AP-5 Pond Phase II Project Implementation Basis of Design Update

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August 24, 2016

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APPENDICES

1.0 INTRODUCTION

At the direction of the Nevada Environmental Response Trust (NERT or Trust), Tetra Tech, Inc. (Tetra Tech) has prepared this design update for the AP-5 Pond solids removal and treatment system. Specifically, this document updates the Phase II Work Plan for AP-5 Solids Removal dated March 13, 2015 (Work Plan) and approved by the Nevada Division of Environmental Protection (NDEP) on March 24, 2015. This document contains the final process design and a refreshed project budget as requested by NDEP in the March 24, 2015 approval letter. At the direction of the Trust, this update document is being provided for informational purposes only as implementation of the plan described herein is in progress and has been approved by Envirogen Technologies, Inc. (ETI).

This report presents the following:

- Project background (Section 2.0),
- Summary of treatability testing to support design (Section 3.0),
- Basis of design for the selected system alternative (Section 4.0),
- Permitting and compliance considerations (Section 5.0), and
- Summary (Section 6.0)

2.0 PROJECT BACKGROUND

Subsequent to Trust and NDEP approval of the Work Plan, Tetra Tech advanced the design of the Phase II process using iterative methods that included hazard operability reviews, field sampling, and bench-scale treatability testing. The findings of the hazard operability review were used to guide the field sampling and subsequent treatability testing. Tetra Tech implemented a preliminary solids sampling event in August 2015 to support design work by obtaining silt and crystal samples for chemical analysis, physical property, and explosives testing. The results raised significant safety concerns related to the planned design and implementation, which led to further sampling and testing. In December 2015, Tetra Tech completed an advanced solids sampling program to support the design work by obtaining discrete and bulk silt, crystal, and waxy substance samples for treatability and explosives testing and chemical analysis. The results of the treatability testing are summarized in Section 3.0. The design process has been further advanced by adapting to the additional treatability testing results, as presented below.

3.0 JANUARY 2016 TREATABILITY TESTING

Tetra Tech conducted treatability testing of the AP-5 Pond samples collected in December 2015 to support key design elements, including mixing, settling, and washing. Due to explosives safety concerns, the analysis was performed at Safety Consulting Engineers' (SCE) laboratory. Two rounds of treatability testing were performed in January 2016. The testing programs and results are summarized in the following subsections.

3.1 INITIAL TREATABILITY TESTING

Tetra Tech visited the SCE laboratory on January 6, 2016, to inspect the samples and perform bench scale testing to better understand the physical characteristics of the pond sediment.

Major findings from the laboratory visit include:

1. Sediment samples from some pond locations contained large ammonium perchlorate (AP) crystals.
2. Sediment samples that had not been mixed had separated into a compacted solids layer at the bottom of the sample with a water layer on top. This solids layer could not be easily disturbed or mixed. However,

once the solids layer was disturbed using a drill with shaft impeller, it could be mixed with the water to make a thick, pumpable slurry.

3. After the sediment samples were mixed, they were left undisturbed to evaluate gravity settling. The solids did not initially settle. Water was then added at a ratio of 1:1 water to sediment, and no settling was observed. However, when water was added at a ratio of 3:1 water to sediment, the solids settled quickly.
4. While AP has high solubility in water at 20°C, AP crystals dissolved slowly at this temperature, taking almost 30 minutes of mixing. The dissolution time decreased to less than one minute when 60°C water was added to the AP crystals.

3.2 ADDITIONAL TREATABILITY TESTS

Based on the above findings, additional treatability tests were requested. Tetra Tech oversaw the additional testing at the SCE laboratory on January 21-22, 2016. The test objectives were to:

1. Confirm the observations from the initial laboratory visit.
2. Develop the interrelationship between conductivity and pure AP in solution at different concentrations.
3. Develop the interrelationship between conductivity and pond AP crystals in solution at different concentrations.
4. Determine additional sediment characteristics, such as moisture and AP content.
5. Evaluate the effect of temperature on AP dissolution rate in sediment, sediment settling rate, and extraction efficiency.
6. Conduct extraction (i.e., sediment washing) tests, settling tests, and Differential Scanning Calorimetry (DSC) tests to see if removing AP from sediments would render the cleaned sediments non-energetic.

Results from the additional treatability testing showed:

1. Conductivity curves prepared using pure AP and AP crystals from the AP-5 Pond were similar. This allows use of a conductivity meter as a real time proxy to measure AP concentration in decanted liquids during sediment washing/extraction tests.
2. Moisture content of the sediment were measured and ranged from 57 to 61%. Water was added to a sediment sample to simulate a representative sample of the pond contents, and the moisture content of that sample was 70%. This moisture content was used for further calculations.
3. Perchlorate content in the liquid fraction of the sediment samples was estimated using a conductivity meter and the proxy conductivity curves, and perchlorate concentrations ranged from 8.1 to 20.0%. Perchlorate content in the liquid fraction of the sediment samples was also measured by the laboratory, and perchlorate concentrations ranged from 7.6 to 19.2%.
4. Washing/extraction tests were conducted by adding water at a given ratio to a sediment sample. Water and sediment were mixed to extract AP from the sediment into the water phase, and then solids were allowed to settle. Water at the top of the sample was then removed along with any AP extracted from the sediment. This was repeated in stages until the AP concentrations in the sediment was below 1%, the current estimated threshold at which the dewatered solids are expected to be acceptable for disposal at a non-hazardous landfill. Washing/extraction tests were shown to be effective in reducing AP concentrations in the solids to less than 1% after 3 or 4 extraction stages.
5. DSC tests were conducted on washed slurries to characterize the solids for energetic/explosive potential. DSC results greater than 800 J/g are considered to be potentially explosive. DSC tests were run on selected washed sediment samples. Test results ranged from 330 to 607 J/g for dried samples. The test results suggest that the residual AP in the washed sediment does not pose an explosion hazard.
6. Adequate settling to facilitate decanting of water containing perchlorate was observed at a water to sediment ratio of 1:1, which was lower than observed during the initial treatability testing.

7. Large AP crystals did not dissolve during extraction tests unless heated water was added to raise the slurry temperature to at least 45°C (113°F).

3.3 FIELD MIXING AND PUMPING DEMONSTRATION TEST

A field mixing and pumping demonstration test was conducted in the AP-5 Pond on May 12 – 17, 2016. The purpose of the demonstration test was to verify the initial and additional treatability test results and to further evaluate several design components to validate or refine design parameters, including size and use of air operated double diaphragm (AODD) pumps and methods for heating and mixing the pond slurry. Results from the demonstration test showed the following:

1. AODD can be utilized to safely pump slurried pond sediments. Slurry with solids content up to approximately 40% was successfully pumped using a 3-inch AODD pump. Pump intake structure was determined to be a significant factor in the success of the pumping. The initial intake configuration resulted in low inlet velocities and clogging of the intake with sediments. To attempt to overcome the clogging issue, the intake design was modified to optimize the inlet velocity while not restricting flow. This proved to be successful and sustained pumping of high solids content slurry was achieved. The intake also intermittently became clogged with tumbleweeds, plastic, and miscellaneous debris.
2. Similar to what was observed during the treatability testing in the laboratory, initial mixing of the sediments proved to be difficult. Several mixing and jetting configurations were tested, and pressures of 3,000 psi and higher were found to be most effective. Thirty (30) minutes of mixing was required to fully break down the solids to a pumpable state in a six (6) foot diameter contained area. Once mixed, the sediments were more easily remixed into a slurry even after settling overnight.
3. Pressure jetting with cold water and with heated water was not effective at breaking down larger AP crystals to facilitate pumping to the Process Tanks. Rental boilers are being evaluated as an alternative to generate the quantity of heated water required to dissolve crystals to facilitate pumping to the Process Tanks.
4. The extent of AP crystals identified via probing was slightly larger than that determined in December 2015. Additional probing was completed in the northeast corner of the pond that had not been accessed during the December 2015 sampling event. A large, solid rectangular object was also identified on the bottom of the pond near the north end. The object was approximately 7 feet long by 4 feet wide and was partially obscured from probing by what is thought to be a submerged pipe or hose. The solid object and pipe or hose were located beneath sediments and could not be observed from the man basket.

4.0 BASIS OF DESIGN SUMMARY

The following subsections provide a description of the current treatment system design components and a description of the system operation. Section 4.1 provides a summary of the key design and operational refinements based on the new data obtained since the conceptual design was presented in the original Work Plan. A Process Flow Diagram of the treatment system design is presented in Appendix A. A preliminary equipment list is included in Appendix B. A revised project implementation budget is included in Appendix C. A revised project implementation schedule is included in Appendix D.

4.1 SYSTEM DESIGN AND OPERATIONAL MODIFICATIONS

The current treatment system design remains consistent with the approved Work Plan to quickly remove the sediment mixture in the AP-5 Pond for treatment in newly constructed process tanks. Elements of the design and operations have been modified based on results of explosives testing and treatability testing of the samples collected in August 2015 and December 2015, as well as from Process Hazard Analyses (PHAs) and engineering safety reviews.

One of the key design modifications recommended during engineering safety reviews was the need for a more flexible treatment system that provides redundancy and reduced operational risks. Furthermore, the solids mixing and settling treatability tests also demonstrated that the solids would be difficult to keep mixed in a slurry in a single 2 million gallon tank, and mixing in multiple smaller tanks is more feasible. As a result of the engineering safety recommendations and the treatability testing results, the design was modified from a single 2 million gallon tank to three 600,000 gallon process tanks.

The treatability testing demonstrated that the solids were difficult to re-suspend in a slurry once they settled and compacted. The initial design included hydraulic jet mixers installed on the bottom of the storage tank to keep the slurry mixed. Explosives testing demonstrated that pond solids were impact sensitive, and particle velocity and impact with the jet mixers and pumps was a concern. Air power mixers were evaluated, but the treatability testing of December 2015 samples determined the air powered bottom mixers were inadequate to remix the solids if they settled and compacted. Vertical shaft mixers were specified as replacements for the bottom mounted hydraulic jet mixers and air powered mixers.

One of the key recommendations of the June 2015 PHA was to consider welded stainless steel tank construction instead of bolted carbon steel for the process tanks. Subsequent laboratory corrosivity testing to simulate mixing conditions in the process tank confirmed that bare carbon steel corroded at an unacceptably high rate, whereas 316 stainless steel was not corroded. Tetra Tech evaluated both a welded carbon steel with an internal liner and a welded stainless steel tank. Due to the risk of corrosion to the carbon steel tank in the event of internal liner failure, Tetra Tech selected a welded 316 stainless steel tank in lieu of the bolted carbon steel tank included in the original Work Plan.

Based on explosives testing and as recommended in a June 2015 PHA, all submersible and centrifugal pumps for handling of slurry or solids were eliminated from the design. The current design uses AODD pumps for these operations.

The treatability testing and field mixing and pumping demonstration test both established that initial mixing of settled pond solids required significant effort to mix the solids into a pumpable slurry. The conceptual approach in the Work Plan assumed the pond could be mixed and removed with a single remotely operated pump suspended by a crane, and that additional mixing within the pond to create a pumpable slurry was not necessary. Treatability testing showed that additional methods to initially break up the solids are required. The currently planned approach involves pumping combined with water jetting at pressures verified for safe operation as part of the explosives testing. In addition to enhanced agitation to initially break up the sediments, up to six (6) pumps will be required to mix the pond at a rate that minimizes settling of the solids during the initial mixing stage.

The original Work Plan intended for the contents of the 2 million gallon tank to be fed to a re-furbished steel sludge thickener in batch mode for washing. The separated solids were to be dewatered with a new permanent filter press. Liquids were to be fed in batch mode to GW-11 Pond. Due to sludge thickener material compatibility and friction sensitivity concerns with respect to the sludge thickener scraper arms, the existing sludge thickener tank was eliminate from the design. The overall design was modified to allow washing of the solids to be conducted in the 600,000 gallon process tanks, which is described in more detail below. Physical property testing of the AP-5 Pond solids also identified that centrifuges would be more effective than a filter press at dewatering solids.

4.2 SYSTEM DESCRIPTION

Consistent with the original design, the current solids removal and treatment system consists of three primary elements. The first element consists of mixing the contents of the pond to create a pumpable slurry to facilitate removal and transfer to three field-constructed process tanks. The second element consists of washing the solids in the process tanks to extract AP to the liquid phase. Three process tanks are included in the design to increase operational flexibility and system redundancy. The wash water containing perchlorate from the process tanks will be decanted to a day tank before being diluted and transferred to a receiving tank for subsequent treatment by the existing fluidized bed reactors (FBRs) in the Groundwater Extraction and Treatment System (GWETS). Tetra Tech will be responsible for solids removal, solids washing, and decanting of wash water to the Day Tank. ETI will control the flow from the Day Tank and the dilution to maintain water levels and desired perchlorate concentrations in the Receiving Tank. The final treatment element consists of dewatering washed solids for disposal at an off-site, non-hazardous landfill. Tetra Tech will implement the solids dewatering. Each of these treatment system elements is described in more detail below. The individual design components referenced below are designated on the attached Process Flow Diagram.

4.2.1 Pond Mixing and Transfer

Pressurized water streams will be used to break up solids and dissolve larger AP crystals in the pond to facilitate removal from the pond. Pressurized water will be provided using jets or pressure washers. In addition, 100-gallon per minute (gpm) AODD Recirculation Pumps (P-101 and P-102) and Transfer Pumps (P-103 through P-106) will be used to mix the pond. After completing the initial break up and mixing of solids, the discharge from the Transfer Pumps will be routed to three (3) 600,000-gallon process tanks, designated as T-201, T-202 and T-203 (Process Tanks). The Recirculation Pumps will be set near the northwest corner of the pond and the Transfer Pumps will be set on the west side of the pond.

Based on the results of the field mixing and pumping demonstration test, heated water will also be needed to break up solids and larger AP crystals. The maximum size solid the AODD pumps can pass is 0.5-inch diameter, and the pump intake suction strainers will have 0.5-inch openings to ensure larger solids will not enter into the pump. AP crystals have been observed up to approximately 4-inches in diameter in the pond. Rental boilers are being evaluated as a means to introduce heated water into the discharge lines of the Recirculation Pumps to break down larger crystals to facilitate transfer to the Process Tanks.

Air for AODD Pond Recirculation and Transfer Pumps will be provided by rental air compressors. Suction strainers with 0.5-inch openings will be provided for each pump intake to protect the pump internals from larger solids, including tumbleweeds and other smaller debris and trash from the pond. Debris encountered during mixing will be placed in water filled drums or troughs and inspected to evaluate options for washing and disposal.

The slurry will be pumped from the pond to the Process Tanks via 6-inch HDPE butt-fusion welded pipe. Per recommendations from the June 2015 PHA, the slurry transfer pipe will not be double walled to eliminate potential hidden seepage and accumulation points for dried perchlorate residues. The pipe will be hydrostatically tested prior to use, and the entire length of the pipe will be visually inspected at the beginning of each shift during the slurry transfer operations.

4.2.2 Solids Washing

After pumping the slurry to the Process Tanks, the tanks will be filled using Stabilized Lake Mead Water (SLMW) to reduce the concentration of AP in the Process Tanks and begin the solids washing process. The slurry in the Process Tanks will be continuously mixed using vertical shaft-mounted submersible mixers, designated as M-201, M-202 and M-203. Process Tank Mixers will be operated with electrically-powered totally enclosed fan cooled (TEFC) 40-horsepower motors. As needed, additional SLMW will be added to the Process Tanks to extract/wash AP from the solids.

Solids will be separated using gravity settling. Wash water containing perchlorate will be decanted from the Process Tanks via one of several ports installed at various heights in the side of the tank. Three 100-gpm AODD Decant Discharge/Transfer Pumps (P-201, P-202, and P-203) will either send the decant to another Process Tank or discharge through 5-μm cartridge filters to the fiberglass reinforced plastic Day Tank (T-204) that will feed the

Receiving Tank (T-205) and ultimately the existing FBRs in the GWETS. The cartridge filters will be rinsed in buckets of water and tested prior to disposal. Rinse water will be returned to the Process Tanks.

The addition of clean water to Process Tanks, mixing, solid/liquid separation, and wash water decantation from the Process Tanks to the Day Tank will occur periodically to ensure that the remaining solids are cleaned to less than the target AP concentration for disposal of dewatered solids at a non-hazardous landfill. The target AP concentration is currently estimated to be 1% based on previous disposal of AP-impacted soil. Testing for landfill disposal criteria of dewatered solids at varying concentrations of AP will be completed to refine the threshold for acceptance at a non-hazardous landfill.

All solids washing activities will be completed within a geomembrane lined secondary containment area.

4.2.2.1 Wash Water Transfer

The Day Tank (T-204) is used to store AP wash water decanted from the Process Tanks prior to transfer to the Receiving Tank (T-205) adjacent to the FBRs for treatment by the existing FBRs. Treatment Facility Feed Pumps (designated as P-207 with an uninstalled spare P-208), which are 50-gpm electrically-operated horizontal end-suction fiberglass reinforced centrifugal pumps, will feed wash water from the Day Tank to the Receiving Tank. At the request of ETI, the existing unused Lime Silo inside the Treatment Facility secondary containment area will be removed and the Receiving Tank will be installed in this location. Also at the request of ETI, the transfer system will be configured to allow AP wash water to be diluted with SLMW prior to transferring to the Receiving Tank. The discharge line to the Receiving Tank will have a flow-modulating valve (FCV-270) controlled by a mass flowmeter (FM-201) and return line with orifice plate to divert excess discharge to the Day Tank so that ETI can vary the flowrate to the Receiving Tank as needed. To allow ETI to dilute the perchlorate concentration to 3.0% or less, a SLMW dilution water supply will be provided which will include a Mass Flowmeter (FM-202) with a Flow-Modulating Valve (FCV-271).

The Day Tank, Water Treatment Facility Feed Pumps, Flow-Modulating Valve, Mass Flowmeter, and SLMW dilution connection are located within the geomembrane lined secondary containment area. Therefore, all higher concentration perchlorate wash water will be processed in the lined secondary containment area. Dilution will occur prior to transfer of wash water out of the secondary containment area.

The Receiving Tank will include a Recirculation/Feed Pump (P-210), Flow-Modulating Valve (FCV-272), and Flowmeter (FM-204), which will be used to feed the diluted wash water to the FBR raw water feed line. The wash water will be injected into the FBR raw water feed line a minimum of 10 pipe diameters upstream of a new sample port. The Recirculation/Feed Pumps (designated as P-210 with uninstalled spare P-211), are 50-gpm electrically-operated horizontal end-suction fiberglass reinforced centrifugal pumps.

4.2.3 Solids Dewatering

Settled solids can either be pumped via 100-gpm AODD Solids Discharge/Transfer Pumps (P-204, P-205, and P-206) to another Process Tank or, once they are washed to an AP concentration of less than the target concentration, to the Solids Mix Tank (T-301). One 3-hp vertical shaft-mounted submersible mixer (M-301) will keep solids in suspension prior to dewatering. A Solids Recirculation Pump (P-301) will be used to recirculate and mix the washed solids in the Solids Mix Tank. Solids feed pumps mounted on the centrifuge skid will send solids through a Centrifuge (C-301) for dewatering. A conveyor will be used to transfer the dewatered solids from the centrifuge to 20-CY roll-off dumpsters. The centrate generated from the Centrifuge will be returned to the Process Tanks for ultimate treatment by the existing FBRs in the GWETS.

All solids dewatering activities will be completed within a concrete curbed secondary containment area.

4.3 SYSTEM OPERATION

Operations associated with the three primary elements of the current solids removal and treatment system are summarized in the following subsections.

4.3.1 Pond Mixing and Transfer

Based on the results of the field mixing and pumping demonstration test, pressurized water streams from jets or pressure washers will be used to break up and mix solids in conjunction with pumping and recirculation. Pumping and recirculation will be completed using 100-gpm AODD Recirculation Pumps (P-101 and P-102) and Transfer Pumps (P-103 through P-106). The discharge from the Transfer Pumps will initially be routed back into the AP-5 Pond to facilitate mixing. Once the preliminary break up and mixing of solids is completed, the discharge from the Transfer Pumps will be rerouted to transfer the slurry to the three (3) 600,000-gallon process tanks (T-201, T-202 and T-203).

Rental boilers are being evaluated as a means to introduce heated water to the pond. The preliminary approach is to generate heated SLMW at up to 175°F using rental boilers, which will be introduced into the discharge line of the Recirculation Pumps at a rate of approximately 25 gpm. Heated SLMW will continue to be added until the temperature of the water in the northern portion of the pond reaches approximately 135°F. Recirculation will continue as the slurry is transferred to the Process Tanks. Water from pressure jets will also be added to the AP-5 Pond for makeup water as needed to keep the remaining solids completely submerged.

During the slurry transfer operations, the intake suction strainer for the Transfer Pumps will be maneuvered around the pond, beginning at the south end of the pond (highest base elevation) and working towards the north end of the pond (lowest base elevation). As the pump intake suction strainers accumulate solids, they will be hosed off, and solids will be directed to water filled drums or troughs. This will ensure that the larger, unpumpable solids do not continue to be recycled in the pond. As pond mixing and solids transfer progresses, the rate of makeup water addition will decrease to allow the water level in the pond to gradually decrease. Residual pockets of unmixed solids that are exposed as the pond water level decreases will be mixed into the slurry with the pressurized water source.

When the depth of slurry in the pond is drawn down to approximately 1 foot, a final addition of approximately 1 foot of water will be added to the pond to wash the remaining solids to the north side of the pond to facilitate transfer to the Process Tanks. The Recirculation Pumps will mix the slurry as needed. The intake of the Transfer Pumps will positioned on the north side, and the pumps will convey the remaining slurry to the Process Tanks. The liner will be rinsed to remove residual solid material, and the rinse water will be transferred to the Process Tanks.

Tetra Tech operators will be on-site and responsible for the duration of the above described processes. Once initiated, the pond mixing stage should be completed within approximately 10 days, and the slurry transfer stage should be completed within an additional approximately 10 days.

Following transfer operations, all transfer pumps and lines will be flushed with SLMW for a minimum of 20 minutes. The rinse water will be sent to the Process Tanks. The AODD transfer pumps will be moved to the secondary containment area, disassembled and cleaned. Any wash water from the final cleaning of the AODD pumps will be placed in the Process Tanks. Transfer pipes will be dismantled into approximately 15 foot sections and visually inspected for residual solids. A subset of the pipe sections will be wipe sampled for perchlorate prior to transportation and offsite disposal.

4.3.2 Solids Washing

The slurry will be transferred to the Process Tanks in sequence, with the first two tanks expected to receive a higher percentage of the pond solids and the third tank receiving fewer solids with the balance of the volume being wash water from final liner rinsing and equipment flushing. Once the slurry has been conveyed to the Process Tanks, the balance of the tanks will be filled with SLMW. Approximately 200,000 gallons of SLMW will be added to each tank, and the resulting concentration of perchlorate in the Process Tanks will be less than 8%. Once the tanks are filled, Tank Mixers (M-201, M-202 and M-203) will be activated to keep the solids in suspension and facilitate extraction of AP from the solids. When the Day Tank is ready to receive wash water for treatment in the FBRs, the mixers will be stopped, and the solids allowed to settle to allow the wash water to be decanted from the tanks.

Based on the sequence for pond mixing and slurry transfer described above, it is expected that the first two Process Tanks (T-201 and T-202) will contain the majority quantity of solids and smaller quantities of solids will be transferred to T-203. The bulk of the solids are anticipated to be removed during the first two slurry transfer steps, which will be pumped to Process Tanks T-201 and T-202. The final one foot of water used to wash solids to the north end of the pond, liner rinsing water, and equipment and piping flushing water will all be pumped to T-203.

After each solids washing and decant cycle is complete, SLMW will be added to the tanks to extract additional AP from the solids, and the mixers in the Process Tanks will be restarted. The solids will not remain unmixed for extended periods of time since this will result in solids compacting in the slurry. The solids washing process will be repeated until the AP content in the washed solids is less than the target AP concentration for the dewatered solids to be characterized as non-hazardous waste.

Tetra Tech operators will be on-site and responsible for the duration of the above described processes. During the solids washing process, the initial wash cycles will have the highest perchlorate concentration, and concentrations will then decrease with every cycle as more AP is washed from the solids. Mass loading is based on concentration and hydraulic load (i.e., flowrate). Assuming that a constant perchlorate mass load can be sent to the existing FBRs, the flowrate out of the Day Tank to the FBRs will increase as pechlorate concentrations decrease. The time required to treat the wash water is dependant on the base mass loading to the FBRs which may increase as a result of other treatment priorities of NERT.

4.3.2.1 Wash Water Transfer

Tetra Tech will be responsible for keeping the Day Tank full of wash water. ETI will control the flow from the Day Tank to the Receiving Tank adjacent to the FBRs using the Water Treatment Facility Feed Pumps. ETI will be responsible for feeding wash water into the FBRs from the Receiving Tank. The Tetra Tech operator will visually check the level in the Day Tank on a daily basis. If the tank is less than half full, the operator will decant liquid from the Process Tanks using the solids washing procedure provided above. The Day Tank will be equipped with a level indicator and a “high” level switch that will automatically stop the Decant Pump once the tank is full. An alarm would be generated if the tank level rises above the “high-high” level, which will also turn off all air header solenoids which will stop the Decant Pump.

The discharge line to the existing FBRs from the Water Treatment Facility Feed Pumps will have a Flow-Modulating Control Valve (FCV-270) and Discharge Flow Meter (FM-201). A recirculation line with flow restriction (i.e., orifice plate) to the Day Tank will be provided upstream of FCV-270 and FM-201. Both FCV-270 and FM-201 will operate a flow-control loop that will be controlled by the existing Master Control Panel, a rack mounted Programmable Logic Controller (PLC) and Human-Machine Interface (HMI).

When ETI is ready to receive flow from the Day Tank to the Receiving Tank, the ETI operator will set the feed flow at the existing FBR system process controller. This will be connected to the existing Master Control Panel, which will turn on the Treatment Facility Feed Pump, and modulate FCV-270 until the desired flow is reached as measured by FM-201. Excess flow will be returned to the Day Tank through the recirculation line. The PLC will be programmed to allow ETI to adjust dilution ratios as needed. Using the density of the wash water as measured by mass flowmeter FM-201, the ETI operator will adjust the flow of SLMW dilution water to achieve the desired concentration of perchlorate in the Receiving Tank. Flow to the Receiving Tank will continue until a high level is reached at the Receiving Tank at the existing FBRs, or the level in the Day Tank falls below a pre-set low level.

4.3.3 Solids Dewatering

When the AP concentrations of the washed solid are below the target AP concentration, the solids will be characterized for waste disposal. Sampling will include first screening a dewatered solids sample for perchlorate as compared to the target AP concentration. Upon confirmation of meeting the target AP concentration, the water in a given Process Tank will be drawn down to the settled solids level, the Process Tank Mixer will be restarted, and the Solids Transfer Pump (P-204, P-205 or P-206) will pump the washed solids to the Solids Mix Tank (T-301). Once the Solids Mix Tank is full, the Solids Transfer Pump will be turned off, and the Solids Tank Mixer (M-301) will be started to keep the solids in suspension. During mixing, a jar test will be conducted on the solids in the Solids Mix Tank to determine the chemical dosage required for solids conditioning prior to dewatering in the Centrifuge (C-301). Once this dosage has been determined and applied accordingly, the Centrifuge Feed Pump will begin to feed solids to the Centrifuge. Dewatered cake will be fed via conveyor belt to a roll-off dumpster placed within the solids dewatering area. When the dumpster is full, it will be removed for disposal at an off-site non-hazardous landfill.

While the first Solids Mix Tank is being dewatered through the Centrifuge, the Solids/Transfer Discharge Pump will, if needed, continue to feed the second Solids Mix Tank. Once the second Solids Mix Tank is filled, another jar test will be conducted to determine chemical dosage for conditioning of that tank. The solids from the second Solids Mix Tank will not be processed until the first Solids Mix Tank has been fully emptied, and the chemical dosage has been reset based on the second jar test (if needed). The use of two (2) Solids Mix Tanks allows for continuous operation of the Centrifuge without interruption.

Tetra Tech operators will be on-site and responsible for the duration of the above described processes. Once initiated, the solids dewatering should be completed within approximately 60 days.

5.0 PERMITTING AND COMPLIANCE

Section 3.5.1 of the approved Work Plan referenced National Pollutant Discharge Elimination System (NPDES) Permit NV0023060 as the overarching permit for treatment of AP-5 Pond wash water in the existing GWETS system. Notice to the NDEP Bureau of Water Pollution Control (BWPC) is required for any anticipated facility expansions or treatment modifications that will result in new, different, or increased discharges of pollutants (Section II.A.1 of the permit). The BWPC confirmed that notification requirements identified in Section II.A.1 were met with the modification description that was provided in the January 2016 NPDES permit renewal application. The BWPC further confirmed on April 26, 2016, that flows to the NPDES-permitted treatment works, to be defined in the NPDES permit renewal, will consist of all inputs to the permitted treatment works, including flows to the AP-5 process tanks. The operations and maintenance (O&M) manual for the facility will be updated to reflect the change in the operation of the GWETS in accordance with Section I.A.13 of the NPDES permit.

Tetra Tech reviewed the revised AP-5 Pond solids removal and treatment methods presented in this Basis of Design Summary report, to determine if the current design changes would cause the removal and treatment of the sediment, water and perchlorate (sediment mixture) in the AP 5 Pond to require a permit for the treatment of hazardous waste pursuant to the Resource Conservation and Recovery Act (RCRA) and applicable Nevada hazardous waste regulations.

Tetra Tech initially performed a review of hazardous waste permit applicability as part of the Work Plan. The Work Plan provided a conceptual design to remove the existing perchlorate crystals and sediment mixture from the AP-5 Pond. The Work Plan proposed to add SLMW to the AP-5 Pond to create a pumpable slurry allowing for dissolution of perchlorate crystals and quick removal of the sediment and all perchlorate-containing solids from the pond. The Work Plan noted that high pressure hoses may be used to move solids towards the transfer pump suction and to aid in creating a pumpable slurry. The Work Plan also provided a description of the chemical and physical properties of the perchlorate present in the AP 5 Pond. The Work Plan further proposed to treat the sediment mixture in a tank as part of the GWETS, and discharge treated effluent under the NPDES permit for the GWETS. The proposed conceptual design was planned to be implemented under the wastewater treatment unit exemption pursuant to 40 C.F.R. §264.1(g)(6), 40 C.F.R. §265.1(c)(10) and 40 C.F.R. §270.1(c)(2)(v). The proposed conceptual design as presented in the Work Plan was reviewed and approved by NDEP in a letter dated March 24, 2015. Implementation of RCRA in Nevada has been delegated by U.S. EPA to the State of Nevada. Section 3.5.4 of the Work Plan presented the following analysis relative to the potential requirement for hazardous waste treatment permitting of the proposed AP-5 Pond solids removal and treatment process:

> *3.5.4 Resource Conservation and Recovery Act (RCRA) Permitting* (Source: Phase II Work Plan for AP-5 Solids Removal, dated March 13, 2015)
>
> *While perchlorate waste is not regulated as a listed waste under RCRA, perchlorate waste can be regulated under RCRA as a characteristic waste if the waste exhibits specific characteristics, including ignitability (D001) and reactivity (D003). Once a characteristic waste no longer exhibits the characteristic, it is no longer a hazardous waste. Perchlorate waste that exhibits the characteristics of ignitability and reactivity can be diluted with water to ionize the perchlorate so the waste is no longer ignitable or reactive. The addition of the water to the waste to render it characteristically inert is considered treatment under RCRA, which would require a permit. However, assuming the AP-5 solids are a waste, the proposed treatment of the AP-5 solids falls under the wastewater treatment unit exemption pursuant to 40 C.F.R.§264.1(g)(6), 40 C.F.R. §265.1(c)(10) and 40 C.F.R. §270.1(c)(2)(v) as the GWETS is subject to the Permit and the proposed tank will be connected to the GWETS. Tetra Tech will ensure compliance with the wastewater treatment unit exemption and a RCRA permit will not be necessary. Tetra Tech has discussed this analysis with NDEP and NDEP has concurred that a RCRA permit is not necessary for the proposed handling of the AP-5 solids.*

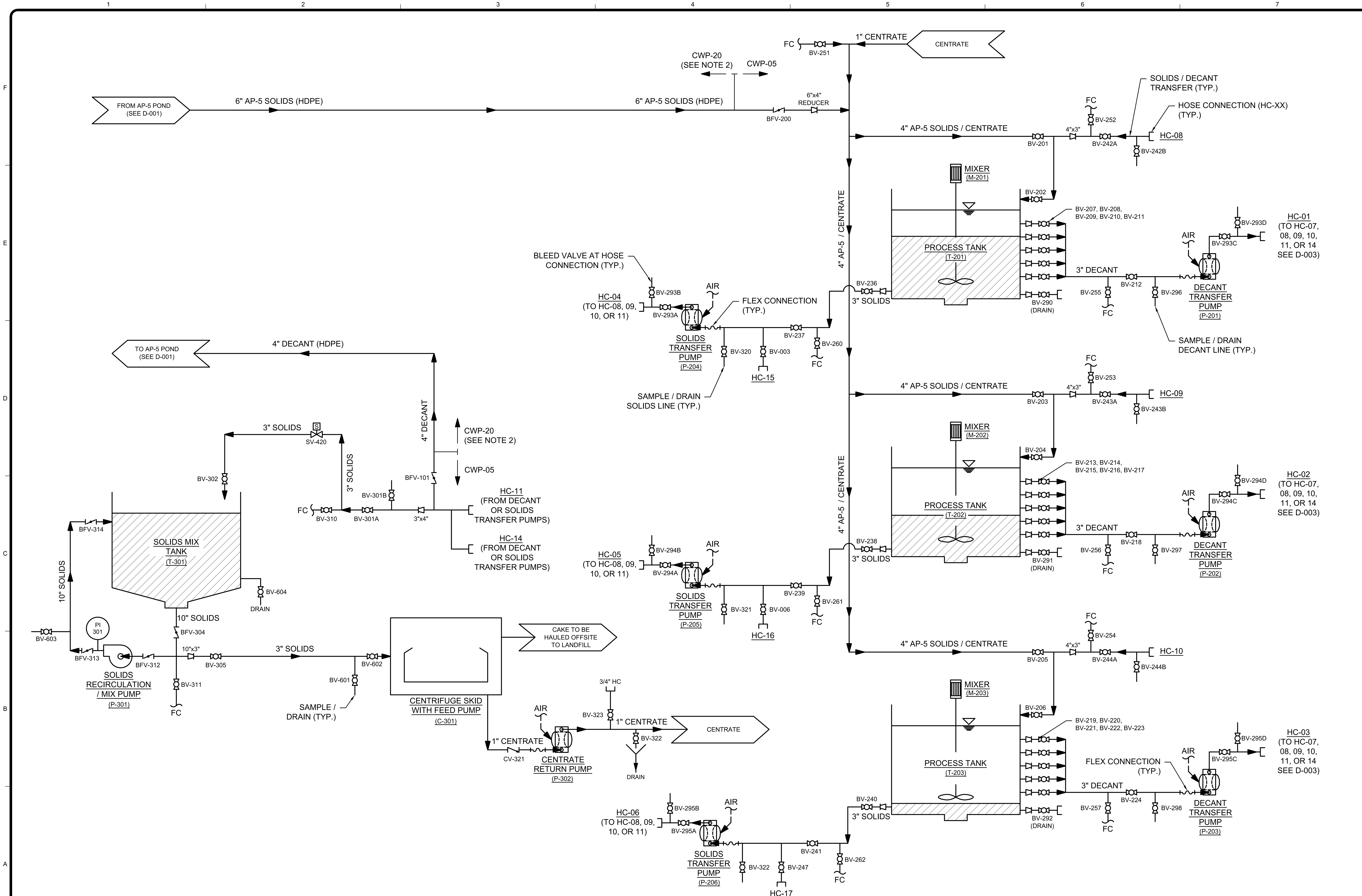
Following preparation of the Work Plan, Tetra Tech implemented two additional sampling and testing programs to further assess the properties of the AP-5 Pond's sediment mixture to support engineering design. Utilizing the new testing data from these 2015 sampling events, results from prior sampling, and knowledge of the chemical properties of perchlorate, Tetra Tech evaluated the ignitability, corrosivity, reactivity and toxicity of the AP-5 Pond sediment mixture. Based upon general knowledge of the wet sediment mixture in the AP-5 Pond, the available data indicates that it does not exhibit the RCRA hazardous waste characteristics of ignitability, corrosivity, reactivity and toxicity. Therefore, based upon prior correspondence with NDEP and U.S. EPA, a hazardous waste treatment permit will not be required to remove the AP-5 Pond sediment mixture as a pumpable slurry for treatment to remove perchlorate in the treatment system.

6.0 SUMMARY

The current AP-5 Pond solids removal process design as described in this Basis of Design Update is currently being implemented and has been reviewed and approved by ETI. Tetra Tech anticipates completion of infrastructure construction and the subsequent transfer of AP-5 Pond material by December 31, 2016.

Appendix A provides the process flow diagram of the system. Based on the nature of the slurry being treated by the proposed system, a PHA was conducted on the detailed design of the pond mixing and transfer system and the solids treatment system. The PHA was completed to identify and mitigate potential hazards prior to finalizing the design and procedures. The PHA did not have a significant impact of the system and operations described in this document, but addressing the recommendations of the PHA may result in changes to improve safety.

Appendix A
Process Flow Diagram



GENERAL NOTES:

1. ALL PIPING SHALL BE SCHEDULE 80 CPVC UNLESS OTHERWISE SPECIFIED.
2. WORK TO BE COVERED UNDER CWP-20 (TO BE DONE BY TETRA TECH).

TETRA TECH
www.tetratech.com
1489 West Warm Springs Road, Suite 110
Henderson, NV 89014
Phone: 702.946.6700 Fax: 702.997.7140

MARK	DATE	DESCRIPTION	BY
1	8/3/16	CWP-05: ISSUED FOR BID	SKU

NEVADA ENVIRONMENTAL RESPONSE TRUST
HENDERSON, NEVADA

AP-5 POND PHASE II
PROJECT IMPLEMENTATION

TREATMENT SYSTEM PROCESS FLOW DIAGRAM

Project No.:	200-01299-16002
Designed By:	C FLORES
Drawn By:	S. ULREY
Checked By:	C FLORES

D-002

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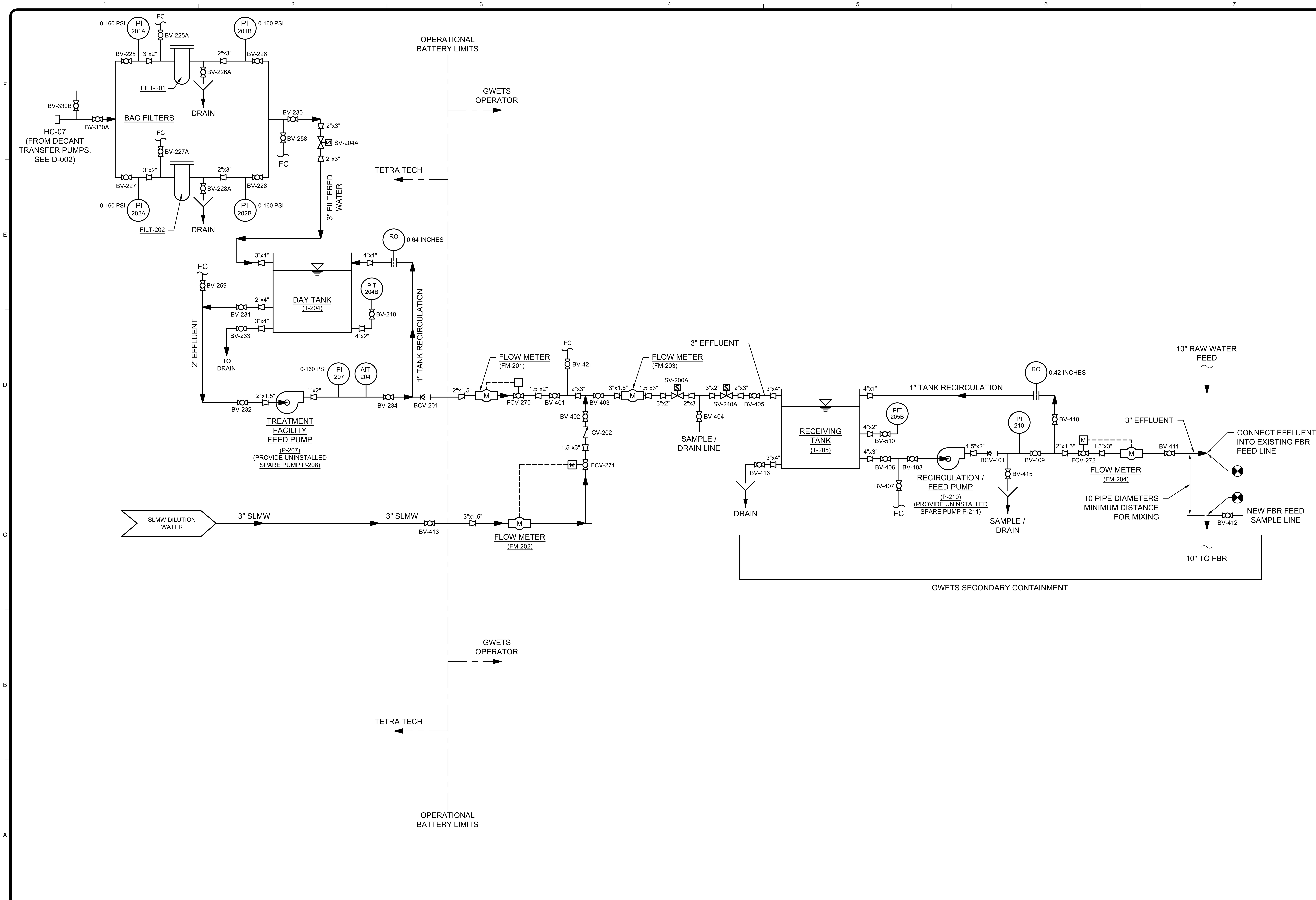

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MARK	DATE	DESCRIPTION	BY	SKU
1	8/3/16	CWP-05: ISSUED FOR BID		

NEVADA ENVIRONMENTAL RESPONSE TRUST
HENDERSON, NEVADA

AP-5 POND PHASE II
PROJECT IMPLEMENTATION

TRANSFER SYSTEM PROCESS FLOW DIAGRAM

Project No.:	200-01299-16002
Designed By:	C FLORES
Drawn By:	S. ULREY
Checked By:	C FLORES

D-003

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Appendix B
Preliminary Equipment List

NERT AP-5 Pond Remediation
Henderson, NV

Table 1: Equipment List
June 2016

No.	Item	Tags	Description	Size	Qty	Vendor	Model No.
1	Recirculating Pumps	P-101, P-102	Air-operated double diaphragm (AODD) pumps to recirculate pond slurry prior to transferring to Process Tanks	100-gpm	2	Wilden	PS1500/KKPPP/TEU/TF/KTV
2	Suction Strainers	-	Plastic strainers on Pond Recirculating and Transfer Pumps to protect pumps.	4-inch; opening size 3/16-inch	6	To be fabricated by Tt	NA
3	Transfer Pumps	P-103, P-104, P-105, P-106	AODD pumps to transfer pond slurry to Process Tanks	100-gpm	4	Wilden	PS1500/KKPPP/TEU/TF/KTV
4	Rental Air Compressor	-	Diesel-driven portable unit to provide air for Pond Recirculating and Transfer Pumps	120-185 SCFM; 100 psig	2	Doosan	P185WDO-T4F
5	Compressed Air Regulator	-	Pressure regulator to control compressor outlet pressure at 80 to 100 psig	80-100 psig	2	Wilkerson	R26-04-G00
6	High-Pressure Washing System	-	High-pressure jets with heated water to break up pond solids and dissolve AP crystals.	5-gpm; 3,000-psig	2	Hotsy Southwest	NA
7	Crane and Man Basket	-	For AP-5 Pond slurrying operations	-	1	TBD	NA
8	Process Tanks	T-201, T-202, T-203	Welded 316L SS flat-bottom tanks with center sump to be used for holding and washing pond slurry.	600,000-gal	3	RMF	NA
9	Process Tank Mixers	M-201, M-202, M-203	Vertical shaft-mounted submersible impeller mixers with TEFC motors to mix contents inside Process Tanks.	40-hp	3	Lotus	H4SV11-40-12
10	Decant Transfer/ Discharge Pumps	P-201, P-202, P-203	AODD pumps to transfer supernatent from Process Tanks.	100-gpm	3	Wilden	PS1500/KKPPP/TEU/TF/KTV
11	Solids Transfer/ Discharge Pumps	P-204, P-205, P-206	AODD pumps to transfer washed solids to Solids Mix Tank.	100-gpm	3	Wilden	PS1500/KKPPP/TEU/TF/KTV
12	Cartridge Filters	FILT-201, FILT-202	Cartridge filter housings to remove residual solids from the supernatent out of the Process Tanks.	3-inch; 400-gpm	2	Harmsco	HIF-100
			Filter bags for cartridge filters.	5-um opening		Harmsco	801-5
13	Day Tank	T-204	FRP flat bottom tanks to be used for holding wash water for feeding to ETI's existing FBR treatment facility	30,000-gal	1	Augusta Fiberglass	NA
14	Treatment Facility Feed Pump	P-207, P-208	Horizontal end-suction fiberglass reinforced centrifugal pumps to feed wash water to ETI's existing FBR system	50-gpm	2	Fybroc	TBD
15	Solids Mix Tank	T-301	FRP sloped bottom tank with center sump to be used for holding washed solids prior to dewatering	30,000-gal	1	Augusta Fiberglass	NA
16	Solids Recirculation/Mix Pump	P-301	Horizontal end-suction fiberglass reinforced centrifugal pump to mix contents in Solids Mix Tank and to keep solids in suspension	250-gpm	1	Fybroc	TBD
17	Centrifuge	C-301	Rental centrifuge skid for dewatering of washed solids out of the Solids Mix Tank; includes polymer feed system and progressing-cavity pumps to transfer washed solids	200-gpm	1	Centrisys	TBD
18	Air Compressor	-	Electric-powered compressor to provide compressed air for AODD pumps and other air operated equipment.	162 SCFM; 125 psig	1	Kaeser	TBD
19	Receiving Tank	T-205	FRP flat bottom tanks to be used for holding wash water for feeding to existing FBR treatment facility	15,000-gal	1	Augusta Fiberglass	NA
20	Flow Meters	FM-201, FM-202, FM-203, FM-204	Mass flow meters to measure the flows and concentrations to and from the Receiving Tank, including SLMW supply	TBD	4	TBD	TBD
21	Recirculation/Feed Pump	P-210, P-211	Horizontal end-suction fiberglass reinforced centrifugal pumps to feed water from Receiving Tank to FBR.	50-gpm	2	Fybroc	TBD

Appendix C
Project Implementation Budget

Draft AP-5 Solids Removal Project Estimated Budget

Cost Breakdown Structure: Code and Description	Labor	Outside Services	Non-Labor Expenses	Total Estimated Cost
1 - EXPLOSIVES MATERIAL CHARACTERIZATION AND SAFETY TESTING	**$372,392**	**$286,703**	**$112,582**	**$771,678**
1.1 - Preliminary Material Characterization and Safety Testing	$168,487	$83,774	$39,662	$291,923
1.2 - Advanced Material Characterization and Safety Testing	$203,906	$202,930	$72,920	$479,755
2 - EXPLOSIVES MATERIAL HANDLING ANALYSIS AND SAFETY ENGINEERING	**$303,866**	**$187,964**	**$41,415**	**$533,245**
2.1 - Safety Consulting	$0	$120,138	$0	$120,138
2.2 - Hazard Analysis & Safety Reviews	$302,805	$59,610	$41,415	$403,830
2.3 - 3-Stage Decontamination Corridor	$1,061	$8,215	$0	$9,277
3 - SAFE HANDLING ALTERNATIVES ENGINEERING ANALYSIS	**$991,329**	**$91,036**	**$23,461**	**$1,105,826**
3.1 - Pre-PHA Process Engineering & Design	$234,700	$458	$5,469	$240,627
3.2 - Post-PHA Transition Process Engineering & Design	$257,893	$902	$7,271	$266,066
3.3 - Post-Sampling Safe Handling Alternatives Engineering	$364,517	$1,059	$6,776	$372,352
3.4 - Phase 1 Pump Test	$134,219	$88,617	$3,944	$226,780
4 - PROCESS CONFIGURATION AND DESIGN	**$1,514,101**	**$3,781**	**$15,108**	**$1,532,990**
4.1 - Process Engineering	$421,002	$1,059	$3,149	$425,210
4.2 - Electrical/I&C	$538,245	$1,331	$6,030	$545,606
4.3 - Mechanical/Civil	$554,854	$1,392	$5,928	$562,174
5 - PERMITTING, CONTROLS, MOBILIZATION AND INITIAL FIELD TASKS	**$330,083**	**$120,217**	**$32,118**	**$482,417**
5.1 - Permitting	$109,386	$494	$19,231	$129,112
5.2 - Controls	$78,062	$0	$0	$78,062
5.3 - Site Surveys	$0	$15,376	$0	$15,376
5.4 - Geotechnical Testing	$65,335	$53,277	$7,649	$126,261
5.5 - Asbestos Testing & Mitigation	$5,585	$15,550	$0	$21,135
5.6 - Demolition & Sampling	$0	$34,594	$0	$34,594
5.7 - Site Facilities Mob	$0	$927	$0	$927
5.8 - Site Staff	$69,062	$0	$5,237	$74,299
5.9 - Construction Management	$2,653	$0	$0	$2,653
6 - PROCESS EQUIPMENT PROCUREMENT	**$382,709**	**$4,789,535**	**$0**	**$5,172,243**
6.1 - Procurement & Scheduling	$382,709	$0	$0	$382,709
6.2 - Process Equipment Procurement	$0	$4,789,535	$0	$4,789,535
7 - SITE CONSTRUCTION - PHASE 1	**$18,069**	**$489,246**	**$0**	**$507,315**
7.1 - Site Facilities	$0	$4,201	$0	$4,201
7.2 - Site Staff - Equipment Setup	$0	$417,383	$0	$417,383
7.3 - Construction Equipment Mob / Demob	$0	$10,378	$0	$10,378
7.4 - Construction Equipment - Rental	$0	$46,962	$0	$46,962
7.5 - Erosion Controls	$12,762	$1,669	$0	$14,432
7.6 - Construction Staking	$0	$8,654	$0	$8,654
7.7 - Construction Management	$5,306	$0	$0	$5,306
8 - SITE CONSTRUCTION - PHASE 2	**$427,521**	**$1,610,214**	**$28,379**	**$2,066,114**
8.1 - Construction Equipment - Rental	$0	$10,378	$0	$10,378
8.2 - Augment AP-5 Berm	$3,881	$3,769	$0	$7,649
8.3 - Construct AP-5 Temporary Equipment Containment Area	$29,105	$24,315	$0	$53,421
8.4 - Containment Area Equipment Pad	$15,523	$38,125	$0	$53,648
8.5 - Solids Processing Area	$23,284	$32,433	$0	$55,717
8.6 - Process Tank Secondary Containment Liner	$0	$247,097	$0	$247,097
8.7 - Process Equipment Installation	$0	$9,959	$0	$9,959
8.8 - Process Piping - Sub Allowance	$0	$555,967	$0	$555,967
8.9 - Electrical / I&C - Sub Allowance	$0	$679,516	$0	$679,516
8.10 - Site Staff	$350,422	$0	$28,379	$378,801
8.11 - Construction Staking	$0	$8,654	$0	$8,654
8.12 - Construction Management	$5,306	$0	$0	$5,306

Draft AP-5 Solids Removal Project Estimated Budget

Cost Breakdown Structure: Code and Description	Labor	Outside Services	Non-Labor Expenses	Total Estimated Cost
9 - AP-5 SOLIDS REMOVAL OPERATIONS	**$859,232**	**$142,792**	**$53,469**	**$1,055,493**
9.1 - Construction Management	$8,490	$0	$0	$8,490
9.2 - Site Facilities	$0	$988	$0	$988
9.3 - Site Staff - Pond Mixing	$415,236	$0	$26,734	$441,970
9.4 - Site Staff - Slurry Transfer	$435,507	$0	$26,734	$462,241
9.5 - Construction Equipment Mob / Demob	$0	$618	$0	$618
9.6 - Construction Equipment - Rental	$0	$141,185	$0	$141,185
10 - DEMOBILIZATION	**$232,672**	**$147,852**	**$11,311**	**$391,834**
10.1 - Construction Management	$5,306	$0	$0	$5,306
10.2 - Site Facilities	$0	$1,050	$0	$1,050
10.3 - Construction Equipment Mob / Demob	$0	$618	$0	$618
10.4 - Construction Equipment - Rental	$0	$53,522	$0	$53,522
10.5 - Decontaminate Process Equipment	$113,683	$0	$5,655	$119,338
10.6 - Transport & Disposal Of Waste	$0	$92,661	$0	$92,661
10.7 - Site Restoration	$113,683	$0	$5,655	$119,338
11 - Supplemental Tasks	**$1,854,842**	**$529,826**	**$1,834,092**	**$4,218,761**
11.1 - Washing of Residual Accumulated Materials (beach)	$16,967	$0	$114	$17,080
11.2 - Inventory and draft work plan for abandoned equip. disposal	$81,417	$0	$3,985	$85,402
11.3 - Hydrostatic testing of piping from AP-5 pond to GW-11	$11,387	$39,854	$2,847	$54,088
11.4 - Work Plan for liner decon. and removal for AP-5 and AP-6 Ponds	$158,279	$0	$5,693	$163,972
11.5 - Sampling for suspected AP-contaminated berm materials	$48,964	$28,467	$7,971	$85,402
11.6 - AP-5 Pond Abandoned Equipment Disposal	$1,537,830	$461,505	$1,813,481	$3,812,816
TOTAL ESTIMATED COST[1]				**$17,837,915**
SPENT 2015				**$2,182,792**
TOTAL BUDGET REQUIRED				**$15,655,123**

Assumptions

1. The total estimated costs are from task inception through completion.
2. The costs presented herein do not include operation and maintenance costs or Envirogen Technologies, Inc. costs for treatment of wash water through the existing GWETS.
3. Mixing and transfer of the AP-5 solids is estimated to take a total of 20 days. The duration will depend on actual field conditions.
4. An allowance has been made for Process Piping Sub-contractor but the final cost will not be known until competitive bidding for this critical construction element is completed.
5. An allowance has been made for Electrical / I&C Sub-contractor but the final cost will not be known until competitive bidding for this critical construction element is completed.
6. Task costs listed above are variable and subject to final pricing. The project will be managed to the total estimated cost for the project.
7. Project costs are based on abandoned equipment and debris in and around the AP-5 Pond being removed, decontaminated and disposed.

Appendix D
Project Implementation Schedule

NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

Tetra Tech 2016 Project Implementation Schedule

Task Name	Start	Finish
Project Implementation Schedule- AP-5 Solids Removal		
K05 - AP-5 Pond Removal	**Thu 1/7/16**	**Thu 12/29/16**
Design Refinement based on Lab Tests	Thu 1/7/16	Fri 1/29/16
Dekra Explosives Lab Testing	Thu 1/7/16	Fri 3/25/16
Review of Design Refinements	Mon 2/1/16	Fri 2/19/16
Draft Implementation Plan	Mon 3/28/16	Tue 5/10/16
Prepare Initial Design Documents	Fri 2/19/16	Fri 5/27/16
Field Mixing and Pumping Demonstration Test	Wed 5/11/16	Tue 5/17/16
PHA	Mon 6/27/16	Fri 7/1/16
Complete Detailed Design	Tue 5/31/16	Mon 8/15/16
Sampling and Analysis of AP-5 Berm	Mon 3/14/16	Fri 4/22/16
Process Tanks (Design, Fabrication and Construction)	Fri 4/1/16	Tue 11/1/16
Asbestos Pipe Removal	Mon 5/23/16	Fri 5/27/16
Removal of Equipment in Vicinity of AP-5	TBD	TBD
Processing Equipment (Fabrication and Construction)	Thu 9/1/16	Tue 11/1/16
Pond Mixing and Slurry Transfer	Wed 11/2/16	Thu 12/29/16