2007-08 Treatability Studies and Interim Treatment Work Plan

Leviathan Mine
Alpine County, California

Prepared for:

Atlantic Richfield Company

6 Centerpointe Drive
LaPalma, CA 90623-1066

June 2007

Project No. 13091

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Leviathan Mine
Alpine County, California

1.0 INTRODUCTION

This 2007-2008 Treatability Studies and Interim Treatment Work Plan (Work Plan) has been prepared by Geomatrix Consultants, Inc. (Geomatrix) in cooperation with AMEC (AMEC) on behalf of Atlantic Richfield Company (Atlantic Richfield) to describe the scope of water treatment activities to be conducted at the Leviathan Mine Site (Site) in 2007 and 2008. The Leviathan Mine Site is located in a remote mountain area of northeastern Alpine County, California, on the eastern slope of the central Sierra Nevada range at an elevation of approximately 7,000 feet. The Site is located about 25 miles southeast of Lake Tahoe, six miles east of Markleeville, California as shown on Figure 1-1.

This Work Plan describes interim water treatment activities to address known sources of contamination to Leviathan and Aspen Creeks while providing important operational information that will be used in formulating a final remedy for the site and preparation of an RI/FS. A phased approach to the Remedial Investigation/Feasibility Study (RI/FS) process, incorporating treatability studies into the long-term Site remedy, allows for a streamlined process to collect, compile, and assess data, while reducing contaminant load from known sources. Interim water treatment activities planned for implementation by Atlantic Richfield in 2007 and 2008 are intended to investigate the cost, effectiveness, and implementability of lime treatment technologies intended to mitigate the affects of low pH waters emanating from the Channel Underdrain (CUD), the Delta Seep (DS), and the Aspen Seep (AS) also referred to as the Overburden Seep (OS).

Planned 2007 and 2008 interim treatability treatment activities are anticipated to improve water quality in Leviathan and Aspen Creeks by constructing and operating an interim Pond 4 Lime Treatment System in 2007 while concurrently designing and constructing a higher capacity (up to 100 gpm) High Density Sludge (HDS) Treatment System that is scheduled to begin operation in 2008. Both the interim Pond 4 Lime Treatment System and the HDS Treatment System are intended to treat acid mine drainage (AMD) waters from the CUD and the DS. However, no capture and conveyance system presently exists for the DS. As a result, Atlantic

Richfield will construct a temporary DS capture and conveyance system in 2007 while concurrently designing and constructing a semi-permanent capture and conveyance system for operation in 2008. Atlantic Richfield will also continue to operate and maintain a bioreactor treatment system for AMD discharges from the AS including making certain improvements to the bioreactor to address system performance, health & safety concerns, and sludge management. This Work Plan does not address flows from other known AMD sources at the Site, including the Adit and Pit Underdrain, which are being treated by the Lahontan Regional Water Quality Control Board (LRWQCB) pursuant to EPA directives and work plans submitted by the LRWQCB to the EPA.

Access to the Site for purposes of completing the tasks outlined in this Work Plan is provided for under an Access Agreement entered into between Atlantic Richfield's affiliate, ARCO Environmental Remediation, L.L.C., the State Water Resources Control Board, and the LRWQCB in 2001. Because the permanent or semi-permanent structures that will be constructed in accordance with this Work Plan are intended to improve conditions at the Site compared to those existing when Atlantic Richfield first accessed the Site under the Access Agreement, Atlantic Richfield does not anticipate having to remove these structures when the work outlined herein is completed.

As noted, this work is being performed with the intended purpose of evaluating the effectiveness and reliability of certain AMD collection and treatment techniques and to provide effective interim water treatment while RI/FS investigations and final remedy selection proceeds. Accordingly, design criteria, performance standards, project schedules and other factors set forth in this Work Plan are subject to change to the extent dictated by circumstances encountered during the course of the work and as additional information is learned while the proposed tasks are implemented. Also, this Work Plan has been prepared to account for upsets, mechanical failures, design flow excursions and other problems inherent to working in a high altitude, limited access environment. However, there likely will be circumstances where discharges of AMD exceeding discharge criteria cannot practicably be avoided. Atlantic Richfield and its contractors will use their best efforts to keep such circumstances to a minimum and to communicate and coordinate with EPA if such discharges occur.

1.1 HEALTH, SAFETY, SECURITY, AND ENVIRONMENTAL EXPECTATIONS

Atlantic Richfield is fully committed to Health, Safety, Security, and Environmental (HSSE) goals that are - *no accidents, no harm to people and no damage to the environment*. Atlantic

Richfield is committed to the protection of the natural environment, to the safety of the communities in which they operate, and to the health, safety and security of people. As a result, Atlantic Richfield has an expectation that everyone who works for them has a responsibility for *getting HSSE right*. In order to reach and promote these expectations, Geomatrix has in place a six pronged health and safety program for the Leviathan Site. The elements of the program include: a comprehensive Site Specific Health and Safety Plan (SSHSP), a site specific safety training program, pre-assignment drug screening and medical evaluation, health and safety procedure documents, a management of change program and site auditing. Each person who works on this site as a Geomatrix employee, subcontractor, or visitor is expected to read the Site Specific Health and Safety Plan, comply with Remediation Management's Functional Standards, Standard Practices, and HSSE Expectations and participate in a process of continuous health and safety improvement.

1.2 WORK PLAN ORGANIZATION

This Work Plan serves as a management tool for the implementation of 2007 and 2008 interim treatment activities and contains a description of the scope of planned treatment activities for 2007 and 2008 intended to address the capture and treatment of CUD, DS and AS flows. However, it should be noted that this work plan provides a general description of the planned activities, the implementation of which will be necessarily addressed and modified as required during subsequent design and construction activities.

Specifically, the remainder of this Work Plan is organized into six sections as summarized below:

Section 2 – *Summary of Previous Treatability Studies*: Section 2 summarizes previous activities conducted by Atlantic Richfield and LRWQCB to treat AMD flows from the AS, CUD, DS, PUD and Adit.

Section 3 – *Planned 2007 Treatment Activities*: This section describes in some detail the activities planned for 2007 to continue and optimize treatment of waters from the three sources listed above.

Section 4 – *Treatment Monitoring and Evaluation:* This section describes the monitoring of treatment system performance and the evaluation of water quality relative to treatment goals.

Section 5 - *Planned 2008 Treatment Activities*: Section 5 provides preliminary details of treatment and monitoring activities planned for 2008.

Section 6 – *Project Team Roles*: This section provides a summary of the roles and contact information for various project team members that have responsibility for the oversight and implementation of 2007 and 2008 treatment activities.

Section 7 – *Implementation Schedule*: This section provides a summary of the projected schedule and anticipated time frames for proposed 2007 and 2008 treatment activities.

Section 8 – *References:* This section provides a listing of references cited.

2.0 SUMMARY OF PREVIOUS TREATABILITY STUDIES

According to EPA, and based on available data, five contaminant source areas contribute the majority of contaminant loading to surface water at the Site (Figure 1-2). These sources include:

- Adit;
- Pit Underdrain (PUD);
- Channel Underdrain (CUD);
- Delta Seep; and
- Aspen Seep (also known as the Overburden Seep).

This section provides a general summary of treatability studies (previously referred to as ERAs) that have been performed by Atlantic Richfield and the LRWQCB at the Site since 2001. Additional details on the scope and results of these treatability studies can be found in various technical reports prepared by Atlantic Richfield and the LRWQCB. Treatability studies performed by Atlantic Richfield to address discharges from the CUD and DS are documented in various completion reports for 2002 through 2006 (Atlantic Richfield, 2002a, 2003a, 2004a, 2005a, 2006a, 2007a). Treatability studies performed by Atlantic Richfield to address discharges from the AS are documented in various technical reports and data summary reports prepared beginning in 2001 (Atlantic Richfield, 2001, 2003b, 2004b, 2005b, 2005c, 2006b, 2007b). The scope and results of treatability activities performed by the LRWQCB have been documented in year-end reports for 2002 through 2006 (LRWQCB 2003, 2004, 2005, 2006, 2007).

Treatability studies performed by Atlantic Richfield to address the AMD discharges have generally involved the addition of base (generally calcium hydroxide [lime]) to AMD in a reaction tank and pond-system to raise the pH of the water in order to precipitate heavy metals.

A lime treatment system referred to as the Lagoon Treatment Facility (LTF) was utilized to treat AMD flows in 2002, 2003, and 2004. Also in 2004, a rotating cylinder treatment system (RCTS) was evaluated. The design concept of the RCTS equipment departs from the deep tank designs of conventional lime treatment systems. The RCTS uses shallow trough like cells for mixing the impacted waters and lime by rotating perforated cylinders for improved oxidation and agitation during treatment of the water. In 2005, a High Density Sludge (HDS) treatment alternative was evaluated as described in the *2004 Additional AMD Treatment Alternative Evaluation and Conceptual Year-Round Treatment Facility Design for Channel Underdrain and Delta Seep Flows* (Atlantic Richfield, 2005d). The HDS technology is based on the traditional lime neutralization method but additionally recycles a portion of the treatment solids from a clarifier to further increase the density and reduce the volume of the sludge. A pilot HDS system having a maximum treatment capacity of 45 gpm was constructed and operated by Atlantic Richfield to treat CUD flows in 2005 and 2006.

The pilot HDS system was operated again in 2006 while the design and efficacy of a winterized system was evaluated pursuant to the EE/CA. Experience gained during 2006 from efforts to design and construct a year-round treatment system demonstrated that it entails implementation challenges, including health and safety, operational reliability and infrastructure concerns, inappropriate for a non-time critical removal action or treatability study.

The Aspen Seep bioreactor treatment system (bioreactor system) has been evaluated and utilized for treatment discharges from the Aspen Seep for a number of years. The bioreactor system uses sodium hydroxide (NaOH) for pH adjustment and utilizes soluble organic carbon to support sulfate-reducing bacteria, which facilitate the precipitation of metal sulfides from source waters. The bioreactor system was designed and constructed in 1996 in collaboration with researchers at the University of Nevada at Reno (UNR). The bioreactor system has undergone a number of improvements including the construction of a collection trench, five ponds (a pretreatment pond, two bioreactor ponds and two settling ponds) and an aeration channel in 2003 and the addition of a recirculation system in 2004.

Treatability activities conducted by the LRWQCB include the operation of a Pond Water Treatment Facility (PWTF), which began treating AMD flows from the Adit and PUD at operational-scale in 2002 (pilot-scale treatment by the LRWQCB began in 1999). This system was originally intended to utilize a biphasic neutralization process that neutralizes AMD with the addition of lime in two phases and the precipitation of two separate sludges. The first phase raises the pH to approximately 2.8 standard units (s.u.), which initiates the precipitation of iron (in the form of ferric hydroxide [$Fe(OH)_3$]) and arsenic (by adsorbing to the ferric oxide). The second phase raises the pH to approximately 8.5 s.u. and precipitates the remaining heavy metals of concern. The bi-phasic treatment process was modified in 2005 and 2006 to produce only one sludge because of increased Adit and PUD flows.

A feasibility evaluation of combined flow treatment (of Adit, PUD, CUD and DS flows) was conducted in 2003. The study was designed to confirm the effectiveness of mono-phasic treatment on the combined flows, to determine the efficiency and lime consumption of the process, and to characterize the generated sludge.

3.0 PLANNED 2007 TREATMENT ACTIVITIES

3.1 SCOPE AND OBJECTIVES

The scope of activities proposed for 2007, as described herein, are specific to treatment of AMD discharges from the CUD, DS and AS. The broad objective is to provide information needed to evaluate and select a long-term remedy consistent with the RI/FS process, while reducing contaminant load from certain known sources and thereby continue to improve the water quality of Leviathan and Aspen Creeks. In the following sections of this Work Plan, details concerning the scope of the proposed activities at the three discharges will be provided, as outlined below.

During 2007 waters from the CUD and, to the extent practicable, the DS will be collected and treated using single phase lime treatment for pH adjustment and metals removal. The activities related to the CUD and DS flows projected to be undertaken during 2007 include:

- Update CUD collection and pumping system;
- Design and construct temporary and semi-permanent DS collection and conveyance system;
- Design, construct, and operate single phase Pond 4 Lime Treatment System;
- Design and construct a treatment building to house the semi-permanent HDS Treatment System beginning in 2008.

As described above, AS flows have been treated with a bioreactor treatment system since 1996. Flows from the AS will continue to be treated with the bioreactor system in 2007 with the following optimization activities scheduled for 2007:

- Implement improvements to the bioreactor and optimize system performance;
- Update system operations & maintenance program;
- Update sludge handling and management program.

The overall site objectives are to:

1) Collect information that will be used to identify effective, reliable and suitable treatment methodologies that may be incorporated into the long-term remedy for the Site.
2) Treat the previously identified flows, CUD, DS, and AS, to discharge criteria previously established for the Site to the extent practicable for a treatability study;
3) Optimize treatment systems;
4) Extend the length of the water treatment season for the CUD and DS flows to the extent practicable;
5) Implement HSSE-related improvements at all treatment sites;
6) Reduce potential for environmental contamination due to spills or treatment disruptions;
7) Reduce timing and spatial constraints affecting the construction of a semi-permanent HDS treatment system.

Specific activities to meet the above objectives are described in the subsequent sections of this Work Plan. The scope of these activities should be considered conceptual and subject to change as modifications to the plans described herein may be necessary to improve treatment system performance or accommodate conditions encountered in the field.

3.2 Channel Underdrain and Delta Seep-Related Activities

Both the CUD and DS flows will be treated as combined flows in the planned treatment systems when a collection system for DS flows is completed and operating. Preparation of Pond 4, evaluation and possible modification of the CUD collection system, construction of a temporary DS collection and conveyance system, and treatment of CUD, DS, and AS flows in 2007 are discussed below.

3.2.1 Preparation of Pond 4 for 2007 Treatment Season

Pond 4 currently contains partially treated water from the last treatment season, accumulated meteoric precipitation and a limited volume of sludge. In addition, at least 10 filter bags filled with metal hydroxide sludge from 2006 treatment activities were left on the Pond 4 berm for disposal in 2007. The following activities are underway or planned:

- **Removal of filter bags and sludge:** Filter bags and related-sludge have been removed from the pond berm and placed in roll-off containers. The waste has been sampled, characterized and profiled as non-hazardous waste. See Table 3-1 for sludge characterization. The sludge will be transported to US Ecology in Beatty, Nevada.
- **Analysis of Pond 4 water:** Pond 4 water was sampled in three locations on May 9, 2007. Laboratory results for dissolved metals and total selenium indicated that only a few metals exceeded previously established discharge criteria. However, untreated CUD water was captured and discharged to Pond 4 between June 15 and June 19. Therefore water from Pond 4 water will be treated, resampled, and analyzed to verify that it will meet discharge criteria prior to discharge as described in Section 4.1.1.
- **Evaluation of Sludge Volume in Pond 4:** Based on sludge depth measurements conducted by EMC^2 in late 2006, it is estimated that there is less than 12 inches of sludge and/or pre-existing sediments on average on the pond floor. In addition, low water levels in Pond 4 in the spring of 2007 indicate sufficient storage capacity exists for the commencement of treatment in 2007. As a result, the risk of damage to the liner by sludge removal activities does not justify the removal of the sludge at this time.
- **Repair of Pond 4 Liner:** Minor tears that have developed in the Pond 4 liner at the water line and on the Pond 4 berm will be repaired during the 2007 treatment season.

3.2.2 CUD Collection and Conveyance System

The CUD collection and conveyance system is used to capture flow from the CUD and convey the water to the Pond 4 Lime Treatment System. At the terminus of the CUD a section of PVC pipe directs the CUD flow to a USGS flow metering box (weir). Flow data indicate that the present volume of flow from the CUD is approximately 25 – 35 gpm. Flow volumes during the summer of 2006 ranged from 30 to 45 gpm. In previous treatment seasons, the flow from the CUD was directed away from the weir box into a 550-gallon polyethylene tank that served as the CUD pumping vault. This precluded the use of the wier box for flow measurements during collection of the CUD flow. In May 2007, the CUD pumping vault was lowered to allow continuous flow through the weir box to maintain collection of flow data by the USGS. Two new submersible pumps (one as a backup) with level controls and variable frequency drives (VFDs) have been installed to pump the CUD flow from the pump vault to the treatment system.

An initial evaluation of the CUD conveyance system indicated that the existing CUD conveyance piping system was not supported adequately and was in need of repair and/or replacement. Currently a temporary piping system has been installed and it is planned that a more permanent system will be installed during the 2007 treatment season. The current temporary piping system allows pumping of 40 gpm, with one pump operating, and up to 60 gpm, when both pumps are operating. Future improvements to the CUD collection and conveyance system will increase the flow capacity, provide increased spill protection, and continue to provide redundant pumping systems. Once collection and treatment of the CUD flow has begun, any additional upgrades to the system will be carried out so as to have little to no interruption of CUD flow collection. The CUD pumping system will be designed to operate continuously 24 hours per day, and throughout the summer treatment season. Power for this pump system will be provided by the diesel generator located near Pond 4. A magnetic totalizing flow meter will be installed in the CUD pump discharge line to measure the flow rate and total volume of CUD flow delivered to the Pond 4 Lime Treatment System. At the end of the season, the pumping system will be decommissioned and prepared for winter storage.

3.2.3 Delta Seep Collection and Conveyance System

Limited flow data are available for the DS but the flows have been estimated to range between 5 and 25 gpm. The present volume of flow from the DS is unknown but is thought to be less than 25 gpm. Currently, the DS flow is uncontrolled and flows into Leviathan Creek down gradient of the CUD pumping vault. A collection and conveyance system was previously installed at this location but was damaged and removed following a landslide in August 2004.

The design of both a temporary and semi-permanent collection and conveyance system is in progress. A temporary collection and conveyance system will be constructed and will begin operation as soon as practical during the 2007 summer treatment season. The temporary collection and conveyance system will be constructed to capture and convey as much of the DS flows as practicable, while also satisfying the constraints of the maximum design capacity of the treatment system. If determined necessary, modifications may be made in late 2007 to increase the durability of the system in preparation for the 2008 treatment season.

The temporary 2007 DS collection and conveyance system will be constructed to collect surface flows with limited excavation to minimize the potential of destabilizing the Delta Slope area. High-Density Polyethylene (HDPE) liner material and sandbags will be used to create a collection depression. A pipeline will direct flow collected in this depression to a small HDPE tank containing two submersible centrifugal pumps with a VFD suitable for pumping low pH water. The tank will keep the pump submerged and a level control and VFD will trim the pump operation to match the pump discharge flow rate to the DS flow. One pump will operate in primary service while the second pump is redundant. An automatic water level directed switching system will be provided so the second pump is energized in the event the tank inflow exceeds the primary pump capacity, or the primary pump fails. This system will pump directly to the equalization tank at the head of the Pond 4 treatment system via a surface pipeline. A magnetic totalizing flow meter will be installed in the DS pump discharge line to measure the flow rate and total volume of DS flow delivered to the Pond 4 Lime Treatment System. The DS pumping system will be designed to operate continuously 24 hours per day, and throughout the summer treatment season. Power for this pump system will be provided by the diesel generator located near Pond 4.

It is anticipated that a more reliable semi-permanent system may be required to replace the collection system initially installed in 2007. If an alternative semi-permanent system is required, changes to the design of the system will be based on the success and lessons learned from the temporary 2007 DS collection and conveyance system and will be modified to address any operational difficulties observed during the 2007 treatment season. Any modifications to the DS collection and conveyance system will be implemented to minimize interruption of the DS collection.

3.2.4 Pond 4 Lime Treatment System

The Pond 4 Lime Treatment System will be designed to treat CUD flows and DS flows. Treatment of CUD flow will likely begin prior to the completion of the construction of the temporary DS collection and conveyance system. DS flows will be treated along with CUD flows once the DS conveyance is completed. Details of the Pond 4 Lime Treatment System are discussed in the subsequent sections.

3.2.4.1 Treatment Goals and System Capacity

The Pond 4 Lime Treatment System is a lime addition system that will employ the Rotating Cylinder Treatment System (RCTS) technology. An RCTS is a compact integrated unit that utilizes rotating cylinders for mixing and efficient aeration to promote a complete reaction between the lime slurry and the feed water. This system will provide pH adjustment and removal of dissolved metals by generation of metal hydroxide sludge. The Pond 4 Lime Treatment System will be designed to operate both manually and automatically with operators on-site during daily shifts to perform optimization, monitoring and regular maintenance. The generalized layout for this system is presented in Figure 3-1.

Treatment goals for the RCTS are to:

- Provide treatment of the CUD flow and DS flow as feasible during the 2007 summer season;
- Contain captured sludge in roll-off bins for ease of removal from Site;
- Utilize the storage volume of Pond 4 to provide settling of suspended lime particles and metal hydroxides not captured in the filtration system;
- Allow for greater dedication of space and resources for construction of the 2008 HDS system.

The Pond 4 Lime Treatment System will utilize equipment procured in previous years to the greatest extent possible. Many of the tanks required for this system are available from previous treatment systems designed for and operated by Atlantic Richfield at the Site. To provide increased treatment performance, redundancy, flexibility and reliability, additional equipment will be rented or purchased and installed.

The Pond 4 Lime Treatment System will mix liquid lime slurry with the untreated water pumped from the CUD and DS collection and conveyance systems and provide mixing and aeration with RCTS units. Process water will be pumped from the RCTS units into a settling tank then gravity fed to filter bags within filter bins to capture suspended solids. Filtrate will be collected from the sludge bins and pumped to Pond 4. Additionally, polymer can be added prior to the settling tank to enhance flocculation and solids capture. The Pond 4 Lime Treatment System will be capable of treating flows up to 75 to 80 gpm, though actual performance will depend upon many variables including the influent water quality, and will operate for the duration of the 2007 treatment season.

At the end of the 2007 treatment season the system will be cleaned, drained, serviced, decommissioned for the winter season and covered to allow for minimal set-up time in the spring of 2008. This system will be available for early season treatment while the HDS Treatment System undergoes assembly and start-up, as described in Section 3.2.5.

3.2.4.2 Treatment System Design

The Pond 4 Lime Treatment System is graphically presented in a Process Flow Diagram shown in Figure 3-3. This system will include the following components:

- **Lime Slurry Storage Tank**. A lime slurry tank will be provided to accept deliveries of custom blended alkali (CBA-45%). This lime slurry product has 45 percent lime solids, but has lower viscosity and mixing requirements than conventional 45 percent lime slurry. The tank will be equipped with an externally mounted lime slurry agitator to keep the lime in suspension. The lime slurry will be pumped to a flash tank for mixing with untreated water from the CUD and DS.

- **Equalization Tank.** A 2000-gallon tank will receive CUD and DS flows and will equalize flow going to the Lime Treatment System. Water will gravity flow to the Flash Tank.

- **Flash Mix Tank.** A 2000-gallon tank with integrated mixer will receive untreated water from the equalization tank as well as metered lime slurry. Water from this tank will flow to the RCTS units.

- **Mixing and Aeration Units.** Three RCTS units capable of treating greater than 40 gpm each will be provided. The units will be installed in parallel operating only two units simultaneously, providing available redundancy with the third unit. The RCTS units are the main reaction step in treating the AMD providing aeration and mixing of the influent water and lime slurry. Water will be pumped from the RCTS units to the settling tank.

- **Settling Tank.** An 11,000-gallon settling tank will provide 2.4 hours of residence time at a treatment flow rate of 75 gpm. Mildly clarified water will gravity flow from the top of this tank into filter bags. Settled solids will be periodically purged from the bottom of this tank into a separate filter bag. Performance from this tank is not expected to be optimal but the tank will provide a hydraulic residence time for settling and solids capture in addition to the solids capture provided by the filter bag system, effectively reducing the sludge loading in Pond 4. Optionally, polymer can be added to increase floc formation and solids capture in the system.

- **Filter Bins.** Filter bags will be placed in filter bins which are roll-off type containers with a built in filtration collection system. Solids from the treated water will be captured in the filter bin for ease of removal from the site. Filtrate from these containers will be captured in a collection tank and pumped into Pond 4.

- **Pond 4 Discharge Pump and Conveyance.** Two 1,000 gpm pumps will be located on the pond berm as a treated water pumping system. One pump will draw treated water in Pond 4 through flexible hosing into a PVC conveyance to the Leviathan Creek. A second pump will be connected as a backup pump.

Discharged flows will be measured by an in-line magnetic totalizing flow meter. The discharge pump system will be operated manually and monitored while discharging.

3.2.4.3 Power Supply

The design and construction of the power supply and distribution system for the Pond 4 Lime Treatment System is underway. The power supply will be provided by the existing 150 kW diesel generator currently at the Site and a backup generator to be procured. The 150 kW generator has been used in previous treatment seasons and has recently been inspected and serviced. Additional parts needed to make the generator fully functional are ordered and will be installed when available. The power demand for the Pond 4 Lime Treatment System is expected to be less than the generator capacity, so the generator will be operating at a small percentage of its rated capacity. The performance of the generator is unknown and the expected fuel usage rate for this generator is also unknown. A 1,000-gallon diesel storage tank with secondary containment is currently at the Site and will be used to distribute fuel to the generator. At the end of the operating season, the generators will be decommissioned for the winter months. Any unused fuel will be removed from the Site at the end of the season.

3.2.4.4 Operations and Maintenance

The Pond 4 Lime Treatment System is designed to operate 24 hours a day. System operators will be on site during daily shifts to maintain effective system operation and perform routine maintenance. Periodic maintenance will be scheduled and performed either by site staff, specialized maintenance contractors or off site maintenance specialists, as appropriate. It is expected that periodic maintenance can be performed by activating redundant pumps and mechanical equipment eliminating the need for plant shutdown to perform regular maintenance. The redundant systems and on-site replacement parts are provided for in the design of the treatment system to limit the potential of extended shutdown due to mechanical failure. If shutdown occurs due to equipment failure or treatment system upset, untreated water from the equalization tank will be diverted to Pond 4. This will potentially contaminate the treated water in Pond 4 (as determined by water quality monitoring of samples collected near the discharge point). Any planned discharges of treated Pond 4 water to Leviathan Creek will be temporarily stopped until the quality of the discharge can be determined. If necessary, water in Pond 4 will be re-routed through the Pond 4 Lime Treatment System until the water quality in the pond meets discharge criteria.

3.2.4.5 Sludge Management for Pond 4 Treatment

The Pond 4 Lime Treatment System will produce sludge that is captured in filter bags. This sludge will be allowed to dewater passively in the filter bin containers. The sludge captured in the filter bags is not expected to be hazardous. Six bins are planned for this system, and sludge bins are expected to be shipped off-site with a solids concentration anticipated to be in the range of 15-20 percent. Following waste characterization sampling and profiling, the sludge will be transported to an appropriate waste disposal facility.

Due to the multi-usage aspect of Pond 4, as both a holding reservoir for treated water and emergency containment of untreated water, some additional sludge as well as windblown sediments may accumulate in Pond 4 over the summer treatment system. The need for and feasibility of removing any accumulated sludge from Pond 4 will be assessed again at the end of the treatment season.

3.2.5 HDS Treatment System Design

The HDS system will be designed by AMEC in coordination with Geomatrix during 2007. Design criteria will be specified and submitted in a separate document. Procurement of components will begin in the summer of 2007, with deliveries expected in late 2007 or early 2008. Subject to weather, access and supply limitations, the goal is to have the system operational in 2008 to treat combined CUD and DS flows. The current goal is to design the HDS treatment system to treat up to 100 gpm of CUD and DS flow based on the design criteria feed characteristics and discharge criteria. Additional treatment capacity above the CUD and DS flows may be utilized to treat any water accumulating in Pond 4 (due to precipitation or system-upset discharges) if necessary.

The HDS treatment system will be designed for a service life of up to 3 years and is expected to operate for up to 7 months per year, weather permitting. The system will be housed inside a treatment building intended for construction during the 2007 summer season, again subject to weather, access and supply limitations (see Section 3.2.6). The building will provide protection of the treatment equipment and operators from weather exposure during the treatment season and will provide protection for the treatment system during the decommissioned winter months. Having the system protected inside a building will reduce the amount of start-up time needed the following spring, enabling earlier treatment operations each spring. In addition, the building may allow the treatment season to be extended longer into the fall for a longer total annual treatment period.

3.2.6 Treatment Building Construction

A steel structure will be designed and procured in summer 2007, with construction of the treatment building expected to be completed by fall of 2007. This structure will house the semi-permanent HDS Treatment System and will be designed to be erected on the treatment building foundation constructed during the 2006 treatment season (though some foundation modification will be required and slabs will first need to be poured). The structure will be sized to house the HDS treatment equipment including the clarifier. The structure will be designed to be consistent with wind and snow loads typical of the area, and seismic zoning specifications dictated by the Alpine County Building Department, although building permits and Building Department inspections should not be required. The structure will be designed for spring, summer, and fall treatment operations.

3.3 ASPEN SEEP-RELATED ACTIVITIES

3.3.1 System Description

The Aspen Seep bioreactor system is designed to treat AMD discharges from the Aspen Seep. The sulfate reducing bacteria active in the system reduce sulfate to sulfide and facilitate metal sulfide formation. Alkalinity addition increases the pH and results in the formation of metal sulfides that are insoluble at neutral to slightly alkaline pH. Insoluble precipitates are removed from the water by settling resulting in treated water with greatly reduced metal loads.

The Bioreactor system generally consists of a series of ponds, chemical feeds, recirculation pumps, and both solar and diesel generator power. The Bioreactor site layout is shown in Figure 3-4. This system includes the following components:

- **Weir Box.** The weir box collects, measures, and logs flow rates from the Aspen Seep. A solar panel powers the data collection. The USGS is responsible for this data collection. Water flows from the weir box into piping leading to Pond 3.
- **Pretreatment Pond**. The capacity of this pond is 100 cubic feet. Recirculated water from Pond 3 is pumped to the Pretreatment Pond then flows by gravity to the succeeding ponds.
- **Ethanol Feed.** Ethanol is fed as a carbon and energy source for the sulfate reducing bacteria (SRB). Currently ethanol is siphon gravity fed into the water flow at the head of Pond 1. Ethanol is stored in 2 x 2,500 gallon tanks and is transferred to 55 gallon drums for the siphon gravity feed.
- **Pond 1 (Biocell 1).** Pond 1 is the first biocell. Pond 1 is filled with 9 inch diameter rounded stones to provide surface area for SRB attachment. The active volume is 5,302 cubic feet. Water gravity flows from Pond 1 into Pond 2.

- **Pond 2 (Biocell 2).** Pond 2 is the second biocell. Pond 2 is also filled with 9 inch diameter rounded stones to provide surface area for SRB attachment. The active volume is 3,052 cubic feet. Water gravity flows from Pond 2 into Pond 3.
- **Sodium Hydroxide Feed**. 25 percent sodium hydroxide is added as water flows into Pond 3. Although some alkalinity is produced by biological sulfate reduction, additional alkalinity is required to further increase pH to encourage efficient metal sulfide precipitation. The current sodium hydroxide feed system consists of a 12V DC peristaltic pump powered by a solar panel, supplying sodium hydroxide from 4 – 1,500-gallon storage tanks.
- **Pond 3**. Pond 3 receives both sulfide rich water from Pond 2 and influent Aspen Seep flow with high metals concentration. Pond 3 acts as both a mixing/reaction basin and a settling basin for the produced metal sulfides. Pond 3 capacity is 16,453 cubic feet. Water flow from Pond 3 is split between gravity flow to Pond 4 and pumped flow into the Pretreatment Pond.
- **Recirculation Pumps**. Currently two 1.5 HP submersible pumps recirculate water from Pond 3 into the Pretreatment Pond. The submersible pumps are powered by an on-site 7KW diesel generator.
- **Pond 4.** Pond 4 receives water from Pond 3. Pond 4 functions as extended settling for particulates. The capacity is 18,099 cubic feet. Water flows from here by gravity to the Aeration Channel.
- **Aeration Channel.** This is the discharge channel for treated water. The rock lined channel allows further aeration and directs treated water to flow by gravity toward a topographically low lying area. Water has collected in this area over the years of operation and is termed the “Infiltration Pond”.
- **Remote Telemetry System.** A trial remote flow monitoring system consisting of two flow meters, radio communication equipment, and a PLC and human machine interface (HMI) to monitor and log flow rates and control the recirculation pump. In addition, a separate satellite data system with attached video camera is also installed at the site. Both systems are powered by the diesel generator. The flow meters are currently operational, however, other components of the system may require replacement or upgrade.

3.3.2 Performance and Reliability Summary

Although a review of previous operations and initial visits to the site indicate that the bioreactor is capable of producing treated water that meets or exceeds previously established discharge criteria, several system upgrades and health and safety improvements have recently been made or are planned for 2007, as detailed below. It is expected that these changes will improve the reliability and consistency of the system performance, and provide for safe and productive work environment.

3.3.2.1 Health and Safety Improvements

Health and safety improvements implemented or planned for the bioreactor system include the following:

- Delineating a barrier to the reactor ponds, to prevent personnel from slipping into the ponds
- Installing steps to improve access to generator
- Adding additional storage for secure, clean on-site storage for PPE and operations and maintenance equipment
- Removing and cleaning or discarding all potentially contaminated material from shed within the sodium hydroxide storage area
- Removing trip hazards by burying or marking permanent electrical and flow lines
- Installing locking caps on ethanol and sodium hydroxide valves located on the lower portion of the tanks.
- Improved access to sodium hydroxide and ethanol tanks with stairs to work platforms
- Installing a feed manifold system for simplified sodium hydroxide tank filling
- Improvements for the sodium hydroxide storage area, by replacing or adjusting the existing liner and secondary containment system, adding a gravel or concrete bed and a grate drainage system to allow workers to decontaminate protective equipment prior to removal
- Generally improved housekeeping
- Implementing a system of “trash-in-trash-out” and securing waste materials that must be stored short-term on-site.
- Redeveloping a safety conscious culture on-site for all personnel and visitors

3.3.2.2 Sodium Hydroxide Feed System

The sodium hydroxide pump is contained in a small secondary containment unit that had been located on the ground surface. A table was recently provided to bring the pump off the ground to improve the ergonomic arrangement for pump maintenance. The pump requires tubing changes on a regular basis to prevent breaks in the tubing. Previous breaks in the tubing have caused accumulation of sodium hydroxide in the containment and interruptions of sodium hydroxide delivery to the treatment system. The current pump system will be replaced with a metering pump skid complete with redundant pumps, integrated plumbing, and self containment. The pump skid will be positioned in an ergonomically appropriate way to facilitate any required maintenance. The self containment can be piped to drain into Pond 3 for efficient evacuation of any spillage. The maintenance of the planned chemical feed system will be significantly reduced compared to the current sodium hydroxide pump set-up. Level indicators will be installed on the storage tanks to allow for planned switching from one source tank to the next to minimize feed interruptions.

3.3.2.3 Ethanol Feed Systems

The ethanol feed system consists of a series of copper tubing used to siphon feed the ethanol into the treatment flow. Although this system requires no electrical power, the feed rates change as the ethanol level in the source container changes. Therefore, precise control over feed rates is not accomplished in this manner. The current feed system will be replaced with an ethanol metering pump skid complete with redundant pumps, integrated plumbing, and self containment. The maintenance of the planned chemical feed systems will be low and it will have more precision and consistency over the gravity feed siphon method used currently for ethanol feed. Level indicators will be installed on the ethanol storage tanks to allow for planned switching from one source tank to the next to minimize feed interruptions.

3.3.2.4 Diesel Generator and Fuel Storage

The current on-site diesel generator will remain in operation to power the water recirculation pumps and flow meters for recirculation and effluent flow until alternative power sources can be evaluated and implemented. The generator will also power the telemetry system and video camera as changes are made to the remote observation system. Currently the generator system consists of a 7 kW Multiquip diesel generator, a 1,000-gallon fuel storage tank with secondary containment, and a 2,000-gallon double-walled fuel storage tank. The lease on the 2,000-gallon tank ends in June, and this tank will be removed from the site at the end of the lease. Improvements to the diesel generator and diesel fuel storage area will prevent diesel spills and include the following:

- Solenoid switching valve that closes diesel feed line when generator powers down
- Secondary containment around the generator
- Secondary spill containment down gradient of the diesel tanks
- Containment of feed lines and power lines in separate conduit

3.3.2.5 *Alternative Energy Sources: Solar and Back-up Generator*

The availability of a reliable power source has hindered operations in the past. Currently a generator is required on-site to provide electrical power for the recirculation pumps. Maintenance of the generator is required frequently and is labor intensive. Delivery and storage of diesel fuel is required and increases potential for environmental contamination and health and safety hazards. A solar panel unit has operated the sodium hydroxide feed pump reliably in the past; malfunctions with the sodium hydroxide pump occurred primarily due to tubing and pump head issues rather than solar power issues. A previous assessment of solar power potential at the Site showed its feasibility but relatively high cost (BP, 2001). In order to implement solar power at a reasonable cost, chemical feed pumps will be chosen that have the lowest power requirement while still delivering required flows reliably. Replacements for the submersible recirculation pumps with lower power requirements are currently being investigated. Current evaluations indicate that the bioreactor system may possibly be powered by solar panels with an on-site propane generator for emergency back-up and to cover the occasional additional power requirements for the use of power tools for on-site improvements or maintenance. Further investigation of these improvements will occur in 2007.

Two photovoltaic systems including batteries are set up on site and are operational. One is located by the sodium hydroxide storage area the other by the ethanol storage area. However, these two systems require improvements including:

- Appropriate battery replacements with weather proof containment
- Inverters to allow for AC power requirements
- Circuit breakers
- Accessible power on/off switch to lock out/tag out pumps for maintenance or in an emergency
- Insulated electrical cable lengths.

Other photovoltaic panels exist on site and will be evaluated for functionality and potential use in additional solar power capacity at the Site.

3.3.2.6 *Telemetry System*

Consistent signal strength is required for an operable remote monitoring and data logging system. Alternative remote communications systems will be evaluated during the summer of 2007 with a goal of designing and implementing an effective system in 2008.

3.3.2.7 Site Storage

As indicated in section 3.3.2.1 (Health and Safety Improvements) secure, clean on-site storage for PPE and maintenance equipment is required. A storage container will be delivered to the Site for storage of such materials. The planned location of the storage unit will be across the access road from the ethanol storage area (Figure 3-4). Grading, leveling and an equipment pad are required prior to delivery of the container.

3.3.3 Bioreactor Operations and Maintenance

Until all planned improvements are implemented, system maintenance will continue to require weekly to twice weekly site visits to maintain the generator, move or change sodium hydroxide pump tubing, and adjust ethanol feed. After planned improvements to the Bioreactor system are in place, regular monitoring of the site and operating components will be required to identify potential maintenance issues before they cause system disruptions. However, site visits can become less frequent. Planned pump skid replacement will require monthly inspection and occasional maintenance. Solar panels will require monthly inspection and replacement of components as necessary. Storage volumes will require monthly monitoring to evaluate remaining capacity. It is anticipated that regular maintenance will be largely reduced compared to the current system.

3.3.4 Solids Handling and Management

Bioreactor treatment removes soluble metals by precipitation as metal sulfides. Metal sulfide precipitates accumulate over time and reduce the effective volume of the settling ponds. The current bioreactor system operated in recirculation mode is designed to collect the majority of precipitates in Pond 3 and Pond 4. To a lesser extent precipitates will also accumulate in the Pretreatment Pond and in Ponds 1 and 2 (Biocells).

A pilot test for removing and dewatering the sludge utilizing filter bags contained within filter bins is currently underway at the site. Sludge is pumped from the ponds into the filter bags, the filtered water will be allowed to drain back into the ponds. Captured sludge will be shipped off site for disposal. The plausibility and cost of this sludge removal technique will be evaluated against other sludge removal techniques and options including bulk water disposal, coagulant enhanced filtration, and mechanical dewatering. Investigation into various dewatering technologies is underway. Alternative methods will be utilized if determined to be efficient and cost effective.

As with other treatment sludge collected at the Site, sludge removed from the bioreactor ponds during 2007 will be transported to an appropriate waste disposal facility following waste characterization sampling and profiling.

4.0 TREATMENT MONITORING AND EVALUATION

Determination of treatment effectiveness and sludge disposal options will require that sufficient data of appropriate quality are gathered and evaluated. The EPA has developed guidance as part of its Quality System, an Agency-wide program of quality assurance for environmental data. One component of this Quality System is the requirement that investigators use a systematic planning process as mandated in EPA Order 5360.1 CHG 1: *Policy and Program Requirements for the Mandatory Agency-wide Quality System* (EPA, 1998b). EPA strongly recommends the Data Quality Objectives (DQO) Process as the appropriate systematic planning process for decision making.

DQOs are statements that identify the objectives of the proposed work. They specify the quality, quantity and analytical level of data required to make decisions relative to these objectives. DQOs for the proposed 2007 interim treatment activities will be established to assure that the data collected are of sufficient quantity and quality for the "intended use" of the data. Data collected during 2007 to support water treatment activities for the Pond 4 Lime Treatment System and the Aspen Seep Bioreactor System will be used to:

- Collect information to evaluate the effectiveness and reliability of certain AMD collection and treatment techniques and to provide effective interim water treatment while RI/FS investigations and final remedy selection proceeds..
- Evaluate the safety and reliability of the treatment systems for treating CUD, DS, and AS flows;
- Evaluate the effectiveness of single phase lime treatment for removing COCs from waters collected at the CUD and DS;
- Evaluate the chemical and physical characteristics of solids generated by water treatment of CUD and DS flows;
- Assess the contingencies that must be considered during system upsets;
- Evaluate the volume of generated solids using the Pond 4 Lime Treatment System;
- Evaluate the Pond 4 Lime Treatment System flow system design and operational parameter requirements;

- Evaluate in real time system enhancements that may be necessary to consistently achieve water quality standards in different conditions;
- Assess the system enhancements that are necessary to consistently and continuously discharge treated waters to Leviathan and Aspen Creeks;
- Verify that the Aspen Seep Bioreactor System effluent meets established discharge criteria;
- Evaluate the physical and chemical characteristics of bioreactor-generated sludge as appropriate for assessing disposal options; and
- Provide operational data for the bioreactor system for use in system optimization and operation guidance for inclusion in the Operations & Maintenance Manual.

The monitoring program implemented for the 2007 interim treatment program is designed to provide sufficient data to meet these objectives. Sampling and analysis procedures for the Pond 4 Lime Treatment System and Aspen Seep Bioreactor System will follow the requirements identified in the Site-Wide Sampling and Analysis Plan (SAP) included as an Attachment to the *Phase 1 RI/FS Work Plan* (Atlantic Richfield, 2002b) a copy of which is provided in Appendix A and Standard Operating Procedures (SOPs) for the Aspen Seep Bioreactor System provided in Appendix B, respectively. Influent and effluent water samples from the treatment systems will be collected for measurement of field parameters and for laboratory analysis to track treatment system effectiveness. Additional process samples will be collected as needed to assist with system optimization. Process generated solids will be evaluated, and following waste characterization and profiling, the sludge will be transported to an appropriate waste disposal facility.

Analytical results for treatment system effluents will be compared to the discharge criteria previously established for the Site (Table 4-1). However, because this work is being performed on an interim basis to evaluate the effectiveness and reliability of certain AMD collection and treatment techniques, criteria exceedances may periodically occur. Design modifications may be made, but only if discharge criteria are consistently being exceeded and other performance measures indicate the need for and practicability of improving the treatment systems within the timeframe contemplated by this Work Plan.

Process solids generated from the Pond 4 Lime Treatment System and the Aspen Seep bioreactor system will be compared to federal hazardous waste characteristics determined by the Toxicity Characteristic Leaching Procedure (TCLP) and California Water Code §13172 criteria, Soluble Threshold Limit Concentration (STLC), and Total Threshold Limit

Concentration (TTLC), to determine whether they are hazardous. Regulatory threshold limits for determining if the treatment solids are hazardous are presented in Table 4-2. In addition, to assess the leaching potential of process solids they will also be tested using the Synthetic Precipitation Leaching Procedure (SPLP).

4.1 SAMPLING AND ANALYSIS

The SAP outlines the procedures that will be followed to assure that project DQOs are achieved. Standard operating procedures (SOPs) will be followed when obtaining field measurements and collecting samples for laboratory analysis to ensure the integrity of the sample and associated data.

4.1.1 Sampling

Table 4-3 provides a summary of the monitoring locations, sampling frequencies, and analyses to be conducted during the 2007 interim treatment program.

Pond 4 Lime Treatment System Monitoring: Flows from the CUD and DS will be quantified with magnetic totalizing flow meters and water samples from each source will be analyzed according to schedule and parameters shown in Table 4-3. Treated water will be stored in Pond 4 prior to discharge to Leviathan Creek. Consistent with the sampling and analysis conducted in 2006, the following sampling and analysis plan is proposed for treated water discharged to Leviathan Creek. Three days prior to discharge a composite sample consisting of three grab samples from the location of the Pond 4 discharge pump on the downstream side of the fabric curtain, will be prepared and sent to the contract laboratory for expedited analysis. Analytical results will be compared to the discharge criteria provided in Table 4-1. Once it is determined that the water quality of the sample meets the criteria, water in Pond 4 will be discharged to Leviathan Creek. The discharge of treated water from Pond 4 is anticipated to last from 12 to 96 hours. Therefore it may not be possible to collect daily discharge samples over four consecutive days for averaging and comparison with the *Average Criteria* shown in Table 4-1. Instead, a composite of three grab samples will be collected each day during discharge events. Maximum analytical results for each daily composite sample collected during a single discharge event will be compared to the *Maximum Criteria* in Table 4-3. Average constituent concentrations measured in composite samples collected during all discharge events occurring in a given month will be compared against the *Average Criteria* in Table 4-3.

Aspen Seep Bioreactor Monitoring: Sampling and analysis of the Aspen Seep bioreactor during 2007 will be conducted to be consistent with previous years sampling and analysis plans as summarized in Table 4-3. However, from late spring to early fall when personnel are on site, sampling frequency will be increased to weekly, and a monthly average concentration will be calculated for comparison against the *Average Criteria*.

4.1.2 Analysis

A summary of field and analytical parameters to be measured at each location during the 2007 treat activities is provided in Table 4-3. Measurement of field parameters and water sampling collection procedures will adhere to the SAP developed in accordance with EPA guidance (EPA, 1998) and SW-846 criteria (EPA, 1997). Table 4.4 provides a summary of the analytical methods for aqueous and solid phase sample analysis and the appropriate method detection limits (MDLs). Methods for field measurements are described in the Site-Wide SAP (Appendix A).

4.2 REPORTING

A completion report summarizing the treatability studies and interim water treatment activities performed during 2007 and the results from those activities will be prepared and submitted to EPA on or before June 1, 2008. Prior to reporting, data collected during the 2007 treatment will be validated and assessed for internal consistency as described in the *Leviathan Mine Site Site-Wide Field Sampling Plan* (Atlantic Richfield, 2002b). The completion report will:

- Summarize the treatment related activities conducted under this Work Plan in 2007;
- Provide details on health and safety performance;
- Present the collected data in a tabulated form;
- Provide interpretation of the data and treatment system performance;

5.0 PLANNED 2008 TREATMENT ACTIVITIES

5.1 SCOPE AND OBJECTIVES

The scope of activities proposed for 2008, as described herein, are specific to treatment of surface water discharges from the CUD, DS and AS. The following sections of this Work Plan provide conceptual descriptions concerning the scope of the proposed activities at the three discharges. Specific design criteria and other details concerning the construction of the HDS

Treatment System will be provided in separate design submittals. The broad objective is to provide information needed to evaluate and select a long-term remedy in the Remedial Investigation/Feasibility Study (RI/FS) process, while reducing contaminant load from known sources and thereby continue to improve the water quality of Leviathan and Aspen Creeks.

In 2008, treatment activities will focus on expansion of those initiated in 2007 and will include:

- Commence treatment of CUD and DS flows using the Pond 4 Lime Treatment System as early as weather, access, equipment deliveries and site conditions permit;
- Complete construction of a 100 gpm HDS treatment system in the treatment building, pending analysis of the 2007 treatability study results and subject to possible design modifications premised on that analysis;
- Initiate treatment of CUD and DS flows using the HDS treatment system; and
- Continue treating AS flows on a year-round basis while optimizing performance of and making other improvements to the bioreactor system based on performance monitoring data.

The overall site objectives for the 2008 interim treatment activities are essentially the same as for 2007. Specific activities to meet these objectives are described in the subsequent sections.

5.2 CHANNEL UNDERDRAIN AND DELTA SEEP-RELATED ACTIVITIES

Treatment of the CUD and DS flows will continue in 2008. The subsequent sections discuss the collection systems and the two treatment systems that will operate during the summer of 2008.

5.2.1 CUD Collection and Conveyance

No additional modifications are anticipated in 2008 but improvements will be considered if necessary.

5.2.2 DS Collection and Conveyance

As described in Section 3.2.3, a semi-permanent collection and conveyance system may be required to effectively capture and convey DS flows. The necessity to upgrade the system installed early in 2007 will be based on any operational difficulties observed with the temporary 2007 system and will be designed to address those difficulties. The temporary 2007 system will be operated until construction of the semi-permanent system is completed.

5.2.3 Pond 4 Lime Treatment System

The Pond 4 Lime Treatment System is planned to be available for early season treatment during 2008 while assembly and start-up activities on the HDS treatment system proceed. Consistent with the operation of the 2007 Pond 4 Lime Treatment System, early season treatment of combined CUD and DS flows with the Pond 4 Lime Treatment System will utilize a delivered lime slurry for pH adjustment.

5.2.4 HDS Treatment System

The HDS treatment system designed by AMEC is expected to be completed and operational during the 2008 treatment season, subject to weather, access and supply limitations. Design of the system and procurement of components is underway. Design documents and drawings are preliminary and should be finalized during the summer of 2007. Equipment will be procured for expected delivery to the Site in late 2007 and early 2008. The subsequent sections discuss the treatment goals, general design and operational plan for the HDS treatment system.

5.2.4.1 Treatment Goals, System Capacity, and Service Life

The HDS treatment system will be designed to treat up to 100 gpm based on the design criteria feed characteristics and discharge criteria. Full-scale operation is expected to occur once the HDS treatment system has completed start-up and achieved steady state operation.

Treatment goals for the HDS treatment system in 2008 are to:

- Demonstrate the reliable and safe operation of the HDS technology for the treatment of combined CUD and DS flows;
- Treat the combined CUD and DS flows to meet or exceed the discharge criteria in Table 4-1; and
- Produce a manageable sludge that is contained in roll-off bins for ease of removal from site.

5.2.4.2 Treatment System Description

The HDS Treatment System design is shown in AMEC Drawings D-154522-20-N-011, D-154522-20-M-0004, and D-154522-20-M-0005. The HDS is still in the design phase and therefore the discussion of system components discussed below are still conceptual, and the final system may deviate from what is described here. This system will consist of the following components:

- **Lime Feed System.** A lime feed system will be provided that will accept dry hydrated lime in one ton bags. The hydrated lime is placed in a bin activator and is fed via a screw conveyor to a day bin for dosing into the Lime/Sludge Mix Tank via a metering screw.
- **Lime/Sludge Mix Tank.** This tank is provided to mix the dry hydrated lime from the Lime Feed System and the return sludge from the clarifier prior to mixing in Reactor Tank No. 1
- **Reactor Tank**. A reactor tank equipped with agitator and air diffuser will provide the aeration and mixing required for complete reaction of the lime slurry. Two redundant air blowers are provided to feed the diffuser.
- **Dry Flocculant Feed System.** This system accepts dry polymer delivered in 50 lb bags, and hydrates this flocculant to a 0.05 percent solution with either treated water provided by the utility water pumps, or fresh water that will be shipped to the Site, stored in a tank and then pumped into the flocculant make-down system. The diluted flocculant will be added to the discharge of the Reactor Tank upstream of the clarifier.
- **Clarifier.** A circular clarifier with a rotating rake system will be used to capture process solids. Solids from this clarifier will be pumped to the Lime/Sludge Mix Tank prior to mixing in the Reactor Tank, or wasted to the filter bins for sludge disposal.
- **Effluent Tank**. Flow from the Clarifier will be collected in the effluent tank to allow utility water storage. Overflow from the tank will flow by gravity to Leviathan Creek or will be diverted to Pond 4.

5.2.4.3 Power Supply

Power for the HDS treatment system is still being evaluated, but may be provided by up to three 100 kW prime diesel generators. The power demand for the HDS treatment system is expected to be handled with one generator however the other two generators will serve as a redundant systems allowing longer maintenance intervals and constant power supply even while one generator is taken off line for service. It is anticipated that a 2,000-gallon self-contained diesel fuel storage tank will be necessary.

5.2.4.4 Operations and Maintenance

The HDS treatment system is designed to run 24 hours a day and will utilize electronic control systems and instrumentation. A Human Machine Interface (HMI) and PLC as well as switchgear, motor starters and variable frequency drives (VFD) will be located in the electrical container located close to the treatment system. The system will control and monitor the drives, control loops, tank levels, and alarms. An operator will be required on site for the day shift to monitor operations. The plant is designed to operate unattended overnight.

Routine maintenance for this system will be performed by system operators during daily 8-hour shifts. Periodic maintenance for this system will be performed by system operators as appropriate, and by contract maintenance personnel for specialty work such as control system repair or diesel generator maintenance. If an unexpected equipment failure occurs, CUD and DS flows will be delivered to Pond 4. Following shutdown and return of the system to steady state operation, the plant treatment flow rate may be increased above the expected CUD and DS flows up to the maximum design flow of the HDS treatment system (assuming the CUD/DS flow is less than the design flow) in order to reduce the volume of water held in Pond 4.

The HDS treatment system will use polymer as the flocculent and calcium hydroxide (hydrated) lime as the primary treatment additive. Additive consumption is anticipated to be approximately one 50 lb bag of dry flocculant every 14 days, and approximately 1 ton of hydrated dry lime every two days at design flow and lime consumption rates. Diesel fuel is anticipated to be delivered as required in volumes of 2,000 gallons.

5.2.4.5 Solids Handling and Management

Sludge generated by the HDS treatment system will be pumped from the clarifier cone to filter bins for dewatering. Following waste characterization and profiling, the sludge will be transported to an appropriate waste disposal facility with a solids concentration anticipated to be up to 50 percent at the projected design flow and sludge generation rate.

5.3 ASPEN SEEP-RELATED ACTIVITIES

The Aspen Seep Bioreactor will continue to operate and treat water from Aspen Seep year-round throughout 2008. During 2008 general site monitoring, sampling and maintenance will continue with planned twice monthly site visits through the winter season, dictated by site accessibility. Site visits will include required sample collection, monitoring of system parameters, and inspection of pumps, solar panels, and storage of chemical feed. The need for additional HSSE improvements will also be evaluated as conditions change at the site.

5.3.1 Bioreactor Optimization

It is expected that careful observation and monitoring of the bioreactor system during 2007 will have allowed optimization of the system performance within the frame work of the existing components and chemical feeds.

A potential change that warrants further investigation in terms of its impact on system performance is to provide an alternative carbon and nutrient feed source. Alternative carbon sources, rather than ethanol, for the bioreactor have been investigated by researchers at UNR. Waste fluid from the generation of biodiesel showed potential in previous lab and field experiments. The benefits of this carbon source are low cost, alkalinity content, and complexity of the carbon content that can lead to more efficient carbon utilization by the SRB. It is anticipated that these investigations can be re-instated during the summer of 2008. Changes may be implemented based on evaluation of the system performance with the biodiesel waste fluid.

5.3.2 Solids Handling and Management

Current on-site handling and management of bioreactor generated solids presents logistical and operational challenges. Long term sludge removal methods that may provide operational efficiency will be investigated during 2007 and 2008. The feasibility of an on-site sludge holding and dewatering impoundment in the vicinity of the bioreactor may be evaluated. The use of a mobile sludge press for effectively dewatering the sludge (and thus reducing the volume) is another alternative. These methods may reduce the volume of sludge that needs to be transported off-site for disposal but may or may not be feasible at the Aspen Seep site due to space limitations. Other possibilities for on site permanent sludge retention such as a sludge repository will also be investigated.

5.4 2008 Treatment Monitoring and Reporting

A monitoring program equivalent to that conducted for the 2007 treatment season will be implemented in 2008 to evaluate the quality of treatment system effluents and the chemical and physical characteristics of treatment solids.

Data collected during the 2008 treatment will be validated and assessed for internal consistency. Following completion of laboratory analysis and data validation, a completion report describing the scope and results of 2008 water treatment activities will be prepared for submittal to EPA on or before June 1, 2009. The report will include a summary of construction and treatment activities completed, as-built details for treatment systems and structures, and treatment system monitoring data and interpretation.

6.0 PROJECT TEAM ORGANIZATION AND RESPONSIBILITIES

The activities described in this Work Plan will be performed by Atlantic Richfield and its contractors. Roles and responsibilities of the various project team members are summarized below.

6.1 PROJECT COORDINATORS

The primary Project Coordinators at the Site include Atlantic Richfield, EPA and the LRWQCB.

Atlantic Richfield's Environmental Business Manager (i.e. Project Manager and Coordinator) is:

Roy Thun, Environmental Business Manager
Atlantic Richfield Company
6 Centerpointe Drive, LPR 6-174
La Palma, CA 90623
TL: (661) 287-3855
FX: (661) 222-7349
E-mail: THUNRI1@bp.com

Chris Winsor, Alternate Emergency Contact
Atlantic Richfield Company
6 Centerpointe Drive, LPR 6-174
La Palma, CA 90623
TL: (714) 670-5125
FX: (714) 670-5195
E-mail: WINSOHC@bp.com

Mr. Thun will manage all phases of the project and oversee project schedule and deliverables.

Communication with EPA will be directed to EPA's Remedial Project Manager (RPM) or Alternate RPM. EPA managers include:

Kevin Mayer, RPM
United States Environmental Protection Agency
75 Hawthorne Street SFD 7-2
San Francisco, CA 94105
TL: 415-972-3176

FX: 415-947-3526
E-mail: mayer.kevin@epa.gov

Cynthia Wetmore, Alternate RPM
United States Environmental Protection Agency
75 Hawthorne Street SFD 8-4
San Francisco, CA 94105
TL: 415-972-3059
E-mail: wetmore.cynthia@epa.gov

The LRWQCB Project Coordinator is:

Richard Booth
California Regional Water Quality Control Board
Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, CA 96150
TL: 530-542-5474
FX: 530-544-5470
E-mail: rbooth@waterboards.ca.gov

6.2 WATER TREATMENT SYSTEM DESIGN AND CONSTRUCTION

The primary contacts for water treatment system design and construction activities for Geomatrix and AMEC are listed below:

Ronald Borrego, PE
Principal Engineer
Geomatrix Consultants, Inc.
1401 17th Street, Suite 600
Denver, CO 80202
Office: (970) 764-4070
Cell: (303) 638-2608
E-mail: rborrego@geomatrix.com

Thomas Higgs, PE
Senior Process Engineer
AMEC
111 Dunsmuir Street, Suite 400
Vancouver, British Columbia, Canada V6B 5W3
Office: (604) 664-4542
Cell: (604) 512-1244

E-mail: tom.higgs@amec.com

6.3 SITE OPERATIONS AND MAINTENANCE

Geomatrix will have overall responsibility of work activities performed on behalf of Atlantic Richfield and their contractors including the operations and maintenance of water treatment systems operated by Atlantic Richfield. The primary contacts for anticipated work activities that are considered to be related to site operations and maintenance include the following:

Marc Lombardi, PG
Senior Hydrogeologist
Geomatrix Consultants, Inc.
10670 White Rock Road, Suite 100
Rancho Cordova, CA 95670
Office: (916) 636-3200
Cell: (916) 302-6326
E-mail: mlombardi@geomatrix.com

Randy Miller
Associate Engineer
Broadbent & Associates, Inc.
2000 Kirman Ave.
Reno, NV 89502
phone (775) 322-7969
E-mail: rlmiller@broadbentinc.com

6.4 HSSE COORDINATION AND OVERSIGHT

Geomatrix and Copper Environmental will provide onsite health and safety coordination and oversight for field activities in 2007 and 2008 in accordance with a Year-Round Site Specific Health Safety Plan currently in preparation by Geomatrix. Geomatrix personnel will have primary responsibility for ensuring that all work is performed in a safe manner and will provide an Onsite Health and Safety Coordinator to coordinate the HSSE elements of all work activities. Copper Environmental will provide HSSE oversight on behalf of Atlantic Richfield to ensure that all work is performed in compliance with Atlantic Richfield's HSSE requirements and protocols. The primary contacts for HSSE coordination and oversight for Geomatrix and Copper Environmental are as follows:

Donald Kubik, PG
Corporate Health and Safety Manager
Geomatrix Consultants, Inc.
2101 Webster Street, 12th Floor
Oakland, CA 94612
Office: (510) 663-4115
Cell: (510) 368-6433
E-mail: dkubik@geomatrix.com

Dave McCarthy
Principal
Copper Environmental Consulting, LLC
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Anaconda, MT 59711

Office: (406) 560-2719
E-mail: dave.mccarthy@copperenv.com

7.0 IMPLEMENTATION SCHEDULE

This section provides a general overview of the anticipated implementation schedule for planned 2007 and 2008 treatment activities. A conceptual schedule showing the sequence and anticipated time frames for planned activities is shown on Figure 7-1. These schedule projections are approximate and subject to change in the event of delays related to procurement of supplies, contractors, and equipment, administrative approvals, treatment system design changes, and other circumstances inherent to working at a high altitude mine site with limited access.

The implementation of the activities described in this Work Plan began in January 2007 with ongoing operations and maintenance activities at the Aspen Seep Bioreactor System. Beginning in March 2007, a number of site improvements at the Aspen Seep Bioreactor System were implemented. Concurrently with site improvement activities at the Aspen Seep, Atlantic Richfield and their contractors have been working on engineering designs and equipment procurement for both the Pond 4 Lime Treatment System and the HDS Treatment System. In mid-May 2007, Atlantic Richfield's contractors mobilized to the Site to begin assembly of the Pond 4 Lime Treatment System and the CUD collection and conveyance system. The CUD collection and conveyance system was placed into operation on June 15, 2007 and began pumping flow from the CUD into Pond 4. On June 19, 2007, the Pond 4 Lime Treatment System began treating AMD directly from the CUD and untreated water from Pond 4. System optimization will occur as necessary to improve system performance. Construction of a temporary collection and conveyance system from the DS to the Pond 4 Lime Treatment System is currently underway and is anticipated to be operational by late June or early July. The Pond 4 Lime Treatment System will be operated into the fall of 2007 for as long as site conditions allow for the safe and reliable operation of the system and delivery of needed supplies. All components of the Pond 4 Lime Treatment System will be decommissioned and stored on Site to facilitate an early start of treatment in the spring of 2008. In 2008 it is expected that treatment of CUD and DS flows will be initiated as soon as site conditions allow for safe access to the site, safe delivery of required chemicals (such as lime slurry) and other essential supplies, and operation of the system without the risk of damage from sub-freezing temperatures.

Engineering designs for the 2008 HDS Treatment System and Treatment Building commenced in early 2007. Atlantic Richfield will submit a design document presenting process design criteria for the 2008 HDS Treatment System under separate cover in June 2007. Equipment procurement activities for the HDS Treatment System are currently underway. Before equipment orders are placed, engineering designs must be approved, price inquiries issued to prospective vendors, quotes and vendor qualifications evaluated, and purchase orders issued. It is anticipated that equipment orders will be placed for those items requiring longer delivery times starting in July 2007 and will extend into September 2007. Procurement activities are also underway for the fabrication and erection of a pre-engineered treatment building. Erection of the Treatment Building is currently planned for August and September 2007 but is dependant on contractor availability.

8.0 REFERENCES

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TABLES

TABLE 3-1
POND 4 FILTER BAG SLUDGE SAMPLES: COLLECTED JUNE 1, 2007
Draft - Provisional Data. Grab samples.

Parameter	**Bag D Total Metals** (004 Sludge D 021) **mg/kg**	**Bag E Total Metals** (004 Sludge E 026) **mg/kg**	**Bag D STLC** (004 Sludge D 022) **mg/l**	**Bag E STLC** (004 Sludge E 027) **mg/l**	**Bag D TCLP** (004 Sludge D 023) **mg/l**	**Bag E TCLP** (004 Sludge E 028) **mg/l**	**Bag D SPLP** (004 Sludge D 024) **mg/l**	**Bag E SPLP** (004 Sludge E 029) **mg/l**	**TTLC** (Regulatory Limits for Total Metals) **mg/kg**	**STLC** (Regulatory Limits) **mg/l**	**TCLP** (Regulatory Limits) **mg/l**
Aluminum	3600	4700	230	170	<0.40	<0.40	<0.40	<0.40	NA[1]	NA	NA
Antimony	<0.88[2]	<1.8	<0.14	<0.14	<0.070	<0.070	<0.070	<0.070	500	15	NA
Arsenic	47	58	1.6	0.61	<0.065	<0.065	<0.065	<0.065	500	5	5.0
Barium	1.5	2.6	<0.12	<0.12	<0.060	<0.060	<0.060	<0.060	10,000	100	100.0
Beryllium	0.64	0.88[3]	0.032[3]	0.033[3]	<0.010	<0.010	<0.010	<0.010	75	0.75	NA
Cadmium	0.30[3]	<0.40	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	100	1	1.0
Chromium	2.4	2.5	0.12	0.11	<0.020	<0.020	<0.020	<0.020	500[4] (2,500)[5]	5	5.0
Cobalt	52	78	3.3	2.7	<0.020	<0.020	<0.020	<0.020	8,000	80	NA
Copper	0.58[3]	0.86[3]	<0.060	<0.060	<0.030	<0.030	<0.030	<0.030	2,500	25	NA
Iron	23,000	31,000	1500	990	<0.15	<0.15	<0.15	<0.15	NA	NA	NA
Lead	0.88[3]	2.0[3]	<0.060	<0.060	<0.030	<0.030	<0.030	<0.030	1,000	5.0	5.0
Mercury	0.014[3]	<0.0080	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	20	0.2	0.2
Molybdenum	0.84[3]	1.2[3]	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	3,500	350	NA
Nickel	120	170	6.1	3.8	<0.020	<0.020	<0.020	<0.020	2,000	20	NA
Selenium	<1.0	<2.0	<0.16	<0.16	<0.080	<0.080	<0.080	<0.080	100	1	1.0
Silver	<0.8	<1.6	<0.12	<0.12	<0.060	<0.060	<0.060	<0.060	500	5	5.0
Thallium	<0.8	<1.6	<0.14	<0.14	<0.070	<0.070	<0.070	<0.070	700	7	NA
Vanadium	9.6	9.8	0.34	0.15[3]	<0.030	<0.030	<0.030	<0.030	2,400	24	NA
Zinc	24	36	1.0	0.68	<0.040	<0.040	<0.040	<0.040	5,000	250	NA
Bag D pH (004 Sludge D 025) (Standard Units)				9.19	---	---	---	---	NA	NA	NA
Bag E pH (004 Sludge E 030) (Standard Units)				9.45	---	---	---	---	NA	NA	NA

1 NA = Not Applicable.
2 < = Compound Not Detected; concentration was below the method detection limit.
3 Concentration is below the reporting limit and above the method detection limit; data is of limited reliability.
4 Concentration limit for Chromium (IV).
5 Concentration limit for Chromium and/or Chromium (III).

TABLE 3-2
ASPEN SEEP SLUDGE SAMPLES: COLLECTED MAY 31, 2007
Draft - Provisional Data. Grab samples of wet sludge collected from Bioreactor Ponds 3 & 4.

Parameter	**BR[1] Pond4 Total Metals** (036 Sludge 071) **mg/kg**	**BR Pond3 Total Metals** (036 Sludge 076) **mg/kg**	**BR Pond4 STLC** (036 Sludge 072) **mg/l**	**BR Pond3 STLC** (036 Sludge 077) **mg/l**	**BR Pond4 TCLP** (036 Sludge 073) **mg/l**	**BR Pond3 TCLP** (036 Sludge 078) **mg/l**	**BR Pond4 SPLP** (036 Sludge 074) **mg/l**	**BR Pond3 SPLP** (036 Sludge 079) **mg/l**	**TTLC** (Regulatory Limits for Total Metals) **mg/kg**	**STLC** (Regulatory Limits) **mg/l**	**TCLP** (Regulatory Limits) **mg/l**
Aluminum	450	990	120	71	20	17	<0.40	<0.40	NA[2]	NA	NA
Antimony	<0.88[3]	1.1[4]	<0.14	<0.14	<0.070	<0.070	<0.070	<0.070	500	15	NA
Arsenic	<0.81	<0.81	<0.13	<0.13	<0.065	<0.065	<0.065	<0.065	500	5	5.0
Barium	<0.80	<0.80	<0.12	<0.12	<0.060	<0.060	<0.060	<0.060	10,000	100	100.0
Beryllium	<0.20	<0.20	0.023[4]	0.019[4]	<0.010	<0.010	<0.010	<0.010	75	0.75	NA
Cadmium	<0.20	<0.20	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	100	1	1.0
Chromium	<0.30	<0.30	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	500[5] (2,500)[6]	5	5.0
Cobalt	2.5	7.3	0.099[4]	0.48	0.063[4]	0.22	<0.020	0.052[4]	8,000	80	NA
Copper	14	27	<0.060	1.7	0.10[4]	0.49	<0.030	<0.030	2,500	25	NA
Iron	940	2,600	250	190	82	18	40	1.3	NA	NA	NA
Lead	<0.40	<0.40	<0.060	<0.060	<0.030	<0.030	<0.030	<0.030	1,000	5.0	5.0
Mercury	0.014[4]	<0.0080	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	20	0.2	0.2
Molybdenum	<0.20	<0.20	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	3,500	350	NA
Nickel	3.8	11	0.36	0.82	0.22	0.36	<0.020	0.087[4]	2,000	20	NA
Selenium	<1.0	<1.0	<0.16	<0.16	<0.080	<0.080	<0.080	<0.080	100	1	1.0
Silver	<0.80	<0.80	<0.12	<0.12	<0.060	<0.060	<0.060	<0.060	500	5	5.0
Thallium	<0.80	<0.80	0.15[4]	0.15[4]	<0.070	<0.070	<0.070	<0.070	700	7	NA
Vanadium	<0.30	<0.30	<0.060	<0.060	<0.030	<0.030	<0.030	<0.030	2,400	24	NA
Zinc	6.5	17	0.84	1.2	0.15[4]	0.47	<0.040	<0.040	5,000	250	NA
Pond 3 pH (036 Sludge 080) (Standard Units)				7.92	---	---	---	---	NA	NA	NA
Pond 4 pH (036 Sludge 075) (Standard Units)				7.81	---	---	---	---	NA	NA	NA

1 BR = Bioreactor.
2 NA = Not Applicable.
3 < = Compound Not Detected; concentration was below the method detection limit.
4 Concentration is below the reporting limit and above the method detection limit.
5 Concentration limit for Chromium (IV).
6 Concentration limit for Chromium and/or Chromium (III).

TABLE 4-1

EFFLUENT DISCHARGE CRITERIA

Concentrations in [mg/L except pH which is in s.u.]

Parameter[1]	Maximum[1]	Average[3]
pH		6.0 – 9.0
Aluminum	4.0	2.0
Arsenic	0.34	0.15
Cadmium[4]	0.009	0.004
Chromium[4]	0.97	0.31
Copper[4]	0.026	0.016
Iron	2.0	1.0
Lead[4]	0.136	0.005
Nickel[4]	0.84	0.094
Selenium[4]	Not Promulgated	0.005
Zinc[4]	0.21	0.21

1 All metals concentrations based on dissolved fraction, except Selenium, which is for total recoverable.

2 Concentrations are based on a daily composite of three grab samples, each grab sample for metals analysis to be field-filtered and acid fixed promptly after collection.

3 Concentrations are based on four daily composite samples, each composite sample consists of three grab samples collected and combined in one day (EPA, 2001). For metals analysis each grab sample is field filtered and acid fixed promptly after collection.

4 Values calculated from 40 CFR 131.38 using hardness of 200 mg/L of $CaCO_3$.

TABLE 4-2

TREATMENT SOLIDS HAZARDOUS CHARACTERIZATION LIMITS

Concentrations in [measurement units]

Parameter	STLC Extract mg/L	TCLP and SPLP Extract mg/L	TTLC mg/kg
Al	NP	NP	NP
Sb	15	NP	500
As	5	5	500
Ba	100	100	10,000
Be	0.75	NP	75
Cd	1	1	100
Ca	NA	NA	NA
Cr	560	5	2,500
Co	80	NP	8,000
Cu	25	NP	2,500
Fe	NP	NP	NP
Pb	5	5	1,000
Mg	NA	NA	NA
Hg	0.2	0.2	20
Mo	350	NP	3,500
Ni	20	NP	2,000
Se	1	1	100
Ag	5	5	500
Ti	7	NP	700
Tl	7	NP	700
V	24	NP	2,400
Zn	250	NP	5,000

1 STLC – California Soluble Threshold Limit Concentration

2 TCLP – Toxicity Characteristic Leaching Procedure (40CFR261.24)

3 TTLC – California Total Threshold Limit Concentration; based on wet weight conc.

4 SPLP – Synthetic Precipitation Leaching Procedure

5 NA – Not Available; Ca and Mg not applicable for hazardous characterization but included in solids analytical parameter list to facilitate mass balance calculations.

6 NP – Not Promulgated

TABLE 4-3

2007 POND 4 LIME TREATMENT SYSTEM AND ASPEN SEEP BIOREACTOR SAMPLINGAND ANALYSIS SCHEDULE

Sample Location	Sample ID Designation	Field Parameters	Sample Frequency	Analytical Parameters	Sample Frequency
Pond 4 Lime Treatment System					
CUD Flow &, DS Flow	CUD & DS	pH, Temp, SpC, DO, Flow rate	Daily	Acidity, alkalinity, hardness, Ca, Cl, Mg, sulfate, TDS, TSS, and target metals[1]	Every seven days[2]
CUD/DS Equalization Tank	P4LTS-In	pH, Temp, SpC, DO, Flow rate, Fe^{2+}/Fe_{total} (Hach)[3]	Daily	Acidity, alkalinity, hardness, Ca, Cl, Mg, sulfate, TDS, TSS, and target metals[1]	Every seven days[2]
P4LTS Effluent	P4LTS-Out	pH, Temp, SpC, DO, Flow rate, Fe^{2+}/Fe_{total} (Hach) [3]	Three times daily or continuously[4]	Alkalinity, hardness, Ca, Cl, Mg, sulfate, TDS, TSS, and target metals[1]	Every seven days[2,5]
Pond 4 Pre-discharge	PND4 PREDIS	pH, Temp, SpC, DO, Flow rate, Fe^{2+}/Fe_{total} (Hach) [3]	Prior to discharge & during discharge	Acidity, alkalinity, hardness, Ca, Cl, Mg, sulfate, TDS, TSS, and target metals[1]	Three days prior to discharge to Leviathan Creek[2]
Effluent	Effluent	pH, Temp, SpC, DO, Flow rate	Daily during discharge	Acidity, alkalinity, hardness, Ca, Cl, Mg, sulfate, TDS, TSS, and target metals[1]	Daily during discharge[2]
Pond 4 Sludge	P4-SLDG	NA	NA	TCLP, STLC, TTLC, SPLP, density, moisture content	Prior to sludge disposal
Aspen Seep Bioreactor					
Bioreactor Influent (USGS Weir)	ASPINF	pH, Temp, SpC, DO, Flow rate[6]	Weekly/Monthly[7]	Acidity, alkalinity, Ca, Cl, Mg, sulfate, TDS, TSS, and target metals[1]	Every two weeks/ Monthly[6]
Bioreactor Effluent	ASPEFF	pH, Temp, SpC, DO, Flow rate	Weekly/Monthly[7]	Acidity, alkalinity, Ca, Cl, Mg, sulfate, TDS, TSS, and target metals[1]	Every two weeks/ Monthly[6]
Process locations[7]	Vary	pH, Temp, SpC, DO, Flow rate	Weekly/Monthly[7]	NA	NA
Bioreactor Sludge	BR-SLDG	NA	NA	TCLP, STLC, TTLC, SPLP, density, moisture	Prior to sludge disposal

[1] Target metals are those listed in Table 4.1 to be measured as dissolved except selenium.
[2] Sample to consist of a composite of three grab samples, each grab sample field-filtered and acid fixed promptly after collection.
[3] Fe^{2+}/Fe_{total} measured calorimetrically once daily.
[4] Continuous will only apply to pH measurement.
[5] Weekly sampling will be conducted initially, with frequency adjusted based on correlation analysis of field measurements (ph and Fe_{total}) with analytical values.
[6] Monthly measurements during the winter.
[7] Process monitoring locations will vary with system configuration and will be selected as appropriate by the project engineer.

TABLE 4-4

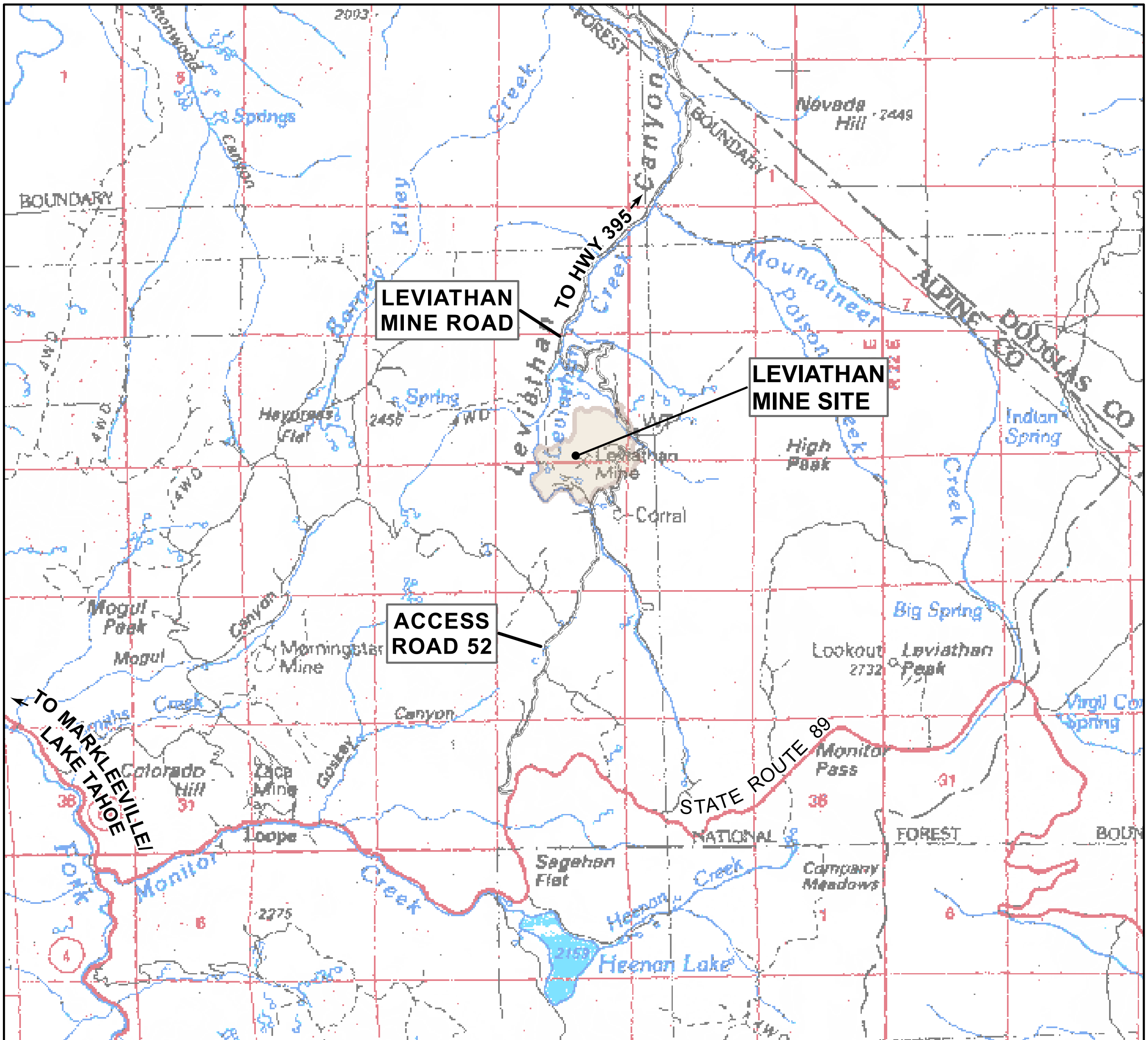
AQUEOUS AND SOLID PHASE LABORATORY ANALYTICAL LIST

Concentrations in [measurement units]

Parameter	Phase	Method [1]	Method Detection Limit	Units
WATER SAMPLES				
Anions and General Parameters				
Acidity	Dissolved	EPA 305.1	10.0	mg/L (as $CaCO_3$)
Alkalinity	Dissolved	EPA 310.1	5.0	mg/L (as $CaCO_3$)
Sulfate	Dissolved	EPA 300.0	5.0	Mg/L
Hardness	Laboratory	EPA 6010B - Calculation	1.0	mg/L (as $CaCO_3$)
Total Dissolved Solids	Filterable Residue	EPA 160.1/2540 C	10.0	Mg/L
Major Cations and Trace Metals				
Aluminum	Total & Dissolved	SW-846 6020	0.05	Mg/L
Arsenic	Total & Dissolved	SW-846 6020	0.005	Mg/L
Calcium	Total & Dissolved	SW-846 6010B	0.5	Mg/L
Cadmium	Total & Dissolved	SW-846 6020	0.001	Mg/L
Chromium	Total & Dissolved	SW-846 6020	0.005	Mg/L
Cobalt	Total & Dissolved	SW-846 6020	0.005	Mg/L
Copper	Total & Dissolved	SW-846 6020	0.005	Mg/L
Iron	Total & Dissolved	SW-846 6010B	0.1	Mg/L
Lead	Total & Dissolved	SW-846 6020	0.001	Mg/L
Magnesium	Total & Dissolved	SW-846 6010B	0.5	Mg/L
Manganese	Total & Dissolved	SW-846 6010B	0.005	Mg/L
Nickel	Total & Dissolved	SW-846 6020	0.005	Mg/L
Selenium	Total	SW-846 6020	0.002	Mg/L
Zinc	Total & Dissolved	SW-846 6020	0.005	Mg/L
SOLIDS SAMPLES				
TCLP	Sludge	SW-846 1311/3010AMod/6010B	Varies	Mg/L
SPLP	Sludge	SW-846 1312/6010B	Varies	Mg/L
TTLC (Total Metals) STLC (Cal WET) Density Specific Gravity	Sludge Sludge Sludge/Slurry Sludge/Slurry	SW 3050B (wet weight) /6010B CCR Title 22 WET/6010B ASTM E1109 (ASTM D2937) ASTM 2710F	Varies Varies NA NA	mg/kg mg/L g/cc
Moisture Content	Sludge/Slurry	ASTM 2450B	0.1	%

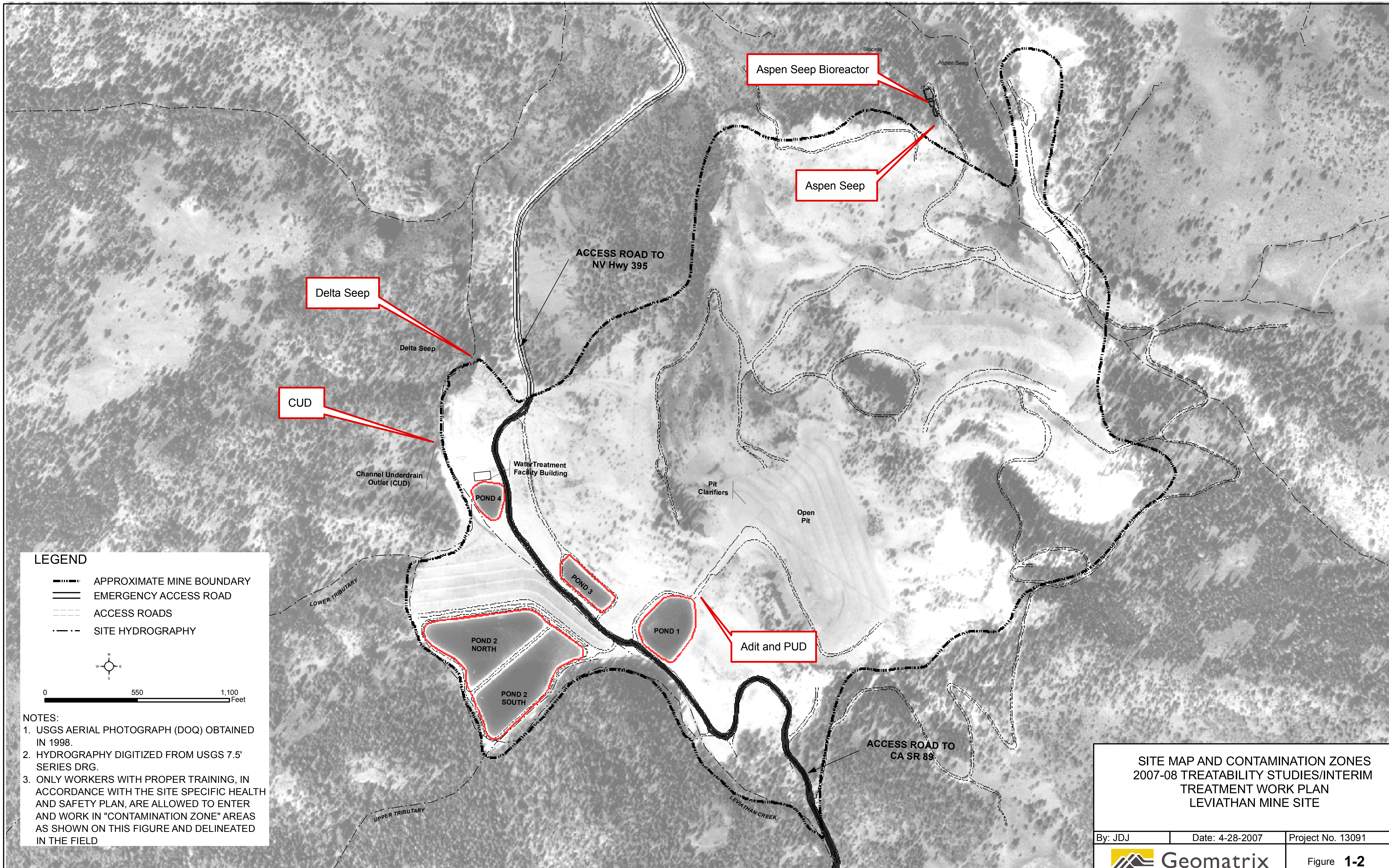
[1] Major cations and trace metals analyses may be performed by either EPA 6010B (ICP) or EPA 6020 (ICP-MS) depending upon the requirements of the project-specific Work Plan.

FIGURES

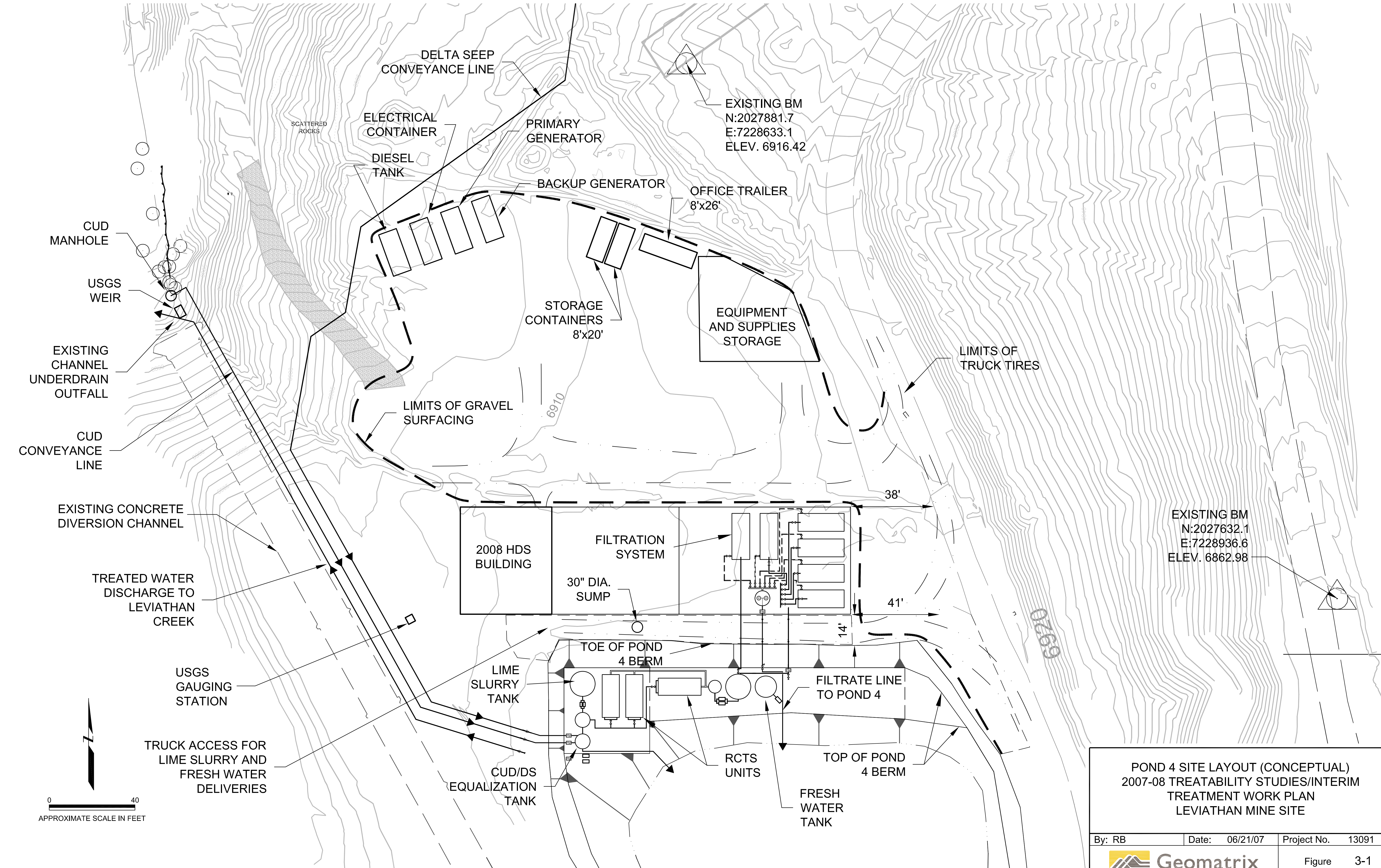


LEVIATHAN MINE - PROPERTY LIES WITHIN A REMOTE PORTION OF NORTHEASTERN ALPINE COUNTY, CALIFORNIA, ON THE EASTERN SLOPE OF THE SIERRA NEVADA MOUNTAIN RANGE, APPROX. 25 MILES SOUTHEAST OF LAKE TAHOE, SIX MILES EAST OF MARKLEEVILLE, AND THREE MILES WEST OF THE CALIFORNIA-NEVADA BORDER, WITHIN THE HUMBOLDT-TOYIABE NATIONAL FOREST.

SITE LOCATION MAP 2007-08 TREATABILITY STUDIES/INTERIM TREATMENT WORK PLAN LEVIATHAN MINE SITE		
By: JDJ	Date: 4-28-2007	Project No. 13091
Geomatrix		Figure **1-1**

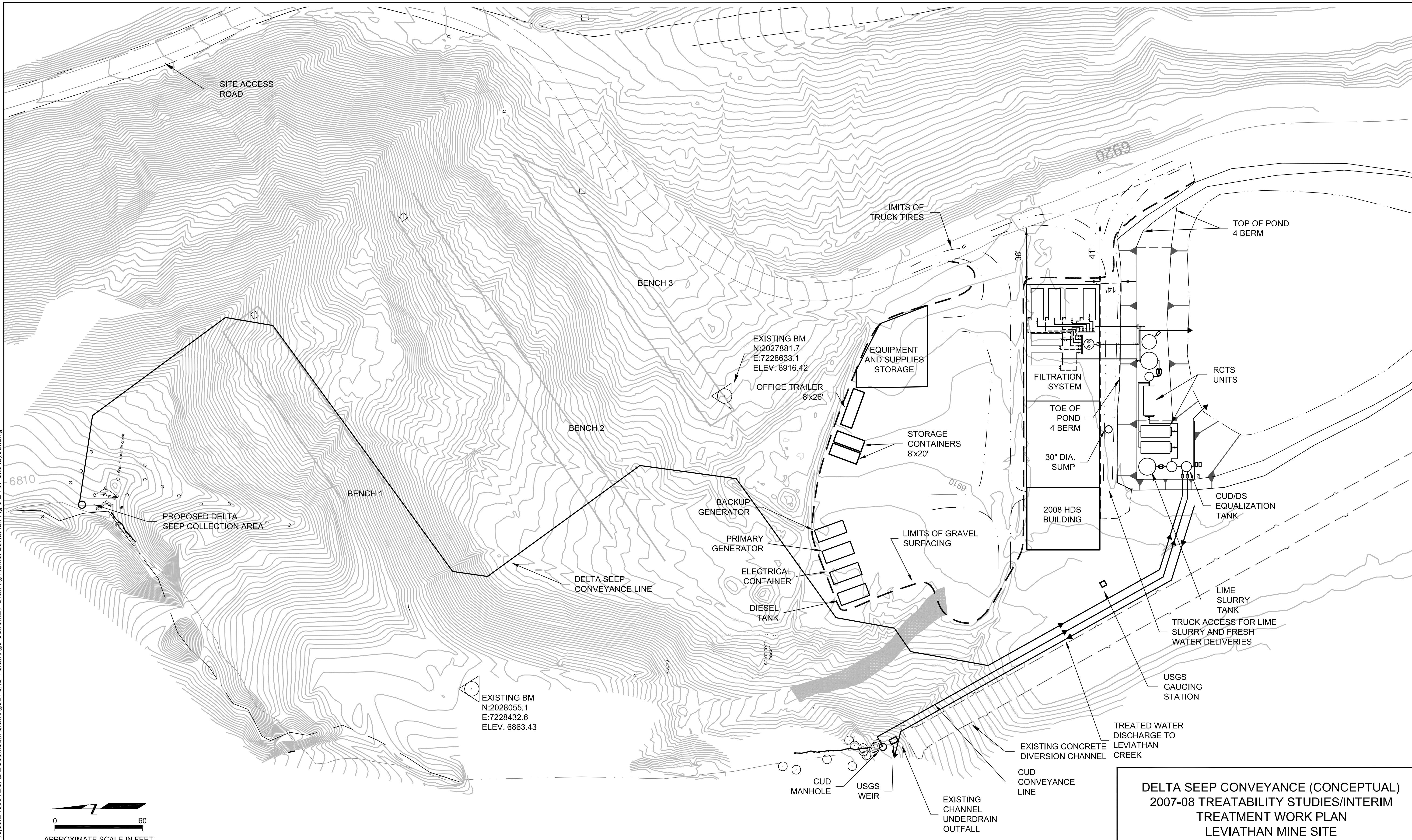


K:\Projects\Leviathan_13091\GIS_Maps\MapDocuments\BG1081-B112_SH&S SiteMap



POND 4 SITE LAYOUT (CONCEPTUAL)
2007-08 TREATABILITY STUDIES/INTERIM TREATMENT WORK PLAN
LEVIATHAN MINE SITE

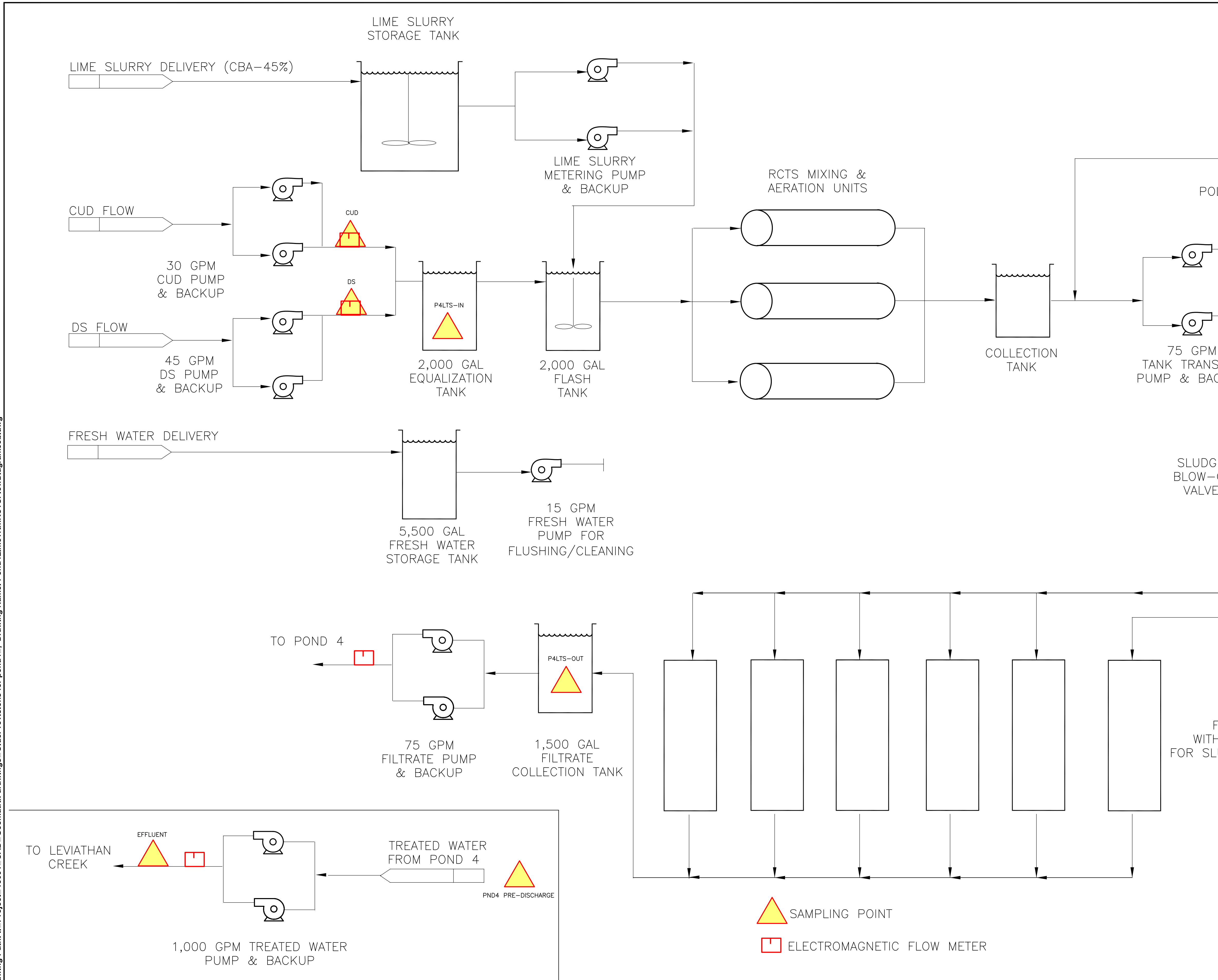
By: RB	Date: 06/21/07	Project No. 13091
Geomatrix		Figure 3-1



DELTA SEEP CONVEYANCE (CONCEPTUAL)
2007-08 TREATABILITY STUDIES/INTERIM
TREATMENT WORK PLAN
LEVIATHAN MINE SITE

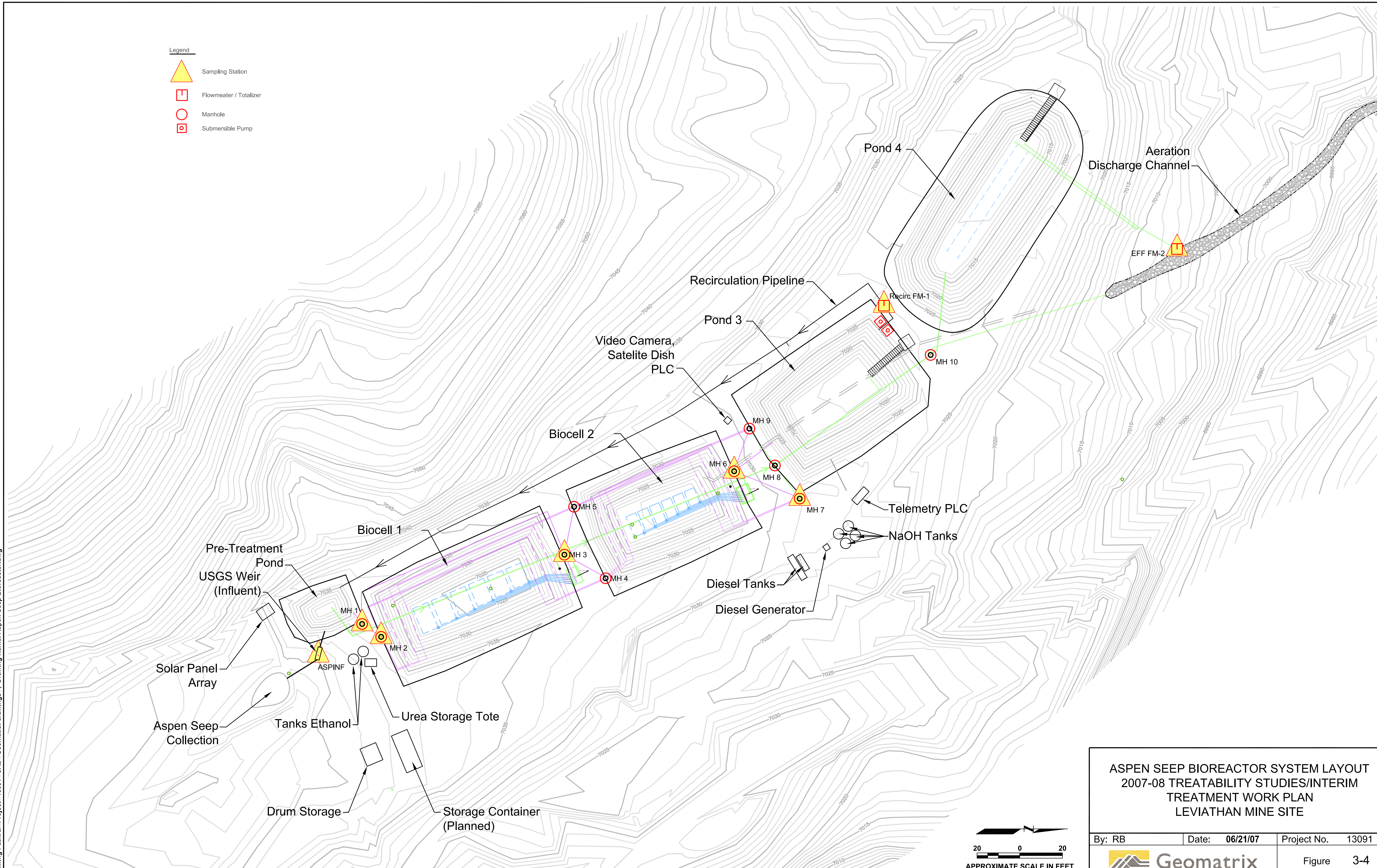
By: RB	Date: 06/21/07	Project No. 13091
Geomatrix		Figure 3-2

Plot Date: 06/21/07 - 6:05pm, Plotted by: jjenkins
Drawing Path: I:\ Project\ 13091\ CAD\ Geomatrix drawings\ Pond 4 drawings-Current\, Drawing Name: Leviathan Fig 3-2 Full Site layout.dwg



PROCESS FLOW DIAGRAM
POND 4 LIME TREATMENT SYSTEM
2007-08 TREATABILITY STUDIES/INTERIM TREATMENT WORK PLAN
LEVIATHAN MINE SITE

By: RB	Date: 06/21/07	Project No. 13091
Geomatrix		Figure 3-3



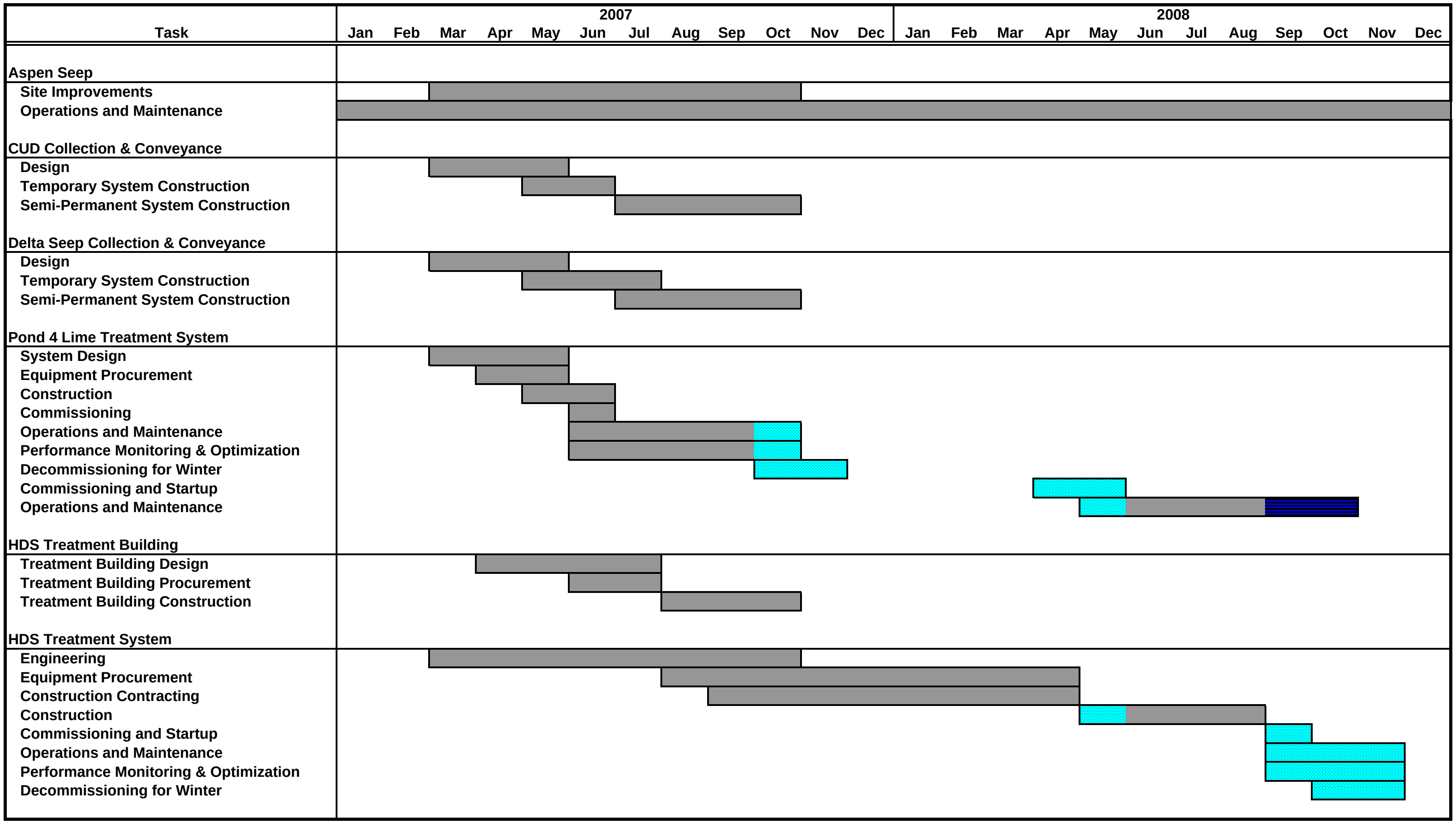
ASPEN SEEP BIOREACTOR SYSTEM LAYOUT
2007-08 TREATABILITY STUDIES/INTERIM
TREATMENT WORK PLAN
LEVIATHAN MINE SITE

By: RB | Date: 06/21/07 | Project No. 13091

Geomatrix | Figure 3-4

Plot Date: 06/21/07 - 6:34pm, Plotted by: jjenkins
Drawing Path: I:_Project_13091_CAD_Geomatrix drawings_, Drawing Name: Aspen Seep Bioreactor.dwg

Figure 7-1. Anticipated Time Frames for Proposed 2007-08 Treatability Studies and Interim Actions



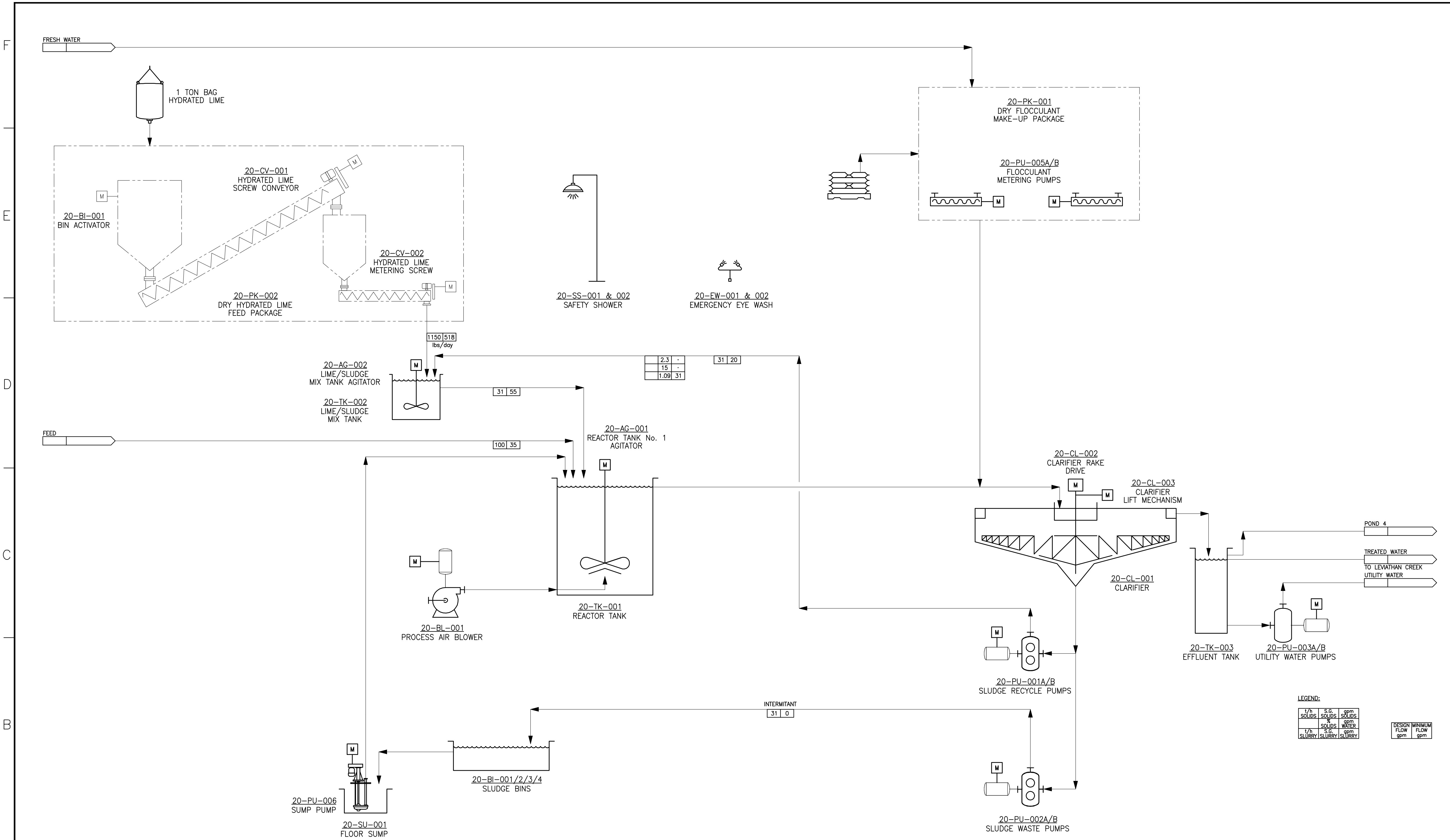
Note: All schedule projections are estimated and subject to change in the event of procurement/supply delays, need for adminstrative approvals, required design changes and other circumstances inherent to working at a high altitude site with limited access.

Explanation:

- indicates anticipated time frame of proposed activities

- indicates that anticipated operation and maintenance schedule dependant on startup of HDS Treatment System

- indicates that anticipated activities are subject to safe access of personnel, equipment, and supplies to the Site



REV	D/M/Y	REVISION	DRN	CHK	APP	APP	APP	APP
P4	06/06/07	SLUDGE WASTE FLOW RATE INDICATED	DP					
P3	01/05/07	2 ND REACTOR DELETED AND FEED TO CLARIFIER NOW BY GRAVITY	RT					
P1	11/04/07	RE-ISSUED FOR CLIENT APPROVAL	RT					
A	06/03/07	ISSUED FOR CLIENT APPROVAL	JY					

ISS	D/M/Y	APP	ISSUED FOR	REV
D	06/06/07	DHL	CLIENT APPROVAL	P4
C	01/05/07	RT	CLIENT APPROVAL	P3
B	11/04/07	DHL	CLIENT APPROVAL	P2

REFERENCES

REF	NUMBER	TITLE
-		

STAMP/SEAL

APPROVED FOR CONSTRUCTION

CLIENT PROJECT MGR. DEPARTMENT MGR. PROJECT MGR.

PROJECT NO. 154522

PACKAGE CODE

	BY	D/M/Y
DSN.	DHL	01/03/07
DRN.	JY	01/03/07
CHK.		
APP.		

SCALE NTS

amec

AREA | AREA NAME HDS 2008

TITLE
ATLANTIC RICHFIELD CO.
LEVIATHAN MINE
2008 HDS PLANT
PROCESS FLOWSHEET

CLIENT NAME/LOGO

PROJECT NAME LEVIATHAN MINE

CLIENT DWG. NO.

DRAWING NO. D-154522-20-N-011 | REV. P4

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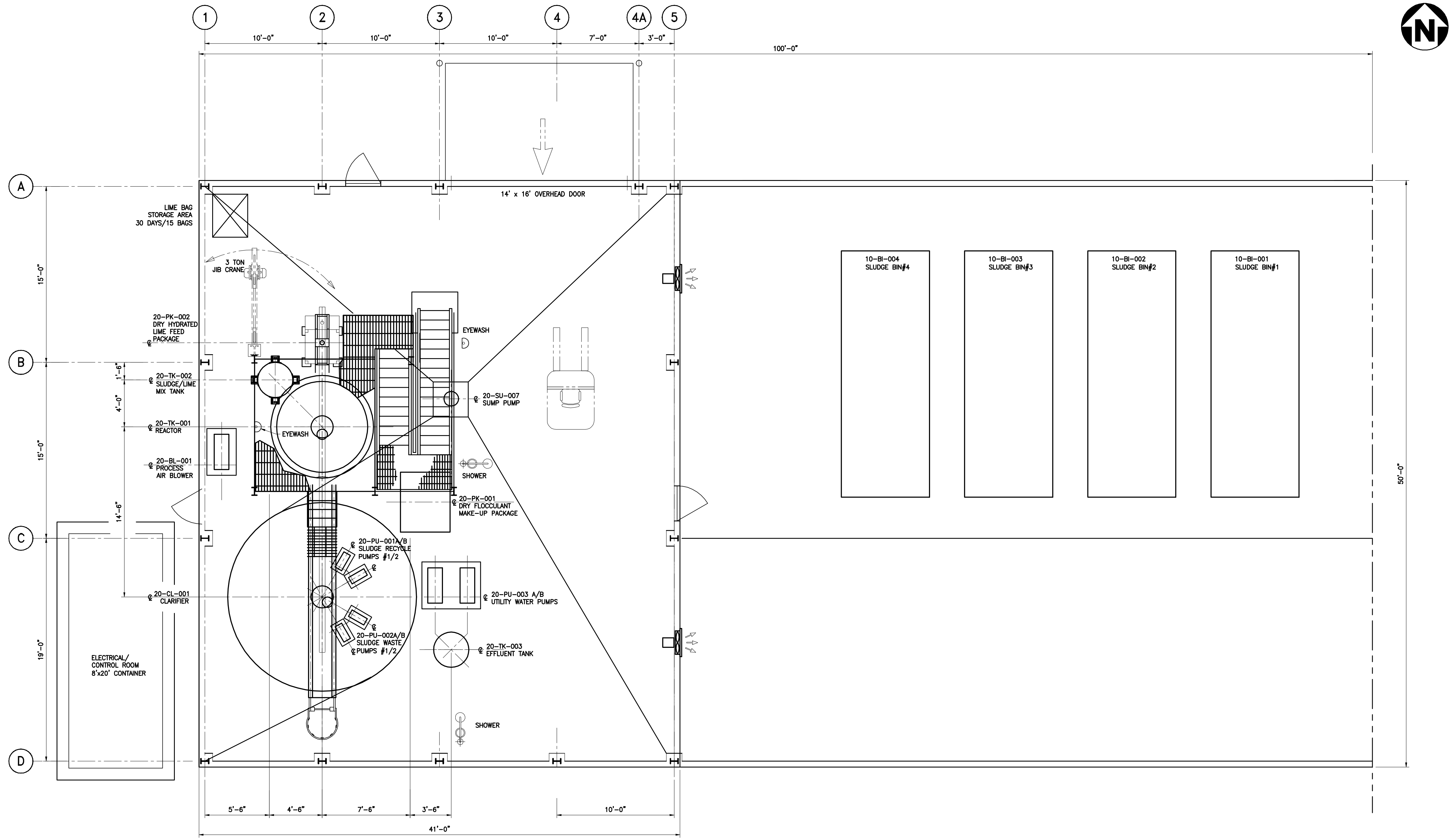

PLAN @ NOM EL

0' 5' 10'
1/4"=1'-0"

REV	D/M/Y	REVISION	DRN	CHK	APP	APP	APP	APP
P3	06/06/07	LIME / SLUDGE MIX TANK SIZE INCREASE	DP					
P2	30/04/07	UPDATED	RT					
P1		ISSUED FOR CLIENT APPROVAL	RT					

ISS	D/M/Y	APP	ISSUED FOR	REV
C	06/06/07	DHL	CLIENT APPROVAL	P3
B	30/04/07	DHL	RE-ISSUED FOR CLIENT APPROVAL	P2
A		DHL	CLIENT APPROVAL	P1

REFERENCES

REF	NUMBER	TITLE
-		

STAMP/SEAL

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CLIENT PROJECT MGR. DEPARTMENT MGR. PROJECT MGR.

PROJECT NO.		BY	D/M/Y
154522	DSN.	DHL	16/04/07
	DRN.	RTIESSENS	16/04/07
PACKAGE CODE XXX	CHK.		
	APP.		

SCALE 1/4"=1'-0"

amec

AREA | AREA NAME HDS 2008

TITLE
ATLANTIC RICHFIELD CO
LEVIATHAN MINE
2008 HDS PLANT
MECHANICAL GENERAL ARRANGEMENT

CLIENT NAME/LOGO

PROJECT NAME

CLIENT DWG. NO.
TO COME

DRAWING NO. D-154522-20-M-0004

REV. P3

CADD FILE ADDRESS
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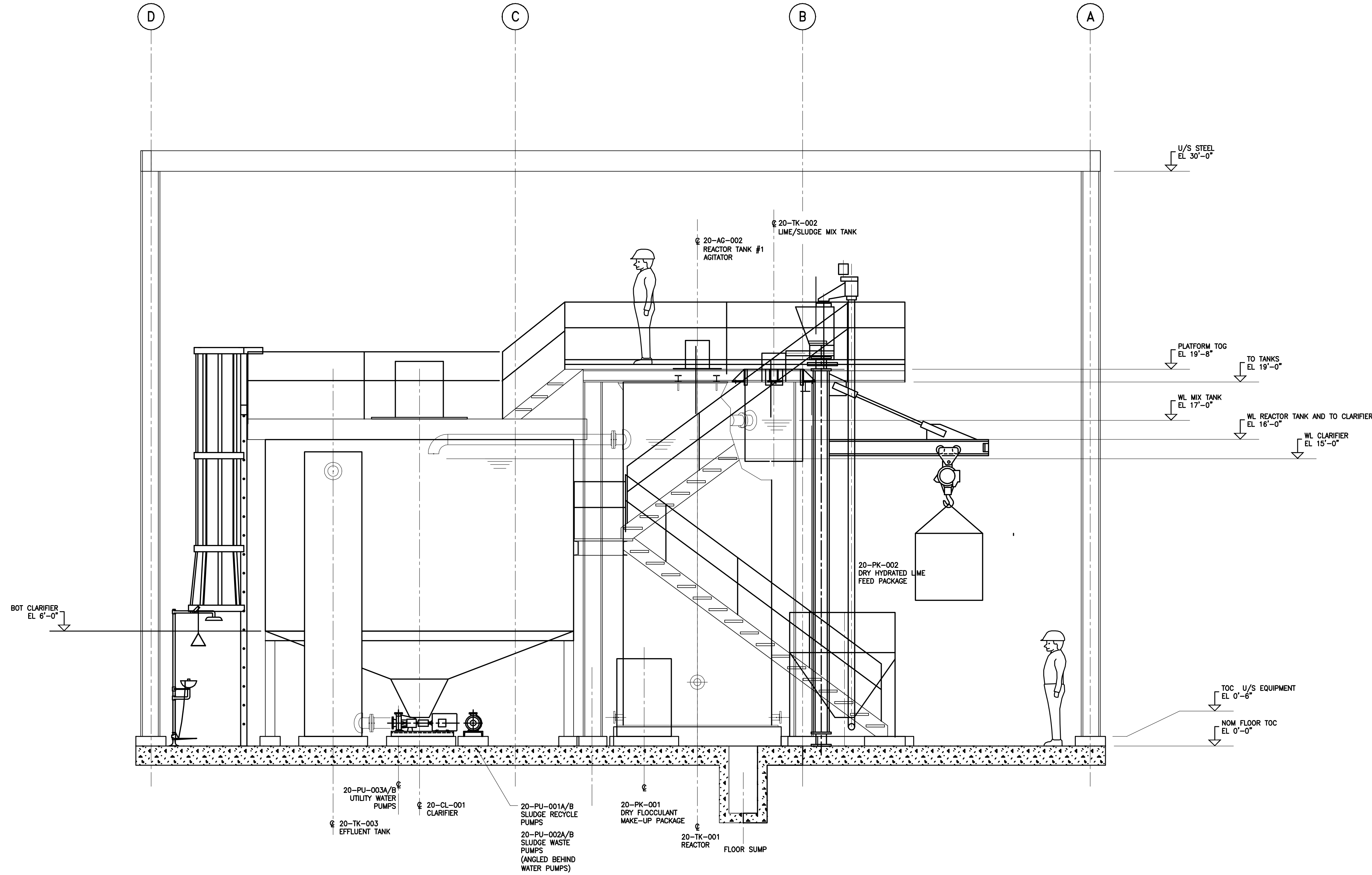

ELEVATION

0' 5'
3/8"=1'-0"

REV	D/M/Y	REVISION	DRN	CHK	APP	APP	APP	APP
P3	06/06/07	LIME/SLUDGE MIX TANK SIZE INCREASE	DP					
P2	30/04/07	UPDATED	RT					
P1		ISSUED FOR CLIENT APPROVAL	RT					

ISS	D/M/Y	APP	ISSUED FOR	REV
C	06/06/07	DHL	CLIENT APPROVAL	P3
B	30/04/07	DHL	REISSSUED FOR CLIENT APPROVAL	P2
A		DHL	CLIENT APPROVAL	P1

REF	NUMBER	TITLE
-		

REFERENCES

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CLIENT PROJECT MGR. DEPARTMENT MGR. PROJECT MGR.

PROJECT NO. 154522

	BY	D/M/Y
DSN.	DHL	16/04/07
DRN.	RTIESSENS	16/04/07
CHK.		
APP.		

PACKAGE CODE XXX

SCALE 3/8"=1'-0"

amec

AREA

AREA NAME HDS 2008

TITLE
ATLANTIC RICHFIELD CO
LEVIATHAN MINE
2008 HDS PLANT
GENERAL ARRANGEMENT ELEVATION

CLIENT NAME/LOGO

PROJECT NAME

CLIENT DWG. NO.
TO COME

DRAWING NO.
D-154522-20-M-0005

REV.
P3

CADD FILE ADDRESS
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