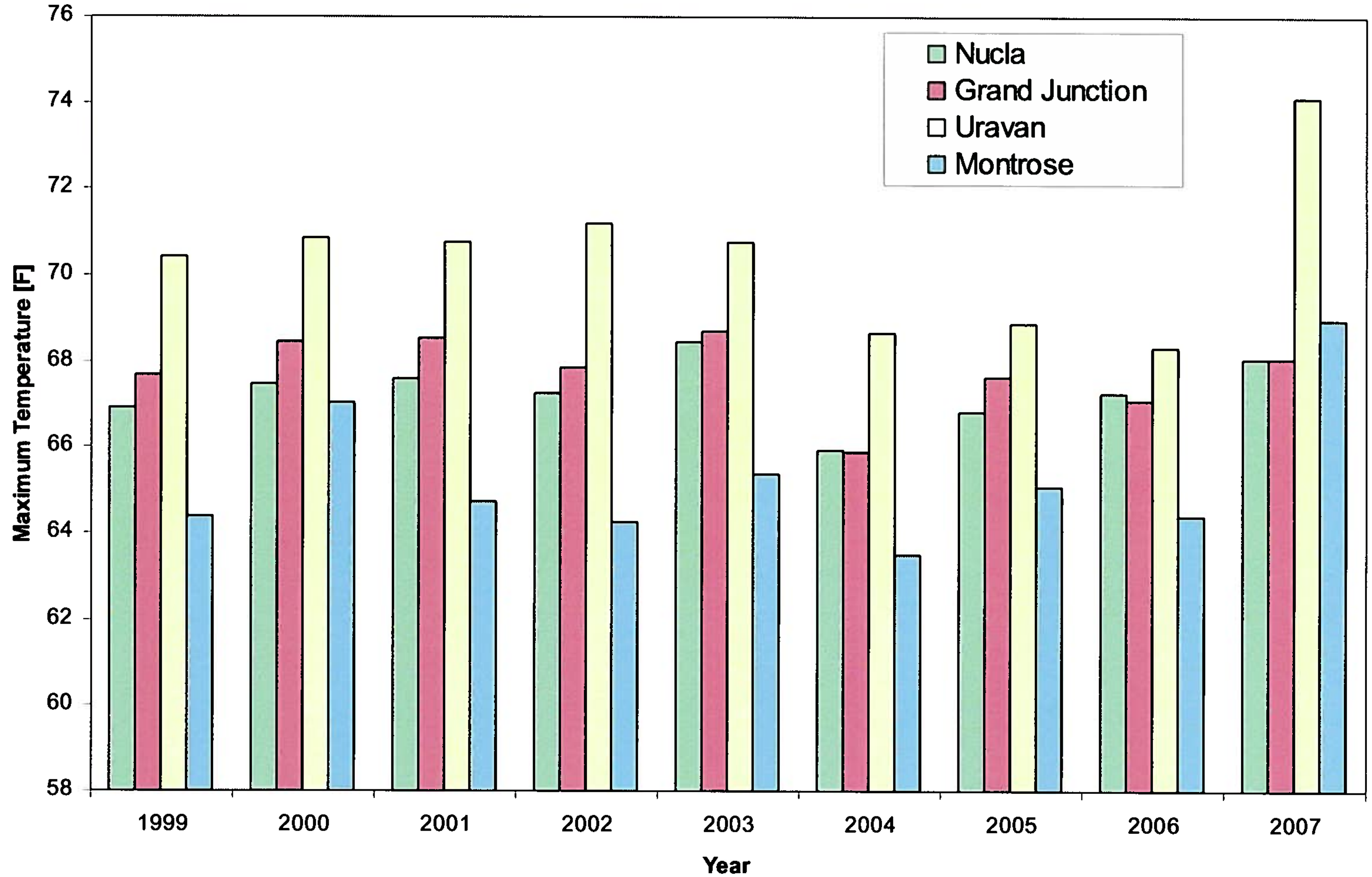

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ANNUAL MAXIMUM TEMPERATURE

CLIENT/PROJECT **ENERGY FUELS RESOURCES CORPORATION** **PIÑON RIDGE PROJECT**					
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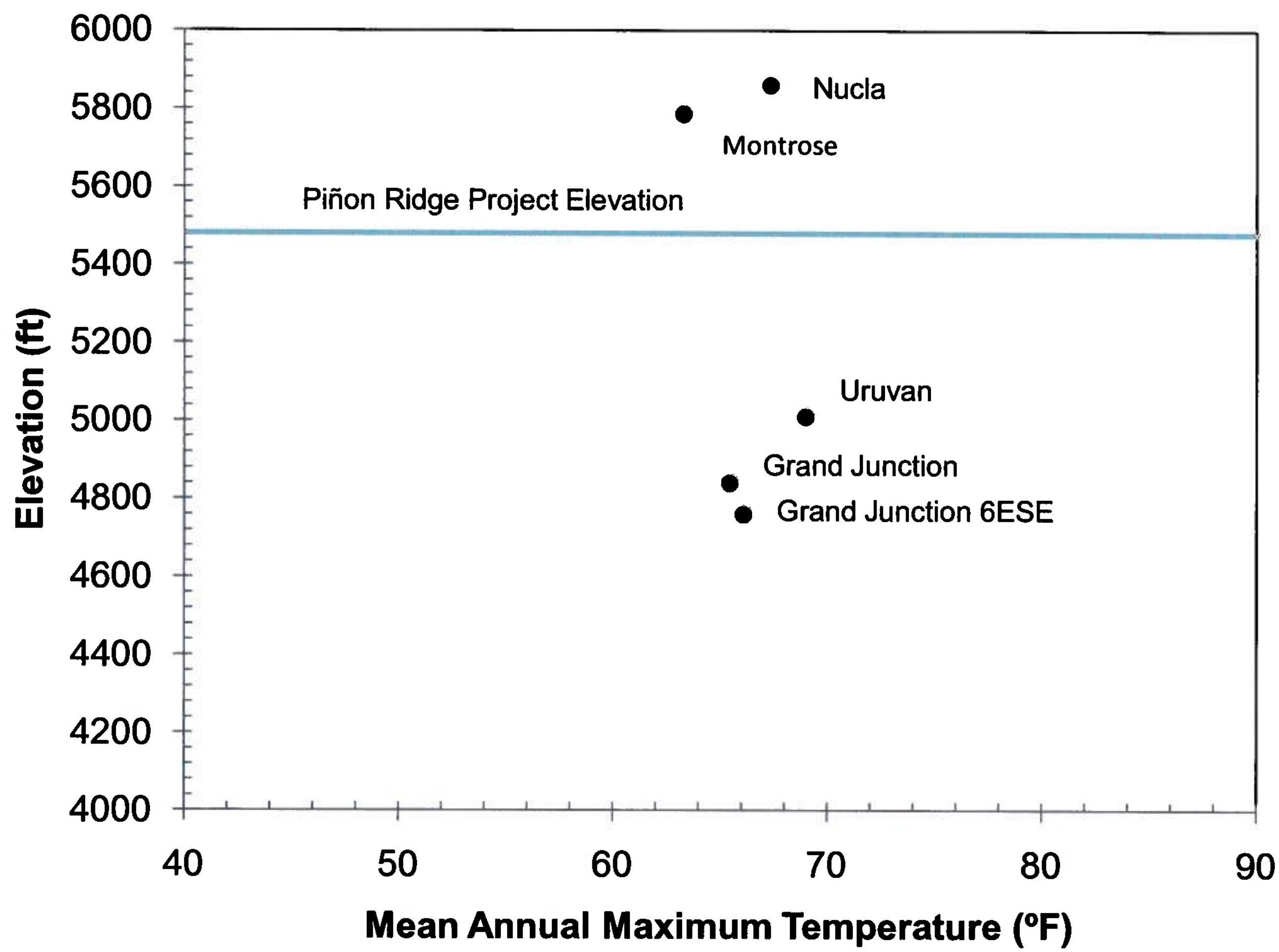

Golder Associates

Denver, Colorado

TITLE

VARIATION IN ANNUAL MAX. TEMPERATURE vs. ELEVATION FOR REGIONAL METEOROLOGICAL STATIONS

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	EF	DATE	1/16/2008	JOB NO.	073-81694
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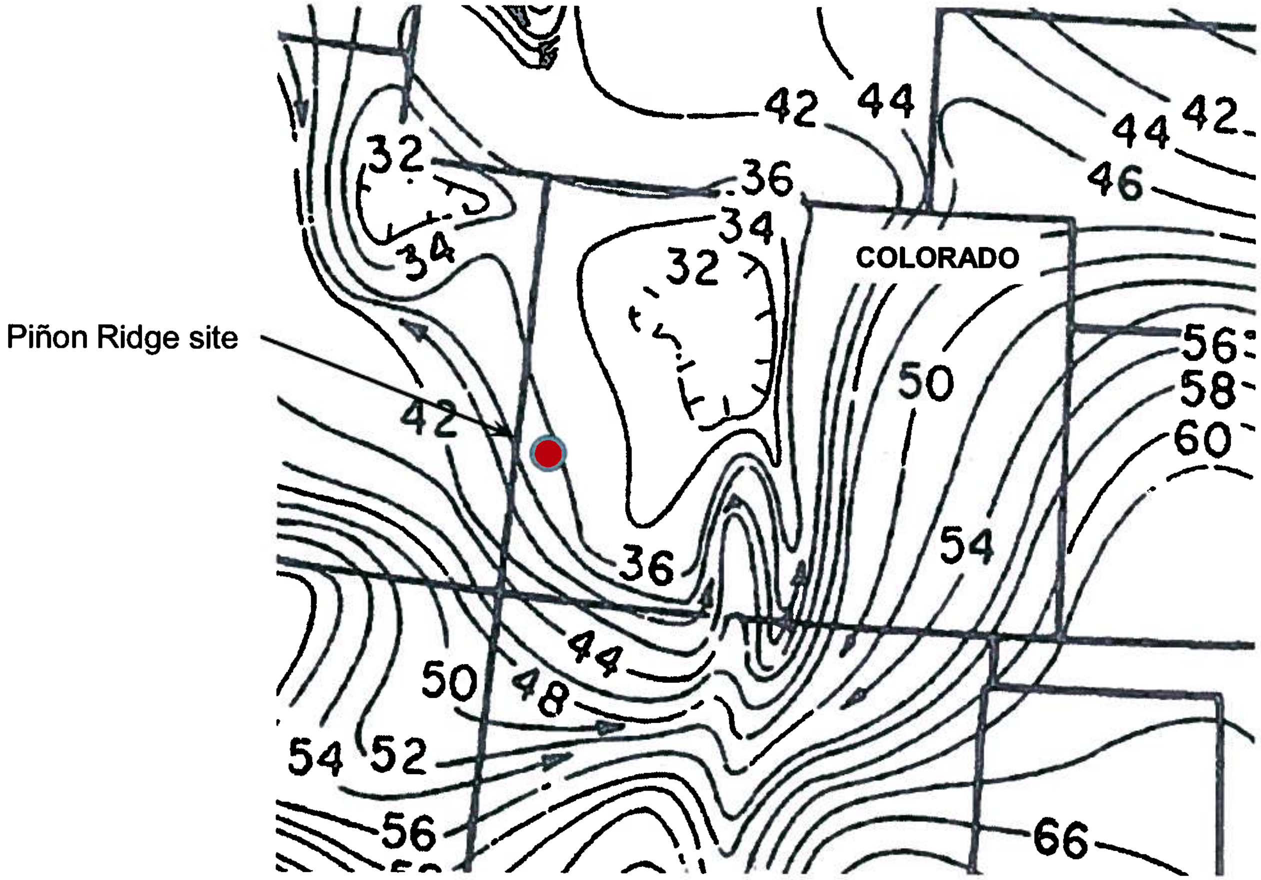

Golder Associates

Denver, Colorado

TITLE

AVERAGE ANNUAL EVAPORATION (INCHES) FROM SHALLOW LAKES

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

DRAWN	EF	DATE	1/16/2008	JOB NO.	073-81694
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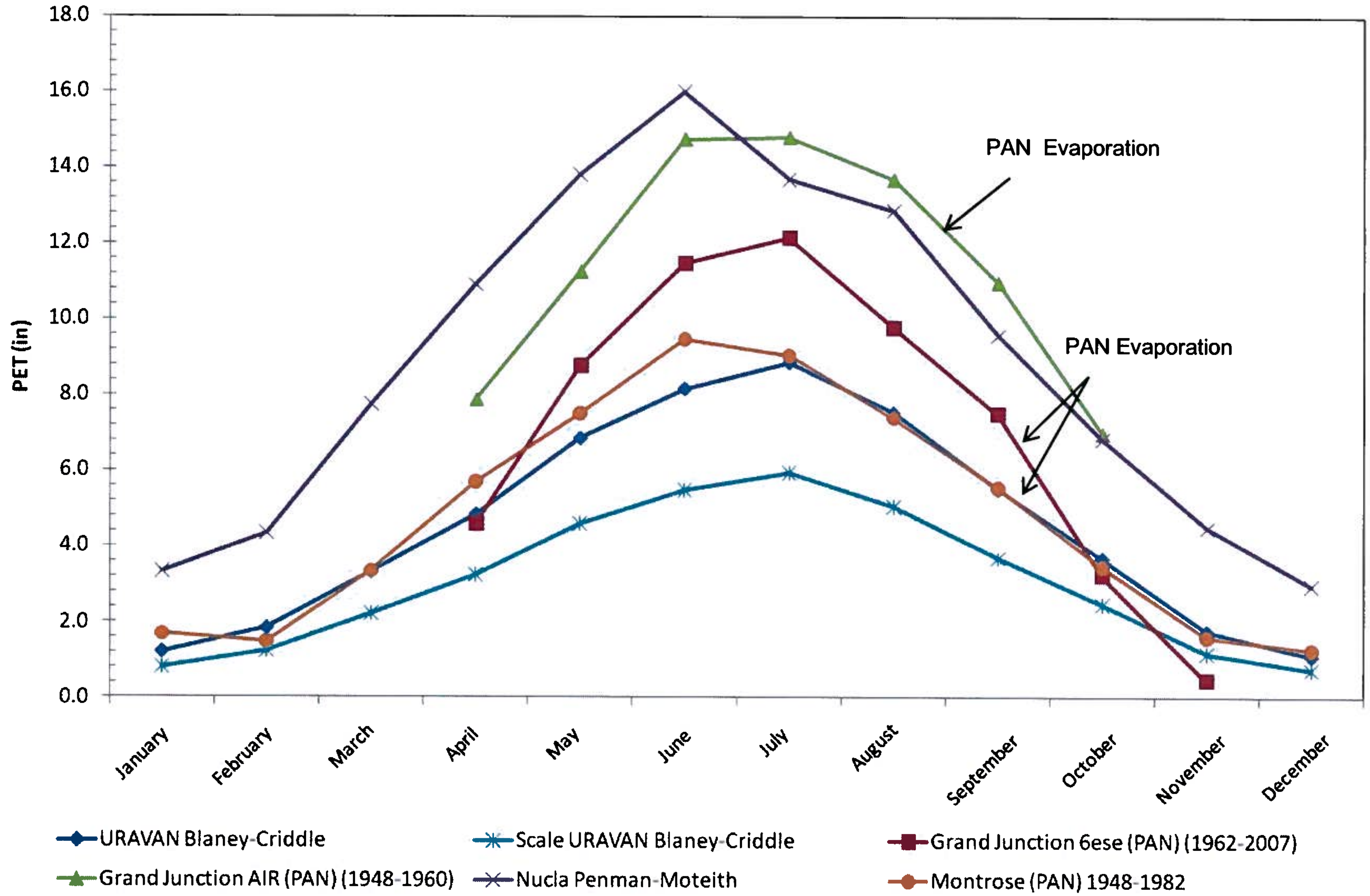

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TITLE

MONTHLY EVAPOTRANSPIRATION

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT

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CHECKED	GG	SCALE	N.T.S	DWG. NO.	N/A
REVIEWED	KFM	FILE NO.	figures-weather.ppt	FIGURE NO.	A-1-11

APPENDIX B

ACTION LEAKAGE RATE

APPENDIX B

ACTION LEAKAGE RATE

This appendix (Appendix B-1) presents a calculation of the Action Leakage Rates (ALR) for the evaporation ponds proposed for construction at the Piñon Ridge Project. As per the U.S. EPA (1992), the ALR is defined 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.*"

Each evaporation pond cell will be equipped with its own dedicated Leak Collection and Recovery System (LCRS) sump. A mobile pump will be used to pump collected solutions from the LCRS sump back into the evaporation pond cells. The ALR was calculated for each LCRS sump. The ALR was calculated to be 12,000 gallons per acre per day (gpad) for each evaporation pond LCRS sump. If a leakage rate exceeding this value is measured, action must be taken as per Title 40 CFR, Section 264.223.

REFERENCES

40 CFR Part 264 – "*Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*", Subpart K (Surface Impoundments).

U.S. Environmental Protection Agency (U.S. EPA). 1992. "Action leakage rates for detection systems (supplemental background document for the final double liners and leak detection systems rule for hazardous waste landfills, waste piles, and surface impoundments)."

APPENDIX B-1

ACTION LEAKAGE RATE CALCULATION

OBJECTIVE:

The objective is to determine the Action Leakage Rate (ALR) for the Piñon Ridge evaporation pond. The ALR is defined 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*" (U.S. EPA 1992; United States Government Printing Office 2002).

GIVEN:

- Leak collection and recovery system (LCRS) configuration.
- Evaporation pond cells configuration (Figure 1).
- Drainage material properties (Attachment 1).

GEOMETRY:

- The evaporation pond cells configuration diagram is shown in Figure 1.
- A typical liner system detail is shown in Figure 2.
- Sump top dimensions of 40 feet by 60 feet for all evaporation pond cells.

MATERIAL PROPERTIES:

Table 1 summarizes the material properties considered in the analysis for the drainage geonet on the evaporation pond cells.

Table 1. Geonet properties

Manufacturer	*Model*	*Transmissivity gal/min ft (m^2/sec)*	*Thickness mil*
GSE	HyperNet	9.66 (2×10^{-3})[1]	200

[1] see Attachment 1

METHOD:

- The ALR calculation is based on the U.S. EPA guidelines published in U.S. EPA (1992).

ASSUMPTIONS:

- Darcy's law is valid;
- The gradient of the floor of the evaporation pond cells is approximately 2 percent. The gradient of the side slopes for the cells is approximately 33.3%;
- One foot of water head is developed on the bottom liner.

CALCULATIONS:

The maximum flow rate within the LCRS geonet is calculated using Darcy's equation:

$$Q = K\, i\, A$$

where :

Q = flow through unit width of the LCRS drainage layer [ft^3/sec];
K= hydraulic conductivity of the LCRS drainage layer [ft/sec];
i = hydraulic gradient; and
A= area of the flow per unit width [ft^2/ft].

For a geonet the flow through the layer is calculated by using the following equation:

$$q_{ult} = i\, \theta\, W$$

where:

q_{ult} = flow through the geosynthetic layer [ft^3/sec/ft];
i = hydraulic gradient;
θ = transmissivity [ft/sec]; and
W= width of the drain [ft].

A factor of safety should be applied to consider the reduction in flow capacity of the geonet due to deformations, intrusions, clogging, or precipitation of chemicals (Koerner 1998):

$$q_{allow} = q_{ult}\left[\frac{1}{RF_{IN} + RF_{CR} + RF_{CC} + RF_{BC}}\right]$$

where:

q_{ult} = flow through the geosynthetic layer;
q_{allow} = allowable flow rate;
RF_{IN} = reduction factor for elastic deformation or intrusion;
RF_{CR} = reduction factor for creep deformation;
RF_{CC} = reduction factor for chemical clogging; and
RF_{BC} = reduction factor for biological clogging.

Table 2 shows the adopted reduction factors for a secondary leachate collection system according to Table 4.2 in Koerner (1998):

Table 2. Reduction factors for determining allowable flow rate of geonets

Factor	Recommend value range	Use value for geonet
RF_{IN}	1.5 – 2.0	1.5 (possible elastic deformation)
RF_{CR}	1.4 – 2.0	1.4 (low normal stress)
RF_{CC}	1.5 – 2.0	2.0 (low pH liquids)
RF_{BC}	1.5 -2.0	1.5 (low pH should preclude biological activity)

A water head equal to 1 foot is assumed to be acting over the bottom liner so the hydraulic gradient can be assumed to be equal to the slope of the geonet. For the bottom of the evaporation pond:

$$i = 2\%$$

For the slopes of the evaporation pond (3H:1V):

$$i = 33.3\%$$

The flow in the geonet per unit width for the bottom of the evaporation pond is:

$$\frac{q_{ult}}{W} = 0.02 * 9.66\ gal/\min ft = 0.193\ gal/\min ft$$

And for the sideslopes the flow per unit width is:

$$\frac{q_{ult}}{W} = 0.3333 * 9.66\ gal/\min ft = 3.22\ gal/\min ft$$

The allowable flow rates per unit width for the bottom of the evaporation pond and the sideslopes are:

$$\frac{q_{allow}}{W} = \frac{q_{ult}}{W} * \frac{1}{\prod RF}$$

$$\prod RF = 1.5 + 1.4 + 2.0 + 1.5 = 6.4 \quad \text{for geonet}$$

Flow rate per unit length from the evaporation pond cell bottom:

$$q_{allow\ 2\%} = \frac{0.193\ gal/\min ft}{6.4} = 0.0302\ gal/\min ft$$

Flow rate per unit length from the evaporation pond cell sides slopes:

$$q_{allow\ 33.3\%} = \frac{3.22\ gal/\min ft}{6.4} = 0.503\ gal/\min ft$$

Flow access to the sump is a function of the perimeter length of the crest of the sump. The sump is located at the low point of each cell and adjacent to one of the sideslopes. As shown in Figure 1, the sump will receive leachate from the cell bottom on three sides and from the sideslope on one side. The flow rate to a sump is:

$q_{allow\ 2\%}$ * perimeter length of sump in that flow direction (3 sides) + $q_{allow\ 33.3\%}$ * perimeter length of sump in that flow direction (1 side)

The ALR expressed in gallons per acre per day (gpad) for each cell is summarized in Table 3:

Table 3. Action leakage rates for different cells expressed in gpad

Sump	Perimeter Length of Sumps		Cell Area (Acres)	ALR (gpd)	ALR (gpad)
	2% slope (ft)	33.3% slope (ft)			
Evap. Pond	140	60	4.1	49,500	12,000

CONCLUSIONS:

Per EPA guidance, the Action Leakage Rate (ALR) was calculated assuming one foot of water head on the bottom geomembrane liner of the evaporation pond liner system. The ALR was calculated to be 12,000 gpad for each evaporation pond cell.

REFERENCES:

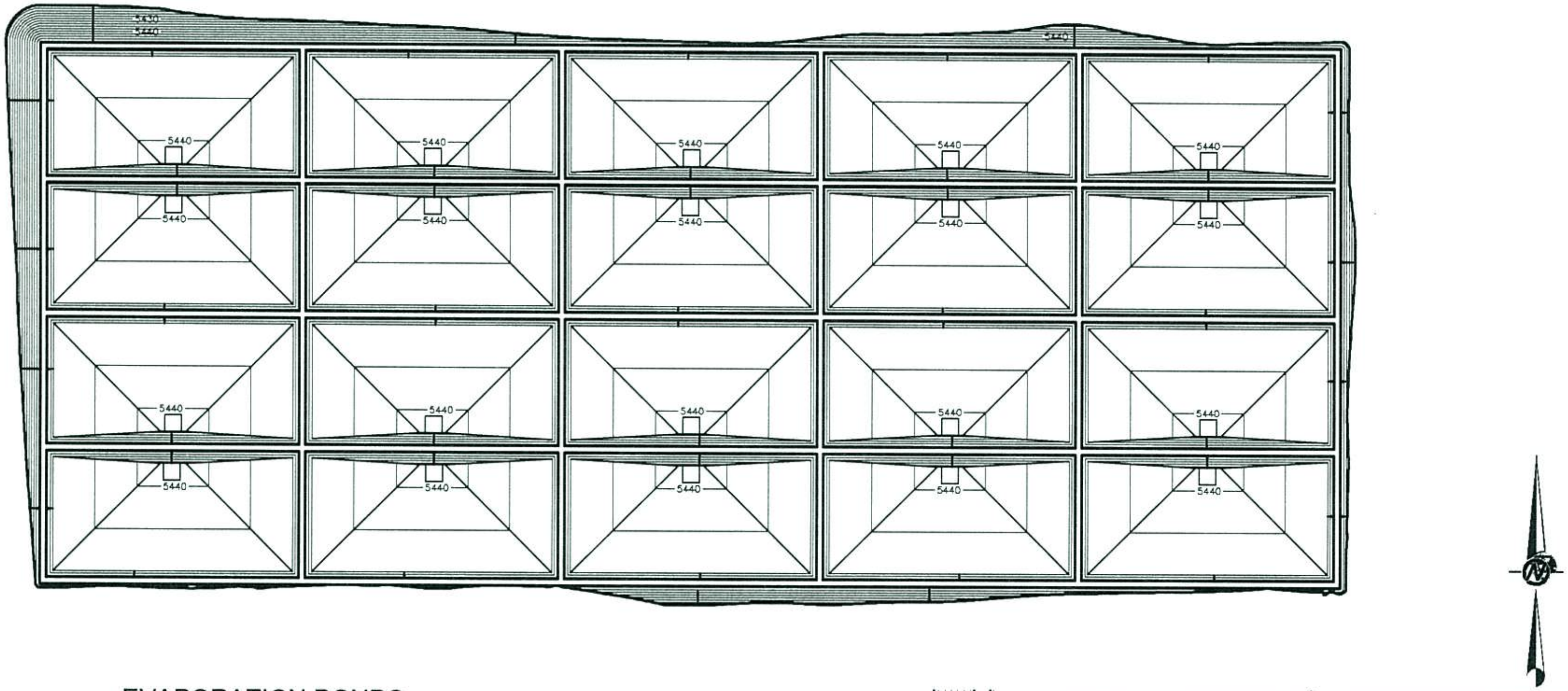
Colorado Department of Public Health and the Environment (CDPHE), Hazardous Waste Regulations 6 CCR 1007-1, Parts 3 and 18.

Koerner, R. M. (1998). *Designing with geosynthetics*, Prentice Hall, Upper Saddle River, N.J.

U.S. EPA. (1992). "Action leakage rates for detection systems (supplemental background document for the final double liners and leak detection systems rule for hazardous waste landfills, waste piles, and surface impoundments)." U.S. Enviromental Protection Agency.

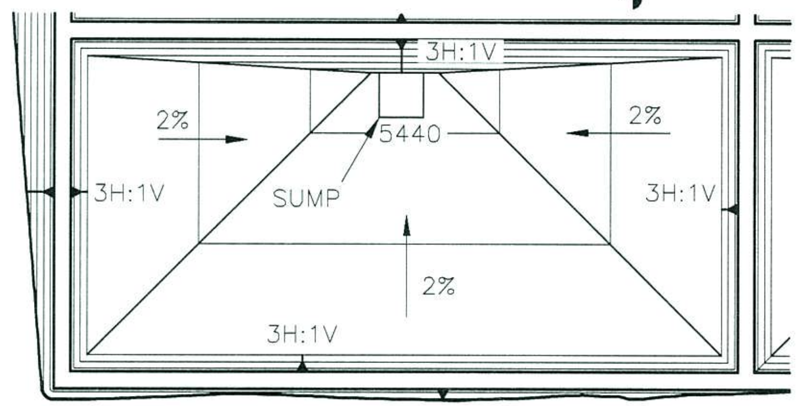
United States Government Printing Office. (2002). *Title 40, CFR*, U.S. G.P.O., Washington, D.C.

FIGURES



EVAPORATION PONDS
GENERAL LAYOUT

EVAPORATION POND
DETAIL

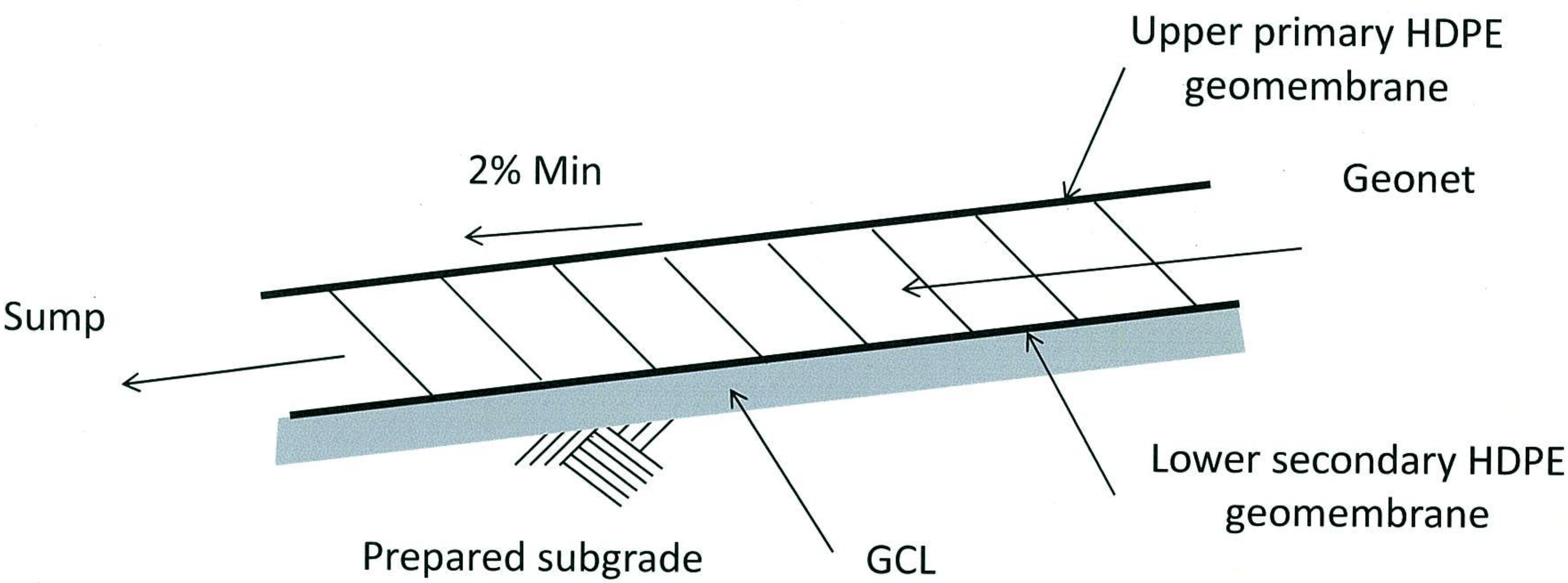


Golder Associates Denver, Colorado

TITLE

EVAPORATION POND CONFIGUR ATION

CLIENT/PROJECT ENERGY FUELS RESOURCES CORPORATION PIÑON RIDGE PROJECT – EVAPORATION POND DESIGN MONTROSE COUNTY, COLORADO	DRAWN EF	DATE APRIL 7, 2008	JOB NO. 073-81694
	CHECKED	SCALE N.T.S.	DWG. NO.
	REVIEWED	FILE NO.	FIGURE NO. 1



Golder Associates
Denver, Colorado

TITLE

LINER SYSTEM TYPICAL DETAIL

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT – EVAPORATION POND DESIGN
MONTROSE COUNTY, COLORADO

DRAWN	EF	DATE	APRIL 7 2008	JOB NO.	073-81694
CHECKED		SCALE	N.T.S.	DWG. NO.	
REVIEWED		FILE NO.		FIGURE NO.	2

ATTACHMENT 1
GEONET PROPERTIES

GSE

GSE STANDARD PRODUCTS

Product Data Sheet

GSE HyperNet Geonets

GSE HyperNet geonets are synthetic drainage materials manufactured from a premium grade high density polyethylene (HDPE) resin. The structure of the HyperNet geonet is formed specifically to transmit fluids uniformly under a variety of field conditions. HDPE resins are inert to chemicals encountered in most of the civil and environmental applications where these materials are used. GSE geonets are formulated to be resistant to ultraviolet light for time periods necessary to complete installation. GSE HyperNet geonets are available in standard, HF, HS, and UF varieties.

The table below provides index physical, mechanical and hydraulic characteristics of GSE geonets. Contact GSE for information regarding performance of these products under site-specific load, gradient, and boundary conditions.

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE ROLL VALUE[c]			
			HyperNet	HyperNet HF	HyperNet HS	HyperNet UF
Product Code			XL4000N004	XL5000N004	XL7000N004	XL8000N004
Transmissivity[a], gal/min/ft (m^2/sec)	ASTM D 4716-00	1/540,000 ft^2	9.66 (2 x 10^{-3})	14.49 (3 x 10^{-3})	28.98 (6 x 10^{-3})	38.64 (8 x 10^{-3})
Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	200 (5)	250 (6.3)	275 (7)	300 (7.6)
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035	1/50,000 ft^2	45 (7.9)	55 (9.6)	65 (11.5)	75 (13.3)
Carbon Black Content, %	ASTM D 1603, modified	1/50,000 ft^2	2.0	2.0	2.0	2.0
Roll Width, ft (m)			15 (4.6)	15 (4.6)	15 (4.6)	15 (4.6)
Roll Length, ft (m)[b]			300 (91)	250 (76)	220 (67)	200 (60)
Roll Area, ft^2 (m^2)			4,500 (418)	3,750 (348)	3,300 (305)	3,000 (278)

NOTES:

- [a]Gradient of 0.1, normal load of 10,000 psf, water at 70° F (20° C), between steel plates for 15 minutes.
- [b]Please check with GSE for other available roll lengths.
- [c]These are MARV values that are based on the cumulative results of specimens tested by GSE.

DS017 R07/07/03

Americas	GSE Lining Technology, Inc.	Houston, Texas	800-435-2008	281-443-8564	Fax: 281-230-8650
Europe/Middle East/Africa	GSE Lining Technology GmbH	Hamburg, Germany		49-40-767420	Fax: 49-40-7674233
Asia/Pacific	GSE Lining Technology Company Ltd.	Bangkok, Thailand		66-2-937-0091	Fax: 66-2-937-0097

This product data sheet is also available on our website at:

www.gseworld.com

APPENDIX C

WATER FOWL PROTECTION SYSTEM

APPENDIX C

WATER FOWL PROTECTION SYSTEM

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 contacting 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 calculations are included in Appendix C-1. Details of the bird netting system are illustrated in Drawings 6 and 7.

The bird netting will be supported by strain wires that span between wooden poles located every 315 feet along the pond separation berms in the north to south direction, and wooden poles located every 48 feet along the pond separation berms in the west to east direction. Also, intermediate strain wires will be located at every 48 feet along the 315-foot span, which will limit the maximum span for the bird netting to 48 feet. In order to increase the effectiveness of the water fowl protection system, it is planned to enclose the evaporation ponds by placing bird netting along the perimeter of the pond network.

In design of the strain wires, factored weights of the bird netting and cable weight were considered. These factored loads were used to consider uncertainties related to wind and snow loads. The strain wire that spans the 315-foot distance was designed for a factor of safety (FS) of two (2). The wooden support poles (i.e., 25-foot long, class 10) were selected to resist the wind effects and tensions produced by the strain wires.

The strain wires were analyzed using the catenary equation (Au & Christiano, 1987; Ortiz-Berrocal, 1991), which was used to describe the shape of the displacements in the cable. A vertical deflection equal to 10 feet was assumed in order to calculate the maximum tensions in the strain wire. Calculations indicate that the embedment depth of 8.5 feet which was adopted for the wooden support poles will be sufficient to resist the considered loads.

The hardware and accessories for the installation of the bird netting were selected according to bird netting manufacturer recommendations, where the weakest element is the perimeter fastener (i.e., polyclip), which will be used to connect the netting to the strain wires.

It is anticipated that permanent maintenance will be required to keep the bird netting system in-place. Activities such as the removal of birds tangled in the net, replacement and repairs of netting sections damaged by extreme wind and snow events, and replacement and repair of fasteners, among other activities, should be taken into consideration in the operations maintenance plan.

The bird netting support design was checked for ice loading, assumed as 0.5 inches of ice per the San Miguel power company specifications for design of powerlines. The ice loading evaluation calculations are provided as Appendix C-2. The calculations indicate that the resultant tension in the polyclip fasteners due to ice loading is nearly 200 pounds, while the polyclips are only designed for a loading capacity of about 20 pounds. As a consequence, the polyclip fasteners will fail under the ice loading. However, the support system (i.e., wooden support poles and cables) for the bird netting is designed to accommodate ice loading conditions. This is the desired response of the bird netting system, as the design ice loading condition will fail the polyclip fasteners and hence the netting, but not fail the netting support system. Therefore, maintenance after an ice event would be required, including replacing and reattachment of polyclips and netting to the netting support system.

REFERENCES

U.S. Congress. 1976. *Migratory Bird Treaty Act.* 16 USC §703 et seq. November.

Au, T., and Christiano, P. 1987. *Structural analysis*, Prentice-Hall, Englewood Cliffs, New Jersey.

Ortiz-Berrocal, L. 1991. *Resistencia de Materiales*, McGraw-Hill, Madrid.

APPENDIX C-1

BIRD NETTING DESIGN CALCULATIONS

OBJECTIVE:

The objective is to design the birdnet support system for the evaporation pond.

GIVEN:

- Evaporation pond configuration;
- Material specifications for wooden support poles, cable supports and connections (see Attachment 2).

GEOMETRY:

- The evaporation pond diagram is shown in Figure 1
- Conceptual view partial section birdnetting frame Figure 2

MATERIAL PROPERTIES:

- Wood Pole
  - Allowable bending stress 500 psi (Assumed)

- Stainless steel cable Type 304 Dia. 3/32" 7x7
  - Breaking strength 920 lb
  - Weight per 1000 ft = 16 lb

- Stainless steel cable Type 304 Dia. 7/32" 7x19
  - Breaking strength 5,000 lb
  - Weight per 1000 ft = 86 lb

- Soil properties (per Golder 2007)
  - Density 89.9 lb/ft^3
  - Friction angle 33.7°
  - Lateral bearing 150 psf/ft (Assumed)

ASSUMPTIONS:

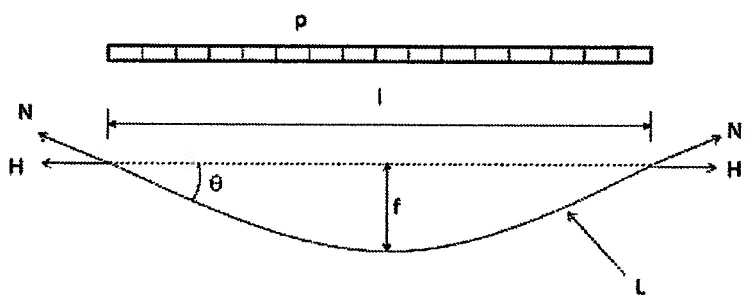
- The bird netting and installation hardware strength provided by the manufacturer allows a maximum span equal to 48 feet.

- The maximum cable dip is assumed to be 10 feet at the center of the 315-foot span.

- The distance between the cable and the ground is assumed to be 6 feet at mid span.

METHOD:

Cable analysis (Au and Christiano 1987; Ortiz-Berrocal 1991)



p = distributed load

H = horizontal component of reaction

N= normal reaction

f = dip

l = span

L= cable length

$$H = \frac{p\,l^2}{8f}$$

$$N = H\sqrt{1 + \frac{p^2}{H^2}\left(\frac{l}{2}\right)^2}$$

$$L = l + \frac{p^2 l^3}{24H^2}$$

Wind load

Simplified wind load method (International Code 2003)

Ultimate soil resistance

The permissible horizontal force at the pole is calculated using the following equation (Keshavarzian 2002):

$$W = \gamma * b * K_p^2 * \frac{E^3}{10 * (L - 0.6E)}$$

where:

γ = unit weight of soil (pcf)
b = width of pole at butt
K_p = coefficient of Rankine passive pressure
E = pole setting depth (ft)
L = pole length (ft)

CALCULATIONS:

The bird netting system is designed using standard of practice for this type of structure. In the design of the strain wires, factored weights of the bird netting and cable weight are considered. These factored loads are used to take into account uncertainties related to wind and snow loads. The wood poles are selected to resist the wind effects and tensions produced by the strain wires. The calculations are presented in Attachment 1.

RESULTS:

Calculations (Attachment 1) indicate that the resultant tension in the cable due to the considered load conditions is 2,800.6 pounds. A strain wire with a diameter of 7/32 inch type 304 7x19 strands with a breaking strength of 5,000 pounds was selected to resist the solicited tension. Wood poles of 25 foot in length with a diameter of 12 inch at the top and 18 inch at the bottom was selected to resist the resultant tension in the cable and lateral wind loads over the wood pole surface. The analysis of the wood pole foundation also indicates that an embedment depth of 8.5 foot provides sufficient resistance to the design loads.

REFERENCES:

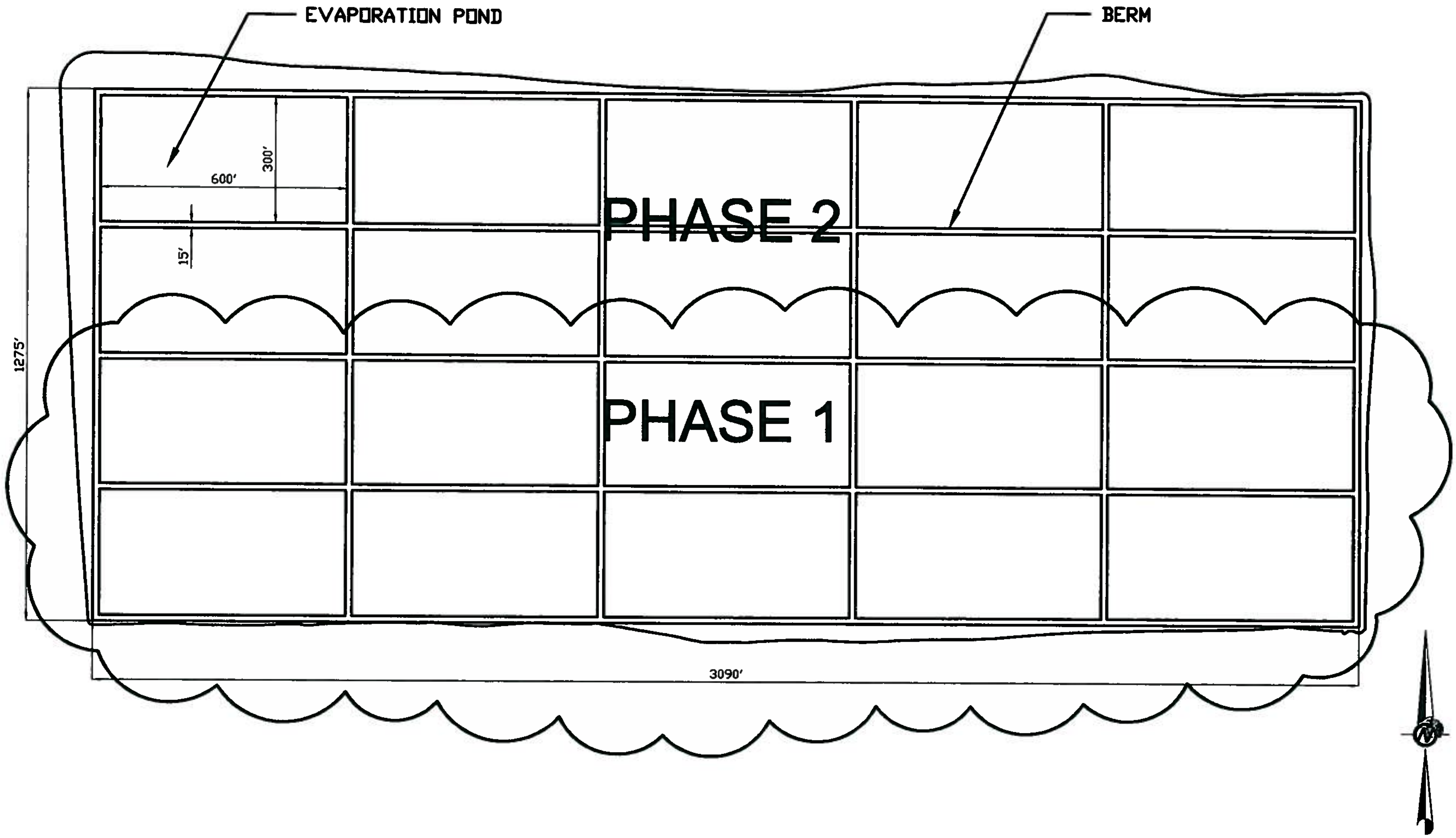
Au, T., and Christiano, P. (1987). *Structural analysis*, Prentice-Hall, Englewood Cliffs, NJ.

International Code, C. (2003). *International building code 2003*, International Code Council, Country Club Hills, IL.

Keshavarzian, M. (2002). "Self-supported wood pole fixity at ANSI groundline." *Practice Periodical on Structural Design and Construction*, 7(4), 147-155.

Ortiz-Berrocal, L. (1991). *Resistencia de Materiales*, McGraw-Hill, Madrid.

FIGURES

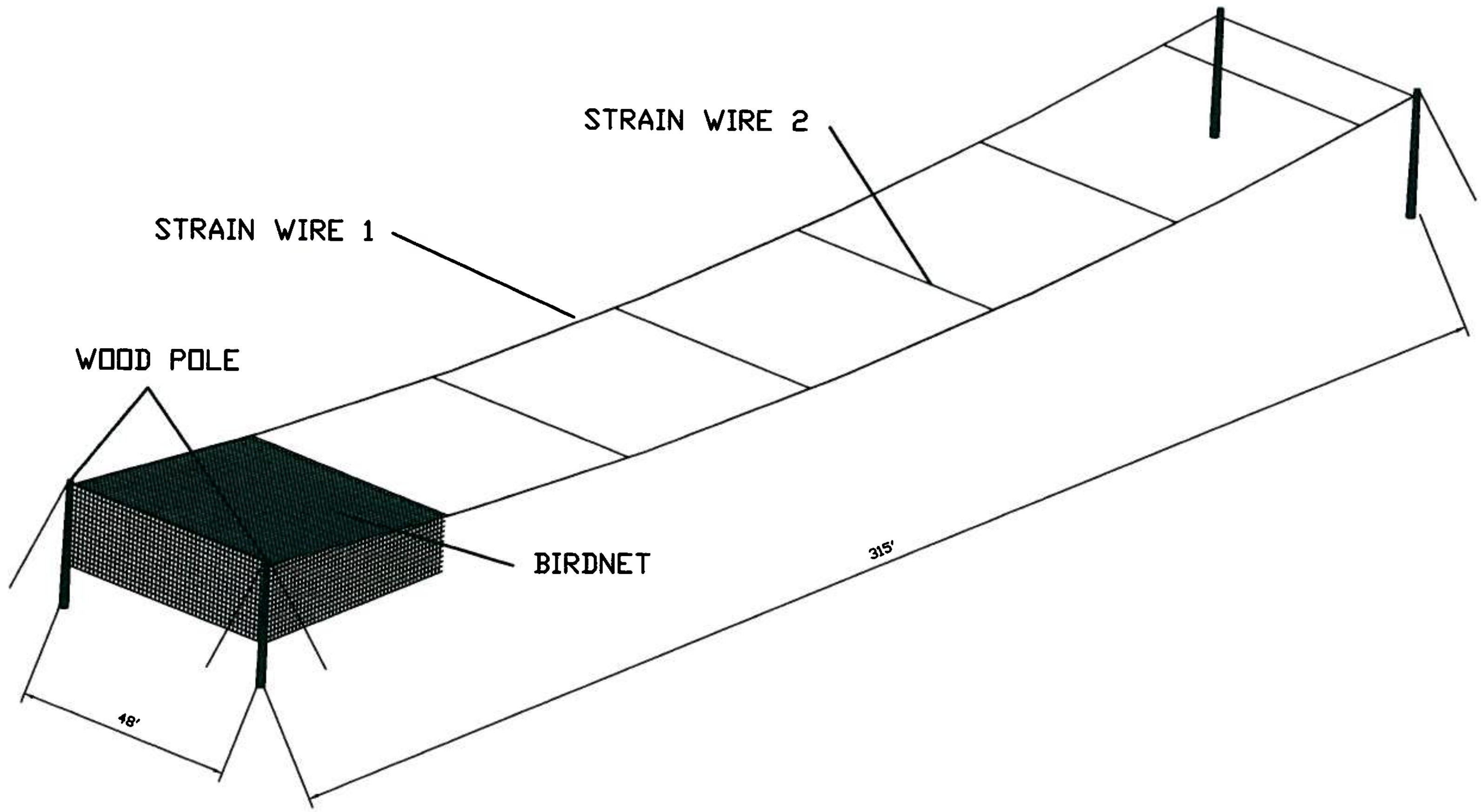


Golder Associates Denver, Colorado

TITLE

EVAPORATION POND PHASE 1 AND PHASE 2

CLIENT/PROJECT ENERGY FUELS RESOURCES CORPORATION PIÑON RIDGE PROJECT - EVAPORATION POND MONTROSE COUNTY, COLORADO	DRAWN EF CHECKED GG REVIEWED KFM	DATE APRIL15, 2008 SCALE N.T.S. FILE NO.
		JOB NO. 073-81694 DWG. NO. FIGURE NO. 1



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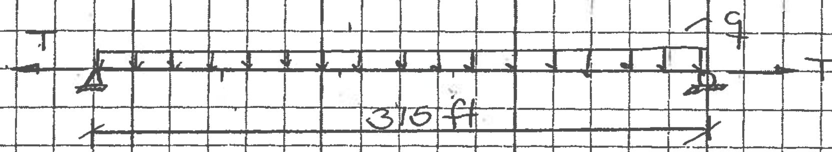
CLIENT/PROJECT	TITLE		
ENERGY FUELS RESOURCES CORPORATION PIÑON RIDGE PROJECT - EVAPORATION POND MONTROSE COUNTY, COLORADO	CONCEPTUAL VIEW PARTIAL SECTION BIRDNETTING FRAME		
	DRAWN EF	DATE APRIL15, 2008	JOB NO. 073-81694
	CHECKED GG	SCALE N.T.S.	DWG. NO.
	REVIEWED KFM	FILE NO.	FIGURE NO. 2

ATTACHMENT 1

Golder Associates

SUBJECT: Bird net
Job No. 073-81694
Ref.
Made by EF
Checked
Reviewed
Date
Sheet 1 of 9

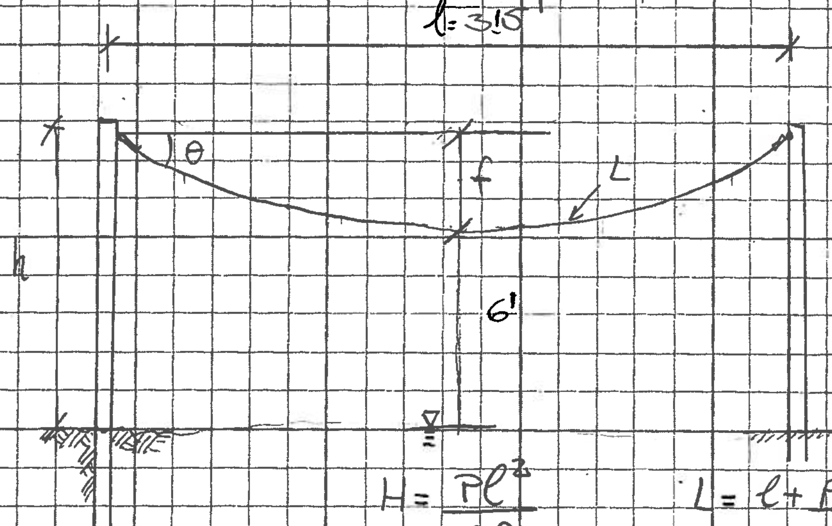
Objective: Calculate the tension in the primery cable.



$q = d \cdot \omega$ $d = 50$ ft   tributary width

$\omega = 0.028 \frac{lb}{ft^2}$ unit weight (net)

$q = 50 \cdot 0.028 = 1.4 \frac{lb}{ft}$



$$H = \frac{P l^2}{8f} \qquad L = l + \frac{P^2 l^3}{24 H^2}$$

$$N = H\sqrt{1 + \frac{P^2}{H^2} x^2}$$

$$N_{max} = H\sqrt{1 + \frac{P^2}{H^2}\left(\frac{l}{2}\right)^2}$$

$$L = l + \frac{P^2 l^3}{24 H^2}$$

Golder Associates	SUBJECT Birdnet		
	Job No. 073-81694 Ref.	Made by EF Checked [signature] Reviewed [signature]	Date Sheet 2 of 9

$f = 10'$

$H = \frac{P\ell^2}{8f}$

Assume a cable weight $w_c = 0.2 \frac{lb}{ft}$

$P = 0.2 \frac{lb}{ft} + 1.4 \frac{lb}{ft} = 1.6 \frac{lb}{ft}$

$1.4P = 2.24 \frac{lb}{ft}$ (factored load)

$H = \frac{2.24 \, lb/ft \cdot 315 ft^2}{8 \cdot 10 ft} = 2778.3 \, lb$

$N_{max} = 2778.3 lb \sqrt{1 + \frac{2.24^2}{2778.3^2} \left(\frac{315}{2}\right)^2}$

$N_{max} = 2800.6 lb$

USE 7×19 ⌀ 7/32" TYPE 304

$P_u = 5000 lb$

$P_n = 0.75 P_u = 0.75(5000) = 3750 lb > 2778.3 lb$ ok

$N \cos\theta = H$

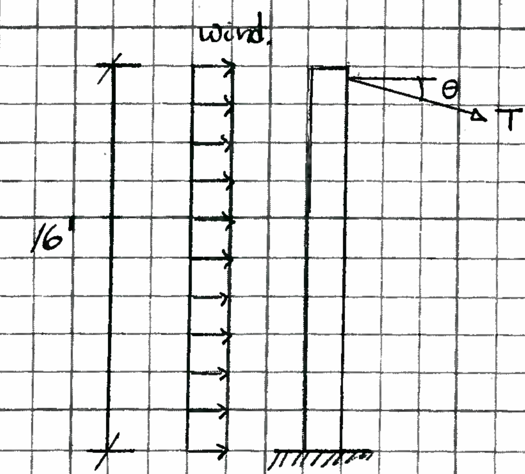
$L = 315 + \frac{2.24^2 \cdot 315^2}{24(2778.3)}$

$\cos\theta = \frac{H}{N} = \frac{2778.3}{2800.6} = 0.992$

$L = 322.5 ft$

$\theta = 7.235°$

pole: $h = f + 6' = 10' + 6' = 16'$



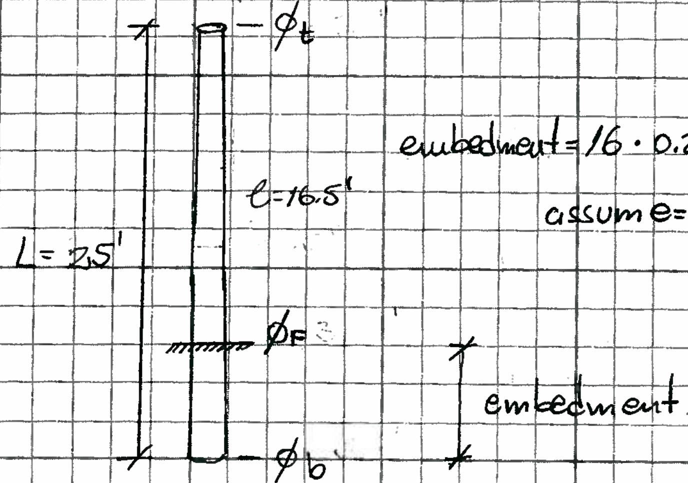
$\theta = 7.235°$

$T = 2800.6$ lb

Material: Wester Red Cedar

Pole dimensions

try class 1



embedment $= 16 \cdot 0.25 = 4' < 6'$ (AASHTO)

assume $e = 6'$

use $L = 25'$

embedment $= 8.5'$

Golder Associates	SUBJECT Birdnet		
	Job No. 073-81694 Ref.	Made by EF Checked Reviewed	Date Sheet 4 of 9

Wind pressure

$F = q_z G C_f A_f$ (6-28)

wind speed = 90 mph

$\frac{d}{L} = \frac{30.3}{16} =$

$G = 0.85$

$C_f = 0.5$

$q_z = 0.00256\, K_z K_{zt} K_d V^2 I$

$K_d = 0.95$

$K_z = 1.03$

$K_{zt} = (1 + K_1 K_2 K_3)^2 = 1.0$

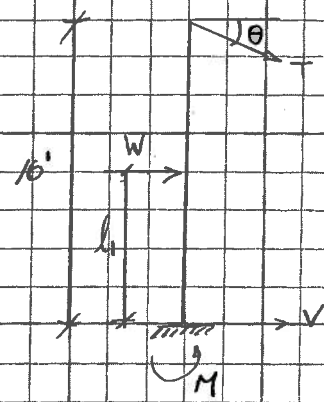
$I = 0.87$

$A_f = 16.5' \cdot \frac{1}{2}(12 + 15.3) \cdot \frac{1}{12} = 18.768\ ft^2$

$q_z = 0.00256 \cdot 0.95 \cdot 1.03 \cdot 1 \cdot (90)^2 \cdot 0.87$

$q_z = 17.65\ \frac{lb}{ft^2}$

$F = 17.65 \cdot 0.85 \cdot 0.5 \cdot 18.77 = 140.8\ lb$



$T = 2800.6$ lb

$\theta = 7.235$

$W = 140.8$ lb

$V = W + T\cos\theta = 140.8 + 2800.6(\cos 7.235)$

$V = 2{,}919.10$ lb

$M = T \cdot 16' + W\left(\frac{16.5'}{2}\right)$

$M = 2800.6 \cdot 16' + 140.8 \cdot \frac{16.5}{2}$

$M = 45{,}971.2$ lb-ft

From LPile:

$M_u = 105$ kips-in $= 8750$ lb-ft

$V_u = 2919.10$ lb.

$f_b = \frac{M}{S}$ $\quad S = \frac{I}{c}$ $\quad I = \frac{\pi r^4}{4}$ $\quad c = r$

$S = \frac{\pi r^4}{4r} = \frac{\pi r^3}{4}$ $\quad r = \frac{15.3''}{2} = 7.65''$

$S = \frac{\pi \cdot (7.65'')^3}{4} = 351.62 \text{ in}^3 = 0.203 \text{ ft}^3$

$f_b = \frac{8750}{0.203} = 43000 \frac{\text{lb}}{\text{ft}^2} = 298.6$ psi

$F_b' = F_b C_D C_M C_{Fu} C_r C_H$

$F_b = 500$ psi utility structure

$F_b' = 500 \cdot 1 \cdot 0.85 \cdot 1.10 \cdot 1.15 \cdot 1 = 537.6$ psi

$F_b' > f_b$ ok

$V = 2919.10$ lb

$F_v = 65$ psi

$f_v = \frac{2919.10}{\frac{\pi}{4}(16.15)^2} = 14.25$ psi $< F_v$ o.k.

Golder Associates

SUBJECT Birdnet

Job No. 073-81694
Ref.

Made by EF
Checked
Reviewed

Date

Foundation Keshavarzian (2002)

$$W = \gamma \cdot b \cdot K_p^2 \cdot E^2 \cdot \frac{E}{10 \times (L - 0.6E)}$$

$\gamma = 89.9 \frac{lb}{ft^3}$

$\phi = 33.7°$ (GA-BH-47)

$K_p = \tan^2\left(45 + \frac{\phi}{2}\right) = 3.49$

$$W = 89.9 \cdot \frac{26.94}{12} \cdot 3.49^2 \cdot 8.5^2 \cdot \frac{8.5}{10 \cdot (16.5 - 0.6 \cdot 8.5)}$$

$W = 13,242.8 \, lb > 2963.65 \, lb$ ok

EYEBOLT

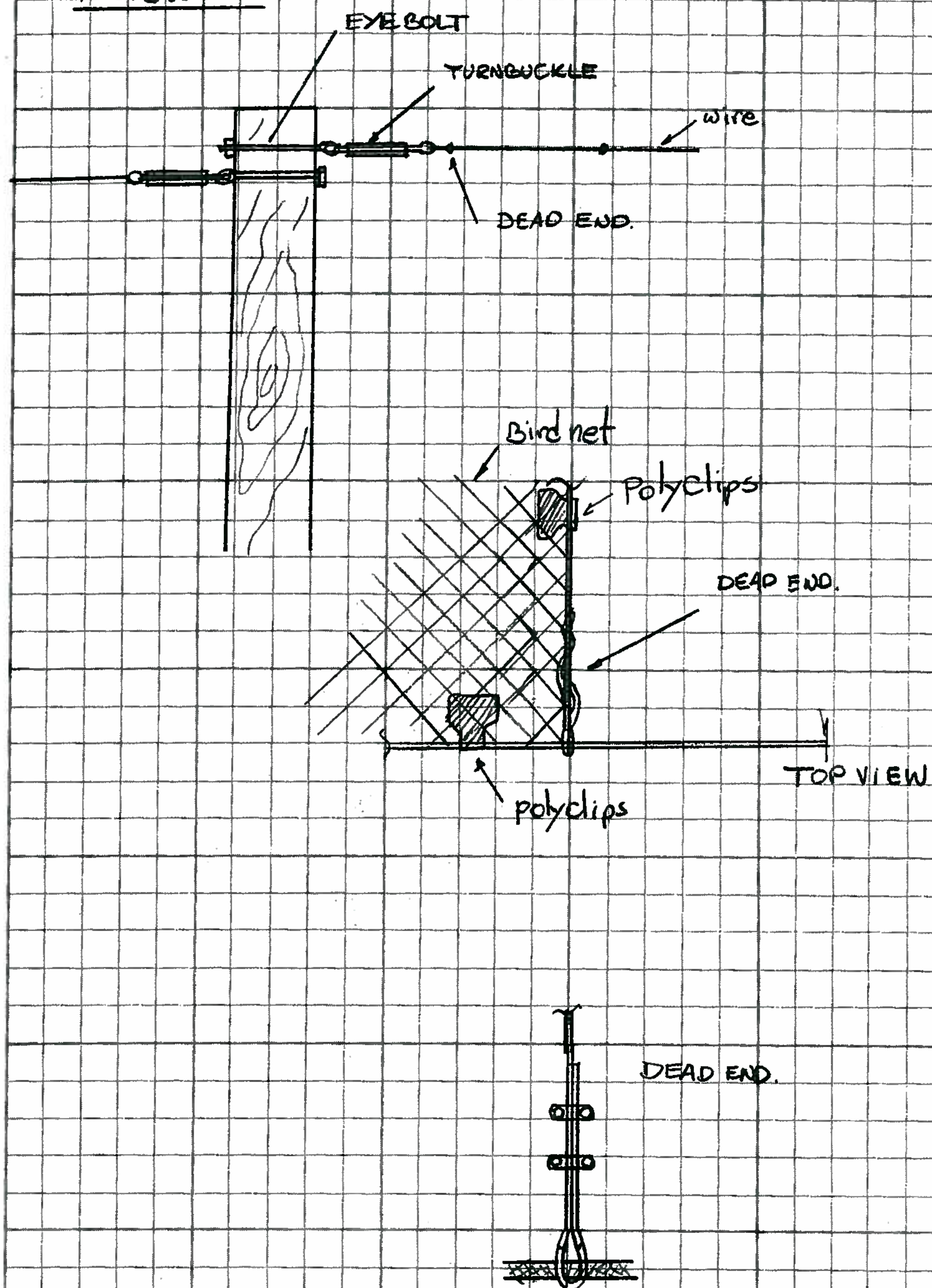
5/8" x 18" A325 (A36)

$A_b = \frac{\pi (5/8)^2}{4} = 0.3067$ $T_u = F_t A_b = 7{,}200$ lb

$\phi R_n = \phi F_t A_b = 0.75(90)\,0.3067 = 20.70$ kips > N ok

Golder Associates	SUBJECT Birdned		
	Job No. 073-81694 Ref.	Made by EF Checked Reviewed	Date Sheet 9 of 9

Hardware



==

LPILE Plus for Windows, Version 5.0 (5.0.21)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==

This program is licensed to:

Enrique Farfan
Golder & Associates

```
Path to file locations:      C:\Documents and Settings\EFarfan\My
Documents\PROJECTS\073-81694\Bird-Nets\
Name of input data file:     Pile.lpd
Name of output file:         Pile.lpo
Name of plot output file:    Pile.lpp
Name of runtime file:        Pile.lpr
```

Time and Date of Analysis

Date: April 15, 2008   Time: 10: 3:49

Problem Title

073-81694 Piñon Ridge Project

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments   =   100

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 102.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	15.30000000	2689.8970	183.8500	900000.00000
2	102.0000	17.00000000	4099.8200	226.9800	900000.00000

Soil and Rock Layering Information

The soil profile is modelled using 1 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 102.000 in
p-y subgrade modulus k for top of soil layer = .000 lbs/in**3
p-y subgrade modulus k for bottom of layer = .000 lbs/in**3

NOTE: Internal default values for p-y subgrade modulus will be computed for the above soil layer.

(Depth of lowest layer extends .00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 2 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	89.90000
2	102.00	89.90000

**** WARNING - POSSIBLE INPUT DATA ERROR ****

Values entered for effective unit weights of soil were outside

the limits of 0.011574 pci (20 pcf) or 0.0810019 pci (140 pcf)
This data may be erroneous. Please check your data.

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 2 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	.00000	33.70	------	------
2	102.000	.00000	33.70	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

---

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head   =   2919.100 lbs
Bending moment at pile head =   45971.200 in-lbs
Axial load at pile head   =   .000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head =   2919.100 lbs

Specified moment at pile head = 45971.200 in-lbs
Specified axial load at pile head = .000 lbs

Non-zero moment for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment)condition.

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.132161	45971.2000	2919.1000	-.0029762	130.7409	0.0000
1.020	.129135	48948.6820	2782.4337	-.0029563	138.6368	-9.1296
2.040	.126130	51916.6655	2900.6922	-.0029352	146.4426	-17.8344
3.060	.123147	54866.0941	2878.2760	-.0029130	154.1342	-26.1190
4.080	.120188	57788.3486	2847.6213	-.0028897	161.6891	-33.9883
5.100	.117252	60675.2416	2809.1489	-.0028653	169.0862	-41.4478
6.120	.114342	63519.0123	2763.2740	-.0028399	176.3061	-48.5030
7.140	.111459	66312.3205	2710.4059	-.0028134	183.3308	-55.1598
8.160	.108603	69048.2404	2650.9479	-.0027860	190.1438	-61.4245
9.180	.105776	71720.2543	2585.2966	-.0027576	196.7298	-67.3035
10.200	.102978	74322.2455	2513.8420	-.0027283	203.0749	-72.8035
11.220	.100210	76848.4919	2436.9671	-.0026981	209.1665	-77.9315
12.240	.097473	79293.6585	2355.0478	-.0026671	214.9932	-82.6946
13.260	.094769	81652.7895	2268.4524	-.0026353	220.5448	-87.1003
14.280	.092098	83921.3013	2177.5416	-.0026027	225.8122	-91.1561
15.300	.089460	86094.9744	2082.6684	-.0025694	230.7876	-94.8698
16.320	.086856	88169.9449	1984.1777	-.0025355	235.4638	-98.2492
17.340	.084287	90142.6969	1882.4063	-.0025009	239.8352	-101.3026
18.360	.081754	92010.0537	1777.6826	-.0024657	243.8966	-104.0380
19.380	.079257	93769.1694	1670.3267	-.0024301	247.6443	-106.4638
20.400	.076797	95417.5201	1560.6501	-.0023939	251.0749	-108.5883
21.420	.074374	96952.8956	1448.9558	-.0023573	254.1864	-110.4201
22.440	.071988	98373.3900	1335.5381	-.0023203	256.9772	-111.9676
23.460	.069640	99677.3933	1220.6826	-.0022830	259.4467	-113.2394
24.480	.067331	100864.	1104.6660	-.0022454	261.5950	-114.2441
25.500	.065060	101931.	987.7565	-.0022075	263.4228	-114.9903
26.520	.062827	102879.	870.2133	-.0021695	264.9317	-115.4865
27.540	.060634	103706.	752.2870	-.0021313	266.1235	-115.7414
28.560	.058480	104413.	634.2195	-.0020929	267.0011	-115.7635
29.580	.056364	105000.	516.2440	-.0020546	267.5677	-115.5611
30.600	.054288	105466.	398.5850	-.0020162	267.8271	-115.1428
31.620	.052251	105813.	281.4586	-.0019778	267.7835	-114.5167
32.640	.050254	106041.	165.0726	-.0019395	267.4416	-113.6911
33.660	.048295	106150.	49.6263	-.0019013	266.8068	-112.6741
34.680	.046375	106142.	-64.6891	-.0018632	265.8845	-111.4737
35.700	.044494	106018.	-177.6904	-.0018254	264.6808	-110.0975
36.720	.042651	105779.	-289.2023	-.0017878	263.2020	-108.5534
37.740	.040847	105428.	-399.0574	-.0017504	261.4549	-106.8487
38.760	.039080	104965.	-507.0955	-.0017134	259.4464	-104.9909
39.780	.037351	104393.	-613.1643	-.0016767	257.1839	-102.9870
40.800	.035660	103714.	-717.1180	-.0016404	254.6749	-100.8440
41.820	.034005	102930.	-818.8185	-.0016044	251.9272	-98.5686
42.840	.032387	102044.	-918.1338	-.0015690	248.9489	-96.1673
43.860	.030804	101057.	-1014.9389	-.0015340	245.7482	-93.6465
44.880	.029258	99973.5368	-1109.1148	-.0014995	242.3335	-91.0122
45.900	.027745	98794.8951	-1200.5489	-.0014655	238.7134	-88.2703
46.920	.026268	97524.4170	-1289.1341	-.0014321	234.8968	-85.4262
47.940	.024824	96165.0614	-1374.7691	-.0013993	230.8924	-82.4855
48.960	.023413	94719.8880	-1457.3578	-.0013671	226.7092	-79.4531
49.980	.022035	93192.0516	-1536.8091	-.0013356	222.3565	-76.3339
51.000	.020689	91584.7974	-1613.0369	-.0013047	217.8433	-73.1324
52.020	.019373	89901.4562	-1685.9595	-.0012744	213.1791	-69.8531
53.040	.018089	88145.4399	-1755.4995	-.0012449	208.3731	-66.4998

54.060	.016834	86320.2373	-1821.5834	-.0012161	203.4348	-63.0764
55.080	.015608	84429.4099	-1884.1414	-.0011880	198.3736	-59.5865
56.100	.014410	82476.5887	-1943.1074	-.0011606	193.1992	-56.0331
57.120	.013240	80465.4707	-1998.4182	-.0011340	187.9210	-52.4194
58.140	.012097	78399.8156	-2050.0135	-.0011082	182.5486	-48.7479
59.160	.010979	76283.4431	-2097.8357	-.0010832	177.0917	-45.0211
60.180	.009887	74120.2307	-2141.8295	-.0010589	171.5598	-41.2412
61.200	.008819	71914.1109	-2181.9417	-.0010355	165.9626	-37.4101
62.220	.007775	69669.0697	-2218.1208	-.0010128	160.3098	-33.5293
63.240	.006753	67389.1445	-2250.3169	-.0009910	154.6109	-29.6004
64.260	.005753	65078.4232	-2278.4815	-.0009700	148.8757	-25.6242
65.280	.004774	62741.0423	-2302.5668	-.0009498	143.1138	-21.6019
66.300	.003816	60381.1869	-2322.5261	-.0009304	137.3347	-17.5339
67.320	.002876	58003.0891	-2338.3129	-.0009118	131.5483	-13.4207
68.340	.001955	55611.0285	-2349.8813	-.0008941	125.7640	-9.2624
69.360	.001052	53209.3313	-2357.1851	-.0008771	119.9915	-5.0589
70.380	.000166	50802.3709	-2360.1782	-.0008610	114.2405	-.8099582
71.400	-.000704	48394.5677	-2358.8140	-.0008457	108.5206	3.4849
72.420	-.001559	45990.3903	-2353.0452	-.0008312	102.8414	7.8265
73.440	-.002400	43594.3556	-2342.8236	-.0008175	97.2126	12.2157
74.460	-.003227	41211.0301	-2328.1004	-.0008045	91.6437	16.6535
75.480	-.004041	38845.0308	-2308.8251	-.0007923	86.1445	21.1412
76.500	-.004843	36501.0269	-2284.9461	-.0007809	80.7245	25.6803
77.520	-.005634	34183.7408	-2256.4103	-.0007702	75.3936	30.2723
78.540	-.006414	31897.9499	-2223.1628	-.0007603	70.1613	34.9189
79.560	-.007185	29648.4888	-2185.1468	-.0007511	65.0373	39.6221
80.580	-.007947	27440.2504	-2142.3039	-.0007426	60.0315	44.3836
81.600	-.008700	25278.1888	-2094.5733	-.0007347	55.1536	49.2057
82.620	-.009446	23167.3208	-2041.8922	-.0007275	50.4134	54.0905
83.640	-.010184	21112.7286	-1984.1956	-.0007210	45.8207	59.0402
84.660	-.010916	19119.5618	-1921.4159	-.0007151	41.3855	64.0571
85.680	-.011643	17193.0401	-1853.4836	-.0007098	37.1177	69.1435
86.700	-.012364	15338.4552	-1780.3265	-.0007050	33.0273	74.3018
87.720	-.013081	13561.1740	-1701.8700	-.0007008	29.1245	79.5344
88.740	-.013794	11866.6404	-1618.0372	-.0006971	25.4192	84.8437
89.760	-.014503	10260.3782	-1528.7486	-.0006939	21.9218	90.2319
90.780	-.015210	8747.9933	-1433.9225	-.0006912	18.6426	95.7015
91.800	-.015913	7335.1762	-1333.4749	-.0006889	15.5919	101.2546
92.820	-.016615	6027.7044	-1227.3194	-.0006870	12.7801	106.8935
93.840	-.017315	4831.4446	-1115.3675	-.0006854	10.2178	112.6201
94.860	-.018013	3752.3548	-997.5286	-.0006842	7.9157	118.4365
95.880	-.018711	2796.4863	-873.7103	-.0006833	5.8845	124.3444
96.900	-.019407	1969.9857	-743.8184	-.0006826	4.1350	130.3456
97.920	-.020103	1279.0967	-607.7571	-.0006822	2.6781	136.4414
98.940	-.020799	730.1613	-465.4291	-.0006819	1.5250	142.6331
99.960	-.021494	329.6213	-316.7362	-.0006817	.6867479	148.9217
100.980	-.022190	84.0194	-161.5791	-.0006817	.1746206	155.3080
102.000	-.022885	0.0000	0.0000	-.0006817	0.0000	161.7924

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      .13216094 in
Computed slope at pile head      =    -.00297616
Maximum bending moment           =  106149.81638 lbs-in
Maximum shear force              =    2919.10000 lbs
Depth of maximum bending moment  =   33.66000000 in
Depth of maximum shear force     =       0.00000 in
Number of iterations             =             5
```

Number of zero deflection points = 1

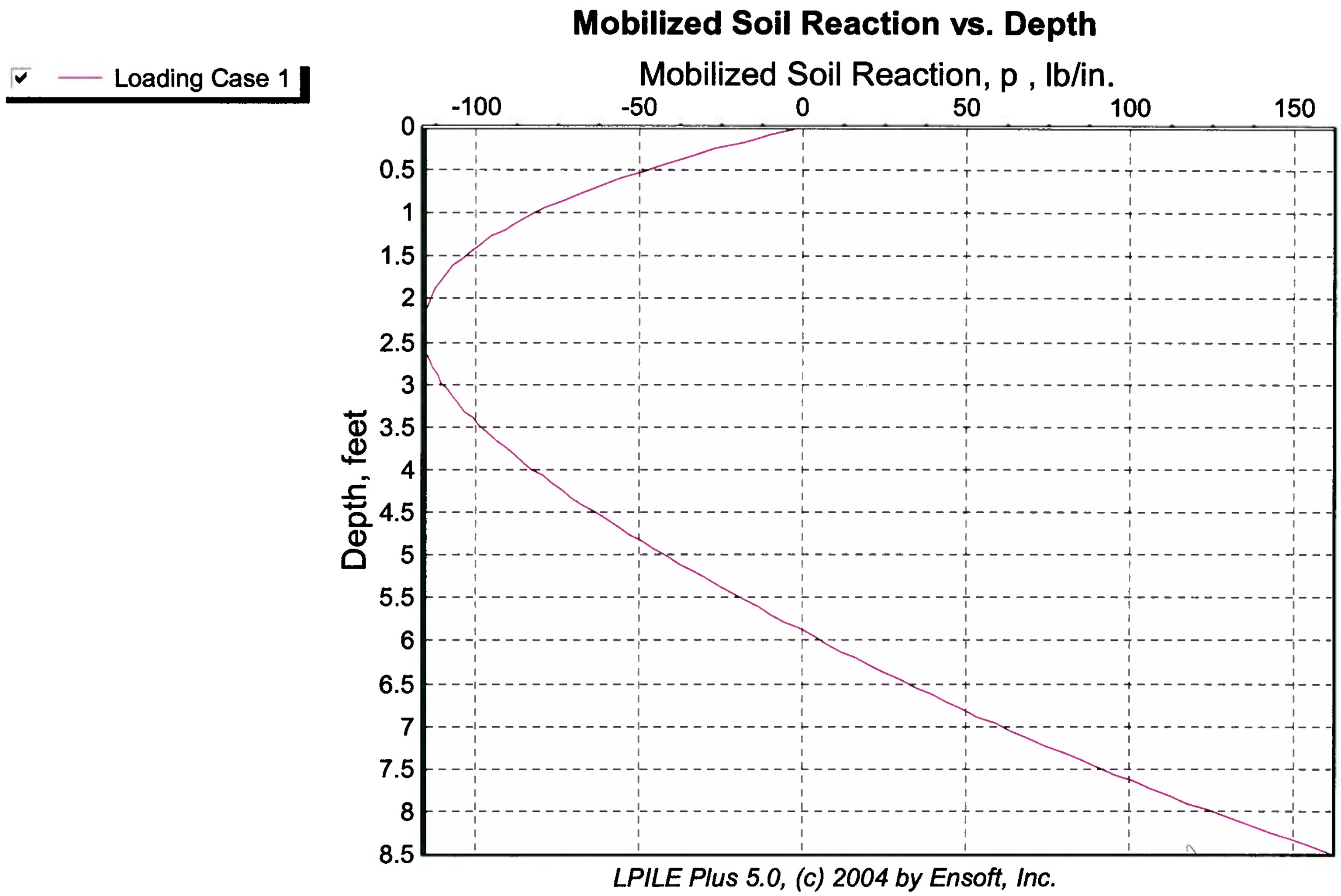
Summary of Pile Response(s)

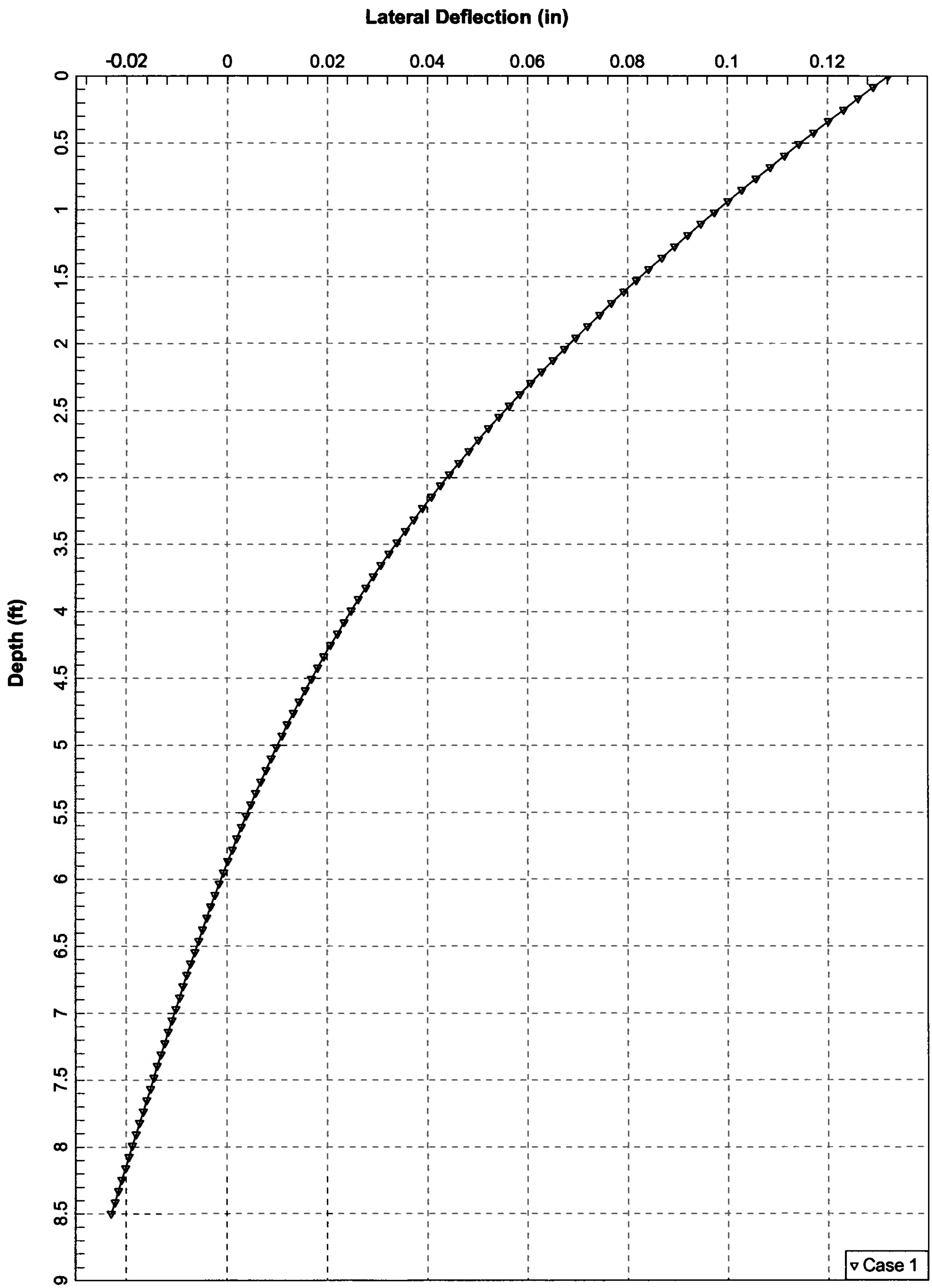
Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

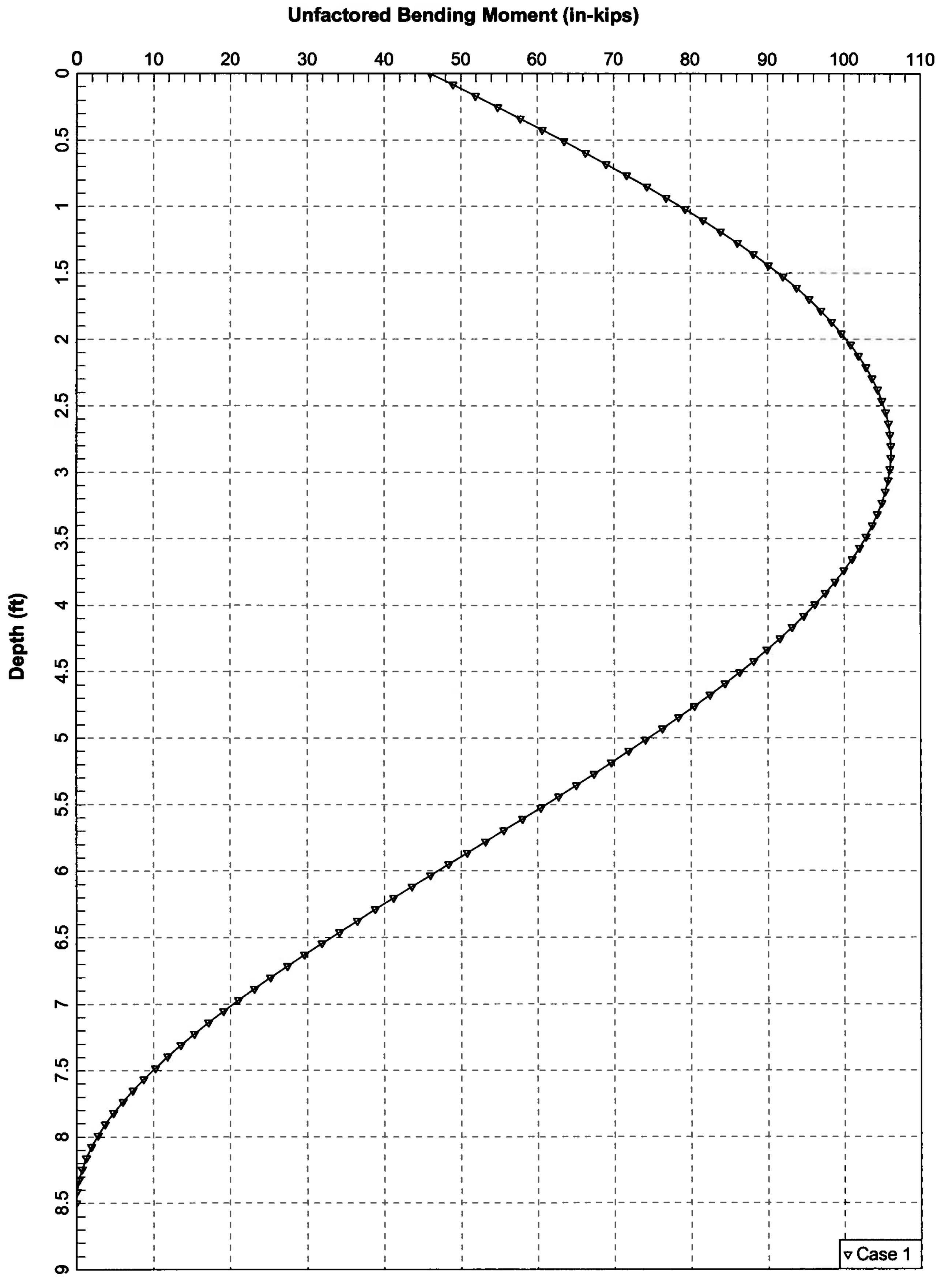
Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 2919.100	M= 45971.	0.0000	.1321609	106150.	2919.1000

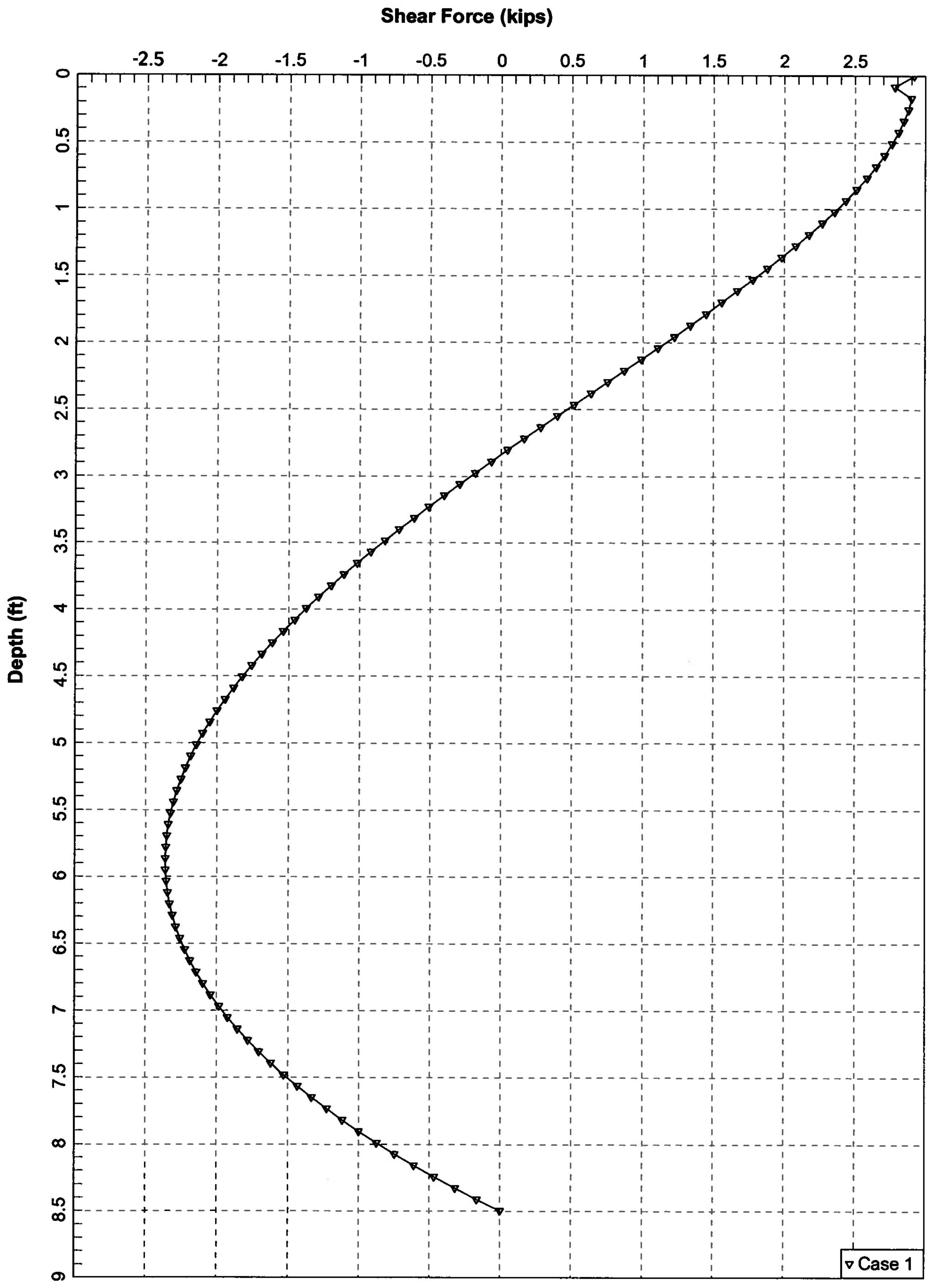
The analysis ended normally.


Mobilized Soil Reaction vs. Depth
Loading Case 1
Mobilized Soil Reaction, p , lb/in.
-100
-50
0
50
100
150
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
Depth, feet
LPILE Plus 5.0, (c) 2004 by Ensoft, Inc.

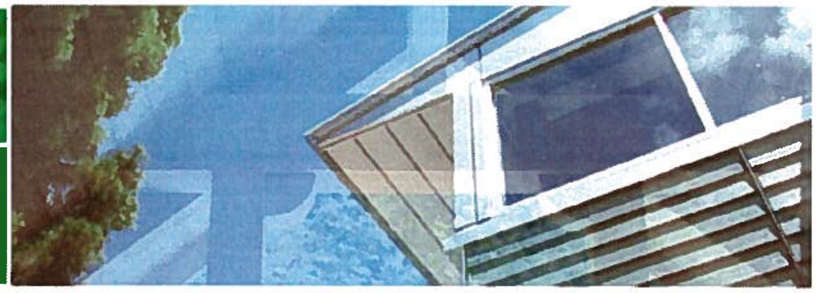


Lateral Deflection (in)
-0.02
0
0.02
0.04
0.06
0.08
0.1
0.12
Depth (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
Case 1


Unfactored Bending Moment (in-kips)
0
10
20
30
40
50
60
70
80
90
100
110
Depth (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
Case 1


Shear Force (kips)
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
Depth (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
Case 1

ATTACHMENT 2



TECHNICAL SPECIFICATIONS

ENGINEERING DATA

WESTERN RED CEDAR EXPORT ASSOCIATION

Section Properties

Section properties are used in various design calculations. For convenience, the following are formulas to calculate the section properties of rectangular beam cross sections.

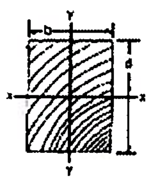
Definitions

Neutral axis, in the cross section of a beam, is the line in which there is neither tension nor compression stress.

Moment of Inertia (I) of the cross section of beam is the sum of the products of each of its elementary areas multiplied by the square of their distance from the neutral axis of the section.

Section Modulus (S) is the moment of inertia divided by the distance from the neutral axis to the extreme fiber of the section.

Cross Section is a section taken through the member perpendicular to its longitudinal axis.



Formulas

The following symbols and formulas apply to rectangular beam cross sections:

X-X= neutral axis for edgewise bending (load applied to narrow face)

Y-Y= Neutral axis for flatwise bending (load applied to narrow face)

b= breadth of rectangular bending member(in.)

d= depth of rectangular bending member (in.)

A= bd=area of cross section (in.2)

c= distance from neutral axis to extreme fiber of cross section (in.)

Ixx= bd3/12 = moment of inertia about the X-X axis (in.4)

Iyy= db3/12 = moment of inertia about the Y-Y axis (in.4)

rxx= Square root of (Ixx/A) = d/Square root of 12 = radius of gyration about the X-X axis (in.)

ryy= Square root of (Iyy/A) = b/Square root of 12 = radius of gyration about the Y-Y axis (in.)

sxx= Ixx /c = bd2/6 = section modulus about the X-X axis (in.3)

syy= Iyy /c = db2/6 = section modulus about the Y-Y axis (in.3)

Sizes of rough and dressed Western Red Cedar are shown in Tables 5 and 6.

Base Design Values (United States Only)

Since different sizes of visually-graded lumber have different values, the design values shown in Table 8 are tabulated in a base value approach. Base values are provided for a base size that depends on the grade. For Select Structural, No.1, No.2 and No.3 grades, the base strength values are published on a 2x12 basis. For Construction Standard and Utility grades, the base strength values are published on a 2x4 basis (the size factor is always 1.0).

For Stud grade, the base strength values are published on a 2x6 basis. These values are for use in the United States only.

To determine the value for a given size, the designer selects a base value for a given grade then multiplies the base value by a size factor from Table 9.

The base design values apply to Western Red Cedar manufactured by members of the Western Red Cedar Export Association and graded to National Lumber Grading Authority Rules (NLGA). Grades and sizes of Canadian dimension lumber are identical to those in use throughout the United States and conform to the requirements of applicable American Standards. Tabulated values are from *The U.S. Span Book for Canadian Lumber* published by the Canadian Wood Council (1-800-463-5091).

Span Tables

Spans for Western Red Cedar dimension lumber used as joists and rafters in residential and commercial structures are available from the Western Red Cedar Lumber Association, the Canadian Wood Council and the National Association of Home Builders. Please request publication *The U.S Span Book for Canadian Lumber*. Cost $10.

Table 1. Base Design Values For Use In The U.S.A. For Western Red Cedar - 2-4" Thick 2" and Wider

Base values in pounds per square inch (psi) - Use with Adjustment Factors (see Table 9)

Grade Fb	Extreme Fiber Stress in Bending Ft	Tension Parallel Parallel to Grain Fv	Horizontal Shear Fv	Compression		Modulus of Elasticity (million psi) E
				Perpendicular To Grain Fc (perp)	Parallel To Grain Fc	
Select Structural	950	450	65	350	1,100	1.1
No.1/No.2	575	275	65	350	825	1.1
No.3	350	150	65	350	475	1.0
Construction	675	300	65	350	1,050	1.0
Standard	375	175	65	350	850	0.9
Utility	175	75	65	350	550	0.9
Stud	450	200	65	350	525	1.0

Notes:

1. No.1/No.2 applies to either No.1 or No.2 grades.
2. Values for Utility grade apply only to 2" and 4" lumber.
3. For studs wider than 6" bearing the "Stud" grademark, use the property values and size factors for No.3 grade.

Table 2. Size Factors (CF) For Tabulated Design Values

Grades	Nominal Width (depth)(in)	Fb less than 4 in. thick	Fb 4 in. thick nominal	Ft	Fc	Other Properties
Select Structural No.1 No.2 & No.3	4 & less	1.5	1.5	1.5	1.15	1.0
	5	1.4	1.4	1.4	1.1	1.0
	6	1.3	1.3	1.3	1.1	1.0
	8	1.2	1.3	1.2	1.05	1.0
	10	1.1	1.2	1.1	1.0	1.0
	12	1.0	1.1	1.0	1.0	1.0
	14 & wider	0.9	0.9	0.9	0.9	1.0
Construction & Standard	4 & less	1.0	1.0	1.0	1.0	1.0
Utility	4	1.0	1.0	1.0	1.0	1.0
Stud*	4 & less	1.1	1.1	1.1	1.05	1.0
	5 & 6	1.0	1.0	1.0	1.0	1.0
MSR and plank decking All grades & sizes		1.0	1.0	1.0	1.0	1.0

Note: Factors are for Stud grade widths 6" and less. For studs wider than 6", use the design values and size factors for No.3 grade.

Table 3. Wet Use Factors (CM) For Tabulated Design Values

The recommended design values are for applications where the moisture content of the wood does not exceed 19%. For use conditions where the moisture content of dimension lumber will exceed 19%, the Wet Use Adjustment Factors below are recommended:

Property	Adjustment Factor
Fb Extreme Fiber Stress in Bending	0.85*
Ft Tension Parallel to Grain	1.0
Fc Compression Parellel to Grain	0.8**
Fv Horizontal Shear	0.97
Fc(perp) Compresion Perpendicular to Grain	0.67
E Modulus of Elasticity	0.9

Notes:

Bending Wet Use Factor = 1.0 where Fb Cf (base value size factor) does not exceed 1,150 psi.
Compression Parallel Wet Use Factor=1.0 where Fc Cf (base value size factor) does not exceed 750 psi.

Table 4. Flat Use Factors (Cfu)

Apply to Tabulated Design Values for Extreme Fiber Stress in Bending Where Lumber is used Flatwise Rather than on Edge.

Nominal Width (inches)	Nominal Thickness (inches)	
	less than 4	4
less than 4	1.00	
4	1.10	1.00
5	1.10	1.05
6	1.15	1.05
8	1.15	1.05
10 & Wider	1.20	1.10

Note: These factors apply to all dimension lumber except tongue-and-grove decking grades. For T & G decking, the following adjustments may be used:

Nominal thickness	2"	3"	4"
Flat use factor	1.10	1.04	1.00

Table 5. Repetitive Member Factor (Cr)

Applies to Tabulated Design Values for Extreme Fiber Stress in Bending when members are used as joists, truss chords, rafters, studs, planks, decking or similar members which are in contact or spaced not more than 24" on centers, are not less than 3 in number and are joined by floor, roof or other load distributing elements adequate to support the design load.

1.15

Table 6. Duration of Load Adjustment (CD) For Tabulated Design Values

Load Duration	Factor
Permanent	0.9
Ten Years (normal load)	1.0
Two Months (snow load)	1.15
Seven Days	1.25
Ten Minutes (wind, earthquake)	1.6

Impact	2.0

Note: Confirm load requirements with local codes. Refer to Model Building Codes or the National Design Specification for high-temperature or fire-retardant treated adjustment factors.

Table 7. Horizontal Shear Adjustment For Tabulated Design Values

(CH) All horizontal shear base values are established as if a piece were split full length and as such the values are reduced from those permitted to be assigned in accordance with ASTM standards. This reduction is made to compensate for any degree of shake, check or split that might develop in a piece.

2 inches Thick (Nominal) Lumber		3 inches Thicker (Nominal) Lumber	
For convenience, the table below may be used to determine horizontal shear values for any grade of 2" thick lumber in any species when the length of split or check is known:		Horizontal shear values for 3" and thicker lumber also are established as if a piece were split full length. When specific lengths of splits are known and any increase in them is not anticipated, the following adjustments may be applied:	
When length of split on wide face does not exceed:	Multiply tabulated FV value by:	When length of split on wide face does not exceed	Multiply tabulated FV value by:
No split	2.00	No split	2.00
1/2 wide face	1.67	1/2 x narrow face	1.67
3/4 wide face	1.50	1 x narrow face	1.33
1 x wide face	1.33	1-1/2 x narrow face or more	1.00
1-1/2 wide face or more	1.00		

Table 8. Adjustments for Compression Perpendicular To Grain To Deformation Basis of 0.02"

Design values for compression perpendicular to grain are established in accordance with the procedures set forth in ASTM D 2555 and D 245. ASTM procedures consider deformation under bearing loads as a serviceability limit state comparable to bending deflection because bearing loads rarely cause structural failures. Therefore, ASTM procedures for determining compression perpendicular to grain values are based on a deformation of 0.04" and are considered adequate for most classes of structures. Where more stringent measures need be taken in design, the following permits the designer to adjust design values to a more conservative deformation basis of 0.02".

Y02=0.73Y04+5.60

Table 9. Design Values For Use In the U.S.A. For Visually Graded (NLGA) Western Red Cedar Timbers (5" 5" and Larger)

Grade	Size Class-ification	Design Values in pounds per square inch (psi)					
		Extreme Fiber Stress in Bending Fb	Tension Parallel to Grain F1	Shear Parallel to Grain FV	Compression Perpendicular to Grain Fc(perp)	Compression Parallelto Grain Fc	Modulus of Elasticity E
Select Strctl.	Beams and Stringers	1,150	675	65	425	850	1,000,000
No.1		925	475	65	425	700	1,000,000
No.2		625	300	65	425	450	800,000
Select Strctl.	Posts and Timber	1,050	700	65	425	900	1,000,000
No.1		875	575	65	425	800	1,000,000
No.2		500	350	65	425	550	800,000

Notes:

Allowable Extreme Fiber Stress in Bending applies only when Beams and Stringers are loaded on narrow face.
Where applicable see Tables 9 through 13 for conditions of use and adjustment factors.

Members of the Western Red Cedar Export Association provide western red cedar to Belgium, France, The Netherlands, United Kingdom, Australia, New Zealand, China, Japan and other markets around the world.

western red cedar poles - the premium utility pole

ANSI Dimensions | Shipping Weights

western red cedar

Bell Pole ensures product availability and on-time delivery.

Our sustainable forest resources, state-of-the-art treating facility and high volume production capabilities ensure on-time delivery of orders to customer standards and specifications.

With on-site inventory of various lengths and sizes, quick service can be provided in emergency situations.

Access to self-unloading trucks allows for delivery to distribution yards or job sites at a cost savings to our customers.

Pole Capacities:

Transmission poles

- have line capacities of 33kV or higher
- lengths range from 60 to 125 feet
- Class 1, 2, 3 or H series poles

Distribution poles

- are single pole structures
- lengths range from 25 to 55 feet
- Class 1 thorugh 7 poles are generally used

The benefits of western red cedar poles:

- **a naturally durable wood** - resistant to decay, fungi and insects.
- **long life** - has the best cost-to-life ratio. With treatment process their natural life can be extended up to 80 years.
- **strength and flexibility** - allow poles to withstand extreme weight and weather conditions.
- **straight grain** - prevents twisting after installation.
- **light weight** - at 30% less than other species - makes handling and installation easier, and fit more poles per load.
- **safer and easier** - for crews to climb because gaffs dig into them easily, for safe footing.
- **low conductivity**
- **selection** - good range of lengths suitable for transmission and distribution.

ANSI dimensions of western red cedar poles

	class														
	6	5	4	3	2	1	1	2	3	4	5	6	7	9	10
	minimum circumference at top (inches)														
	39	37	35	33	31	29	27	25	23	21	19	17	15	15	12
length (feet)	minimum circumference at 6 feet from butt (inches)														
20							34	32	30	27	25	23	22	19	15
25							37	35	33	30	28	26	24	21	17
30							40	38	35	33	30	28	26	22	
35					48	46	43	40	38	35	32	30	28		
40			57	54	51	48	45	43	40	37	34	32			
45	65	62	59	56	54	51	48	45	42	39	36	33			
50	67	65	62	59	56	53	50	47	44	40	38				
55	70	67	64	61	58	55	52	49	45	42					
60	72	69	66	63	60	57	54	50	47	44					
65	75	72	68	65	62	59	55	52	48	45					
70	77	74	70	67	64	60	57	53	50	46					
75	79	76	72	69	65	62	58	55	51						
80	81	77	74	71	67	63	60	56	52						
85	83	79	76	72	69	65	61	57	54						
90	85	81	77	74	70	66	63	59	55						
95	86	83	79	75	72	68	64	60							
##	88	84	81	77	73	69	65	61							
##	90	86	82	78	74	70	66	62							
##	91	87	84	80	76	72	68	63							
##	93	89	85	81	77	73	69	64							
##	94	90	86	82	78	74	70	65							
##	96	92	88	83	79	75	71	66							

NI

Tensioned Cable Installation Example

The information below provides the basic procedures for installing a tensioned cable system. This example shows an all steel surface. Your application may be different. If you have any questions contact **ABC/Nixalite**.

General Procedures

1. Install Corner Hardware.

Drill 9/32" dia. hole for corner hardware eyebolt. Secure with the supplied hex nut.

2. Install Cable Guide Hardware.

Install 24"o.c. Use 14S Driver Socket to seat sidewinders properly. Align sidewinder holes for cable.

3. Fasten Cable to Eyebolts.

Each connection - 2 rope clamps, 1 thimble.

Push a thimble into the eyebolt. Make a loop by passing the cable through the eyebolt. Make sure there is 3"of extra cable.

Apply the first rope clamp 2" from eyebolt and lightly tighten the nuts. Apply the second rope clamp as close to the eyebolt as possible. Lightly tighten nuts. Take up slack in cable and torque all rope clamp nuts to 7.5ft.lbs.

4. Fasten Cable to Turnbuckles.

Run the cable through all cable guides before fastening the cable to the turnbuckle.

Open the turnbuckle to its maximum safe length. Push a thimble into the eyelet of the turnbuckle. Make a loop by passing cable through turnbuckle eye. Make sure there is 3"of extra cable. Apply the first rope clamp 2" from eyelet and lightly tighten the nuts. Apply second rope clamp as close to the eyelet as possible. Lightly tighten nuts.

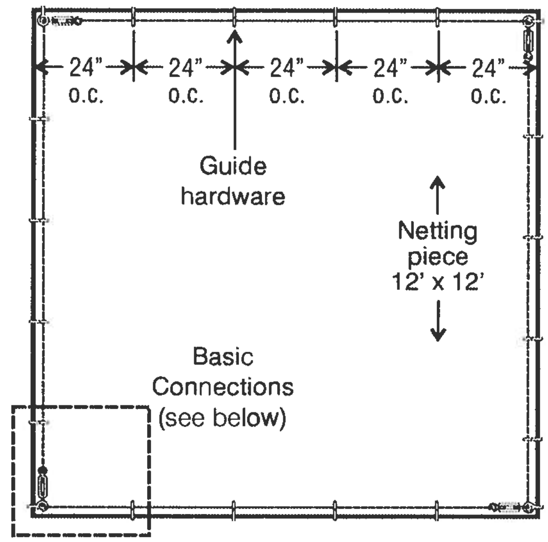
Adjust the length of the cable so the hook end of the turnbuckle will go through the corner eyebolt then torque all rope clamp nuts to 7.5ft.lbs.

5. Apply load and Re-torque all clamps!

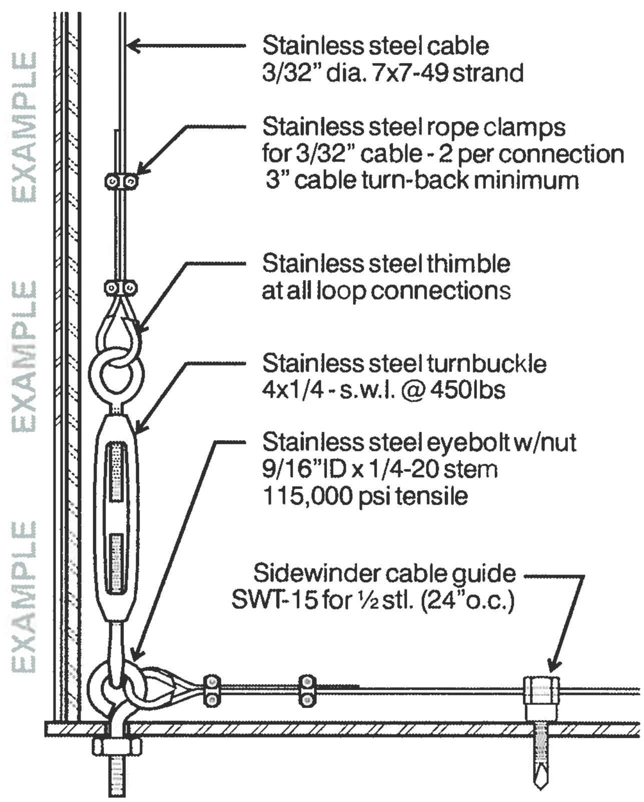
After the netting has been attached to cable with net rings, the installation is tensioned by tightening the turnbuckles. In tension, multi-strand cables will stretch in length and shrink in diameter (small amounts). This can lead to loose rope clamps. Be sure to re-torque all rope clamp nuts to 7.5ft.lbs.

Questions? Call ABC/Nixalite! 800.624.1189

Example Area (10' x 10')



Basic Cable Connections



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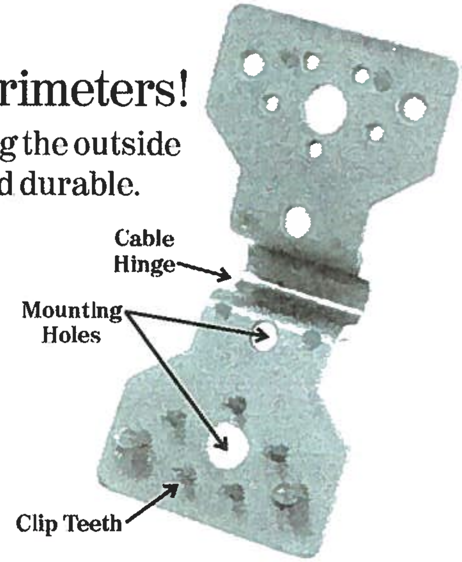
Use **PolyClips** to secure bird netting perimeters!

PolyClips provide a low cost, easy-to-install method for fastening the outside edges of any bird netting installation. **PolyClips** are versatile and durable.



PolyClip Specifications:

Material:
Black, UV resistant polypropylene.

Overall Size:
Open: 1-3/4" wide, 3-1/2" long.
Closed: 1-3/4" wide, 2" long.

Mounting Hole Sizes
Large: 5/16" diameter.
Small: 3/16" diameter.

Cable Hinge: 1/4" diameter when PolyClip is closed. Maximum cable diameter: 7/32".

Clip 'Teeth': Clip Teeth are what grip the net fabric. Each PolyClip has 5 small guide teeth to align the clip when closing, 2 large clamping teeth to hold the clip together after closing.

Availability: Sold individually or in 250 count boxes.

PolyClip Installation Guidelines:

Use PolyClips to:
Secure the perimeter (outside edges) of a netting installation.

1. PolyClip Perimeter Spacing:
Flat surfaces: 12" center-to-center maximum.
Curved Surfaces: 6" center-to-center maximum.

NOTE: Mounting Hardware for PolyClips:
Many types of hardware can be used as long as it fits through the mounting holes in the PolyClip (see PolyClip Specs). ABC/Nixalite offers mounting hardware for all types of surfaces (sold separately).

2. Installing PolyClips on the surface first:
PolyClips have two halves, one side with 'teeth', one without. ALWAYS fasten side with 'teeth' to the mounting surface. This will allow proper closing and 'locking' of the clip. Roll the edge of the netting 2 or 3 times and insert it into the PolyClip. Snap the PolyClip shut over the netting.

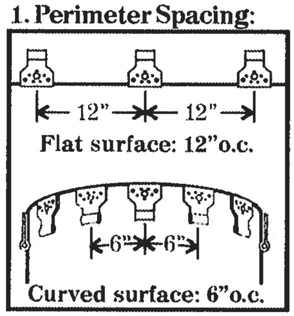
3. Roll netting edges:
The edges of the netting are ALWAYS rolled at least 2 times to allow the Poly Clip teeth to grip as much of the netting as possible. This applies for all bird netting installed with the PolyClips.

4. Installing PolyClips on netting first:
PolyClips can be closed over a rolled edge of netting, and then fastened to a mounting surface. Install the PolyClip so the side with teeth will be against the installation surface. Install mounting hardware through the mounting holes of the closed PolyClip. Not recommended for curved or complex surfaces.

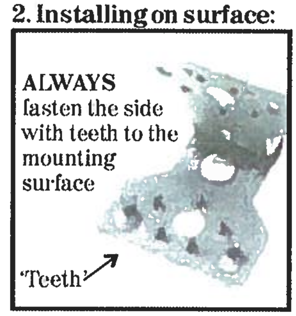
5. Installing PolyClips along a perimeter cable:
Some netting installations use a tensioned cable support system. PolyClips have a cable hinge just for this type of installation. With the PolyClip open, position the cable inside the cable hinge (max. cable diameter of 7/32"). Close PolyClip over the cable and the rolled edge of the bird netting. Follow the recommended PolyClip center-to-center spacing.

Have Questions or Need Help?:
Call ABC/Nixalite for assistance.

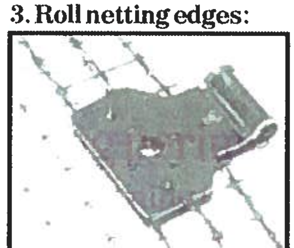
1. Perimeter Spacing:



2. Installing on surface:



3. Roll netting edges:

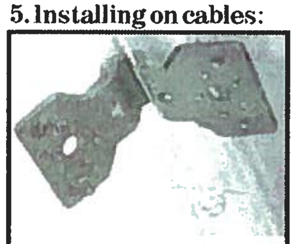


Roll netting 2 or 3 times, insert, close PolyClip

4. Installing on netting:

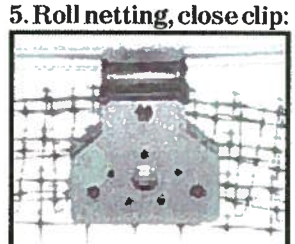
Roll netting, close PolyClip over netting, fasten.

5. Installing on cables:



Position cable at back of the Cable Hinge.

5. Roll netting, close clip:



Roll netting, close PolyClip over netting and cable.

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WIRE ROPE

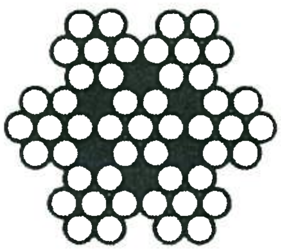
West Coast Wire Rope

STAINLESS STEEL CABLE

(TYPE 304 7X7, 7X19)

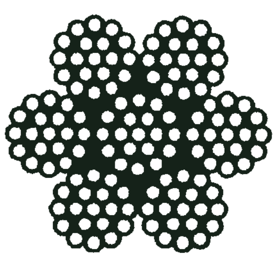
According to Federal Specification RR-W-410D, preformed, right regular lay, strand core.
Small diameter 7x7 and 7x19 construction wire rope is sometimes referred to as "aircraft cable".
IT IS NOT INTENDED FOR AIRCRAFT USE but designed for industrial and marine applications.

Read important warnings and information on pages 6 - 7 and 12 preceding wire rope section.



7 X 7

Diameter In Inches	7 X 7 STAINLESS STEEL CABLE	
	Approx. weight per 1000 Ft. in pounds	Breaking strength in Pounds*
1/16	7.5	480
3/32	16	920
1/8	28	1,700
5/32	43	2,400
3/16	62	3,700
1/4	106	6,100



7 X 19

Diameter In Inches	7 X 19 STAINLESS STEEL CABLE	
	Approx. weight per 1000 Ft. in pounds	Breaking strength in Pounds*
3/32	17.4	920
1/8	29	1,760
5/32	45	2,400
3/16	65	3,700
7/32	86	5,000
1/4	110	6,400
5/16	173	9,000
3/8	243	12,000
7/16	356	16,300

*Listed for comparison only. Actual operating loads may vary, but should never exceed the recommended design factor or 20% of catalog Breaking Strength.

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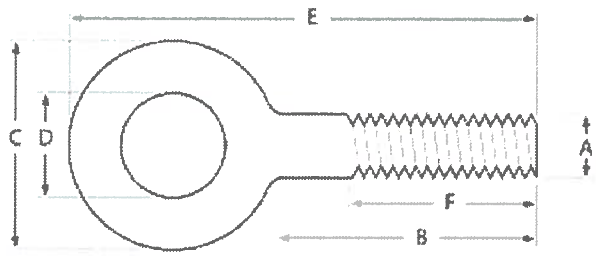
Dimensions of Forged Eye Bolts



Length (B)	**Outside Eye Diameter** (C)	**Inside Eye Diameter** (D)	**Overall Length** (E)	**Thread Length** (F)
1/4-20 (A)				
2	1	1/2	3-7/32	1-1/2
3	1	1/2	4-7/32	1-1/2
4	1	1/2	5-7/32	2
5	1	1/2	6-7/32	2-1/2
6	1	1/2	7-7/32	3
5/16-18 (A)				
2-1/4	1-1/4	5/8	3-23/32	1-1/2
3-1/4	1-1/4	5/8	4-23/32	1-1/2
4-1/4	1-1/4	5/8	5-23/32	2-1/2
5	1-1/4	5/8	6-15/32	2-1/2
6	1-1/4	5/8	7-15/32	3
3/8-16 (A)				
2-1/2	1-1/2	3/4	4-1/4	1-1/2
3	1-1/2	3/4	4-3/4	1-1/2
4	1-1/2	3/4	5-3/4	2
4-1/4	1-1/2	3/4	6	2
4-1/2	1-1/2	3/4	6-1/4	3
5	1-1/2	3/4	6-3/4	3
6	1-1/2	3/4	7-3/4	3
8	1-1/2	3/4	9-3/4	4
10	1-1/2	3/4	11-3/4	4

1/2-13 (A)				
2	2	1	4-3/16	1-5/8
3-1/4	2	1	5-7/16	2
4	2	1	6-3/16	3
4-1/2	2	1	6-11/16	3
6	2	1	8-3/16	3
8	2	1	10-3/16	4
10	2	1	12-3/16	4
12	2	1	14-3/16	4
5/8-11 (A)				
4	2-1/2	1-3/8	6-5/8	3
4-1/2	2-1/2	1-3/8	7-1/8	3
6	2-1/2	1-3/8	8-5/8	3
8	2-1/2	1-3/8	10-5/8	4
10	2-1/2	1-3/8	12-5/8	4
12	2-1/2	1-3/8	14-5/8	4
15	2-1/2	1-3/8	17-5/8	6
18	2-1/2	1-3/8	20-5/8	6
24	2-1/2	1-3/8	26-5/8	6
3/4-10 (A)				
4	2-13/16	1-1/2	6-7/8	3
4-1/2	2-13/16	1-1/2	7-3/8	3
6	2-13/16	1-1/2	8-7/8	3
8	2-13/16	1-1/2	10-7/8	4
10	2-13/16	1-1/2	12-7/8	4
12	2-13/16	1-1/2	14-7/8	4
15	2-13/16	1-1/2	17-7/8	6
18	2-13/16	1-1/2	20-7/8	6
24	2-13/16	1-1/2	26-7/8	6
7/8-9 (A)				
5	3-1/2	1-3/4	8-1/4	3
6	3-1/2	1-3/4	9-1/4	3
8	3-1/2	1-3/4	11-1/4	4
10	3-1/2	1-3/4	13-1/4	4
12	3-1/2	1-3/4	15-1/4	4
18	3-1/2	1-3/4	21-1/4	6

24	3-1/2	1-3/4	27-1/4	6
1-8 (A)				
6	4	2	9-5/8	3
8	4	2	11-5/8	4
10	4	2	13-5/8	4
12	4	2	15-5/8	4
15	4	2	18-5/8	6
18	4	2	21-5/8	6
24	4	2	27-5/8	6
1-1/4-7 (A)				
6	4-7/16	2-3/16	10-1/2	3
8	4-7/16	2-3/16	12-1/2	4
12	4-7/16	2-3/16	16-1/2	4
18	4-7/16	2-3/16	22-1/2	6
24	4-7/16	2-3/16	28-1/2	6
1-1/2-6 (A)				
6	5-3/16	2-1/2	11-1/4	3
12	5-3/16	2-1/2	17-1/4	4
18	5-3/16	2-1/2	23-1/4	6
24	5-3/16	2-1/2	29-1/4	6
2-4-1/2 (A)				
12	6-7/8	3-1/4	19	4

Making Cable Loop Connections:

The following steps guide you through the process of creating simple loop connections. Use these steps to fasten the net cable to Corner Hardware and Turnbuckle Eyelets.

Connections with Wire Rope Clamps:

1. Push 1 thimble onto the eyelet of the eyebolt, screw eye or turnbuckle.
2. Slide 2 wire rope clamps over the end of the cable.

3. Pass the cable through the eyelet (on the thimble) and then back through both clamps. Have at least 3" of lapped cable (the 'tag' end).
4. Position back clamp 2" from the eyelet and tighten 'finger tight'. Position front clamp tight against the eyelet and tighten 'finger-tight'.

5. Take up cable slack by pushing the front clamp towards the eyelet while pulling on the tag end of the cable. Tighten all clamps.

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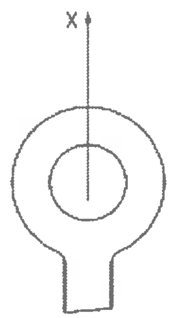
Forged Eye Bolt Working Load Limits

Important:

Working load limits for eye bolts are based on a straight vertical lift in a gradually increasing manner.

Standard forged eye bolts should **not** be used with angular lifts. If an angular lift is required, a properly seated shoulder pattern **machinery** eye bolt **must** be used.

Load limits are based on a safety factor of 5 to 1.



Diameter	Straight Pull (lbs)
1/4 - 20	500
5/16 - 18	800
3/8 - 16	1,200
1/2 - 13	2,200
5/8 - 11	3,500
3/4 - 10	5,200
7/8 - 9	7,200
1 - 8	10,000
1-1/4 - 7	13,500
1-1/2 - 6	20,000
2 - 4-1/2	35,000

✓ FS=5

APPENDIX C-2

ICE LOADING EVALUATION

OBJECTIVE:

Calculate the force developed at the bird netting fastener (polyclip) due to ice forming in the bird netting, and calculate the capacity of the strain wire that supports the bird netting, considering ice forming on the cable.

GIVEN:

- Evaporation pond netting design configuration.

GEOMETRY:

- Conceptual view of the birdnetting frame (see Figure 1).

MATERIAL PROPERTIES:

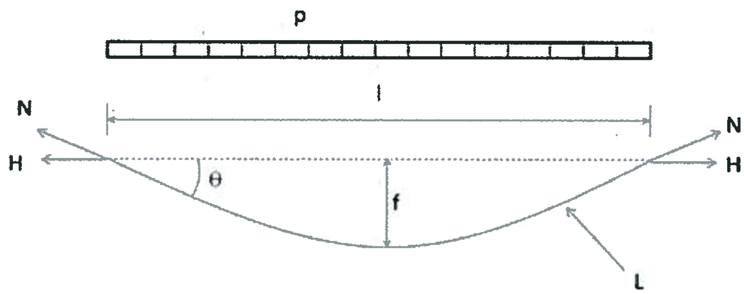
- Polyclip
  - Tension resistance 20 lb (per personal correspondence with George Winthturst of Nixalite)
- Stainless steel cable Type 304 Dia. 7/32" 7x19
  - Breaking strength 5,000 lb
  - Weight per 1000 ft = 86 lb

ASSUMPTIONS:

- The maximum bird netting dip is assumed to be 0.5 feet at the center of the 50-foot span.
- A 0.5-inch ice coating is assumed to be formed on the bird netting and the stainless steel cable per San Miguel power line design specifications.

METHOD:

Cable analysis (Au and Christiano 1987; Ortiz-Berrocal 1991)



p = distributed load

H = horizontal component of reaction

N= normal reaction

f = dip

l = span

L= cable length

$$H = \frac{p\,l^2}{8f}$$

$$N = H\sqrt{1 + \frac{p^2}{H^2}\left(\frac{l}{2}\right)^2}$$

$$L = l + \frac{p^2 l^3}{24H^2}$$

CALCULATIONS:

The calculations are presented in Attachments 1 and 2.

RESULTS:

Calculations (Attachments 1 and 2) indicate that the resultant tension in the fastener due to an ice coating is 196.5 pounds while the resistance of the polyclip is 20 pounds. As a consequence the fastener will fail under the considered load condition.

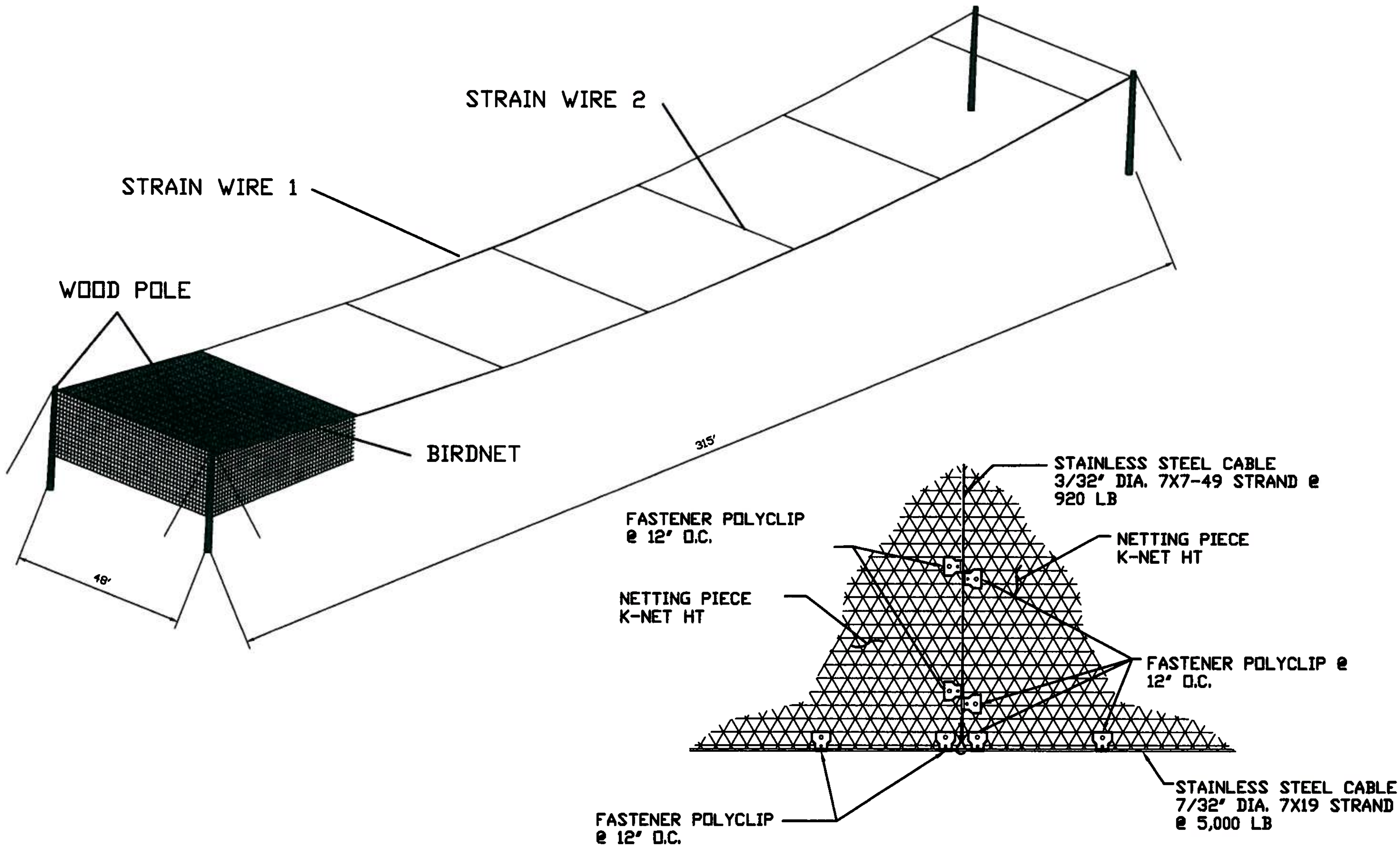
Considering the load combinations under the load and resistance factor design (LFRD) methodology, the factored load taking into account 0.5-inches of ice over the cable (2.05 pounds per foot) is less than the factored load considering only the bird netting and the cable weight (2.24 pounds per foot). Because the factored load excluding netting (i.e. assumes clip failing) is less than the cable design factored load (i.e., netting plus cable weight), the calculations indicate that the cable is adequately design to resist the ice load condition.

REFERENCES:

Au, T., and Christiano, P. (1987). *Structural analysis*, Prentice-Hall, Englewood Cliffs, NJ.

Ortiz-Berrocal, L. (1991). *Resistencia de Materiales*, McGraw-Hill, Madrid.

FIGURES



Golder Associates Denver, Colorado

TITLE

CONCEPTUAL VIEW
PARTIAL SECTION BIRDNETTING FRAME

CLIENT/PROJECT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT - EVAPORATION POND
MONTROSE COUNTY, COLORADO

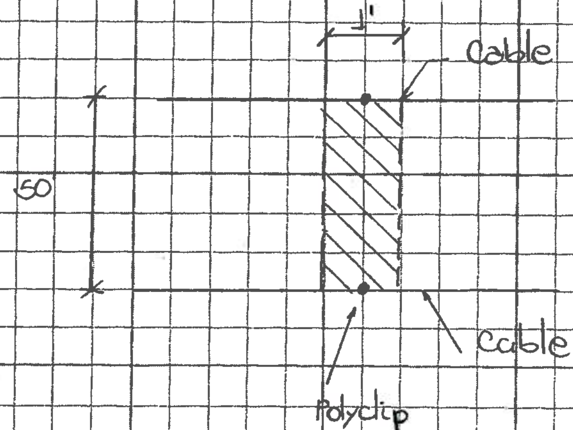
DRAWN EF	DATE APRIL15, 2008	JOB NO. 073-81694
CHECKED GG	SCALE N.T.S.	DWG. NO.
REVIEWED KFM	FILE NO.	FIGURE NO. 1

ATTACHMENT 1

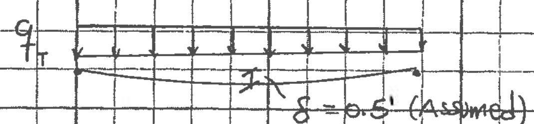
Golder Associates

SUBJECT Bird net		
Job No. 073-81694. Ref.	Made by EF Checked KG Reviewed KJM	Date Sheet 1 of 1

Objective: Calculate the force at the fastener (polyclip) when ice is considered in the birdnet



tributary width = 1'



net $\omega_n = 0.028 \frac{lb}{ft}$

Ice $\gamma = 57.22 \frac{lb}{ft^3}$

Ice thickness = 0.5"

$q_{net} = 1 \cdot 0.028 = 0.028 \frac{lb}{ft}$

$q_{ice} = 1 \cdot \frac{0.5}{12} \cdot 57.22 \left(\frac{100-88}{100}\right) = 0.2861 \frac{lb}{ft}$

$q_T = 0.028 + 0.2861 = 0.3141$

$P = q_T$ $\quad H = \frac{P\ell^2}{8f} = \frac{0.3141 \cdot 50^2}{8 \cdot 0.5'} = 196.31\,lb$

$N_{max} = H\sqrt{1 + \frac{P^2}{H^2}\left(\frac{\ell}{2}\right)^2}$

$N_{max} = 196.3\sqrt{1 + \frac{0.3141^2}{196.31^2}\left(\frac{50}{2}\right)^2}$

resistance

$N_{max} = 196.46$ lb / per polyclip > 20 lb ok

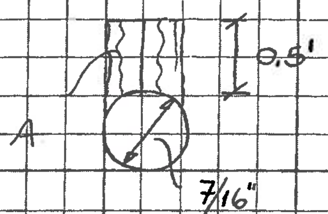
polyclip will fail.

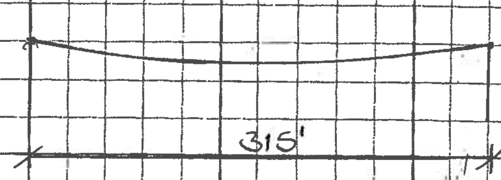
ATTACHMENT 2

Golder Associates

SUBJECT Birdnet		
Job No. 073-81694 Ref.	Made by EF Checked OCF Reviewed KFM	Date Sheet 1 of 1

Objective: Calculate the tension in the cable due to Ice forming in the primary cable.





net $w_n = 0.028 \frac{lb}{ft^2}$

tributary width = 50'

$$q_{net} = 50 \cdot 0.028 = 1.4 \frac{lb}{ft}$$

Cable weight $w_c = 0.2 \frac{lb}{ft}$

Ice $\gamma = 57.2 \frac{lb}{ft^3}$

Area Ice $A = \frac{0.5}{12} \cdot \frac{7}{16} \cdot \frac{1}{12} = 1.52 \times 10^{-3}\ ft^2$

$q_{Ice} = 1.52 \times 10^{-3}\ ft^2 \cdot 57.2 \frac{lb}{ft^3} = 0.0869 \frac{lb}{ft}$

$q_T = 1.2(q_{net} + W_c) + 1.6(q_{ice})$ LRFD factors

$q_T = 1.2(1.4 + 0.2) + 1.6(0.0869) = 2.05 \frac{lb}{ft} < 1.4(q_{net} + W_c)$

The distributed load (q_T) considering Ice is less than the factored load only considering the dead load. So the tension developed in the cable due to Ice will be less that the designed load

APPENDIX D

CHEMICAL RESISTANCE INFORMATION

APPENDIX D

CHEMICAL RESISTANCE INFORMATION

Appendix D-1 presents a Chemical Resistance Chart listing the resistance of high density polyethylene (HDPE) to various chemicals at various concentrations and temperatures (GSE, 2006). An 'S' in the resistance column stands for satisfactory, specifically "*Liner material is resistant to the given reagent at the given concentration and temperature. No mechanical or chemical degradation is observed*." Other qualitative descriptions include 'L' – limited application possible, and 'U' – unsatisfactory.

When the anticipated chemical concentrations of the raffinate stream (CH2M Hill, 2008) are compared with some relevant reagents presented in the Chemical Resistance Chart, the following results are found:

- Sulfuric Acid (H_2SO_4)
  - Concentration in tailings stream – 0.01 g/l, or 0.01 percent (CH2M Hill, 2008).
  - Highest satisfactory concentration at 140 degrees Fahrenheit (^oF) – 50 percent (GSE, 2006).
  - *Therefore, HDPE exhibits satisfactory resistance to the expected sulfuric acid concentration.*
- Ferric Sulfate ($Fe_2(SO_4)_3$)
  - Concentration in tailings stream – 35.998 g/l, or 3.6 percent (CH2M Hill, 2008).
  - Highest satisfactory concentration at 140 ^oF – fully saturated solution (GSE, 2006).
  - *Therefore, HDPE exhibits satisfactory resistance to the expected ferric sulfate concentration.*
- Ammonium Sulfate ($(NH_4)_2SO_4$)
  - Concentration in tailings stream – 34.9 g/l, or 3.5 percent (CH2M Hill, 2008).
  - Highest satisfactory concentration at 140 ^oF – fully saturated solution (GSE, 2006).
  - *Therefore, HDPE exhibits satisfactory resistance to the expected ammonium sulfate concentration.*

- Sodium Sulfate (Na_2SO_4)
    - Concentration in tailings stream – 3.916 g/l, or 0.39 percent (CH2M Hill, 2008).
    - Highest satisfactory concentration at 140 ^{o}F – fully saturated solution (GSE, 2006).
    - *Therefore, HDPE exhibits satisfactory resistance to the expected sodium sulfate concentration.*
- Sodium Chloride (NaCl)
    - Concentration in tailings stream – 5.8 g/l, or 0.58 percent (CH2M Hill, 2008).
    - Highest satisfactory concentration at 140 ^{o}F – fully saturated solution (GSE, 2006).
    - *Therefore, HDPE exhibits satisfactory resistance to the expected sodium chloride concentration.*

The chemical concentration within the raffinate stream which is directed to the evaporation ponds differs somewhat from the tailings stream solution. The most notable differences include the solids content (zero percent by weight to the evaporation ponds versus 27.3 percent to the tailings pond) and temperature (88 ^{o}F of the tailings stream versus 102 ^{o}F of the raffinate).

Note that only the most toxic and most highly concentrated reagents are presented here. Ratings are based on single reagent concentrations and do not account for the presence of multiple reagents in the same solution.

REFERENCES

Gundle/SLT Environmental, Inc. (GSE). 2006. Chemical Resistance Chart. Technical Note TN032. http://www.gseworld.com/Literature/TechnicalNtes/PDF/TN032ResistChart.pdf.

CH2M Hill. 2008. Piñon Ridge Project – Tailings Stream Analysis (Rev. 2). 12 March 2008.

APPENDIX D-1

CHEMICAL RESISTANCE CHART

Technical Note

Chemical Resistance Chart

GSE is the world's leading supplier of high quality, polyethylene geomembranes. GSE polyethylene geomembranes are resistant to a great number and combinations of chemicals. Note that the effect of chemicals on any material is influenced by a number of variable factors such as temperature, concentration, exposed area and duration. Many tests have been performed that use geomembranes and certain specific chemical mixtures. Naturally, however, every mixture of chemicals cannot be tested for, and various criteria may be used to judge performance. Reported performance ratings may not apply to all applications of a given material in the same chemical. Therefore, these ratings are offered as a guide only. This information is provided for reference purposes only and is not intended as a warranty or guarantee. GSE assumes no liability in connection with the use of this information.

Medium	Concentration	Resistance at: 20 °C (68 °F)	60 °C (140 °F)
A			
Acetic acid	100%	S	L
Acetic acid	10%	S	S
Acetic acid anhydride	100%	S	L
Acetone	100%	L	L
Adipic acid	sat. sol.	S	S
Allyl alcohol	96%	S	S
Aluminum chloride	sat. sol.	S	S
Aluminum fluoride	sat. sol.	S	S
Aluminum sulfate	sat. sol.	S	S
Alum	sol.	S	S
Ammonia, aqueous	dil. sol.	S	S
Ammonia, gaseous dry	100%	S	S
Ammonia, liquid	100%	S	S
Ammonium chloride	sat. sol.	S	S
Ammonium fluoride	sol.	S	S
Ammonium nitrate	sat. sol.	S	S
Ammonium sulfate	sat. sol.	S	S
Ammonium sulfide	sol.	S	S
Amyl acetate	100%	S	L
Amyl alcohol	100%	S	L
Aniline	100%	S	L
Antimony trichloride	90%	S	S
Arsenic acid	sat. sol.	S	S
Aqua regia	HCI-HNO3	U	U
B			
Barium carbonate	sat. sol.	S	S
Barium chloride	sat. sol.	S	S
Barium hydroxide	sat. sol.	S	S
Barium sulfate	sat. sol.	S	S
Barium sulfide	sol.	S	S
Benzaldehyde	100%	S	L
Benzene	—	L	L
Benzoic acid	sat. sol.	S	S
Beer	—	S	S
Borax (sodium tetraborate)	sat. sol.	S	S
Boric acid	sat. sol.	S	S
Bromine, gaseous dry	100%	U	U
Bromine, liquid	100%	U	U
Butane, gaseous	100%	S	S
1-Butanol	100%	S	S
Butyric acid	100%	S	L
C			
Calcium carbonate	sat. sol.	S	S
Calcium chlorate	sat. sol.	S	S
Calcium chloride	sat. sol.	S	S
Calcium nitrate	sat. sol.	S	S
Calcium sulfate	sat. sol.	S	S
Calcium sulfide	dil. sol.	L	L
Carbon dioxide, gaseous dry	100%	S	S
Carbon disulfide	100%	L	U
Carbon monoxide	100%	S	S
Chloracetic acid	sol.	S	S
Carbon tetrachloride	100%	L	U
Chlorine, aqueous solution	sat. sol.	L	U
Chlorine, gaseous dry	100%	L	U
Chloroform	100%	U	U
Chromic acid	20%	S	L
Chromic acid	50%	S	L
Citric acid	sat. sol.	S	S

Medium	Concentration	Resistance at: 20 °C (68 °F)	60 °C (140 °F)
Copper chloride	sat. sol.	S	S
Copper nitrate	sat. sol.	S	S
Copper sulfate	sat. sol.	S	S
Cresylic acid	sat. sol.	L	—
Cyclohexanol	100%	S	S
Cyclohexanone	100%	S	L
D			
Decahydronaphthalene	100%	S	L
Dextrine	sol.	S	S
Diethyl ether	100%	L	—
Dioctylphthalate	100%	S	L
Dioxane	100%	S	S
E			
Ethanediol	100%	S	S
Ethanol	40%	S	L
Ethyl acetate	100%	S	U
Ethylene trichloride	100%	U	U
F			
Ferric chloride	sat. sol.	S	S
Ferric nitrate	sol.	S	S
Ferric sulfate	sat. sol.	S	S
Ferrous chloride	sat. sol.	S	S
Ferrous sulfate	sat. sol.	S	S
Fluorine, gaseous	100%	U	U
Fluorosilicic acid	40%	S	S
Formaldehyde	40%	S	S
Formic acid	50%	S	S
Formic acid	98-100%	S	S
Furfuryl alcohol	100%	S	L
G			
Gasoline	—	S	L
Glacial acetic acid	96%	S	L
Glucose	sat. sol.	S	S
Glycerine	100%	S	S
Glycol	sol.	S	S
H			
Heptane	100%	S	U
Hydrobromic acid	50%	S	S
Hydrobromic acid	100%	S	S
Hydrochloric acid	10%	S	S
Hydrochloric acid	35%	S	S
Hydrocyanic acid	10%	S	S
Hydrofluoric acid	4%	S	S
Hydrofluoric acid	60%	S	L
Hydrogen	100%	S	S
Hydrogen peroxide	30%	S	L
Hydrogen peroxide	90%	S	U
Hydrogen sulfide, gaseous	100%	S	S
L			
Lactic acid	100%	S	S
Lead acetate	sat. sol.	S	—
M			
Magnesium carbonate	sat. sol.	S	S
Magnesium chloride	sat. sol.	S	S
Magnesium hydroxide	sat. sol.	S	S
Magnesium nitrate	sat. sol.	S	S
Maleic acid	sat. sol.	S	S
Mercuric chloride	sat. sol.	S	S

- Continued -

Medium	Concentration	Resistance at: 20 °C (68 °F)	60 °C (140 °F)
Mercuric cyanide	sat. sol.	S	S
Mercuric nitrate	sol.	S	S
Mercury	100%	S	S
Methanol	100%	S	S
Methylene chloride	100%	L	—
Milk	—	S	S
Molasses	—	S	S
N			
Nickel chloride	sat. sol.	S	S
Nickel nitrate	sat. sol.	S	S
Nickel sulfate	sat. sol.	S	S
Nicotinic acid	dil. sol.	S	—
Nitric acid	25%	S	S
Nitric acid	50%	S	U
Nitric acid	75%	U	U
Nitric acid	100%	U	U
O			
Oils and Grease	—	S	L
Oleic acid	100%	S	L
Orthophosphoric acid	50%	S	S
Orthophosphoric acid	95%	S	L
Oxalic acid	sat. sol.	S	S
Oxygen	100%	S	L
Ozone	100%	L	U
P			
Petroleum (kerosene)	—	S	L
Phenol	sol.	S	S
Phosphorus trichloride	100%	S	L
Photographic developer	cust. conc.	S	S
Picric acid	sat. sol.	S	—
Potassium bicarbonate	sat. sol.	S	S
Potassium bisulfide	sol.	S	S
Potassium bromate	sat. sol.	S	S
Potassium bromide	sat. sol.	S	S
Potassium carbonate	sat. sol.	S	S
Potassium chlorate	sat. sol.	S	S
Potassium chloride	sat. sol.	S	S
Potassium chromate	sat. sol.	S	S
Potassium cyanide	sol.	S	S
Potassium dichromate	sat. sol.	S	S
Potassium ferricyanide	sat. sol.	S	S
Potassium ferrocyanide	sat. sol.	S	S
Potassium fluoride	sat. sol.	S	S
Potassium hydroxide	10%	S	S
Potassium hydroxide	sol.	S	S
Potassium hypochlorite	sol.	S	L
Potassium nitrate	sat. sol.	S	S
Potassium orthophosphate	sat. sol.	S	S
Potassium perchlorate	sat. sol.	S	S
Potassium permanganate	20%	S	S
Potassium persulfate	sat. sol.	S	S
Potassium sulfate	sat. sol.	S	S
Potassium sulfite	sol.	S	S
Propionic acid	50%	S	S
Propionic acid	100%	S	L
Pyridine	100%	S	L
Q			
Quinol (Hydroquinone)	sat. sol.	S	S
S			
Salicylic acid	sat. sol.	S	S

Medium	Concentration	Resistance at: 20 °C (68 °F)	60 °C (140 °F)
Silver acetate	sat. sol.	S	S
Silver cyanide	sat. sol.	S	S
Silver nitrate	sat. sol.	S	S
Sodium benzoate	sat. sol.	S	S
Sodium bicarbonate	sat. sol.	S	S
Sodium biphosphate	sat. sol.	S	S
Sodium bisulfite	sol.	S	S
Sodium bromide	sat. sol.	S	S
Sodium carbonate	sat. sol.	S	S
Sodium chlorate	sat. sol.	S	S
Sodium chloride	sat. sol.	S	S
Sodium cyanide	sat. sol.	S	S
Sodium ferricyanide	sat. sol.	S	S
Sodium ferrocyanide	sat. sol.	S	S
Sodium fluoride	sat. sol.	S	S
Sodium hydroxide	40%	S	S
Sodium hydroxide	sat. sol.	S	S
Sodium hypochlorite	15% active chlorine	S	S
Sodium nitrate	sat. sol.	S	S
Sodium nitrite	sat. sol.	S	S
Sodium orthophosphate	sat. sol.	S	S
Sodium sulfate	sat. sol.	S	S
Sodium sulfide	sat. sol.	S	S
Sulfur dioxide, dry	100%	S	S
Sulfur trioxide	100%	U	U
Sulfuric acid	10%	S	S
Sulfuric acid	50%	S	S
Sulfuric acid	98%	S	U
Sulfuric acid	fuming	U	U
Sulfurous acid	30%	S	S
T			
Tannic acid	sol.	S	S
Tartaric acid	sol.	S	S
Thionyl chloride	100%	L	U
Toluene	100%	L	U
Triethylamine	sol.	S	L
U			
Urea	sol.	S	S
Urine	—	S	S
W			
Water	—	S	S
Wine vinegar	—	S	S
Wines and liquors	—	S	S
X			
Xylenes	100%	L	U
Y			
Yeast	sol.	S	S
Z			
Zinc carbonate	sat. sol.	S	S
Zinc chloride	sat. sol.	S	S
Zinc (II) chloride	sat. sol.	S	S
Zinc (IV) chloride	sat. sol.	S	S
Zinc oxide	sat. sol.	S	S
Zinc sulfate	sat. sol.	S	S

Specific immersion testing should be undertaken to ascertain the suitability of chemicals not listed above with reference to special requirements.

NOTES:

(S) Satisfactory: *Liner material is resistant to the given reagent at the given concentration and temperature. No mechanical or chemical degradation is observed.*

(L) Limited Application Possible: *Liner material may reflect some attack. Factors such as concentration, pressure and temperature directly affect liner performance against the given media. Application, however, is possible under less severe conditions, e.g. lower concentration, secondary containment, additional liner protections, etc.*

(U) Unsatisfactory: ***Liner material is not resistant to the given reagent at the given concentration and temperature. Mechanical and/or chemical degradation is observed.***

(–) Not tested

sat. sol. = *Saturated aqueous solution, prepared at 20°C (68°F)*

sol. = *aqueous solution with concentration above 10% but below saturation level*

dil. sol. = *diluted aqueous solution with concentration below 10%*

cust. conc. = *customary service concentration*

TN032 ResistChart R03/17/06

North America	GSE Lining Technology, Inc.	Houston, Texas	800 435 2008	281 443 8564	Fax: 281 230 8650
South America	GSE Lining Technology Chile S.A.	Santiago, Chile		56 2 595 4200	Fax: 56 2 595 4290
Asia Pacific	GSE Lining Technology Company Limited	Bangkok, Thailand		66 2 937 0091	Fax: 66 2 937 0097
Europe & Africa	GSE Lining Technology GmbH	Hamburg, Germany		49 40 767420	Fax: 49 40 7674234
Middle East	GSE Lining Technology-Egypt	The 6th of October City, Egypt		202 2 828 8888	Fax: 202 2 828 8889

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APPENDIX E

LEAK COLLECTION AND RECOVERY SYSTEM DESIGN

APPENDIX E

LEAK COLLECTION AND RECOVERY SYSTEM DESIGN

An important feature of the evaporation pond liner system is the Leak Collection and Recovery System (LCRS). The purpose of the LCRS is to provide a method to collect potential seepage should leakage develop within the pond through the primary geomembrane liner.

The LCRS layer has been designed as a high density polyethylene (HDPE) geonet. Per the requirements of 40 CFR 264.221, the transmissivity of the selected drainage layer exceeds the minimum transmissivity requirement of $3x10^{-4}$ square meters per second (m^2/sec), and is designed with a minimum grade of one percent. Based on the geonet design presented in Appendix E-1 using the equations proposed by Giroud et al. (1997), the evaporation pond geonet is required to have a minimum transmissivity of $2x10^{-3}$ m^2/sec and a minimum thickness of 200 mil.

Leakage through the upper geomembrane liner will be collected in the LCRS layer and routed (via gravity flow) to a LCRS sump located in each of the pond cells. Each LCRS sump is sized to contain a minimum of 48 hours of anticipated leakage in the LCRS layer (i.e., geonet) assuming one liner defect per acre for good installation (Giroud & Bonaparte, 1989), an effective porosity of 30 percent in the sump drainage gravels, and applying a factor of safety of 1.5. The LCRS sump sizing calculations is provided in Appendix E-1. Based on these calculations, a sump with base dimensions of 10 feet by 30 feet with 3H:1V (horizontal:vertical) side slopes and 5-foot depth (i.e., sump beneath all ‘flat’ portions of the pond cell) provides sufficient containment for approximately 14 days of leakage solutions.

REFERENCES

40 CFR Part 264 – “*Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*”, Subpart K (Surface Impoundments).

Giroud, J.P., and Bonaparte, R. 1989. “Leakage through liners constructed with geomembranes – Part I. Geomembrane Liners.” *Geotextiles and Geomembranes*, No. 8, 27-67.

Giroud, J.P., Gross, B.A., Bonaparte, R., and McKelvey, J.A. 1997. “Leachate flow in leakage collection layers due to defects in geomembrane liners.” *Geosynthetics International*, 4(3-4), 215-292.

APPENDIX E-1

LEAK COLLECTION AND RECOVERY SYSTEM SUMP CAPACITY CALCULATION

OBJECTIVE:

Evaluate the capacity of the Leak Collection and Recovery System (LCRS) sumps for the evaporation pond cells based on calculated leakage though the geomembrane in the LCRS layer.

GIVEN:

- Evaporation pond cell and LCRS sump dimensions.
  - Cell Area: 4.13 acres
  - Sump base dimensions: 30 feet by 10 feet
  - Sump depth: 5 feet
  - Sump side slopes: 3H:1V

ASSUMPTIONS:

- Because the evaporation pond LCRS sumps will not be equipped with their own dedicated pump (a mobile pump will be used), the LCRS sump should be sized to accommodate a minimum of 48 hours of the maximum leakage flow in the LCRS layer;
- Apply a factor of safety (FS) of 1.5;
- Porosity of the gravel within the LCRS sumps is assumed as 0.3;
- Assume 1 liner defect per acre;
- According to the EPA, common practice is to assume a circular defect with a diameter equal to the thickness of the geomembrane. Accordingly, these calculations assume circular defects with a diameter of 60 mil (0.005 ft, or 0.06 inches);
- The flow in the leakage collection layer is laminar;
- It is assumed that flows through various defects do not interfere with each other; and
- The maximum height of liquid above the primary geomembrane is conservatively assumed to be equal to the ultimate height of the evaporation pond (e.g. 8 ft).

MATERIAL PROPERTIES:

Table 1 summarizes the material properties considered in the analysis for the drainage geonet on the evaporation pond cells.

Table 1. Geonet properties

Manufacturer	*Model*	*Transmissitivity gal/min ft (m^2/sec)*	*Thickness mil*
GSE	HyperNet	9.66 (2×10^{-3})[1]	200

[1] see Attachment 3

Golder Associates	Subject Piñon Ridge Project	Made by EF	Job No 073-81694
	Evaporation Pond Design	Checked by JL	Date 09/30/08
	LCRS Sump Capacity Calculation	Approved by KAM	Sheet No 2 of 3

CALCULATIONS:

Flow in the LCRS Layer due to a Geomembrane Defect

Flow in the LCRS layer for the evaporation pond cells (Attachment 1)

- Geonet: 2.67 x 10^{-4} ft^3/sec per defect

Required Size of the LCRS

Flow in the LCRS layer

Q = 2.67 x 10^{-4} ft^3/sec = 173 gallons per defect per day

Total flow

$$Q_T = Q(A) * \left(\frac{1\,defect}{Acre}\right)$$

Q_T = (172.6 gpd/acre) * (4.13 acres) = 713 gallons per day

t = 48 hr (time)
n = 0.3 (porosity)
FS = 1.5 (factor of safety)

$$Required\ volume = Q_T * t * FS$$

$$Required\ water\ storage\ volume = 713\ \frac{gal}{day} * \frac{1\ day}{24\ hr} * 48\ hr * \frac{1\ ft^3}{7.48\ gal} * 1.5\ = 286\ ft^3$$

Sump Capacity

The designed size of the LCRS sump based on pond cell geometry (i.e., sump beneath all 'flat' portions of the cell) is:

Sump base dimensions: 10 feet x 30 feet
Sump top dimensions: 40 feet x 60 feet
Sump depth: 5 feet
Side slopes: 3H:1V

Calculations of the sump capacity are provided in Attachment 2. A sump with these dimensions has a volume capacity of 6,750 ft^3. The corresponding available solution volume, based on 30 percent porosity, is 2,025 ft^3 (15,150 gal).

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RESULTS:

The calculated leakage volume to each LCRS sump due to geomembrane defects within the primary liner during a 48-hour period with a factor of safety of 1.5 is approximately 286 cubic feet. The fluid capacity (i.e. pore volume) of the LCRS sump is approximately 2,025 cubic feet, which greatly exceeds the anticipated amount of leakage accumulated in 48 hours.

CONCLUSIONS:

The LCRS sump with the designed dimensions (10 feet by 30 feet at the base, with 3H:1V side slopes and a 5 foot depth) provides sufficient capacity to accommodate approximately 14 days of leakage in the LCRS layer.

REFERENCES:

Giroud, J. P., Gross, B. A., Bonaparte, R., and McKelvey, J. A. (1997). "Leachate flow in leakage collection layers due to defects in geomembrane liners." Geosynthetics International, 4(3-4), 215-292.

ATTACHMENT 1
FLOW CALCULATION

FLOW THROUGH LINER DEFECT CALCULATIONS

The flow rate through a defect in the geomembrane is given by the following equation (Giroud et al. 1997):

$d := 0.005$ ft defect diameter

$h_{prim} := 8$ ft total liquid head over primary geomembrane

$g := 32.2$ ft / sec2 gravity

$$Q := \frac{2}{3} d^2 \cdot \sqrt{g \cdot h_{prim}}$$

where the maximum flow rate through the primary liner geomembrane is:

$Q = 2.675 \times 10^{-4}$ ft 3 /sec

The permeability of the geonet can be defined by:

$t_{LCL} := 0.017$ ft thickness of the geonet

$\theta := 0.0215$ ft2 / sec geonet transmissivity

$$k := \frac{\theta}{t_{LCL}}$$ geonet hydraulic conductivity

$k = 1.265$ ft / sec

The maximum steady-state rate of leachate migration through a defect in the primary liner that a leakage collection layer can accommodate without being filled with leachate (Giroud et al. 1997b):

$$Q_{full} := k \cdot t_{LCL}^{2}$$

$Q_{full} = 3.655 \times 10^{-4}$ ft 3/ sec

The liquid head build-up on the secondary geomembrane liner can be calculated by using the following equation (Giroud et al. 1997b):

$$to := \sqrt{\frac{Q}{k}}$$

$$to = 0.015 \ \text{ft}$$

Since the flow rate through a defect in the geomembrane (Q) is lower than the maximum flow rate that the leakage collection layer can accommodate (Qfull), and the estimated liquid head build-up (to) is less than the thickness of the geonet (tLCL), the calculated flow in the geomembrane is validated.

References

Giroud, J. P., Gross, B. A., Bonaparte, R., and McKelvey, J. A. (1997). "Leachate flow in leakage collection layers due to defects in geomembrane liners." *Geosynthetics International*, 4(3-4), 215-292.

ATTACHMENT 2
LCRS SUMP SIZING WORKSHEET

Attachment 2 - LCRS Sizing Worksheet

Project Name: Pinon Mill - Evaporation Ponds
Project Number: 073-81694.0004
Client: Energy Fuels Resources Corp. (EFRC)
By: KFM
Date: 5/20/2008

Pond Depth:	5	ft	1.5	m
Pond Side 1(upper):	40	ft	12.2	m
Pond Side 2 (upper):	60	ft	18.3	m
Pond Side 1(lower):	10	ft	3.0	m
Pond Side 2 (lower):	30	ft	9.1	m
Side Slope:	3	H	1	V
Liner Overlap per Side	0	ft	0.0	m
Dry Freeboard	0	ft	0.0	m
Pond Volume w/o freeboard:	6,750	ft^3	191	m^3
	50,490	gal.	191,289	liters
Liner Area:	2,514	ft^2	234	m^2
Pond Volume w/ freeboard:	6,750	ft^3	191	m^3
	50,490	gal.	191,289	liters

ATTACHMENT 3
GEONET PROPERTIES

GSE

GSE STANDARD PRODUCTS

Product Data Sheet

GSE HyperNet Geonets

GSE HyperNet geonets are synthetic drainage materials manufactured from a premium grade high density polyethylene (HDPE) resin. The structure of the HyperNet geonet is formed specifically to transmit fluids uniformly under a variety of field conditions. HDPE resins are inert to chemicals encountered in most of the civil and environmental applications where these materials are used. GSE geonets are formulated to be resistant to ultraviolet light for time periods necessary to complete installation. GSE HyperNet geonets are available in standard, HF, HS, and UF varieties.

The table below provides index physical, mechanical and hydraulic characteristics of GSE geonets. Contact GSE for information regarding performance of these products under site-specific load, gradient, and boundary conditions.

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE ROLL VALUE[c]			
			HyperNet	HyperNet HF	HyperNet HS	HyperNet UF
Product Code			XL4000N004	XL5000N004	XL7000N004	XL8000N004
Transmissivity[a], gal/min/ft (m^2/sec)	ASTM D 4716-00	1/540,000 ft^2	9.66 (2 x 10^{-3})	14.49 (3 x 10^{-3})	28.98 (6 x 10^{-3})	38.64 (8 x 10^{-3})
Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	200 (5)	250 (6.3)	275 (7)	300 (7.6)
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035	1/50,000 ft^2	45 (7.9)	55 (9.6)	65 (11.5)	75 (13.3)
Carbon Black Content, %	ASTM D 1603, modified	1/50,000 ft^2	2.0	2.0	2.0	2.0
Roll Width, ft (m)			15 (4.6)	15 (4.6)	15 (4.6)	15 (4.6)
Roll Length, ft (m)[b]			300 (91)	250 (76)	220 (67)	200 (60)
Roll Area, ft^2 (m^2)			4,500 (418)	3,750 (348)	3,300 (305)	3,000 (278)

NOTES:

- [a]Gradient of 0.1, normal load of 10,000 psf, water at 70° F (20° C), between steel plates for 15 minutes.
- [b]Please check with GSE for other available roll lengths.
- [c]These are MARV values that are based on the cumulative results of specimens tested by GSE.

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Europe/Middle East/Africa	GSE Lining Technology GmbH	Hamburg, Germany		49-40-767420	Fax: 49-40-7674233
Asia/Pacific	GSE Lining Technology Company Ltd.	Bangkok, Thailand		66-2-937-0091	Fax: 66-2-937-0097