PARADOX VALLEY UNIT
SALINITY CONTROL INVESTIGATIONS
STUDY 1 – HYDROGEN SULFIDE MANAGEMENT

50% DESIGN REPORT – FINAL

Submitted to:
Wastren Advantage, Inc.
1571 Shyville Road
Piketon, OH 45661

Submitted by:
Amec Foster Wheeler Environment & Infrastructure
a division of Amec Foster Wheeler Americas Limited
900 Maple Grove Road, Unit 10
Cambridge, ON N3H 4R7

March 2017

Project Number 1655500023.0001.0004

EXECUTIVE SUMMARY

The Bureau of Reclamation (Reclamation) is currently evaluating alternatives for brine disposal for the Paradox Valley Unit (PVU). One of the long-term disposal alternatives under consideration is evaporation of brine in ponds and either the sale or disposal of salt products. The brine includes high levels of naturally-occurring dissolved hydrogen sulfide, which must be managed before the brine can be placed into evaporation ponds. Hydrogen sulfide can be dangerous to human health, has an objectionable odor at low concentrations, and volatilizes into the air rapidly when the brine is exposed to the atmosphere. This report details a preliminary design for a treatment system to remove hydrogen sulfide from the brine. The preliminary design was prepared for a 50-year life and includes equipment, building infrastructure, and utilities required to remove hydrogen sulfide from the brine.

Several treatment options for hydrogen sulfide removal were bench-scale tested at the PVU in May 2016. Based on the results, oxidation of hydrogen sulfide using sodium hypochlorite was the recommended treatment option. The preliminary treatment system design presented in this 50% Design Report was based on data and recommendations described in the PVU Hydrogen Sulfide Management Treatment Options Bench Testing Report (Amec Foster Wheeler, 2016a).

For this preliminary design, raw brine from the extraction wells located near the existing Surface Treatment Facility (STF) will be pumped to the hydrogen sulfide treatment facility, located adjacent to the evaporation ponds system. Brine will enter the treatment system at the Oxidation Tank. Sodium hypochlorite will be dosed into the Oxidation Tank to oxidize hydrogen sulfide to either sulfate or elemental sulfur, depending on the reaction pathway. Effluent from the Oxidation Tank will flow by gravity to the Dechlorination Tank, where it will be dosed with sodium bisulfite to remove residual chlorine that may be present in the brine due to excess sodium hypochlorite addition (in the Oxidation Tank). Dechlorinated brine will flow by gravity to the Coagulation/Flocculation Tank, where ferric chloride will be added to the brine to promote precipitation and settling of elemental sulfur. From this tank, effluent will flow to the Neutralization Tank, where sodium hydroxide will be added to increase the pH back to neutral prior to discharge to the evaporation ponds. Effluent from the Neutralization Tank will be conveyed by gravity to the evaporation system surge pond, where the elemental sulfur solids will settle.

On-site generation of sodium hypochlorite using salt produced from the evaporation ponds and freshwater from the Dolores River was identified to be the most economically attractive source of sodium hypochlorite for the hydrogen sulfide treatment system. The overall treatment system was designed to be flexible and can also accept commercially-supplied salt and sodium hypochlorite as needed.

The capital cost for the constructed hydrogen sulfide treatment system, including the on-site hypochlorite generation system, is estimated to be $5,200,000. Annual operations and maintenance (O&M) costs are estimated to be $1,031,000. The net present value over a 50-year project lifetime, including capital costs for equipment and construction, costs for replacement parts and equipment, and O&M costs, is estimated to be $33,900,000.

TABLE OF CONTENTS

PAGE

TABLES

APPENDICES

1.0 INTRODUCTION

Amec Foster Wheeler Environment & Infrastructure, a division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler), has prepared this Draft Hydrogen Sulfide Management 50% Design Report (Report) for Wastren Advantage Inc., on behalf of the United States Department of the Interior Bureau of Reclamation (Reclamation), in support of the Colorado River Basin Salinity Control Project Paradox Valley Unit (PVU). This report describes the assumptions, rationale, and design elements incorporated into the Hydrogen Sulfide Treatment System 50% design for the PVU Hydrogen Sulfide Management Study component of the Evaporation Pond Evaluation. The 50% design, presented in Appendix A, includes general arrangement of the proposed treatment system equipment and mechanical, electrical, plumbing, and civil engineering drawings. The 50% design was developed with sufficient detail to provide a basis for the 50-year project life-cycle cost presented herein.

2.0 BACKGROUND INFORMATION AND SCOPE OF WORK

The PVU is a component of the Colorado River Basin Salinity Control Program, a multi-works program to control the salinity of Colorado River water delivered to users in the United States and Mexico. The PVU currently intercepts 200 gallons per minute (gpm) of 260,000 milligrams per liter (mg/L) brine and diverts it to a 16,000-foot deep injection well for disposal. The injection rate has been curtailed during the 20-year life of the well due mainly to induced seismic activity associated with the injection process. At the current rate, Reclamation prevents approximately 100,000 tons of salt per year from entering the Colorado River system. The current collection well field is capable of producing 400 gpm. Reclamation’s goal is to control up to 170,000 tons of salt per year, or 300 gpm of brine. Due to current and future limitations of the injection well, and long-term salinity control considerations at PVU, Reclamation is currently evaluating alternative methods of brine disposal. One of the long-term strategies being considered for brine disposal is diverting the brine to an evaporation pond or series of ponds.

The brine produced at the PVU contains dissolved hydrogen sulfide at concentrations of approximately 50 to 125 mg/L. When the brine at PVU is exposed to the atmosphere, hydrogen sulfide readily volatilizes out of the brine and into the air. Concentrations in the air above the brine surface can exceed 500 ppm.

Hydrogen sulfide is a colorless and flammable gas with a “rotten egg” smell. It is heavier than air and may travel along the ground and collect in low-lying, enclosed, or poorly-ventilated areas. This compound is toxic if inhaled at high concentrations.[1] In addition, hydrogen sulfide is a flammable gas, with a Lower Explosive Limit (LEL) of 4.3% in air, and gas/air mixtures can be

---

[1] At a concentration in the air at or above 100 parts per million (ppm), hydrogen sulfide gas is Immediately Dangerous to Life and Health (IDLH). Occupational Safety and Health Administration (OSHA) standards include a maximum exposure limit of 20 ppm in air over an eight-hour work shift. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a short-term exposure limit (STEL) of 5 ppm in air, which is the alarm setpoint for all hydrogen sulfide sensors at the existing PVU facilities.

explosive. If ignited, the gas burns to produce hazardous gaseous by-products of combustion, such as sulfur dioxide. Hydrogen sulfide is corrosive to metals and concrete.

Amec Foster Wheeler has been tasked with designing a brine treatment strategy to remove dissolved hydrogen sulfide prior to conveying the brine to evaporation ponds. The 50% design presented herein proposes a treatment system to remove dissolved hydrogen sulfide from the brine via sodium hypochlorite (bleach) oxidation. The reaction is as follows:

$$H_2S + 4\,NaOCl \rightarrow\ H_2SO_4\ + 4\,NaCl$$

By dosing the brine with sodium hypochlorite, sulfate and sodium chloride (i.e., salt) would be produced. These compounds would then be discharged to the evaporation system surge pond with the remaining brine constituents.

The target concentration of less than 0.5 mg/L of hydrogen sulfide in the effluent to the evaporation ponds is based on the occupational health and safety risks to workers at the proposed facility. During our testing, we measured hydrogen sulfide concentrations greater than 500 ppm in the air above freshly collected brine samples (which measured 80 mg/L of H_2S in the brine). This underestimates the risk as we were limited by the 500 ppm range of our personal hydrogen sulfide detectors. Concentrations over the brine could actually reach as high as 20,000 ppm (2% by volume in air). At a concentration in the air at or above 100 ppm, hydrogen sulfide gas is Immediately Dangerous to Life and Health (IDLH). Occupational Safety and Health Administration (OSHA) standards include a maximum exposure limit of 20 ppm in air over an eight-hour work shift. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a short-term exposure limit (STEL) of 5 ppm in air, which is the alarm setpoint for all hydrogen sulfide sensors at the existing PVU facilities. EPA Acute Exposure Guideline Levels (AEGL) reference non-disabling human effects as low as 0.75 ppm (headaches). Atmospheric modelling of hydrogen sulfide releases was not included in the scope of this project, but based on the high hydrogen sulfide concentration above the fresh untreated brine samples, the concentration of hydrogen sulfide left in the treated brine would have to be very low to meet the OSHA exposure limits for workers employed at the site.

3.0 BASIS OF DESIGN

The following information summarizes the Design Basis used to develop the Hydrogen Sulfide Treatment System 50% Design.

3.1 Treatment System Capacity

- Design flow rate: 300 gpm
- Maximum hydraulic flow capacity: 400 gpm
- Influent chemistry – maximum concentrations detected during preliminary water sampling in March 2016 will be used to specify equipment and material compatibilities, as summarized below and in Amec Foster Wheeler (2016a).
    - Dissolved hydrogen sulfide concentrations: 50 to 125 mg/L
    - Total dissolved solids: 250,000 – 300,000 mg/L

  - Total suspended solids: <20 mg/L
  - Total alkalinity: 200 mg/L (as calcium carbonate)
  - Ammonia: 17 mg/L (as nitrogen)
  - Methane: 1.2 mg/L
  - Sodium: 100,000 mg/L
  - Chloride: 170,000 mg/L
  - Bromide: 86 mg/L
  - Specific conductance: 238,000 microSiemen per centimeter
  - pH: 6.1 to 6.6 standard units

- Target effluent water quality
  - Dissolved hydrogen sulfide: <0.5 mg/L
  - Residual chlorine: non-detectable
  - pH: 6 to 9 standard units

- Hydrogen Sulfide Oxidation
  - Tank hydraulic retention time (HRT): 20 minutes (5 minutes for chemical oxidation, with additional volume provided for contaminant equalization)
  - Sodium hypochlorite reagent concentration: 12.5% by weight
  - Design hypochlorite dose: 5.7 milliliters per liter (mL/L) [2]
  - Metering pump design flow, maximum: 520 liters per hour (LPH); 140 gallons per hour (gph) [3]
  - Metering pump design flow, minimum: 5.2 LPH, 1.4 gph [4]

- Dechlorination
  - Tank HRT: 5 minutes
  - Sodium bisulfite concentration: 38%
  - Design dose rate: 0.097 mL/L
  - Metering pump design flow, maximum: 13 LPH; 3.5 gph [5]
  - Metering pump design flow, minimum: 0.13 LPH, 0.035 gph [6]

- Coagulation/Rapid Mix
  - Tank HRT: 5 minutes
  - Ferric chloride concentration: 40%
  - Design dose rate: 0.044 mL/L
  - Metering pump design flow, maximum: 4.0 LPH; 1.0 gph [7]
  - Metering pump design flow, minimum: 0.20 LPH, 0.05 gph [8]

- Flocculation/pH Adjustment
  - Tank HRT: 20 minutes

---

[2] Based on titration curves developed during bench-scale testing, which indicated 3.15 moles of sodium hypochlorite per mole of hydrogen sulfide; assumed reagent concentration; and assumed maximum dissolved hydrogen sulfide concentration of 125 mg/L (Amec Foster Wheeler, 2016a).
[3] Based on design dose rate. Assumes peak flow is achieved at 75% of pump capacity.
[4] Assumes 100 to 1 turndown ratio from maximum flow.
[5] Based on design dose rate. Assumes peak flow is achieved at 50% of pump capacity.
[6] Assumes 100 to 1 turndown ratio from maximum flow.
[7] Based on design dose rate. Assumes peak flow is achieved at 75% of pump capacity.
[8] Assumes 20 to 1 turndown ratio from maximum flow.

  - Sodium hydroxide concentration: 50%
  - Design dose rate: 0.18 mL/L
  - Metering pump design flow, maximum: 16 LPH; 4.2 gph [9]
  - Metering pump design flow, minimum: 0.16 LPH, 0.042 gph [10]

- Maximum potential elevation: 6,300 feet above mean sea level (amsl; at proposed Landfill site)
- Minimum potential elevation: 4,970 feet amsl (at Surface Treatment Facility)
- Ambient temperatures: -5 degrees Fahrenheit (°F) to 100°F [11]
- Design life: 20 years, designed for continuous service, 24 hours per day, 365 days per year [12]
- Redundancy (N+1) will be provided for chemical dosing operations, monitoring, and alarming.

3.2 Reagent Chemicals

The hydrogen sulfide treatment system will be provided with an on-site sodium hypochlorite generator. The sodium hypochlorite generator will have a capacity to produce 1,125 kilograms (nominal 2,500 pounds) per day of product. The produced sodium hypochlorite will be diluted to 12.5% solution strength.

3.3 Location and Conveyance

The chemical oxidation tests performed during bench-scale testing (Amec Foster Wheeler, 2016a), including peroxide, permanganate, and hypochlorite addition, resulted in the generation of fine elemental sulfur solids. There was concern that these solids could plug pumps and conveyance pipelines, especially over fairly long pipeline runs across varying topography to the evaporation ponds. Therefore, it was assumed that the treatment system would be located immediately upstream of the outfall to the evaporation system surge pond. Based on this initial assumption, the following additional assumptions were made.

- The treatment system may be located at one of three potential evaporation pond sites (Paradox NW, BLM, or Landfill, per Amec Foster Wheeler, 2016b). Brine conveyance piping and pumps are included in the evaporation pond siting evaluation/design.
- The existing pump station at the Surface Treatment Facility (STF) will be used to convey flows from the existing extraction wells to the new treatment system, though the pumping station may be modified, especially if the Paradox NW site is not chosen. Pump station design and/or modifications are included in the Pond Optimization Study (Amec Foster Wheeler, 2016c).

---

[9] Based on design dose rate. Assumes peak flow is achieved at 75% of pump capacity.
[10] Assumes 100 to 1 turndown ratio from maximum flow.
[11] 2013 to 2016 data set for Nucla Hopkins Field Airport, weather station KAIB, per www.wunderground.com.
[12] Replacement costs will be included in the 50-year cost estimate.

- The transfer pump from the existing well collection system will pump brine directly into the treatment system at the inlet to the oxidation tank.
- Brine will flow through the treatment system by gravity from the oxidation tank. Concrete pads or steel stands may be used to ensure gravity flow along the hydraulic profile. Effluent from the treatment system will discharge via gravity to the surge pond.
- No effluent polishing will be required. Solids generated in the treatment system will settle in the surge pond.
- Road access to the treatment system is part of the evaporation pond siting evaluation / design and is not included in this 50% design or costs.

3.4 Building

The treatment system, control room, analytical laboratory, plumbing and washrooms, and electrical system will be installed and constructed within a pre-engineered building.

- The building will conform to locally adopted standards and ordinances (as applicable).
- Building designed is an F-1 occupancy, Category 3 facility.
- The process building will be a fully enclosed, heated, insulated structure. This pre-engineered, metal building, will be placed on a concrete slab on grade.
- Building office areas will be insulated with fixed, double-pane, low-e windows.
- Geotechnical engineering for the building foundation and subgrade is not included in this evaluation/design. Earthwork costs for preparing the building footprint are included in the Pond Optimization Study (Amec Foster Wheeler, 2016c) grading cost estimate.
- Prevailing winds were assumed to be from the west.
- Gas detector sensors for hydrogen sulfide will be located within the building, in the vicinity of the collection sumps. Sensors will be connected to an alarm system that will automatically trigger ventilation system activation, as per design at the existing Brine Injection Facility (BIF).
- A heating, ventilation, and air conditioning (HVAC) system is incorporated into building design to facilitate active ventilation within the building.
- The reaction tanks T-HYPO-1 and T-DECHLOR-2 will be provided with a continuously operating exhaust fan to sweep fugitive hydrogen sulfide from the headspace in the tank directly to the outdoors. This is strictly a precautionary measure as the brine enters the bottom of the oxidation tank, which is dosed an excess of sodium hypochlorite.
- A fire alarm system will be provided. No automatic fire protection systems will be provided.
- A septic tank and leach field are incorporated into the design for domestic sewage from the building.

- Propane from an externally located storage tank will be used to heat the building and provide hot water. Propane was chosen since it is readily available for delivery, and we had no records of natural gas pipelines in the area. Propane is also likely more cost effective than electricity for heating the building and providing hot water.
- Building occupancy is assumed to be two persons, 24 hours per day, for purposes of lighting and septic system sizing.
- A sump system is included to convey overflow from the treatment system tanks and laboratory sink drainage to the hydrogen sulfide treatment system oxidation tank. Sump pumps may also convey flow directly to the evaporation system surge pond.
- A Supervisory Control and Data Acquisition (SCADA) system will be provided for monitoring and control, with remote monitoring capability.
- The treatment system building and associated chemical storage tanks will be surrounded by security fencing, similar to the existing Brine Injection Facility. Even though the entire pond system is to be fenced, we believe that the treatment system should have separate fencing to ensure only authorized personnel and contractors have access to the treatment system area for health & safety reasons.

3.5 Chemical Storage

Chemical storage and dispensing assumptions are as follows.

- Chemical tanks, pumps, and dispensing piping will be secondarily contained.
- Chemical storage tanks are sized to accept a full, bulk chemical delivery, if feasible, based on recommended storage conditions from chemical vendors.
- Chemical metering systems will be installed indoors, with secondary containment.
- Chemical metering systems will be pre-fabricated, skid-mounted systems with redundant pumps, calibration columns, pressure-relief valves, backpressure valves, isolation valves, and pulsation dampeners.

Chemical storage will be as follows.

- Two sodium hypochlorite storage tanks will be insulated but not heat traced. Tank material will be opaque to avoid contact with sunlight, which degrades hypochlorite.
- One ferric chloride storage tank will be insulated and heat traced.
- One sodium hydroxide system will be insulated and heat traced.
- One hydrochloric acid tank will not require freeze protection (due to the low freeze point of hydrochloric acid). The hydrochloric acid tank will be vented to a vapor scrubber.
- One sodium bisulfite tank will be stored indoors, within a secondary containment berm.

3.6 Electrical

The majority of the 50% design was based on information received during coordination (phone and email) with Amec Foster Wheeler design team members, along with equipment and one-line diagram information received from Electrolytic Technologies, LLC. Additional information on electrical utility requirements was obtained during phone and email communication with a Service Planner at San Miguel Power Association (SMPA). SMPA assisted in preparing a rough cost for construction of overhead power to serve the proposed facility. The following assumptions were made in designing the electrical supply.

- An emergency generator is not required.
- SMPA has sufficient capacity on their grid to serve the facility. SMPA will require final load information and location of the site to determine exactly how it will impact their electrical system.
- IT/Communications systems will be coordinated and provided by owner. This design assumes IT/ Communications infrastructure only (e.g., conduit, back-boxes).
- Power is not currently available at the proposed evaporation pond sites. Installation of a high-voltage overhead power line from the existing pole line of the local utility, a transformer adjacent to the treatment facility, power requirements, and distribution at the facility are included in this 50% design.
- Overhead power costs were based on a $35,000 estimate from SMPA for 1,000 linear feet of overhead powerline installation. A cost of $35 per foot was used to estimate overhead costs at the alternative pond site locations.

3.7 Freshwater

- Limited freshwater is available at the PVU (Amec Foster Wheeler, 2016b). Water supply to the treatment system is part of the Pond Optimization Study (Amec Foster Wheeler, 2016c) and not included in this report.
- Freshwater for the hydrogen sulfide treatment system is to be supplied year-round from the Dolores River via the existing withdrawal point near the Brine Injection Facility. This freshwater source is assumed to be sufficiently treated by existing processes to be used for non-potable purposes at the hydrogen sulfide treatment system, including lavatory, sink, cooling water, chemical dilution, and hypochlorite generation systems.
- The H_2S treatment system will require an average of 1,650 GPD of freshwater with a peak design rate of 2,450 GPD. This water will come from the freshwater supply for the wildlife pond and pump flushing water. The design of this system includes storage tanks at the evaporation ponds location and is detailed in the Pond Optimization Study (Amec Foster Wheeler, 2016c)
- A potable water supply is not included in this design. Potable water for drinking and standalone safety showers and eyewash stations will be transported to the site periodically.

3.8 Septic System

- All portions of the septic system, from the building to the infiltration trenches, will flow by gravity. Pumps or lift stations will not be required.
- The depth to groundwater and/or bedrock is not less than 8 feet.

- Soil types at the site will provide long-term acceptance rates greater than 0.4 gallon per day per square foot. Import of suitable adsorption soil will not be required.
- Minimum separation distances between the site features (on-site well, water bodies, dry gulches, etc.) listed in the *Montrose County Board of Health Resolution for On-Site Wastewater Treatment Systems* will be feasible.
- The septic system will not be constructed in a 100-year floodplain or floodway.

4.0 HYPOCHLORITE SOURCE EVALUATION

Bench-scale brine oxidation via sodium hypochlorite addition was evaluated by Amec Foster Wheeler in spring 2016 (Amec Foster Wheeler, 2016a). Of the chemicals evaluated, sodium hypochlorite addition proved most favorable to treatment of the PVU brine hydrogen sulfide. Based on dosing curves developed during bench-scale testing, 3.15 moles of sodium hypochlorite were required per mole of hydrogen sulfide. For an average dissolved hydrogen sulfide concentration of 82 mg/L, this equates to a dose rate of 3.8 mL of 12.5% sodium hypochlorite per liter of brine. Scaled to an assumed 300 gpm full-scale brine flow rate (see Section 3.1 for treatment system design basis assumptions), the daily, weekly, and annual estimated sodium hypochlorite requirements would be as follows. Estimated chemical costs, per a vendor-supplied quote of $1.58 per gallon for bulk 12.5% sodium hypochlorite solution, including a $2,400 fee per delivery, are included below.

Frequency:	**per Day**	**per Week**	**per Year**
Gallons of 12.5% Sodium Hypochlorite	1,630	11,400	595,000
Estimated Chemical Cost	$3,400	$24,000	$1,300,000

These values demonstrate that sodium hypochlorite delivery is feasible but may be cost prohibitive. Deliveries would be required every 2.8 days on average[13] to treat average hydrogen sulfide concentrations – higher concentrations would result in more rapid consumption. On-site sodium hypochlorite generation was then evaluated as an alternative to bulk chemical delivery of sodium hypochlorite.

Amec Foster Wheeler contacted an on-site sodium hypochlorite generation system provider, Electrolytic Technologies, for support. Electrolytic Technologies manufacturers a proprietary “Klorigen™ System” that is scalable to meet various hypochlorite demands. Per their product information:

> Electrolytic Technologies specializes in the manufacture of electrochemical chlor-alkali systems that bring value to customers through savings in installation, operation and life cycle maintenance. All systems are supplied in factory manufactured modules, pre-piped and pre-wired to maximum extent to facilitate cost effective installation and operability.

[13] This assumes 45,000-gallon deliveries and a vendor-supplied density of 10 pounds per gallon.

> Klorigen™ Systems are designed to generate elemental chlorine gas and very pure sodium hydroxide on-site using a state-of-the-art membrane cell-based process. During normal operation, chlorine (Cl_2) gas is produced in the anolyte compartments of the electrolyzers and sodium hydroxide is produced in the catholyte compartments as a co-product. They are then reacted together in a separate conversion module to produce sodium hypochlorite (NaOCl) on a continuous basis. The hypochlorite product concentration range is adjustable between 5 and 15 trade % (50 to 150 gm/L as NaOCl). The by-product hydrogen co-produced in the catholyte compartments of the electrolyzers is immediately and safely diluted with ambient air to 2% by volume, or less, in concentration and is safely vented to the atmosphere.

Electrochemical chlor-alkali systems are the most common method used to generate chlorine for industry on a large scale. They are also becoming more common on a smaller scale for on-site generation of sodium hypochlorite for use at drinking water plants and wastewater treatment plants.

On-site sodium hypochlorite generation requires food-grade salt (sodium chloride, NaCl) to be dissolved in freshwater to produce a brine. This brine is pre-treated to remove chemical impurities and then conveyed to electrolyzers, which use anodes and cathodes to convert the sodium chloride into chlorine gas and sodium hydroxide (NaOH). These are conveyed to a hypochlorite conversion module, which they react to form sodium hypochlorite, sodium chloride, and water. A chiller is used to cool the hot sodium hypochlorite prior to conveying it to storage tanks. Depleted brine from the electrolyzers are sent to a chlorine stripper to remove residual chlorine. Sodium chloride, water, and depleted brine (after chlorine stripping) are ultimately returned to the brine maker, and the process continues. A more thorough explanation of this process is included in the Electrolytic Technologies quote provided in Appendix B.

A Klorigen™ System sized to produce 2,500 gallons per day of 12.5% sodium hypochlorite (1,125 kg chlorine equivalent per day), suitable for treatment of maximum hydrogen sulfide concentrations at PVU (125 mg/L) at a brine flow rate of 300 gpm, was quoted for approximately $1,639,500. The capital cost was less than the annual chemical cost for one year of bulk sodium hypochlorite delivery. Coupled with significant annual operational savings for on-site generation versus bulk delivery, the overall cost savings are very attractive. For these reasons, on-site hypochlorite generation was incorporated into the treatment system design.

Further information regarding the sodium hypochlorite generation process and annual operations and maintenance costs are discussed in Sections 6.0 and 7.0.

5.0 SALT SOURCE EVALUATION

On-site sodium hypochlorite generation typically uses a food grade salt (Morton Culinox® 999 or equivalent) that is shipped by truck and pneumatically loaded into a brine maker or “briner”. An evaluation was performed to determine if the salt produced from the PVU evaporation system ponds could be utilized for sodium hypochlorite generation. Cost comparisons were made for bulk delivery of food-grade Morton salt (delivered from Hutchinson, Kansas); locally-available

Intrepid Potash salt (shipped from Moab, Utah); and salt produced on site. Table 1 presents a summary of this cost comparison. Both the PVU salt and the locally-available Intrepid Potash salt would require brine pre-treatment prior to use in the sodium hypochlorite generator.

Based on this information, it was concluded that reuse of on-site salt from evaporation ponds would be cost effective, even with the added cost for pre-treatment of the PVU salt before it could be used in the hypochlorite generation system. Until sufficient quantities of PVU salt are harvested from the evaporation ponds, the sodium hypochlorite generation system will have to rely on salt shipped to the PVU site. For this interim period, the most cost-effective solution would be locally available salt, even if it requires brine pre-treatment prior to use in the sodium hypochlorite generator.

6.0 50% DESIGN SUMMARY

The hydrogen sulfide treatment system will consist of a series of reactor tanks designed to remove hydrogen sulfide from brine. For a Process Flow Diagram, see sheet PFD-101 in Appendix A.

Raw brine from the extraction wells located near the existing Surface Treatment Facility will be pumped to the hydrogen sulfide treatment facility. Brine will enter the treatment system at the Oxidation Tank. Sodium hypochlorite will be dosed into the Oxidation Tank to oxidize hydrogen sulfide to either sulfate or elemental sulfur, depending on the reaction pathway. Hydrogen ions also will be produced by the oxidation reaction, resulting in a decrease in the brine pH. Effluent from the Oxidation Tank will flow by gravity to the Dechlorination Tank, where it will be dosed with sodium bisulfite to remove residual chlorine that may be present in the brine due to excess sodium hypochlorite addition (in the Oxidation Tank). Dechlorinated brine will flow by gravity to the Coagulation/Flocculation Tank, where ferric chloride will be added to the brine to promote precipitation and settling of elemental sulfur. From this tank, effluent will flow to the Neutralization Tank, where sodium hydroxide will be added to increase the pH back to neutral prior to discharge. Effluent from the Neutralization Tank will be conveyed by gravity to the evaporation system surge pond, where the elemental sulfur solids will settle.

The following sections describe the specific design elements incorporated into the 50% design. The Process & Instrumentation Diagrams (P&IDs) provided in Appendix A, as well as mechanical, electrical, and civil engineering drawings, support this discussion.

6.1 Building

To enclose the hydrogen sulfide treatment system and associated sodium hypochlorite generation system equipment, it was determined an enclosed building 8,366 square feet in size would be required. The proposed steel-frame structure is 72 feet wide in the east-west direction and 96 feet long in the north-south direction, as indicated on Sheet M-101 in Appendix A. An additional “bay” approximately 20.5 feet in the north-south direction extends off the northern end of the building to provide cover for the outdoor chemical storage tanks. This bay would not be enclosed on three sides.

The building roofline runs approximately north-south to promote snowmelt during the winter. Based on the assumption that prevailing winds blow from the west at this site, a 14-foot high by 14-foot wide roll-up garage door is located on the eastern, leeward side of the building. Consideration was given to doors opening to the exterior of the building to mitigate potential wind-blown door hazards.

For the purposes of laying out the process equipment and ancillary rooms, the Northwest Paradox site was considered. This site was selected as a “reference area” since it was the preferred location identified in the *Pre-Final Site Selection Report* (Amec Foster Wheeler, 2016b). The proposed layout is shown on Sheet C-101 in Appendix A. Per this layout, the proposed power line follows the access road route to the building from the west and does not require chemical delivery trucks or salt handling equipment to drive below it for access to the chemical storage bay to the north or Brine Maker Pit to the east. The Brine Maker Pit is located toward the east, providing ready access from the evaporation system ponds farther to the east. Salt handling equipment would not be impacted by foot traffic, passenger vehicles, or chemical delivery vehicles present on the western and northern sides of the building. The leach field drains south, away from the building, and does not require heavy vehicle or equipment to cross the sewer line to access the building. For protection, the leach field will be well outside of the parking lot area to avoid vehicular traffic, though the septic tank will be accessible for periodic emptying. Lastly, both untreated raw brine and treated effluent brine can enter and exit the building on the east side, in the direction of the Surface Treatment Facility and surge pond. Such a layout keeps pipelines well clear of parking areas or chemical delivery areas/turnouts.

6.2 Oxidation

The oxidation tank will receive raw brine and sodium hypochlorite, produced using the on-site hypochlorite generation system. pH and oxidation-reduction potential (ORP) probes will monitor tank conditions and control hypochlorite dosing rates. Influent (raw) brine will have negative ORP values, typically in the range of -270 to -320 millivolts (mV; Amec Foster Wheeler, 2016a). Brine that has been sufficiently dosed with sodium hypochlorite to achieve hydrogen sulfide oxidation should result in positive ORP in the range of +480 mV (based on bench-scale testing; Amec Foster Wheeler, 2016a). Regular operational bench-top testing of hydrogen sulfide concentrations, chlorine residuals, and ORP by PVU operators will be used to confirm performance of the oxidation tanks and inform adjustments of control setpoints. A mixer will promote rapid and thorough mixing of the influent to assure hydrogen sulfide oxidation.

Although the reaction is nearly instantaneous, a 20-minute HRT was used to size the Oxidation Tank to promote adequate mixing and allow influent hydraulics to stabilize. This larger HRT was selected to ensure relatively consistent water levels in the tank, as it will be fed directly from the Surface Treatment Facility transfer pump system. The larger HRT also enable flow to the rest of the treatment system to increase or decrease slowly, promoting more consistent control of chemical dosing in the downstream tanks.

To avoid double-handling the untreated brine, an equalization tank was not incorporated into the design. Collection tank/pumping systems pose the greatest risk of hydrogen sulfide off-gassing anywhere in the system. The Oxidation Tank is expected to be the only tank in the treatment system with the potential to accumulate hydrogen sulfide gas in the headspace. To prevent pressurized buildup, a vent and continuously operating in-line exhaust fan will draw air from outside the tank, through the tank headspace, to a pipeline that discharges outside of the building. The exhaust point of the tank vent will be installed above the building roofline, away from the fresh air intakes, and will be continuously monitored for chlorine and hydrogen sulfide. Any alarm condition in the system that would affect the systems ability to oxidize hydrogen sulfide will trigger the shutdown of the brine transfer pumps, stopping the flow of untreated brine to the Oxidation Tank (e.g. failure of sodium hypochlorite dosing pumps).

6.3 Dechlorination

The target effluent quality for residual chlorine (non-detectable) was selected to mitigate potential chlorine odors as well as to avoid additional ecological stressors in the evaporation ponds. Chlorine residual was not incorporated into the Ecological Risk Assessment performed for the evaporation ponds. Incorporating a dechlorination step provides assurance that residual chlorine will not pose a hazard or nuisance. An ORP probe in the Dechlorination Tank will monitor tank conditions and control sodium bisulfite dosing rates. A mixer will promote rapid and thorough mixing of the influent.

Dechlorination may not be required, depending on the amount of residual chlorine required for consistent removal of hydrogen sulfide from the brine. The incremental cost to include the dechlorination system is relatively small, so we have included dechlorination. Sodium bisulfite would be required for the hypochlorite generation system, so the infrastructure would already be in place for sodium bisulfite.

6.4 Coagulation/Flocculation

Bench-scale testing of hypochlorite oxidation at PVU in spring 2016 (Amec Foster Wheeler, 2016a) produced fine elemental sulfur solids, which appeared to be almost neutrally buoyant. There was concern that, if these solids did not sufficiently settled in the surge pond, prior to entering the subsequent evaporation pond system, they could affect the performance of evaporation ponds by causing the brine to reflect rather than absorb sunlight.

Ferric chloride was selected as the design coagulant based on the results of pilot plant studies conducted by Boegli and Murphy (1985) for direct electrochemical oxidation of aqueous sulfide at the PVU. In that study, the electrochemical oxidation of the hydrogen sulfide in the PVU brine produced elemental sulfur solids, which were found to settle best using 25 mg/L of ferric chloride. After the addition of ferric chloride and 15 minutes of slow mixing, the majority of precipitated solids settled within five minutes after mixing stopped. Several other polymers tested by Boegli and Murphy (1985) did not improve settling notably.

The precipitated solids will be composed mainly of ferric hydroxide and elemental sulfur. The annual volume of precipitated solids is estimated to be 0.2 acre-foot, based on 60 tons of solids generated annually and an assumed solids density of 20% by weight. This estimate conservatively assumes all sulfides will be oxidized to elemental sulfur. The surge pond has been designed to store the expected volume of solids created from the hydrogen sulfide treatment system over a 50-year period. The surge pond will have an area to collect and store the settled solids. The settled solids will remain wet and unexposed to the atmosphere for the duration of the 50-year operating life of the evaporation ponds. During closure, care will have to be taken to keep the solids wet prior to final placement for disposal. Further discussion of the surge pond design and waste handling is included in the Pond Design Strategy report (Amec Foster Wheeler, 2016c).

A pH probe in the Coagulation/Flocculation Tank will be used to monitor tank conditions. A mixer will promote rapid and thorough mixing of the influent. The residence time will only be five minutes, as the tank is only required to rapidly mix the ferric chloride into the brine. The majority of flocculation will occur in the Neutralization Tank, which will have a longer residence time and gentle mixing to promote flocculation.

6.5 Neutralization

The oxidation process is expected to decrease the pH of the raw brine. Based on bench-scale testing results (Amec Foster Wheeler, 2016a), pH is expected to decrease from an influent pH averaging pH 6.4 to less than pH 5.0. In addition, the dechlorination (sodium bisulphite) and coagulation (ferric chloride) chemicals are both acidic and will depress the brine pH further. A neutralization step, using sodium hydroxide as the reagent, will be used to raise the pH prior to discharging the treated brine to the surge pond. The target effluent pH is neutral to mitigate potential negative ecological effects. Located in the Neutralization Tank, probes measuring pH and ORP will be used to monitor tank conditions and control the sodium hydroxide dosing rate. A mixer will promote gentle mixing of the influent.

The neutralization tank will have an HRT of 20 minutes. Typically, pH adjustment requires a residence time of 15 to 20 minutes to maintain stable pH control.

Sodium hydroxide is readily available as a 25% and 50% solution. Higher concentrations require less frequent chemical delivery and/or smaller storage capacity. However, 50% sodium hydroxide has a freezing point of approximately 54 degrees Fahrenheit (°F). By comparison, 25% sodium hydroxide has a freezing point of approximately 0°F.

Although the sodium hydroxide storage tank will be insulated and heat traced (as described in Section 3.5), average daily ambient air temperature at the site can drop below the 50% solution freezing point outside of the summer months. To mitigate the potential for freezing, the treatment system 50% design allows both 25% and 50% sodium hydroxide solutions to be utilized for neutralization. The proposed operational plan would be to utilize 50% solution during the warmer months and 25% solution the rest of the year, when ambient air temperatures drop below the 50% solution freezing point. This is a common operating method for sodium hydroxide users. Dosing equipment and chemical storage has been designed accordingly.

6.6 Reactor Tanks

The hydrogen sulfide treatment system reactor tanks (i.e., the Oxidation, Dechlorination, Coagulation/Flocculation, and Neutralization Tanks) will be constructed of fiberglass reinforced plastic (FRP). Tanks were sized based on the maximum hydraulic flow capacity (400 gpm) and design HRTs presented in Section 3.1. Tank access will be via a raised manway for safe, easy access. The tanks will be installed on raised concrete pads or steel stands to assure proper hydraulics and gravity-feed through the system. Tanks will all contain agitators mounted vertically on powder or epoxy coated steel support brackets for easy maintenance access from the manway. Product data sheets are included in Appendix C.

6.7 Chemical Storage Tanks

Chemical storage tanks will be constructed of high-density crosslinked polyethylene (XLPE). Tanks were sized to accommodate one full bulk chemical delivery, plus 10% delivery volume (the residual chemical 'heel'), and then rounded up to achieve off-the-shelf mold volumes. Chemical storage tanks were designed to incorporate powder or epoxy coated steel outside seismic restraints and manways with fiberglass ladders. To mitigate the potential for leaks, tanks will not have sidewall penetrations; chemical delivery and extraction will be via dip tubes and ports in the tank domes. Additional product information on XLPE is provided in Appendix C.

As described in Section 3.5, corrosive chemicals will be stored outdoors to avoid classifying the building interior as a hazardous occupancy. Chemical storage tanks will be located along the north side of the building to mitigate tank damage from ultraviolet radiation (UV) and chemical degradation caused by heat. All chemical storage tanks will be located under the building roofline to minimize UV and weather impacts. A 22-inch high concrete secondary containment curb will surround the tanks, and a fire-resistive barrier (thin steel wall) will be provided to physically separate acids (ferric chloride, hydrochloric acid) from bases (sodium hydroxide, sodium hypochlorite).

6.8 Dosing Pumps

Chemical dosing pumps for this system will be peristaltic pumps. Peristaltic pumps are typically low-maintenance and are effective at operating over a wide range of chemical injection rates. Chemical dosing pump capacities were calculated based on maximum anticipated hydrogen sulfide concentrations (125 mg/L) requiring treatment at the design flow rate of 300 gpm. Pumps were rated with a 100:1 turndown where technically possible. Operation of a pilot system would identify the variability required in dosing pump operation, and simpler, more cost efficient dosing pumps with smaller turndown ratios may be sufficient.

Dosing pumps will be supplied as duplex pump skids complete with pressure relief valves, isolation valves, backpressure regulators, calibration columns, and pulsation dampeners.

6.9 Sodium Hypochlorite Generation System

As discussed in Section 4.0, on-site sodium hypochlorite generation was incorporated into the treatment system 50% design to provide long-term operational cost savings. Storage tanks for the sodium hypochlorite generated on site will also be configured to accept deliveries of commercially-produced sodium hypochlorite. Deliveries are anticipated to be needed several times per year to facilitate routine maintenance of the on-site hypochlorite generation system.

Brine for the hypochlorite generation system will be generated on site in a 36-ton Brine Maker Pit, located outside the building (see sheet M-101 in Appendix A). Freshwater (provided from a freshwater storage tank as needed – same tank to supply freshwater pond) and salt from the evaporation ponds system will be combined in the Brine Maker Pit to re-dissolve the salt.

The produced raw brine will be conveyed to the Primary Brine Treatment System to remove chemical impurities (see sheets PFD102 and PFD103 in Appendix A). The chemicals required for brine treatment are sodium carbonate, calcium chloride, and sodium hydroxide. Details regarding chemical concentrations, liquid or solid forms, and dosing rates were requested from Electrolytic Technologies but not received as of the date of this report. Therefore, the costs associated with the purchase, delivery, storage, and conveyance of these chemicals were estimated. It is our understanding that the chemical requirements for the Primary Brine Treatment System will be small in comparison to the chemical requirements for the overall treatment system.

After receiving chemical treatment, the brine is conveyed to a microfiltration unit and then back to the Brine Treatment Unit. The Brine Treatment Unit incorporates an ion exchange column with hydrochloric acid and diluted sodium hydroxide solution to further polish the brine prior to use in the sodium hypochlorite generation system electrolyzers. The treated brine is stored in a Finished Brine Tank prior to hypochlorite generation.

The sodium hypochlorite generation system quoted by Electrolytic Technologies includes the following.

- Primary Brine Treatment System
- Brine Treatment Unit
- Electrolyzer Module each utilizing eight electrolyzers
- Receiver Unit incorporating Blower Module
- Caustic Receiver/Brine Dechlorination Unit
- Hypo Conversion/Chlorine Stripper Unit
- Transformer/Rectifier (2)
- Master Control Panel (MCP) and Motor Control Center (MCC)

A water softening system, air compressor, air drier, chiller, and cooling tower are also incorporated into the design. It was assumed that waste streams from the various unit processes would be conveyed to the Brine Maker Pit, the building sump, the hydrogen sulfide treatment system Oxidation Tank, and/or the evaporation ponds. As such, the filter press shown on sheet PFD103 (Appendix A) is included in the Electrolytic Technologies proposal but may not be required for this site. The filter press is designed for dewatering solids produced in the brine treatment system, which are similar to the salts already contained in the PVU brine and therefore could be discharged directly to the surge pond.

Reference drawings provided by Electrolytic Technologies for the Brine Maker Pit, MCP and MCC, electrical single line diagram, and example Process Flow Diagram are included in Appendix A.

6.10 Electrical Service and Distribution

The electrical service to the site will be via an overhead primary line extended from San Miguel Power Association's (SMPA) existing overhead three-phase power line. SMPA will perform all overhead work to install the new overhead primary, and will bill the customer for this service. Once power has been brought to the site, a step-down transformer, either pole-mounted or pad-mounted depending on size, will deliver 277/480V, 3-phase, 4-wire power to the building. A main service disconnect (GFCI circuit breaker) will be located on the outside of the building per SMPA's requirements.

This design estimates the main service to be sized at 3,000 amps based on initial information provided by Electrolytic Technologies' Motor Control Center (MCC) Single Line diagram provided to Amec Foster Wheeler, plus the much smaller power requirements for the rest of the hydrogen sulfide treatment system. The main service disconnect will feed a 3000-amp main distribution panel (MDP) inside the electrical room.

The MDP will house circuit breakers that will serve as overcurrent protection for branch feeders to the two motor control centers (MCC-SC1 and MCC-SC2), and a 277/480V 225-amp branch panel. "H1."

Panel "H1" serves a 120/208V branch panel "L1" via a 75kVA 480V: 120/208V step-down transformer. General lighting, receptacles, and mechanical (HVAC) loads are fed from these panels.

The two MCCs are designed by Electrolytic Technologies, and contain all starters and variable frequency drives (VFDs) that serve the process equipment for the hypochlorite generation process. All process equipment is provided with local disconnects.

It was assumed that the MCCs will require being served at full bus capacity, therefore increasing the MDP size, and ultimately the electrical service size. This assumption is based on the MCC Single-line information received from Electrolytic Technologies. If the MCCs could be served based on their actual load with a 25% spare capacity, the service size and associated equipment costs could be drastically reduced.

Electrical equipment costs for the two MCCs, MCP, and disconnect switches serving process equipment is included in the pricing quote from Electrolytic Technologies and therefore is not included in the electrical cost estimate.

Per communication with SMPA, customers are responsible for all costs associated with constructing new power lines, with the exception of installing the transformer. If the new service is overhead, the utility company will do the construction. If there is to be any underground line, the customer must provide the trenching and conduit. For this cost estimate, it was assumed that all new service lines would be overhead from the existing pole line to the new hydrogen sulfide treatment system building.

6.11 Power

General convenience receptacle outlets and outlets for specific pieces of equipment (dryer, washer, lab hood, etc.) are provided as needed throughout the facility. Receptacle outlets are provided for control room and other miscellaneous equipment as required. Mechanical branch circuits sized in accordance with codes will serve HVAC, process equipment, and other specialized equipment. Disconnect switches, special outlets, or special connectors will be provided for this equipment as required. All raceways within process areas will be Schedule 40 PVC. All other interior areas will be electrical metallic tubing (EMT) conduit.

6.12 Lighting

Interior lighting fixtures will be comprised of LED luminaires to minimize maintenance requirements and increase energy efficiency. Fixture types for various areas are described as:

1. Control Room, Lab, Break Room, Hallway, and Restroom: LED 2-foot by 4-foot lensed, volumetric troffer for suspended ceiling.
2. Electrical Room: LED strip light with wire guard, and diffuse lens, for surface or chain mount.
3. Process area: LED Vapor-tight, enclosed fixtures for surface or chain mount.

Exterior lighting will consist of building-mounted, LED full-cutoff wall packs.

Emergency lighting will consist of “frog-eye” type emergency lighting units (ELU) with integral battery packs, with selected fixtures within the process area being provided with integral battery packs to illuminate the mezzanine and stairs in the event of a power outage. Battery packs will provide minimum code required egress lighting for a duration of 90 minutes. Exit signs will be combination exit/ELU fixtures with integral battery packs. Fixtures located at exterior doors will be provided with a high-output battery capable of powering a remote fixture on the exterior of the building to illuminate the exterior path of egress, as required by code.

Lighting controls will consist of occupancy sensors with manual over-ride switches for the control room, break room, lab, hallway, and restroom. The process area lighting will be controlled by manual switches. Exterior lighting will be controlled via photocell.

6.13 Mechanical Systems

The 2015 International Mechanical Code was consulted in developing this design.

6.13.1 Office/Lab Area

The office/lab areas will be heated from a high efficiency propane-fired furnace located in the process area. The air will be distributed in overhead ducts. A small ceiling mounted exhaust fan will be installed in the bathroom and exhausted to the roof. For the laundry dryer, a dryer vent box will be installed.

The lab will be equipped with a four-foot wide bench-mounted fume hood. The fume hood will include an integral exhaust fan, with ductwork routed through the roof. Makeup air for the fume hood will be provided from the process area via a transfer duct. This transfer duct will be equipped with a motorized damper to close in the event of an emergency air flush from the process area.

6.13.2 Process Area

The process area will be ventilated by a two-stage wall mounted exhaust fan. The first stage will be for general ventilation, and the second stage sized for 10 air changes per hour in the event of an emergency air flush. The intake air is located on the opposite side of the building using two stationary louvers and motorized dampers interlocked with the exhaust fan.

The oxidation tank and dechlorination tank will have a separate ventilation system. An in-line exhaust fan will draw air from the outside, through the tanks, and directly to the outside. The ductwork for this system will be fiberglass reinforced plastic.

The space is heated by propane fired unit heaters. The unit heater located closest to the stationary louvers is sized to handle additional heating required if the emergency air flush activates in the winter to maintain the space at a minimum 40°F.

6.13.3 Fire Alarm System

A fire alarm system will be provided for this building. The main fire alarm control panel (FACP) will be installed in the main hallway. The panel will be provided with its own battery back-up, capable of 24 hours of monitoring back-up followed by five minutes of alarm. An auto-dialer will be provided with the system for tie-in to a remote monitoring company.

Initiation of the system will be via manual pull stations located at exits and photoelectric smoke and heat detectors located throughout the building.

Notification will be provided by audible and visual indicating devices (horns and strobes) located throughout the building in order to alert all occupants to an alarm condition. Areas that generally have a high ambient noise level will be provided with more horn/strobe devices or with devices that provide for higher decibel levels. In addition, strobes will be provided to meet Americans with Disabilities Act Guidelines and Life Safety Code requirements.

6.14 Safety Showers and Eyewash Stations

Standalone safety showers and eyewash stations will be provided at four locations within the building (in the laboratory, adjacent to the hypochlorite generation system brine treatment unit, adjacent to the sodium bisulfite chemical storage tank, and on the manway access to the reactor tanks) and one location outside (adjacent to the chemical storage tanks). The outdoor eyewash/safety shower will be heat traced. Locations were selected to meet the ANSI Z358.1-2014 standard, which states that all flushing equipment must be located in areas that are accessible within 10 seconds (roughly 55 feet).

The freshwater supply to the treatment facility is assumed to be non-potable, conveyed to the pond site location and stored in a tank on site, as described in Section 3.7. As such, there is a potential for biological growth in the storage tank and along the freshwater pipelines to the treatment facility. To mitigate the potential for contaminated water being used for emergency medical purposes, safety showers and eyewash stations will not be plumbed to the freshwater source. The safety showers and eyewash stations will be supplied from a single, stand-alone tank filled with potable water and dosed with anti-bacterial solution. Water and anti-bacterial solution will be replaced monthly.

6.15 Plumbing

The building will be served by a new domestic cold water service line connected to the process water entry. The domestic cold water entry assembly will include the building shut-off valve, a reduced pressure backflow preventer, size 1.5 inches in diameter. A second backflow preventer will be installed on the tee that supplies all industrial water uses in the building to prevent the process from contaminating the water supply to the office and lab areas.

Downstream of the main, the water pipe will be type K or L copper. Distribution piping will be routed to the bathroom group, the lab sink, and the clothes washer. All water lines will be insulated.

The domestic water heater will be propane fired and high efficiency direct vent located in the process area. Water will be heated from 40°F to an outlet temperature of 110°F.

Sanitary waste will extend five feet beyond the face of the building, where it will be extended by the civil design (see Section 6.17, Septic System). A two-way cleanout will be provided at the building exit. Waste and vent piping below grade will be Schedule 40 PVC.

Plumbing fixtures will be standard and include water closet, lavatory, break room stainless steel kitchen sink, laboratory sink, and a washer wall box. The laboratory sink will not be a sanitary sink as it will be used mainly for washing lab equipment and handling small amounts of brine waste. An additional small sink will be located in the laboratory for handwashing and will be directed to the septic system.

Low pressure propane will connect five feet outside of the building, where it will be extended to four propane storage tanks connected in series. The propane will be routed to the furnace, water heater, and unit heaters. The piping system will consist of Schedule 40 black steel.

The 2015 International Plumbing Code and NFPA 54 National Fuel Gas Code were consulted in developing this design.

6.16 Sump

The building will include two low-point sumps. Building Sump 1 will be located near the brine treatment reactor tanks and will be used to collect water in the event that water levels in the tanks overflows. This sump would also be used to collect wash-down water or process water, should the tanks needs to be drained. Sump 1 will be provided with a pair of submersible pumps able to convey water to the reactor tanks or the surge pond. These sumps will measure approximately 3 feet by 3 feet by 3 feet and be covered with a fiberglass grate.

Building Sump 2 will be located near the laboratory. This sump will be used to collect laboratory wastewater and air compressor blowdown (from the oil/water separator). Directing the laboratory sink to this sump will minimize salt load to the septic system. Sump 2 will be similar to Sump 1 and will be able to convey water to the reactor tanks or the surge pond.

6.17 Septic System

The wastewater design flow used was 120 gallons per day (gpd). This consists of flow from the restroom, laundry washing machine, and break room sink. Process flows and the lab sink drain will not be directed to the septic system.

Using the flow estimates in the Montrose County Board of Health Resolution for On-Site Wastewater Treatment Systems, the design wastewater flows were calculated using two methods. First, a fixture-by-fixture estimate was prepared based on the fixtures shown in the proposed floorplan (toilet, lavatory, laundry washing machine, and breakroom sink). The second method was based on the recommended value for factories/plants without shower facilities. The second method yielded the higher flow estimate and was used for this 50% design estimate.

A 4-inch PVC sewer pipe will be used to carry wastewater from the building to the septic tank (length varies for alternative pond site locations based on topography), from the septic tank to the distribution box (assumed 20 linear feet), and from the distribution box to the adsorption trenches (assume total of 20 linear feet). Sewer pipe lengths from the building to the septic tank, for each alternative pond site location, are presented in Table 3. Sewer pipe sizes were compared to the minimum size allowed by the Montrose County Board of Health Resolution for On-Site Wastewater Treatment Systems, which is 3 inches in diameter. A size of 4 inches was selected, since it is the most commonly used size, and connections to small septic tanks are typically based on this size.

Wastewater from the treatment facility will be conveyed to a 1,000-gallon, dual-chamber septic tank. The tank will be pre-cast concrete. The septic tank was sized to meet the requirements of the Montrose County Board of Health Resolution for On-Site Wastewater Treatment Systems, which required a minimum of 48 hours of detention time. Using the typical minimum residential septic tank size of 1,000 gallons will provide over 190 hours of detention time.

A trench-style soil treatment area will be used. The flow will be distributed equally to the two trenches by a two-outlet distribution box. The soil treatment area was designed using the characteristics of a typical soil in the project area, from the NRCS Web Soil Survey (From Soil Survey of San Miguel Area, Colorado, Parts of Delores, Montrose, and San Miguel Counties). A typical soil selected from the project area consisted of a sandy loam, which according to the Montrose County Board of Health Resolution for On-Site Wastewater Treatment Systems, will provide a long-term acceptance rate of 0.70 gallon per day per square foot. Based on the design flow of 120 gpd, this yields a required soil treatment area of 171 square feet. To allow for variation in the soils at the site ultimately selected, a soil treatment area of 300 square feet was used for design, which allows for a long-term acceptance rate of 0.4 gallon per day per square foot.

Thirteen ADS Arc 36 (or equivalent) adsorption chambers will be placed in each trench. An ADS Arc 36 adsorption chamber has a bottom area of 12.27 square feet, so 25 chambers would be required to provide 300 square feet of soil treatment area. Each chamber is 60 inches long, so 125 feet of trench will be required. The Montrose County Board of Health Resolution for On-Site Wastewater Treatment Systems limits trench lengths to 100 feet, so two 65-foot trenches (13 chambers each) will provide the required soil treatment area.

7.0 COST ESTIMATES

The intent of the 50% design was to provide a sufficient level of detail to develop a cost estimate of reasonable accuracy for capital investment and 50-year operations and maintenance. This section describes cost estimate development for the hydrogen sulfide treatment system. All costs presented herein were estimated based on vendor-supplied quotes and professional experience.

7.1 Capital Cost Estimate

A capital cost estimate of **$5,200,000** was developed for design and construction of the 50% design described in Section 6.0. This cost estimate is presented in Table 2. Vendor estimates for the on-site sodium hypochlorite generation system, reactor tanks, mixers, and chemical storage tanks are included in Appendix B.

7.2 Alternative Pond Sites Capital Cost Comparison

The capital cost estimate presented in Section 7.1 above was developed assuming construction of the treatment facility at the Northwest Paradox Site. However, evaluation of alternative pond site locations is ongoing. For the purposes of this treatment system evaluation, capital costs were compared for the Northwest Paradox Site, BLM Site, and Landfill Site. These locations are identified on Sheet C-101 in Appendix A. While the treatment facility was designed such that it could be relocated to any of the potential pond site locations, the items would vary between locations.

- Access road – Access road construction is included in the Pond Design Strategy report (Amec Foster Wheeler, 2016c) and not in this hydrogen sulfide 50% design. However, for comparative purposes, the estimated distances of access road construction required for each of the alternative locations, from the nearest existing roadway to the proposed building location, was considered. As indicated on Sheets C-110, C-111, and C-112 in Appendix A, access to the Northwest Paradox Site would be via a new or improved route to the east of 900 Road. Access to the BLM Site would be via a short new or improved route to the north of Colorado State Highway 90 (HWY-90). Access to the Landfill Site would be via the existing landfill.
- Overhead power supply to the building – As described in Section 6.10, it was assumed that electrical service to the site will be via an overhead primary line extended from SMPA's existing overhead three-phase power line. The proximity of existing powerlines varies between potential pond site locations. As indicated on Sheets C-110, C-111, and C-112 in Appendix A, existing power lines are assumed to run along 900 Road (near the Northwest Paradox Site) and along HWY-90 (near the

BLM Site). The existing power line near the Landfill Site appears to run south from Colorado State Highway 141, approximately 0.7 mile east of the Landfill Site.

- Effluent pipeline length from the treatment facility to the surge pond – The potential pond site locations were selected based on their favorable (relatively flat) topography. Therefore, no features exist that would require the treatment facility to be located far from the surge pond. This item does not vary significantly between the pond site locations.
- Sewer pipe length from the treatment facility building to the septic tank – The treatment facility building was designed such that chemical storage tanks would be to the north. While minor reconfiguration of the building layout could be considered for the alternative pond site locations, the pipe run from the lavatory/sink area of the building to the septic tank and leach field must follow the local topography. As indicated on Sheets C-110, C-111, and C-112 in Appendix A, leach fields were located down- or cross-gradient of the building for each proposed pond site location. The resulting pipe lengths varied accordingly.

Estimated capital cost differences for these variables are presented in Table 3. Based on its close proximity to HWY-90 for road and powerline access, construction of the treatment facility at the BLM Site would result in a slight cost savings (approximately $54,500) as compared to the Northwest Paradox Site. In contrast, the relatively remote location of the Landfill Site would result in approximately $75,300 of additional costs, as compared to the Northwest Paradox Site, primarily for overhead powerline construction.

In addition, the various pond site locations, construction of the treatment system at the existing Surface Treatment Facility also was considered. The treatment system effluent pipeline (to the evaporation ponds) would replace the brine conveyance pipeline (from the Surface Treatment Facility to the hydrogen sulfide treatment facility at the selected pond site), so no significant cost difference would be expected for piping. The existing power supply would require modifications to accommodate the hypochlorite generation system, so only minor cost savings would be had for new overhead powerlines. The building footprint and associated treatment system costs would remain unchanged. Given the existing site development at the Surface Treatment Facility, cost savings would be expected for access road and septic system construction.

Given the relatively small potential cost savings, construction of the treatment system was preferred at the pond site, rather than at the Surface Treatment Facility, due to likely generation of solid precipitates during the oxidation process (as noted in Section 3.3). During bench-scale testing performed in spring 2016 (Amec Foster Wheeler, 2016a), every chemical oxidation test that was performed generated what appeared to be fine-grained elemental sulfur solids. Thus, performing oxidation as close to the evaporation ponds as possible was preferred in order to mitigate the potential for solids to plug conveyance pipelines over long pipe runs and across varying topography. Additionally, the solids were fine, white, and did not settle well. This lead to concerns that they might affect the performance of the evaporation ponds if they did not settle sufficiently in the surge pond. Flocculant addition was recommended. However, the addition of a flocculant prior to conveyance to the pond site would further exacerbate the potential for solids to plug the pipelines. Performing flocculant addition as close to the evaporation ponds as possible was also preferred.

Pilot-scale testing, described in Section 8.0, is recommended to verify these design assumptions and fine-tune the recommendations for post-oxidation treatment.

7.3 Operations and Maintenance Costs

Annual operations and maintenance (O&M) costs were estimated for the hydrogen sulfide treatment facility, as presented in Table 4. These costs assume full-time operation of the facility 24 hours per day, 360 days per year. The system would need a full-time operator manning the treatment system from the control room 24-7, plus another full-time operator performing lab testing, inspection rounds, general maintenance and housekeeping, and system troubleshooting. It was assumed that existing personnel required to oversee and operate the existing Surface Treatment Facility would not be impacted by this new facility.

To augment on-site salt production (from the evaporation ponds system) and hypochlorite generation during routine maintenance or unexpected system downtime, it was assumed that one salt delivery (assumed to be 45,000 pounds or 22.5 tons) and three hypochlorite deliveries (assumed to be 4,500 gallons each) would be required annually. Additional assumptions and notes are provided for each line item in Table 4. The annual estimated O&M cost, in 2016 dollars, is **$1,031,000**.

7.4 50-Year Capital Improvements

In addition to routine O&M, capital improvements will be required to replacement or upgrade equipment. An estimated capital improvements cost schedule is provided in Table 5. This table simplifies the capital cost estimates provided in Table 2 and includes only those items with a life expectancy shorter than 50 years. During initial operations, it was assumed that salt would be imported to meet first year on-site hypochlorite generation needs. Additionally, hypochlorite delivery to the site was included as a first-year cost to facilitate system start-up.

7.5 50-Year Net Present Value Cost Estimate

The net present value (NPV) of the initial capital cost, 50-year capital improvements costs, and 50-year O&M costs was estimated for the hydrogen sulfide treatment facility. As presented in Table 6, the estimated O&M and capital improvements costs were discounted to 2016 dollars by 3.375% (as requested in the Request for Proposals for this study). The estimated 50-year NPV for the hydrogen sulfide treatment facility, based on this 50% design and cost estimate, is **$33,900,000**.

8.0 CONCLUSIONS & RECOMMENDATIONS

The results of this 50% design cost estimate indicate that chemical oxidation through hypochlorite addition may be a feasible and economical method to remove dissolved hydrogen sulfide present in the PVU brine. Initial capital expenditures required for design and construction of an on-site hypochlorite generation system (approximately $2.5 million for equipment and all ancillary systems required) offset approximately two (2) years of sodium hypochlorite delivery to the site (estimated to be $1.3 million annually). Furthermore, annual O&M costs for one year of treatment facility operation (estimated to be $1.0 million), including hypochlorite generation, are less than one year of sodium hypochlorite delivery alone, making on-site generation the preferred alternative. On-site hypochlorite generation also utilizes the salt generated on site through the evaporation ponds system.

Beneficial reuse of the PVU salt reduces the overall project footprint and improves the system's sustainability. Additional sustainability efforts could be incorporated into the treatment system design. On-site solar (e.g., rooftop solar panels) or wind turbine power generation could provide energy for hypochlorite generation or building power. Rooftop rainfall could be containerized and fed to the on-site freshwater storage tank, augmenting the Dolores River water required for treatment system process water.

The hydrogen sulfide treatment system design is based on bench-scale batch testing results. The PVU brine is chemically complex and it is unknown what operational challenges the brine could present when operating a dynamic continuous-flow system. Therefore, pilot-scale testing is highly recommended to verify the assumptions and design bases for the brine treatment process, prior to detailed design and construction. Pilot-scale testing should be performed to evaluate and optimize the oxidation, dechlorination, coagulation, and neutralization process treatment steps and identify process bottlenecks and operational issues to inform the detailed design.

Pilot-scale testing a hypochlorite generation system is not recommended due to the substantial capital costs required to construct these systems. Hypochlorite generation is a well-established chemical process. Therefore, design and installation of a hypochlorite generation system does not pose the same level of uncertainty as remains for the brine treatment process.

Commercially available products have improved and diversified since the Boegli and Murphy (1985) pilot-scale testing was performed. Therefore, settling tests are recommended to evaluate a range of coagulants/flocculants and identify a recommended product. Settling tests should also be performed to determine the target dose rate with more accuracy. The resulting target dose could then be evaluated in conjunction with pilot-scale brine treatment testing.

9.0 REFERENCES

Amec Foster Wheeler, 2016a. Paradox Valley Unit Salinity Control Investigations Study 1 – Hydrogen Sulfide Management, Bedrock, Colorado. Treatment Options Bench Testing Report Draft. Submitted to: Wastren Advantage, Inc. Submitted by: Amec Foster Wheeler Environment & Infrastructure, Inc. May 19.

Amec Foster Wheeler, 2016b. Pre-Final Site Selection Report Pond Optimization Study 2 for Paradox Valley Unit Evaporation Ponds. Submitted to: Wastren Advantage, Inc. Submitted by: Amec Foster Wheeler Environment & Infrastructure, Inc. June.

Amec Foster Wheeler, 2016c. Draft Pond Design Strategy Report – Pond Optimization Study 2. Submitted to: Wastren Advantage, Inc. Submitted by: Amec Foster Wheeler Environment & Infrastructure, Inc., September.

Boegli, W.J. and Murphy, A.P., 1985. Pilot Plant Studies of Two Processes for Oxidation of Aqueous Sulfide – Paradox Valley Unit, Colorado River Basin Salinity Control Project. Report No. REC-ERC-84-18. U.S. Dept of the Interior, Bureau of Reclamation, Engineering and Research Center. October.

amec foster wheeler

TABLES

TABLE 1
SALT SOURCE COMPARISON
Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Source	Product, Location	Sodium Chloride Percent [1]	Unit	Unit Cost [2,3,4]	Quantity per Year [5,6]	Estimated Annual Cost	Total Estimated Annual Cost
Morton Salt	Culinox 999, Hutchinson, KS	>99.95	ton	$ 320.60	821	$ 263,293	$ 263,293
	Brine Pre-Treatment		pound	$ 0.03	0	$ -	
Intrepid Potash	Moab Fine Salt, Moab, UT	99.48	ton	$ 60.00	821	$ 49,275	$ 98,550
	Brine Pre-Treatment		pound	$ 0.03	1,642,500	$ 49,275	
PVU	Evaporated Brine, On-site	98.58	ton	$ 5.00	821	$ 4,106	$ 53,381
	Brine Pre-Treatment		pound	$ 0.03	1,642,500	$ 49,275	

Notes:
1. Sodium chloride percent for PVU on-site evaporated brine was determined based on the sodium chloride concentrations of crystals produced from PVU brine during the evaporation pond evaluation.
2. Unit costs for Morton Salt and Intrepid Potash provided as vendor quotes.
3. Unit cost for brine pre-treatment per an estimate provided by Electrolytic Technologies.
4. Unit cost for PVU on-site evaporated brine was estimated assuming salt would be diverted from the evaporation ponds waste stream and hauled to the brine maker using a front-end loader.
5. Quantity of salt required per year assumes 4,500 pounds (2.25 tons) of salt are required for electrolyzer operation and water softener, assuming the maximum sodium hypochlorite production rate of 2,500 gallons of 12.5% solution per day, based on consumption rate information provided by Electrolytic Technologies.
6. No brine pre-treatment is required for Morton Salt, per information provided by Electrolytic Technologies.

Abbreviations:
> = greater than
KS = Kansas
PVU = Paradox Valley Unit
UT = Utah

TABLE 2
HYDROGEN SULFIDE 50% DESIGN
CAPITAL COST ESTIMATE
Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category / Cost Element	Unit	Unit Cost	Estimated Quantity	Extended Cost	Subtotal
Total Estimated Capital Cost					**$ 5,200,000**
Building					**$ 734,300**
Concrete slab, 8-inch thick w/ footers, incl. installation	sf	$ 27.00	8,388	$ 226,476	
Floor coating, 3-part epoxy novolac, incl. installation	sf	$ 12.00	8,388	$ 100,656	
Steel-Clad Building: • Epoxy painted structural steel • Painted liner panels w/ SS hardware • Painted exterior cladding and roofing • SSR roof • Personnel doors with SS hardware, finish painted • Gutters and downspouts • Equipment door, 14x14 with SS guides, chain hoist operation • Freight to destination • Engineering drawings • Assumes a reasonable number of mechanical penetrations and framed openings	sf	$ 36.00	8,388	$ 301,968	
Interior walls	ls	$ 20,000.00	1	$ 20,000	
Chain-Link Security Fence, 8-foot w/ 3-strand barbed wire, concrete posts	lf	$ 50.00	1,400	$ 70,000	
Gates, 8-foot by 10-foot	ea	$ 511.15	2	$ 1,022	
Installation	% of ST	$ 71,022	20%	$ 14,204	
Reactor Tanks, FRP					**$ 99,100**
Oxidation Tank, 9,438 gal	ea	$ 17,666	1	$ 17,666	
Dechlorination Tank, 2,536 gal	ea	$ 12,188	1	$ 12,188	
Coagulation Tank, 2,536 gal	ea	$ 12,188	1	$ 12,188	
Neutralization Tank, 9,438 gal	ea	$ 17,666	1	$ 17,666	
Finished Brine Tank, 3,484 gal	ea	$ 16,072	1	$ 16,072	
Freight	ls	$ 8,129	1	$ 8,129	
Installation	% of ST	$ 75,781	20%	$ 15,156	
Mixers					**$ 109,100**
Oxidation Tank Mixer	ea	$ 10,815	1	$ 10,815	
Dechlorination Tank Mixer	ea	$ 10,043	1	$ 10,043	
Coagulation Tank Mixer	ea	$ 10,021	1	$ 10,021	
Neutralization Tank Mixer	ea	$ 12,120	1	$ 12,120	
Finished Brine Tank Mixer	ea	$ 10,346	1	$ 10,346	
Freight	ls	$ 1,500	1	$ 1,500	
Mixer Support Bracket, incl. Freight	ea	$ 8,400	5	$ 42,000	
Installation	% of ST	$ 61,345	20%	$ 12,269	

TABLE 2
HYDROGEN SULFIDE 50% DESIGN
CAPITAL COST ESTIMATE

Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category Cost Element	Unit	Unit Cost	Estimated Quantity	Extended Cost	Subtotal
Hydrogen Sulfide Treatment System & Sump					**$ 76,300**
Calibration Cylinder	ea	$ 60.00	4	$ 240	
Dip Tubes	ea	$ 550	6	$ 3,300	
Hose, 150 psi	lf	$ 5.00	16	$ 80	
Pipe, FRP, 6-inch	sm	$ 21.89	540	$ 11,821	
Pipe, PVC, Conduit, 2-inch	lf	$ 1.17	600	$ 703	
Pipe, PVC, Sch 80, 2-inch	lf	$ 1.61	600	$ 967	
Pipe, PVC, Sch 80, 8-inch	lf	$ 14.46	10	$ 145	
Pipe, PVC, 4-inch, vent pipe	lf	$ 4.74	5	$ 24	
Pumps w/ Stainless Steel Mounts	ea	$ 6,300	2	$ 12,600	
Raised Manway for Reactor Tanks	ls	$ 15,000	1	$ 15,000	
Tubing, PTFE, 1/2-inch	lf	$ 6.00	400	$ 2,400	
Tubing, PVDF, 1/2-inch	lf	$ 8.00	400	$ 3,200	
Valve, Back-Pressure, 1/2-inch	ea	$ 300	4	$ 1,198	
Valve, Ball, 1/2-inch	ea	$ 19.66	15	$ 295	
Valve, Ball, 2-inch	ea	$ 60.73	17	$ 1,032	
Valve, Check, 2-inch	ea	$ 82.85	4	$ 331	
Valve, Check, 8-inch	ea	$ 2,674	1	$ 2,674	
Valve, Diaphragm, 1/2-inch	ea	$ 115	2	$ 229	
Valve, Diaphragm, 2-inch	ea	$ 467	2	$ 935	
Valve, Foot valve, 1/2-inch	ea	$ 20.66	6	$ 124	
Valve, Plug, 8-inch	ea	$ 1,174	2	$ 2,347	
Valve, Pressure Relief, 1/2-inch	ea	$ 340	4	$ 1,361	
Freight	% of ST	$ 61,007	5%	$ 3,050	
Installation	% of ST	$ 61,007	20%	$ 12,201	
Instrumentation					**$ 249,600**
pH Probe, 30-foot cable	ea	$ 400	3	$ 1,200	
pH Analyzer	ea	$ 1,624	3	$ 4,872	
ORP Probe, 30-foot cable	ea	$ 400	3	$ 1,200	
ORP Analyzer	ea	$ 1,624	3	$ 4,872	
Level Switch	ea	$ 285	16	$ 4,560	
Level Transmitter	ea	$ 535	16	$ 8,560	
Magmeter Flow Meter	ea	$ 3,000	1	$ 3,000	
SCADA System Instrumentation & Controls	ea	$ 50,000	1	$ 50,000	
SCADA System Panel Fabrication	ea	$ 100,000	1	$ 100,000	
Freight	% of ST	$ 178,264	5%	$ 8,913	
Installation, Programming, & Commissioning	% of ST	$ 178,264	35%	$ 62,392	

TABLE 2
HYDROGEN SULFIDE 50% DESIGN
CAPITAL COST ESTIMATE

Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category Cost Element	Unit	Unit Cost	Estimated Quantity	Extended Cost	Subtotal
Chemical Storage Tanks, XLPE					**$ 234,200**
Sodium Hypochlorite Tank, 6,100 gal	ea	$ 34,100	2	$ 68,200	
Sodium Bisulfite Tank, 4,600 gal	ea	$ 17,900	1	$ 17,900	
Sodium Hydroxide Tank, 4,600 gal	ea	$ 26,700	1	$ 26,700	
Ferric Chloride Tank, 4,600 gal	ea	$ 25,400	1	$ 25,400	
Hydrochloric Acid Tank, 6,100 gal	ea	$ 24,100	1	$ 24,100	
Freight	ls	$ 8,250	1	$ 8,250	
Hydrochloric Acid Tank Scrubber	ea	$ 22,000	1	$ 22,000	
FRP Box for Scrubber Hose Connection	ea	$ 4,000	1	$ 4,000	
Installation	% of ST	$ 188,300	20%	$ 37,660	
Chemical Dosing Pumps					**$ 34,800**
Dosing Pump, Sodium Hypochlorite	ea	$ 5,100	2	$ 10,200	
Dosing Pump, Sodium Bisulfite	ea	$ 1,900	3	$ 5,700	
Dosing Pump, Sodium Hydroxide	ea	$ 2,040	3	$ 6,120	
Dosing Pump, Ferric Chloride	ea	$ 1,900	2	$ 3,800	
Dosing Pump, Hydrochloric Acid	ea	$ 2,040	1	$ 2,040	
Freight	% of ST	$ 27,860	5%	$ 1,393	
Installation	% of ST	$ 27,860	20%	$ 5,572	
Hypochlorite Generation System					**$ 2,530,000**
Hypochlorite Generation System, 1,125 kg/d	ls	$ 1,639,500	1	$ 1,639,500	
(1) Electrolyzer module each utilizing 8 electrolyzers					
(1) Receiver unit incorporating Blower Module					
(1) Brine Treatment Unit					
(1) Caustic Receiver/Brine Dechlorination Unit					
(1) Hypo Conversion/Chlorine Stripper Unit					
(2) Transformer/Rectifier					
(1) Master Control Panel/Motor Control Center					
Brine Maker Pit, 36 ton capacity	ea	$ 86,000	1	$ 86,000	
Primary Brine Treatment System	ls	$ 280,000	1	$ 280,000	
Water Softener System	ls	$ 20,000	1	$ 20,000	
Freight	% of ST	$ 2,025,500	5%	$ 101,275	
Installation	% of ST	$ 2,025,500	20%	$ 405,100	

TABLE 2
HYDROGEN SULFIDE 50% DESIGN
CAPITAL COST ESTIMATE

Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category Cost Element	Unit	Unit Cost	Estimated Quantity	Extended Cost	Subtotal
Electrical (incl. installation)					**$ 191,000**
Conductor	ls	$ 37,758	1	$ 37,758	
Fire Alarm					
Fire Alarm Control Panel	ea	$ 91	1	$ 91	
Strobe	ea	$ 182	1	$ 182	
Horn Strobe	ea	$ 255	11	$ 2,800	
Manual Pull Station	ea	$ 150	3	$ 450	
Photoelectric Detector	ea	$ 196	4	$ 784	
Thermal Detector	ea	$ 115	14	$ 1,610	
#14 Conductor	clf	$ 46.25	12	$ 555	
Conduit	ea	$ 3.98	60	$ 239	
Lighting					
Lighting - Type A	ea	$ 230	12	$ 2,760	
Lighting - Type B	ea	$ 210	4	$ 840	
Lighting - Type C	ea	$ 585	24	$ 14,040	
Lighting - Type D	ea	$ 445	3	$ 1,335	
Lighting - Type E	ea	$ 427	7	$ 2,989	
Lighting - Type F	ea	$ 298	4	$ 1,192	
Lighting - Type G	ea	$ 106.50	3	$ 320	
Lighting - Type H	ea	$ 250	11	$ 2,750	
Overhead Power Supply to Building	lf	$ 35.00	992	$ 34,720	
Switchboards and Panels					
3000 A Main Disconnect, NEMA 3R	ea	$ 44,500	1	$ 44,500	
3000 A Main Distribution Panel 277/480V	ea	$ 19,350	1	$ 19,350	
Panel H1, 277/480V, 3-phase, 4-wire, 225A	ea	$ 4,675	1	$ 4,675	
Transformer T1, 75kVA, 480V: 120/208V	ea	$ 4,350	1	$ 4,350	
Panel L1, 120/208V, 3-phase, 4-wire, 225A	ea	$ 2,050	1	$ 2,050	
Surge Protection Device	ea	$ 3,400	1	$ 3,400	
600V, 30A non-fused disconnect	ea	$ 294	1	$ 294	
250V, 30A non-fused disconnect	ea	$ 224	1	$ 224	
Thermal Switches	ea	$ 38.00	6	$ 228	
Wiring					
Drier Receptacle	ea	$ 60	1	$ 60	
Photocell	ea	$ 60	1	$ 60	
Standard Receptacle	ea	$ 65	32	$ 2,080	
GFCI Receptacle	ea	$ 95	10	$ 950	
Motor Connections	ea	$ 81	27	$ 2,174	
Light Switches	ea	$ 65	10	$ 650	
Occupancy Sensors	ea	$ 100	5	$ 500	

TABLE 2
HYDROGEN SULFIDE 50% DESIGN
CAPITAL COST ESTIMATE
Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category / **Cost Element**	**Unit**	**Unit Cost**	**Estimated Quantity**	**Extended Cost**	**Subtotal**
Mechanical Systems (incl. installation)					**$ 129,400**
Furnace	ea	$ 870	1	$ 870	
Tank Exhaust Fan	ea	$ 3,700	1	$ 3,700	
Fume Hood	ea	$ 9,700	1	$ 9,700	
Sidewall Exhaust Fan	ls	$ 3,800	1	$ 3,800	
Ductwork, Unlined	cfm	$ 0.34	725	$ 247	
Ductwork, FRP	lf	$ 15.00	100	$ 1,500	
Ductwork, Med. Press. VAV	cfm	$ 1.60	825	$ 1,320	
Louver	sf	$ 49.50	50	$ 2,475	
Louver Damper	ea	$ 480	2	$ 960	
Unit Heater, 300 MBH gas-fired	ea	$ 3,525	1	$ 3,525	
Unit Heater, 100 MBH gas-fired	ea	$ 1,550	3	$ 4,650	
Unit Heater, Electric	ea	$ 134	1	$ 134	
Grilles, Regulators, & Diffusers	cfm	$ 0.65	825	$ 536	
Construction Cost	ls	$ 10,733	1	$ 10,733	
Construction Fees	ls	$ 5,298	1	$ 5,298	
Balancing	% of ST	$ 44,150	6.7%	$ 2,958	
Temperature Control	% of ST	$ 44,150	27%	$ 11,921	
Hydrogen Sulfide Alarm System	ea	$ 7,200	2	$ 14,400	
Skid-Mounted Emergency Tempered Shower and Eye/Face Wash System, 325-gal tank, heat exchanger	ea	$ 42,000	1	$ 42,000	
Combination Eye/Face Wash Station and Drench Shower	ea	$ 1,152	3	$ 3,456	
Combination Eye/Face Wash Station and Drench Shower, Heat Traced	ea	$ 5,256	1	$ 5,256	

TABLE 2
HYDROGEN SULFIDE 50% DESIGN
CAPITAL COST ESTIMATE

Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category Cost Element	Unit	Unit Cost		Estimated Quantity	Extended Cost		Subtotal	
Laboratory							**$**	**27,500**
Laboratory Bench w/ sink	ea	$	6,000	1	$	6,000		
Laboratory Bench w/ Storage	ea	$	6,000	1	$	6,000		
Laboratory Hood, 4' w/ built-in exhaust blower, 2 service features, explosion proof	ea	$	9,161	1	$	9,161		
Freight	% of ST	$	21,161	10%	$	2,116		
Installation	% of ST	$	21,161	20%	$	4,232		
Air Compressor System							**$**	**88,300**
Air Compressor System	ea	$	70,672	1	$	70,672		
Air Compressor								
Air Receiver								
Desiccant Dryer								
Filters (2)								
Oil Water Separator								
Pipe, BCS, var.								
Refrigerated Air Dryer w/ Auto Drain								
Valves, var.								
Freight	% of ST	$	70,672	5%	$	3,534		
Installation	% of ST	$	70,672	20%	$	14,134		
Plumbing (incl. installation)							**$**	**45,000**
PRV Station, 1-1/4"	ea	$	305	1	$	305		
Water Heater, gas	gal	$	24.85	40	$	994		
Water Closet	ea	$	750	1	$	750		
Lavatory	ea	$	600	1	$	600		
Sink, single	ea	$	500	2	$	1,000		
Floor Drain	ea	$	200	1	$	200		
Tempering Valve, 3/4"	ea	$	200	1	$	200		
Red. Pressure Backflow, 1-1/2"	ea	$	330	1	$	330		
Water Pipe, copper, 1-1/2"	lf	$	17.15	20	$	343		
Water Pipe, copper, 1"	lf	$	10.60	80	$	848		
Water Pipe, copper, 3/4"	lf	$	7.80	80	$	624		
Gas Pipe, 2-1/2"	lf	$	13.45	100	$	1,345		
Gas Pipe 1"	lf	$	4.41	250	$	1,103		
Sewer, 4"	lf	$	22.50	50	$	1,125		
Sewer, 2"	lf	$	7.85	50	$	393		
Vent, 4"	lf	$	22.50	20	$	450		
Vent, 2"	lf	$	7.85	40	$	314		
Propane Storage Tank, delivered and set	ea	$	4,000	4	$	16,000		
Construction Cost	ls	$	10,432	1	$	10,432		
Construction Fees	ls	$	4,483	1	$	4,483		
Insulation	% of ST	$	37,355	8.4%	$	3,138		

TABLE 2
HYDROGEN SULFIDE 50% DESIGN
CAPITAL COST ESTIMATE
Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category **Cost Element**	**Unit**	**Unit Cost**	**Estimated Quantity**	**Extended Cost**	**Subtotal**
Septic System (incl. installation)					**$ 25,000**
Pipe to Septic Tank					
Trench 4' to 6' deep 3/4-cy excavator	cy	$ 4.75	222	$ 1,055	
Bedding, bank run gravel	cy	$ 45.86	17	$ 780	
Compacting bedding in trench, 90%	cy	$ 3.77	17	$ 64	
Dozer trench backfill	cy	$ 2.05	222	$ 456	
Air tamped compaction	cy	$ 12.12	222	$ 2,691	
4-inch Sch 40 PVC pipe	lf	$ 34.09	100	$ 3,409	
Surface Restoration - fine grading, seed & fertilizer	sy	$ 2.47	222	$ 549	
Septic Tank					
Excavation 3/4-cy backhoe	cy	$ 9.82	156	$ 1,531	
6-inch gravel leveling course	cy	$ 43.48	3	$ 130	
Dual chamber 1,000-gal septic tank	ea	$ 3,472	1	$ 3,472	
Cleanout Access Manways	ea	$ 1,844	2	$ 3,687	
Structural backfill - sandy clay loam	cy	$ 0.96	156	$ 149	
Compact backfill, vibratory plate, common 90%	cy	$ 1.70	156	$ 265	
Surface Restoration - fine grading, seed & fertilizer	sy	$ 2.47	178	$ 440	
Pipe to Distribution Field					
Trench 4' deep, 16" wide chain trencher, incl. backfill	lf	$ 3.15	20	$ 63	
Bedding, bank run gravel	cy	$ 45.86	3	$ 138	
4-inch Sch 40 PVC pipe	lf	$ 16.84	20	$ 337	
Surface restoration - fine grading, seed & fertilizer	sy	$ 2.47	22	$ 54	
Distribution Box and Absorption Field - Bed Design					
Excavation 1-cy backhoe, sandy clay loam	cy	$ 3.76	58	$ 218	
Distribution Box - 2 outlet	ea	$ 127	1	$ 127	
4-inch Sch 40 PVC pipe	lf	$ 24.36	20	$ 487	
Polyethylene chambers	ea	$ 49.77	26	$ 1,294	
Structural backfill - sandy clay loam	cy	$ 0.96	50	$ 48	
Compact backfill, vibratory plate, common 85%	cy	$ 1.70	50	$ 85	
Spread excess material	cy	$ 2.88	8	$ 23	
Surface restoration - fine grading, seed & fertilizer	sy	$ 2.47	178	$ 440	
Percolation Test & Test Pits	ls	$ 3,000	1	$ 3,000	

TABLE 2
HYDROGEN SULFIDE 50% DESIGN
CAPITAL COST ESTIMATE

Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category Cost Element	Unit	Unit Cost	Estimated Quantity	Extended Cost	Subtotal
Other					**$ 548,800**
Engineering	% of ST	$ 4,573,600	5%	$ 228,680	
Permitting	% of ST	$ 4,573,600	2%	$ 91,472	
Construction Management	% of ST	$ 4,573,600	5%	$ 228,680	

Note:
1. All costs are estimated in 2016 dollars based on vendor-supplied quotes and professional judgment.

Abbreviations:

% of ST = percent of subtotal
cfm = cubic foot per minute
clf = 100 linear feet
cy = cubic yard
ea = each
gal = gallon
incl. = including
lf = linear foot
ls = lump sum
sf = square foot
sm = square meter
ST = subtotal
sy = square yard
var. = various, varies
Sch = schedule

TABLE 3
HYDROGEN SULFIDE 50% DESIGN CAPITAL COST ESTIMATE
COMPARISON BETWEEN PROPOSED POND SITES
Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category	Unit	Unit Cost	Northwest Paradox Site		BLM Site		Landfill Site	
			Estimated Quantity	Estimated Cost	Estimated Quantity	Estimated Cost	Estimated Quantity	Estimated Cost
Civil - Access Road to Building	lf	$ 50.00	970	$ 48,500	190	$ 9,500	650	$ 32,500
Electrical - Overhead Power Supply to Building	lf	$ 35.00	990	$ 34,650	290	$ 10,150	3,470	$ 121,450
Mechanical - Pipeline to Surge Pond, 8-inch PVC	lf	$ 63.50	200	$ 12,700	200	$ 12,700	200	$ 12,700
Mechanical - Sewer Pipe from Building to Septic Tank, 4-inch PVC (material, labor, equipment)	lf	$ 90.00	100	$ 9,000	200	$ 18,000	150	$ 13,500
Comparative Estimated Capital Costs				**$ 104,850**		**$ 50,350**		**$ 180,150**
Cost Comparison to Northwest Paradox Site				**$ -**		**$ (54,500)**		**$ 75,300**

Notes:
1. All costs are estimated in 2016 dollars based on vendor-supplied quotes and professional judgment.
2. Estimated quantities were generated from proposed site layouts, per Civil 50% Design Drawings C110, C111, and C112.

Locations of exisiting power lines and access roads were estimated from aerial imagery obtained via Google Earth.

Abbreviation:
lf = linear foot

TABLE 4
HYDROGEN SULFIDE 50% DESIGN
ANNUAL OPERATIONS & MAINTENANCE COST ESTIMATE

Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category Cost Element	Unit	Estimated Unit Cost	Estimated Quantity	Extended Cost	Subtotal	Comments / Notes / Assumptions
Total Estimated Annual Cost					**$ 1,031,000**	**2016 dollars (see Table 6 for NPV).**
Labor					**$ 445,000**	
Technician Labor	hour	$ 20.00	17,280	$ 345,600		Assumes 2 FTE, 24 h/d, 360 d/yr.
Special Labor	hour	$ 40.00	1,728	$ 69,120		Assumes 10% of technician labor.
Engineering Support	hour	$ 150	200	$ 30,000		Estimated quantity.
Utilities					**$ 257,000**	
Electricity - Standard Rate	kWh	$ 0.080029	2,548,800	$ 203,978		Assumes 24 h/d operations, 360 d/yr, 369 kVA demand, 0.8 power factor. Rate is per July 2016 SMPA STF power bill.
Electricity - "Demand" Usage	kWh	$ 14.00	2,549	$ 35,683		Assumed to be 0.1% of total usage. Rate is per July 2016 SMPA STF power bill.
Propane, delivered	gal	$ 2.00	8,000	$ 16,000		Estimated; assumes two refills per four tanks per yr.
Potable Water, delivered	gal	$ 1.60	1,130	$ 1,808		Assumes 1 gal/d per person. Refill eyewashes (5x 37-gal) every 6 mo.
Maintenance					**$ 78,000**	
Mechanical Systems Maintenance	ls	$ 1,500	1	$ 1,500		
Replace Mixer Seals/Gaskets	ea	$ 200	5	$ 1,000		
Replace Dosing Pump Seals/Gaskets	ea	$ 200	5	$ 1,000		
Regenerate/Replace Hypochlorite Generation System Filters	ls	$ 10,000	1	$ 10,000		Estimated cost; requested but not provided by vendor.
Alarm Systems Testing	ls	$ 10,000	1	$ 10,000		
Steel Building Wall Sheet/Roof Repair/Replacement	lf	$ 30.00	839	$ 25,164		Assumes 10% replacement per yr.
Fence Repair/Replacement	lf	$ 30.00	140	$ 4,200		Assumes 10% fence line replacement per yr.
Road Maintenance	ls	$ 15,000	1	$ 15,000		Assumes annual road grading/dust suppression.
Snow Removal	ls	$ 10,000	1	$ 10,000		Assumes plowing access road performed by others.

TABLE 4
HYDROGEN SULFIDE 50% DESIGN
ANNUAL OPERATIONS & MAINTENANCE COST ESTIMATE

Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Category Cost Element	Unit	Estimated Unit Cost	Estimated Quantity	Extended Cost	Subtotal	Comments / Notes / Assumptions
Instrumentation					**$ 12,000**	
pH Probe, 30-foot cable	ea	$ 500	12	$ 6,000		Incl. freight, installation, and programming.
ORP Probe, 30-foot cable	ea	$ 500	12	$ 6,000		Incl. freight, installation, and programming.
Chemical Delivery					**$ 239,000**	
Sodium Bisulfite, 40%, delivered	gal	$ 1.561	18,533	$ 28,931		Vendor cost per Thatcher, incl. base rate plus $2,400/ delivery. Deliveries assume 45,000 gal/truck, based on vendor-provided density. Assumes 50% sodium hydroxide delivery 4 mo/yr.
Sodium Hydroxide, 50%, delivered	gal	$ 2.791	11,605	$ 32,389		
Sodium Hydroxide, 25%, delivered	gal	$ 2.315	53,779	$ 124,499		Vendor cost per Univar, incl. base rate plus $150/ delivery. Deliveries assume 45,000 gal/truck, based on vendor-provided density. Assumes 25% sodium hydroxide delivery 8 mo/yr.
Ferric Chloride, 40%, delivered	gal	$ 1.690	7,005	$ 11,838		Vendor cost per Thatcher, incl. base rate plus $2,400/delivery. Deliveries assume 45,000 gal/truck, based on vendor-provided density. Assumes three hypochlorite deliveries per year to augment on-site generation.
Hydrochloric Acid, 32%, delivered	gal	$ 1.148	10,096	$ 11,590		
Sodium Hypochlorite, 12.5%, delivered	gal	$ 2.113	13,500	$ 28,526		
Salt, delivered	ton	$ 60.00	22.5	$ 1,350		Vendor cost per Intrepid Potash, incl. delivery. Assumes one 45,000-pound (22.5-ton) delivery per year to augment on-site generation.

Note:
1. All costs are estimated in 2016 dollars based on vendor-supplied quotes and professional judgment.

Abbreviations:
d = day
ea = each
FTE = full-time employee
gal = gallon
h = hour
kVA = kilovolt amp
kWh = kilowatt hour
lf = linear foot
ls = lump sum
mo = month
NPV = net present value
SMPA = San Miguel Power Association
STF = Surface Treatment Facility
yr = year

TABLE 5
HYDROGEN SULFIDE 50% DESIGN
ESTIMATED CAPITAL IMPROVEMENTS COST SCHEDULE

Colorado River Basin Salinity Control Project

Paradox Valley Unit, Bedrock, Colorado

DRAFT

Year	Cost Element	Replacement Frequency (years)	Cost (2016 Value)	Subtotal (2016 Value)
1	Salt (Start-up Operations, 1-Year Supply)	50	$ 263,300	$ 291,800
	Hypochlorite (Start-Up Operations, 3 Deliveries)	50	$ 28,500	
5	Instrumentation	5	$ 32,300	$ 32,300
10	Instrumentation	5	$ 32,300	$ 814,500
	Building - floor coating, replace gates	10	$ 122,000	
	Hydrogen Sulfide Treatment System & Sump Pipe, Valve, & Pump Replacement	10	$ 57,500	
	Reactor Tanks, FRP	10	$ 99,100	
	Mixers - replace motors, wetted parts	10	$ 150,800	
	Chemical dosing pumps	10	$ 34,800	
	Electrical Systems Replacement	10	$ 130,000	
	Mechanical Systems Replacement	10	$ 99,700	
	Air Compressor Replacement	10	$ 88,300	
15	Instrumentation	5	$ 32,300	$ 266,500
	Chemical Storage Tanks, XLPE, and Scrubber	15	$ 234,200	
20	Instrumentation	5	$ 32,300	$ 814,500
	Building - floor coating, replace gates	10	$ 122,000	
	Hydrogen Sulfide Treatment System & Sump Pipe, Valve, & Pump Replacement	10	$ 57,500	
	Reactor Tanks, FRP	10	$ 99,100	
	Mixers - replace motors, wetted parts	10	$ 150,800	
	Chemical dosing pumps	10	$ 34,800	
	Electrical Systems Replacement	10	$ 130,000	
	Mechanical Systems Replacement	10	$ 99,700	
	Air Compressor Replacement	10	$ 88,300	
25	Instrumentation	5	$ 32,300	$ 2,606,900
	Hypochlorite Generation System	25	$ 2,531,900	
	Plumbing System Components Replacement	25	$ 37,700	
	Septic Tank Pump	25	$ 5,000	
30	Instrumentation	5	$ 32,300	$ 1,048,700
	Building - floor coating, replace gates	10	$ 122,000	
	Hydrogen Sulfide Treatment System & Sump Pipe, Valve, & Pump Replacement	10	$ 57,500	
	Reactor Tanks, FRP	10	$ 99,100	
	Mixers - replace motors, wetted parts	10	$ 150,800	
	Chemical Storage Tanks, XLPE, and Scrubber	15	$ 234,200	
	Chemical dosing pumps	10	$ 34,800	
	Electrical Systems Replacement	10	$ 130,000	
	Mechanical Systems Replacement	10	$ 99,700	
	Air Compressor Replacement	10	$ 88,300	
35	Instrumentation	5	$ 32,300	$ 32,300

TABLE 5
HYDROGEN SULFIDE 50% DESIGN
ESTIMATED CAPITAL IMPROVEMENTS COST SCHEDULE
Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Year	Cost Element	Replacement Frequency (years)	Cost (2016 Value)	Subtotal (2016 Value)
40	Instrumentation	5	$ 32,300	$ 814,500
	Building - floor coating, replace gates	10	$ 122,000	
	Hydrogen Sulfide Treatment System & Sump Pipe, Valve, & Pump Replacement	10	$ 57,500	
	Reactor Tanks, FRP	10	$ 99,100	
	Mixers - replace motors, wetted parts	10	$ 150,800	
	Chemical dosing pumps	10	$ 34,800	
	Electrical Systems Replacement	10	$ 130,000	
	Mechanical Systems Replacement	10	$ 99,700	
	Air Compressor Replacement	10	$ 88,300	
45	Instrumentation	5	$ 32,300	$ 266,500
	Chemical Storage Tanks, XLPE, and Scrubber	15	$ 234,200	
50	Instrumentation	5	$ 32,300	$ 3,389,100
	Building - floor coating, replace gates	10	$ 122,000	
	Hydrogen Sulfide Treatment System & Sump Pipe, Valve, & Pump Replacement	10	$ 57,500	
	Reactor Tanks, FRP	10	$ 99,100	
	Mixers - replace motors, wetted parts	10	$ 150,800	
	Chemical dosing pumps	10	$ 34,800	
	Electrical Systems Replacement	10	$ 130,000	
	Mechanical Systems Replacement	10	$ 99,700	
	Air Compressor Replacement	10	$ 88,300	
	Hypochlorite Generation System	25	$ 2,531,900	
	Plumbing System Components Replacement	25	$ 37,700	
	Septic Tank Pump	25	$ 5,000	

Note:
1. All costs are estimated in 2016 dollars based on vendor-supplied quotes and professional judgment.

TABLE 6
HYDROGEN SULFIDE 50% DESIGN
50-YEAR NET PRESENT VALUE ANALYSIS

Colorado River Basin Salinity Control Project
Paradox Valley Unit, Bedrock, Colorado

DRAFT

Cost Element				
Initial Capital Cost:[1]		$ 5,200,000		
Net Present Value Discount Rate:[2]		3.375%		
Operating Year	**Capital Improvements[1]**	**Operations & Maintenance[1]**	**Annual Cost, Subtotal[1]**	**Annual Cost, Net Present Value[2]**
1	$ 291,800	$ 1,091,000	$ 1,382,800	$ 1,337,654
2	$ -	$ 1,031,000	$ 1,031,000	$ 964,779
3	$ -	$ 1,031,000	$ 1,031,000	$ 933,280
4	$ -	$ 1,031,000	$ 1,031,000	$ 902,810
5	$ 32,300	$ 1,031,000	$ 1,063,300	$ 900,696
6	$ -	$ 1,031,000	$ 1,031,000	$ 844,823
7	$ -	$ 1,031,000	$ 1,031,000	$ 817,241
8	$ -	$ 1,031,000	$ 1,031,000	$ 790,559
9	$ -	$ 1,031,000	$ 1,031,000	$ 764,749
10	$ 814,500	$ 1,031,000	$ 1,845,500	$ 1,324,216
11	$ -	$ 1,031,000	$ 1,031,000	$ 715,629
12	$ -	$ 1,031,000	$ 1,031,000	$ 692,265
13	$ -	$ 1,031,000	$ 1,031,000	$ 669,664
14	$ -	$ 1,031,000	$ 1,031,000	$ 647,801
15	$ 266,500	$ 1,031,000	$ 1,297,500	$ 788,632
20	$ 814,500	$ 1,031,000	$ 1,845,500	$ 950,175
25	$ 2,606,900	$ 1,031,000	$ 3,637,900	$ 1,586,583
30	$ 1,048,700	$ 1,031,000	$ 2,079,700	$ 768,307
35	$ 32,300	$ 1,031,000	$ 1,063,300	$ 332,746
40	$ 814,500	$ 1,031,000	$ 1,845,500	$ 489,208
45	$ 266,500	$ 1,031,000	$ 1,297,500	$ 291,346
50	$ 3,389,100	$ 1,031,000	$ 4,420,100	$ 840,729
10-Year Total:	$ 1,140,000	$ 10,400,000	$ 11,500,000	$ 9,600,000
50-Year Total:	$ 10,400,000	$ 51,600,000	$ 62,000,000	$ 28,700,000
50-Year Net Present Value, including Initial Capital Cost:				**$ 33,900,000**

Notes:

1. All costs are shown as 2016 values. Year 1 O&M costs includes additional funds for operator & maintenance training, and additional engineering support for operation of the hypochlorite generator
2. The net present value discount rate was assumed per Wastren Advantage Inc.'s Request for Qualifications "Paradox Valley Unit Salinity Control Investigations"

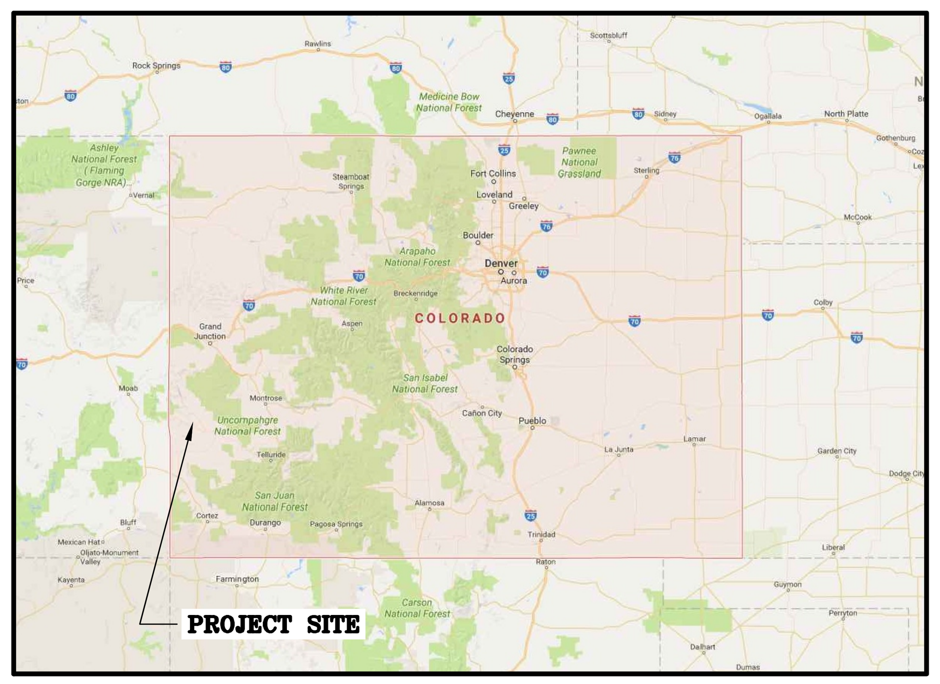
APPENDIX A

50% Design Drawings

PARADOX VALLEY UNIT
SALINITY CONTROL PROJECT
EVAPORATION POND EVALUATION

HYDROGEN SULFIDE TREATMENT SYSTEM
50% DESIGN

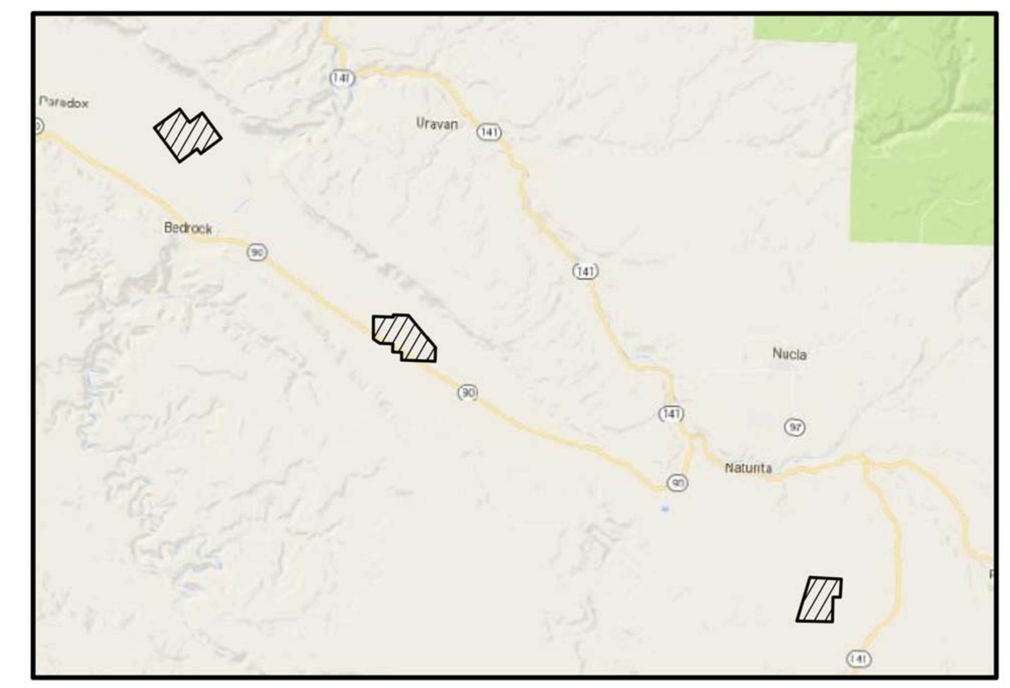
ISSUED FOR CLIENT REVIEW
SEPTEMBER 12, 2016



LOCATION MAP

DRAWING LIST TABLE

DRAWING NO.	DRAWING TITLE	REVISION
CIVIL		
C-101	SITE OPTIONS PLAN	0
C-110	NORTHWEST PARADOX POND	0
C-111	BLM POND	0
C-112	LANDFILL POND	0
PROCESS		
PFD-100	SYMBOLS FOR PIPING AND INSTRUMENTATION	0
PFD-101	PROCESS FLOW DIAGRAM	0
PID-201	PID - HYDROGEN SULFIDE & COAGULATION/FLOCCULATION SYSTEMS	0
PID-202	PID - DECHLORINATION & pH ADJUST SYSTEMS	0
PID-203	PID - HYPOCHLORITE DOSING SYSTEM	0
PID-204	PID - SODIUM BISULFITE DOSING SYSTEM	0
PID-205	PID - SODIUM HYDROXIDE DOSING SYSTEM	0
PID-206	PID - FERRIC CHLORIDE & HYDROCHLORIC ACID DOSING SYSTEM	0
PID-207	PID - COMPRESSED AIR SYSTEM	0
MECHANICAL		
M-101	EQUIPMENT AND PIPING LAYOUT PLAN	0
M-110	MECHANICAL FLOOR PLAN	0
M-120	PLUMBING FLOOR PLAN	0
ELECTRICAL		
E-101	ELECTRICAL LIGHTING LAYOUT	0
E-102	ELECTRICAL POWER AND SYSTEMS	0
E-103	SINGLE LINE DIAGRAM	0
E-104	ELECTRICAL SCHEDULES	0
VENDOR DRAWINGS		
8-100-AMM-033	BRINE MAKER PIT	-
8-910-HON-001	EXAMPLE MCP-MCC KLORIGEN MAIN CONTROL FOR 5,000 - 10,000 PPD SYSTEM	-
8-950-COL-000	SINGLE LINE DIAGRAM MCC MAIN POWER	-
PFD102	EXAMPLE PROCESS FLOW DIAGRAM HYPOCHLORITE GENERATION SYSTEM	-
PFD103	EXAMPLE PROCESS FLOW DIAGRAM PRIMARY BRINE TREATMENT	-



VICINITY MAP

PREPARED FOR:

WASTREN ADVANTAGE, INC.

UNDER CONTRACT TO:

UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

PREPARED BY:

amec foster wheeler
10940 White Rock Road, Suite 190
Rancho Cordova, CA 95670
Phone: (916)-636-3200

SCALE BAR (1' : 5000')
0 125m 250m 375m

GENERAL NOTES:

1. LOCATIONS ARE APPROXIMATE, SEE DRAWINGS C110 TO C112 FOR DETAILS.

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	JULY 2016
DESIGNED	S.T.A	JULY 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

CIVIL
SITE OPTIONS PLAN
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORATION PONDS EVALUATION
USBR PARADOX VALLEY UNIT

DATE:	JULY 2016
SCALE:	1' : 5000'
SHEET:	- OF - SHEETS
PROJ No: 1655500023.0001.0004	C101

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 - C101.dwg
Plot Time: Sep 30, 2016 - 4:54pm, Plotted By: Admin

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 - C110.dwg
Plot Time: Sep 30, 2016 - 4:59pm, Plotted By: Admin

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	SEPT 2016
DESIGNED	S.T.A	SEPT 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

CIVIL
NORTHWEST PARADOX POND
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE: SEPTEMBER 2016
SCALE: 1' : 400'
SHEET: - OF - SHEETS
PROJ No: 1655500023.0001.0004
C110

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	SEPT 2016
DESIGNED	S.T.A	SEPT 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

CIVIL
BLM POND
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE: SEPTEMBER 2016
SCALE: 1' : 400'
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004
C111

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 - C110.dwg
Plot Time: Sep 30, 2016 - 4:55pm, Plotted By: Admin

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	SEPT 2016
DESIGNED	S.T.A	SEPT 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

CIVIL
LANDFILL POND
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE:	SEPTEMBER 2016
SCALE:	1' : 400'
SHEET:	– OF – SHEETS
PROJ No: 1655500023.0001.0004	C112

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 – C110.dwg
Plot Time: Sep 30, 2016 – 4:51pm, Plotted By: Admin

GENERAL SYMBOLS

- 1/4 TURN BALL VALVE
- 3-WAY VALVE
- AIR PURGED VALVE
- AIR RELEASE VACUUM VALVE
- ANGLE VALVE
- ANTI-SIPHON VALVE
- BACKFLOW PREVENTOR
- BALL VALVE
- BALL CHECK VALVE
- BLIND FLANGE (BF)
- BUTTERFLY VALVE
- DIAPHRAM VALVE
- EXPANSION JOINT
- FLEXIBLE HOSE
- FOOT VALVE
- GATE VALVE
- GLOBE VALVE
- HOSE CONNECTION
- HYDRAULIC CONTROL VALVE (H)
- LINE STRAINER
- NEEDLE VALVE
- PLUG VALVE
- PLUGGED CONNECTION
- PRESSURE RELIEF VALVE
- REDUCER
- SAFETY SHOWER (S); EYE WASH (E)
- SCREWED PIPE CAP
- SLIP BLIND
- SOLENOID VALVE (S)
- SPECTACLE BLIND
- STEAM TRAP ASSEMBLY (ST)
- STOP CHECK VALVE
- SWING CHECK VALVE
- TEMPORARY STRAINER

- MOTOR DRIVEN CENTRIFUGAL PUMP
- TURBINE DRIVEN CENTRIFUGAL PUMP
- AIR DRIVEN DIAPHRAM PUMP
- BLOWER
- CHEMICAL METERING PUMP
- WALL OR FLOOR PENETRATION
- STEAM TRACED EQUIPMENT
- FLAME ARRESTER
- SUMP PUMP
- EXHAUST FAN

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

USUAL ABBREVIATIONS

A/S	AIR SUPPLY
BF	BLIND FLANGE
CC	CABLE CONTROL
CO	CLEANOUT
CS	CARBON STEEL
CSC	CAR SEAL CLOSED
CSO	CAR SEAL OPEN
CWS	UTILITY LINE
EQC	EXTRA QUICK CLOSING
EQO	EXTRA QUICK OPENING
E/I	VOLTAGE TO ELECTRIC CURRENT
FC	FAIL CLOSED
FO	FAIL OPEN
FL	FAIL LAST POSITION
FFW	FIELD FIT WELD (PROVIDE 4" RANDOM)
FOB	FLAT ON BOTTOM
FOT	FLAT ON TOP
FP	FULL PORT
FS	FAIL STATIONARY
FW	FIELD WELD
FV	FULL VACUUM
GH	GAUGE HATCH
HC	HOSE CONNECTION
HH	HAND HOLE
HLL	HIGH LIQUID LEVEL
HOA	HAND-OFF-AUTOMATIC SWITCH
IAS	INSTRUMENT AIR SUPPLY
I/P	ELECTRIC CURRENT TO PNEUMATIC
LC	LOCKED CLOSED
LLL	LOW LIQUID LEVEL
LO	LOCKED OPEN
MW	MANWAY
NC	NORMALLY CLOSED
NLL	NORMAL LIQUID LEVEL
NNF	NOT NORMALLY FLOWING
NO	NORMAL OPEN
OP	ORIFICE PLATE
OSIG	OUNCES PER SQ. INCH GAUGE
P/I	PNEUMATIC TO ELECTRIC CURRENT
POC	POINT OF CONNECTION
PSIG	POUNDS PER SQ. INCH GAUGE
PWHT	POST WELD HEAT TREAT
QC	QUICK CLOSING
QO	QUICK OPENING
RD	RUPTURE DISK
RO	RESTRICTING ORIFICE
RTD	RESISTANCE TYPE THERMAL DETECTOR
RV	PRESSURE RELIEF VALVE
SC	SAMPLE CONNECTION
SG	SIGHT GLASS
SI	STUB IN
SO	STEAM OUT
SP	SET POINT
SS	STAINLESS STEEL
VB	VORTEX BREAKER
VC	VENT CONNECTION
WC	WELD CAP
WO	WASH OUT
WV	WARNING VALVE
XCV	STEAM TRAP-OTHER THAN BALL FLOAT
(E)	EXISTING
(N)	NEW
(R)	RELOCATED

ELEMENT SYMBOLS

- LOCALLY MOUNTED
- PANEL MOUNTED
- PANEL MOUNTED (NORMALLY INACCESSIBLE)
- AUXILIARY PANEL (NORMALLY INACCESSIBLE)
- AUXILIARY PANEL
- DISTRIBUTED CONTROL SYSTEM (DCS)
- LOCALLY MOUNTED LIGHT
- PANEL MOUNTED LIGHT
- PROGRAMMABLE LOGIC CONTROLLER
- PROGRAMMABLE LOGIC CONTROLLER (NORMALLY INACCESSIBLE)
- INTERLOCK (I)
- QUICK CONNECT
- FILTER
- CALIBRATION CYLINDER
- RUPTURE DISK (RD)
- DRAIN
- ROTAMETER
- TURBINE FLOW METER
- MAGMETER FLOW METER
- INTEGRAL ORIFICE W/ DP CELL (FT)
- ORIFACE PLATE FLOW ELEMENT (RO)
- STANDARD PRESSURE INDICATOR (PI)
- STANDARD TEMPERATURE INDICATOR (TE, TI)
- VORTEX (FT, FLOW)
- VENTURI FLOW ELEMENT
- ANNUBAR TYPE FLOW ELEMENT
- TANK VENT
- MIXER (M)

CONTROL VALVE AND ACTUATOR SYMBOLS

- CONTROL VALVE STATION (FY, FV)
- REDUCING OR BACK-PRESSURE VALVE (INTERNALLY CONNECTED)
- REDUCING OR BACK-PRESSURE VALVE (EXTERNALLY CONNECTED)
- PRESSURE REDUCING REGULATOR W/RELIEF VALVE
- DIFFERENTIAL PRESSURE REDUCING REGULATOR
- PRESSURE RELIEF VALVE
- PRESSURE & VACUUM RELIEF VALVE
- DIAPHRAGM SPRING OPPOSED
- DIAPHRAGM PRESSURE BALANCED
- CYLINDER PISTON OPERATED
- SOLENOID (S)
- ELECTROHYDRAULIC (E/H)
- UNCLASSIFIED (X)
- MOTOR (M)
- HAND ACTUATOR

SCADA ABBREVIATIONS

PROCESS MEASUREMENT	ELEMENT TYPE	ELEMENT	TRANSMITTER	INDICATOR	CONTROLLER	HAND SWITCH	SWITCH LOW	SWITCH LOW LOW	SWITCH HIGH	SWITCH HIGH HIGH	ALARM LOW	ALARM LOW LOW	ALARM HIGH	ALARM HIGH HIGH	INDICATING TRANSMITTER
	CODE	E	T	I	C	HS	SL	SLL	SH	SHH	AL	ALL	AH	AHH	IT
ANALYSIS	A	AE	AT	AI	AC	AHS	ASL	ASLL	ASH	ASHH	AAL	AALL	AAH	AAHH	AIT
FLOW	F	FE	FT	FI	FC	FHS	FSL	FSLL	FSH	FSHH	FAL	FALL	FAH	FAHH	FIT
CURRENT	I	IE	IT	II	IC	IHS	ISL	ISLL	ISH	ISHH	IAL	IALL	IAH	IAHH	IIT
LEVEL	L	LE	LT	LI	LC	LHS	LSL	LSLL	LSH	LSHH	LAL	LALL	LAH	LAHH	LIT
PRESSURE/VACUM	P	PE	PT	PI	PC	PHS	PSL	PSLL	PSH	PSHH	PAL	PALL	PAH	PAHH	PIT
VIBRATION/STATUS	Y	YE	YE	YI	YC	YHS	YSL	YSLL	YSH	YSHH	YAL	YALL	YAH	YAHH	YIE

LINE LEGEND

- PROCESS PRIMARY
- PROCESS SECONDARY
- PROCESS SERVICE
- INSTRUMENT AIR
- ELECTRICAL
- INSULATED AND HEAT TRACED PIPE
- SECONDARY CONTAINMENT
- SKID LIMITS

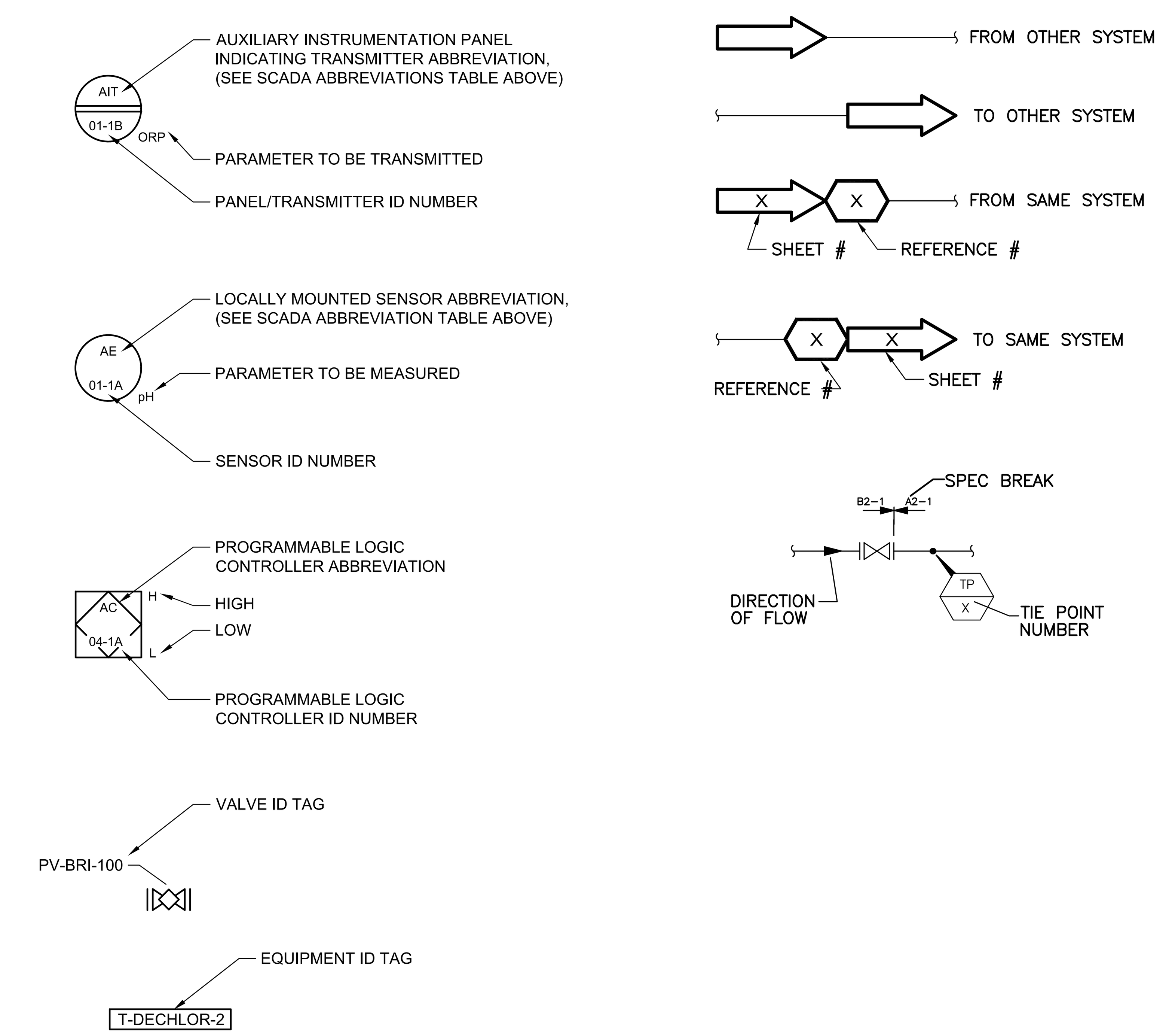
INSTRUMENTATION FUNCTION SYMBOLS

SYMBOL	MEANING	SYMBOL	MEANING	SYMBOL	MEANING
Σ	ADD	REV	REVERSE	%	GAIN OR ATTENUATE (ADJUSTABLE)
Δ	SUBTRACT	1:1	BOOSTER	1:1	INTEGRATE
X	MULTIPLY	$\top$	HIGH LIMIT	D	DERIVATIVE
$\div$	DIVIDE	$\bot$	LOW LIMIT	I/D	INVERSE DERIVATIVE
$\sqrt{}$	SQUARE ROOT	>	HIGH SELECTOR	3-9	SPLIT RANGE(NUMBERS REPRESENT INPUT CONVERTED TO 3-15psi)
X^n	RAISE TO POWER	<	LOW SELECTOR	CI	INPUT TO COMPUTER OR INTERLOCK
AVG	AVERAGE	1-0	ON-OFF	CO	OUTPUT FROM COMPUTER OR INTERLOCK
f(x)	CHARACTERIZE	1:3	GAIN OR ATTENUATE (RATIO AS SHOWN)		

CONVERSION

- A ANALOG
- D DIGITAL
- E VOLTAGE
- H HYDRAULIC
- I CURRENT
- P PNEUMATIC
- R RESISTANCE

MISCELLANEOUS ELEMENT DETAILS



NO.	REVISION	DATE	APRVD
1	REVISED PER CLIENT COMMENTS	DEC 22/16	V.A.F.
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	V.A.F.

DRAWN	C.P.F.	JULY 2016
DESIGNED	S.T.A.	JULY 2016
CHECKED	V.A.F.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

PIPING AND INSTRUMENTATION DIAGRAM
SYMBOLS FOR PIPING AND INSTRUMENTATION
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE: JULY 2016
SCALE: N.T.S.
SHEET: - OF - SHEETS
PROJ No: 1655500023.0001.0004
PFD100

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	V.A.F.

DRAWN	C.P.F.	JULY 2016
DESIGNED	S.T.A.	JULY 2016
CHECKED	V.A.F.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

PROCESS FLOW DIAGRAM

PROCESS FLOW DIAGRAM
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORTION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE: JUNE 2016
SCALE: N.T.S.
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004
PFD101

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	V.A.F.

DRAWN	C.P.F.	JULY 2016
DESIGNED	S.T.A.	JULY 2016
CHECKED	V.A.F.	AUG 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN SULFIDE & COAGULATION/ FLOCCULATION SYSTEMS
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION
USBR PARADOX VALLEY UNIT

DATE: JULY 2016
SCALE: N.T.S.
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004
PID201

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	V.A.F.

DRAWN	C.P.F.	JULY 2016
DESIGNED	S.T.A.	JULY 2016
CHECKED	V.A.F.	AUG 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

PIPING AND INSTRUMENTATION DIAGRAM
DECHLORINATION & pH ADJUST SYSTEMS
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE: JULY 2016
SCALE: N.T.S.
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004

PID202

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 – PID201.dwg
Plot Time: Oct 03, 2016 – 8:26am, Plotted By: Admin

P-BLE-101/P-BLE-201
SODIUM HYPOCHLORITE DOSING PUMPS

T-BLE-101
HYPOCHLORITE STORAGE TANK
HRT: N/A
OPR CAP: 6,100 GALLONS
TOTAL CAP: 6,100 GALLONS
DIA: 10ft
HEIGHT: 12.6ft
MAT'L: XLPE

T-BLE-201
HYPOCHLORITE STORAGE TANK
HRT: N/A
OPR CAP: 6,100 GALLONS
TOTAL CAP: 6,100 GALLONS
DIA: 10ft
HEIGHT: 12.6ft
MAT'L: XLPE

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	V.A.F.

DRAWN	C.P.F.	JULY 2016
DESIGNED	S.T.A.	JULY 2016
CHECKED	V.A.F.	AUG 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

PIPING AND INSTRUMENTATION DIAGRAM
HYPOCHLORITE
DOSING SYSTEMS
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION
USBR PARADOX VALLEY UNIT

DATE: JULY 2016
SCALE: N.T.S.
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004
PID203

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 – PID201.dwg
Plot Time: Oct 03, 2016 – 8:26am, Plotted By: Admin

P-SBS-101/P-SBS-201/P-SBS-301/P-SBS-401
SODIUM BISULFITE DOSING PUMPS

T-SBS-101
SODIUM BISULFITE STORAGE TANK
HRT: N/A
OPR CAP: 4,600 GALLONS
TOTAL CAP: 4,600 GALLONS
DIA: 10.2ft
HEIGHT: 9.6ft
MAT'L: XLPE

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	V.A.F.

DRAWN	C.P.F.	AUG 2016
DESIGNED	S.T.A.	AUG 2016
CHECKED	V.A.F.	AUG 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

PIPING AND INSTRUMENTATION DIAGRAM
SODIUM BISULFITE
DOSING SYSTEMS
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION
USBR PARADOX VALLEY UNIT

DATE: JULY 2016
SCALE: N.T.S.
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004
PID204

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 – PID201.dwg
Plot Time: Oct 03, 2016 – 8:27am, Plotted By: Admin

P-CAUS-101/P-CAUS-201/P-CAUS-301/P-CAUS-401
SODIUM HYDROXIDE DOSING PUMPS

T-CAUS-101
SODIUM HYDROXIDE STORAGE TANK
HRT: N/A
OPR CAP: 4,600 GALLONS
TOTAL CAP: 4,600 GALLONS
DIA: 10.2ft
HEIGHT: 9.6ft
MAT'L: XLPE

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	V.A.F.

DRAWN	C.P.F.	AUG 2016
DESIGNED	S.T.A.	AUG 2016
CHECKED	V.A.F.	AUG 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

PIPING AND INSTRUMENTATION DIAGRAM
SODIUM HYDROXIDE
DOSING SYSTEM
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION
USBR PARADOX VALLEY UNIT

DATE: JULY 2016
SCALE: N.T.S.
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004
PID205

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 – PID201.dwg
Plot Time: Oct 03, 2016 – 8:27am, Plotted By: Admin

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	V.A.F.

DRAWN	C.P.F.	AUG 2016
DESIGNED	S.T.A.	AUG 2016
CHECKED	V.A.F.	AUG 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

PIPING AND INSTRUMENTATION DIAGRAM
FERRIC CHLORIDE & HYDROCHLORIC ACID DOSING SYSTEM
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION
USBR PARADOX VALLEY UNIT

DATE: JULY 2016
SCALE: N.T.S.
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004
PID206

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 – PID201.dwg
Plot Time: Oct 03, 2016 – 8:27am, Plotted By: Admin

NOTES:

1. ALL PIPING FROM THE RECIEVER TANK TO THE FIRST SHUT-OFF VALVE SHALL BE SCHEDULE 80 METALLIC PIPE.
2. UNLESS OTHERWISE NOTED, ALL BCS PIPING SHALL BE SCHEDULE 40.
3. VERIFY PHYSICAL LOCATION OF SERVICE LATERALS TO POINTS OF USE WITH ENGINEER.

AC-PVU-1-1
AIR COMPRESSOR, ROTARY SCREW
50 HP
250 SCFM @ 100 PSI
QUINCY

RAD-PVU-1-1
REFRIGERATED DRYER
3 HP
250 SCFM CAPACITY AT 120 DEGREE INLET AIR
HANKISON HES-360

OW-PVU-1-1
OIL WATER SEPARATOR
450 CFM
QWIK PURE 100

DD-PVU-1-1
DESICCANT DRYER
60 SCFM INLET CAPACITY
HANKISON TWIN TOWER HEAT LESS
SENSA THERM DEW POINT CONTROLLER
HHS-60

P-BLDS-301/P-BLDS-401
BUILDING SUMP PUMPS

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	V.A.F.

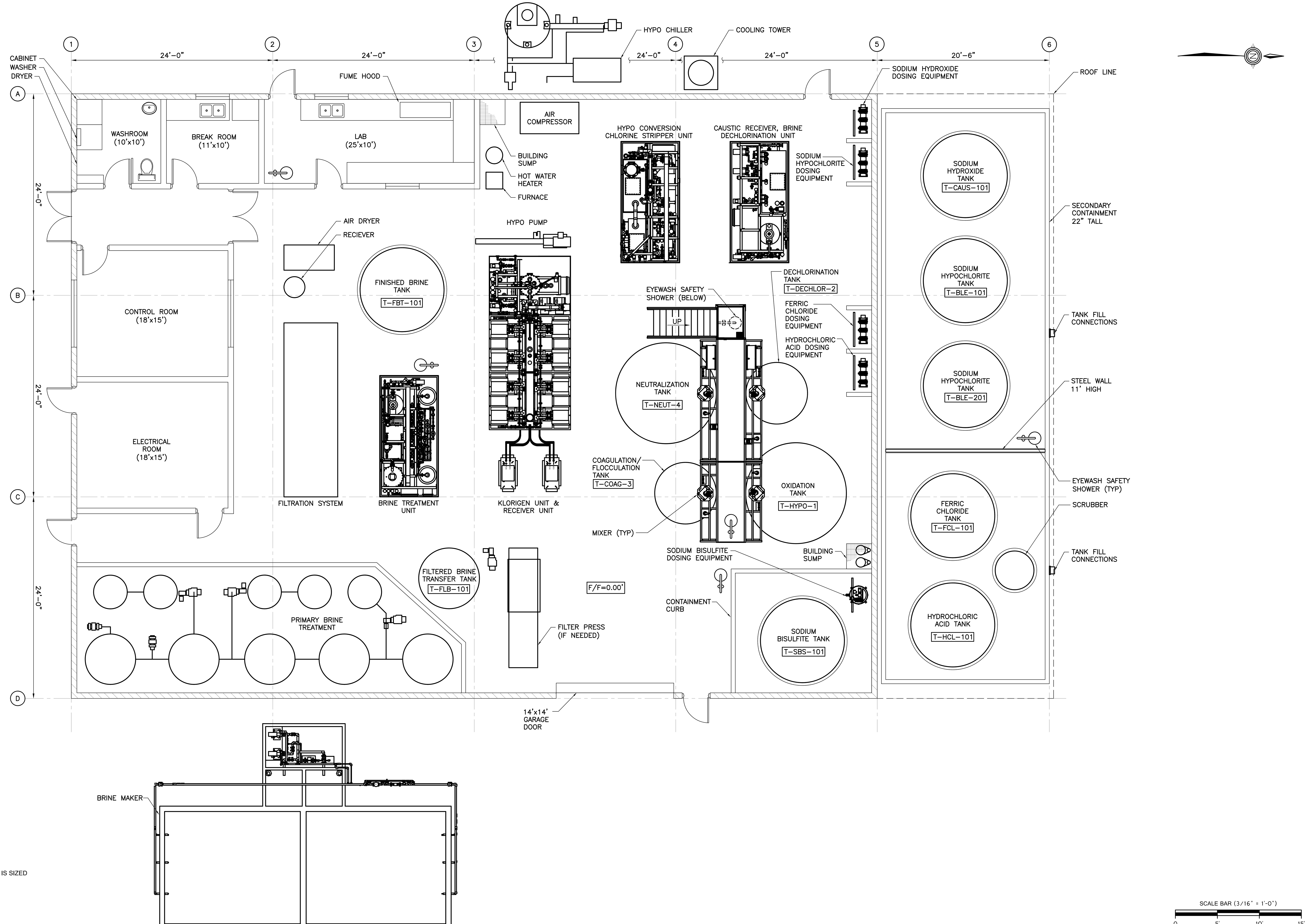
DRAWN	C.P.F.	SEPT 2016
DESIGNED	S.T.A.	SEPT 2016
CHECKED	V.A.F.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

PIPING AND INSTRUMENTATION DIAGRAM
COMPRESSED AIR SYSTEM
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION
USBR PARADOX VALLEY UNIT

DATE: SEPT 2016
SCALE: N.T.S.
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004
PID207



NOTE:

1. VENDOR SUPPLIED BRINE TREATMENT EQUIPMENT IS SIZED APPROXIMATELY.

CAUTION: THIS PLAN MAY BE REDUCED 25mm 50mm ORIGINAL SCALE

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 - M101.dwg
Plot Time: Sep 30, 2016 - 2:43pm, Plotted By: Admin

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	JULY 2016
DESIGNED	H.B.S.	JULY 2016
CHECKED	V.A.F.	AUG 2016
REVIEWED	G.H.	SEPT 2016

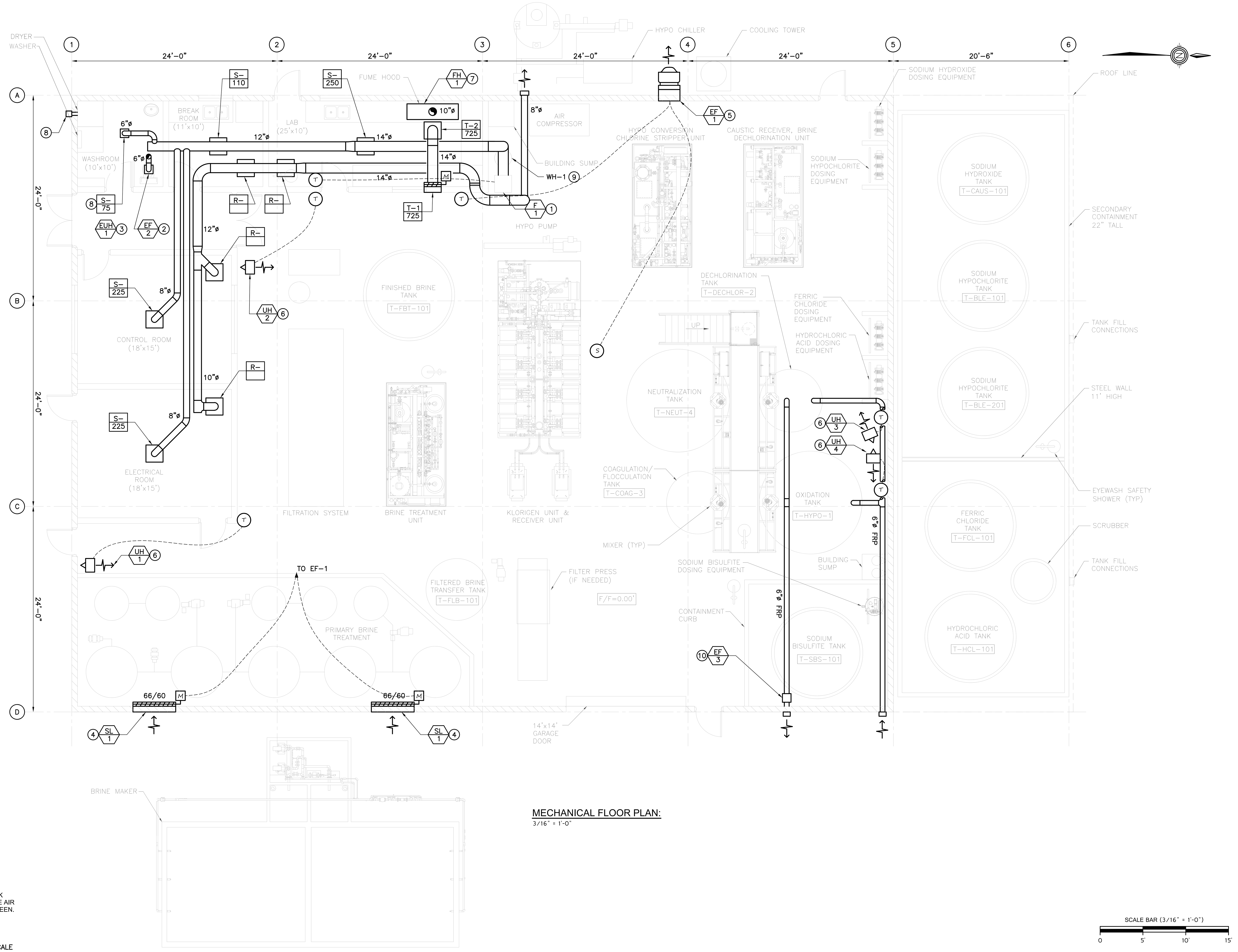
AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

MECHANICAL
EQUIPMENT & PIPING LAYOUT PLAN
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE:	JULY 2016
SCALE:	3/16" – 1'-0"
SHEET:	– OF – SHEETS
PROJ No: 1655500023.0001.0004	M101



MECHANICAL FLOOR PLAN:

3/16" = 1'-0"

SCALE BAR (3/16" = 1'-0")

0 5' 10' 15'

LEGEND:

- EVH 1 — HVAC TAG
- S-225 — HVAC DUCT TAG
- (3) — NOTE REFERENCE
- UNIT HEATER
- (T) — THERMOSTAT
- (S) — CHEMICAL SENSOR

MECHANICAL NOTES:

1. F-1 DIRECT COMBUSTION HIGH EFFICIENCY FURNACE. TRANSITION DUCTWORK TO UNIT OPENINGS AS REQUIRED. ROUTE ASSOCIATED OSA DUCT THRU WALL AND TERMINATE WITH GOOSENECK FITTING WITH ¼" MESH SCREEN. ROUTE ASSOCIATED COMBUSTION AND VENT TO A CONCENTRIC VENT KIT. FLASH AND COUNTERFLASH ROOF PENETRATIONS WEATHERTIGHT.
2. EF-2 CEILING MOUNTED EXHAUST FAN. TRANSITION DUCTWORK TO UNIT OPENING AS REQUIRED. ROUTE DUCTWORK THROUGH ROOF AND TERMINATE WITH BREIDART CAP. FLASH AND COUNTERFLASH ROOF PENETRATION WEATHERTIGHT.
3. EUH-1 SURFACE MOUNTED ELECTRIC UNIT HEATER WITH INTEGRAL THERMOSTAT. MOUNT BOTTOM OF UNIT AT 24" AFF.
4. SL-1,2 STATIONARY LOUVER. MOUNT BOTTOM OF LOUVER AT 7'-0". INTERLOCK MOTORIZED DAMPER WITH ASSOCIATED EF-1.
5. EF-1 SIDEALL EXHAUST FAN MOUNTED ON FACTORY CURB. TRANSITION TO DUCT OPENING AS REQUIRED. FLASH AND COUNTERFLASH WALL OPENING WEATHERTIGHT. MOUNT ASSOCIATED THERMOSTAT 48" AFF. MOUNT FAN CLOSE TO UNDERSIDE OF WALL STRUCTURE. EXHAUST FAN TO BE ACTIVATED EITHER BY THERMOSTAT OR CHEMICAL SENSOR IN SPACE.
6. UH-1,2,3,4 PROPANE FIRED UNIT HEATER. ROUTE 4" TYPE B FLUE UP THROUGH ROOF TO 3' ABOVE ROOF. TERMINATE WITH WIND CAP. MOUNT UNIT 9' AFF. MOUNT ASSOCIATED THERMOSTAT 48" AFF.
7. FUME HOOD. ROUTE ASSOCIATED 18 GAUGE TYPE 316 STAINLESS STEEL DUCT THROUGH ROOF 7'-0" ABOVE ROOF LINE. SUPPORT WITH GUY WIRES. INSTALL WITH HIGH VELOCITY DISCHARGE.
8. 4" DRYER EXHAUST. ROUTE THROUGH WALL AND TERMINATE WITH DRYER WALL VENT. SEAL WEATHERTIGHT.
9. PROPANE FIRED GAS WATER HEATER. ROUTE ASSOCIATED COMBUSTION AND VENT TO A CONCENTRIC VENT KIT. FLASH AND COUNTERFLASH ROOF PENETRATIONS WEATHERTIGHT
10. EF-3 OXIDATION AND DECHLORINIZATION TANK EXHAUST SYSTEM. ALL DUCTWORK TO BE FRP. EXHAUST FAN TO BE INLINE, SUSPENDED FROM THE CEILING. OUTSIDE AIR INTAKE AND EXHAUST OUTLET TO HAVE GOOSENECK FITTING AND 1/4" MESH SCREEN.

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	AUG 2016
DESIGNED	N.P.	AUG 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

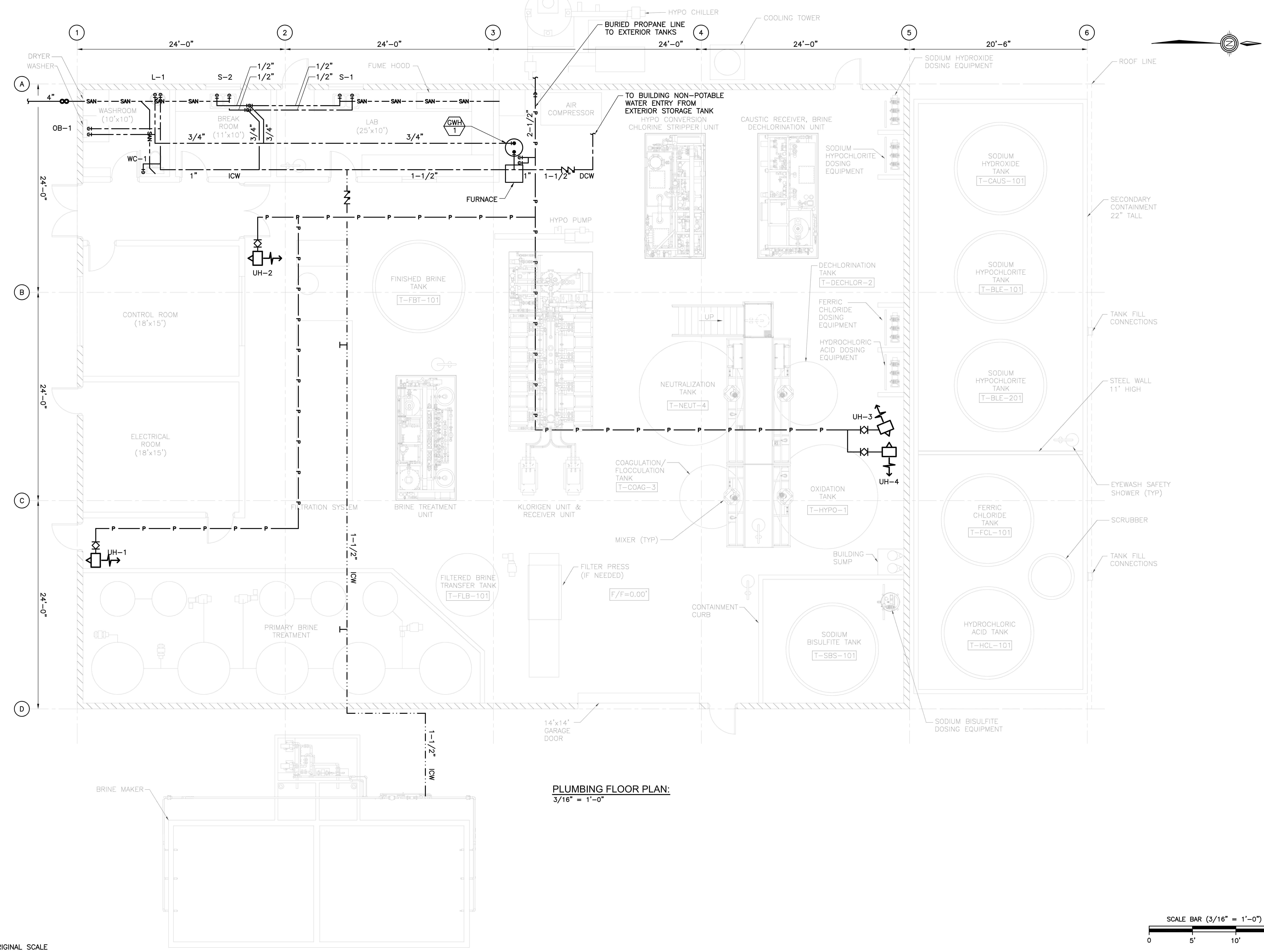
amec foster wheeler

MECHANICAL
MECHANICAL FLOOR PLAN
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE:	AUGUST 2016
SCALE:	3/16" – 1'-0"
SHEET:	– OF – SHEETS
PROJ No: 1655500023.0001.0004	M110

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 – M110.dwg
Plot Time: Sep 30, 2016 – 2:43pm, Plotted By: Admin



PLUMBING FLOOR PLAN:
3/16" = 1'-0"

SCALE BAR (3/16" = 1'-0")
0 5' 10' 15'

LEGEND:

- GWH 1 — HVAC TAG
- UH-1 — EQUIPMENT TAG
- UNIT HEATER
- DOMESTIC COLD WATER
- INDUSTRIAL COLD WATER
- DOMESTIC HOT WATER
- V — VENT
- SAN — SANITARY SEWER
- P — PROPANE

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	AUG 2016
DESIGNED	N.P.	AUG 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

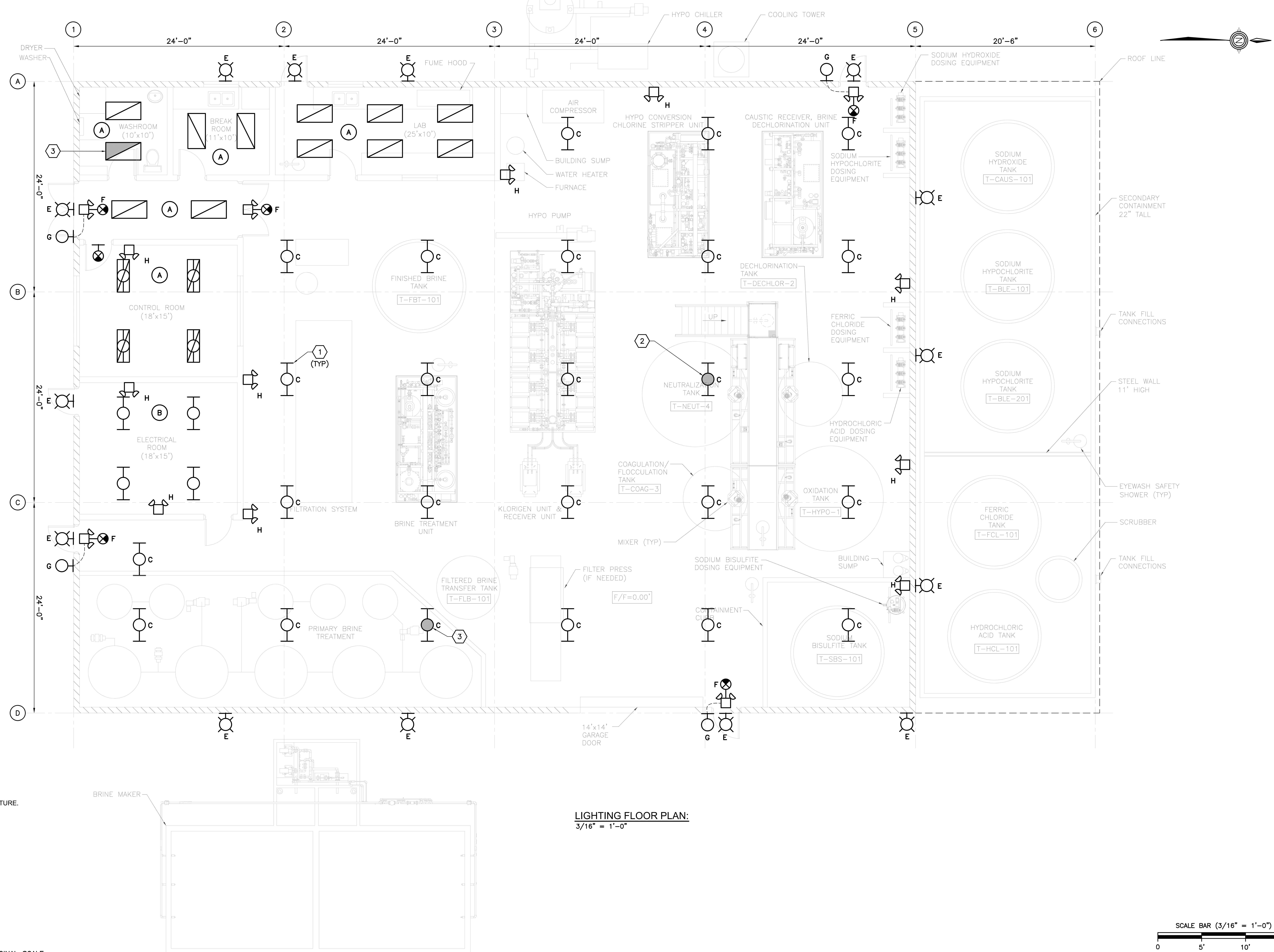
amec foster wheeler

MECHANICAL
PLUMBING FLOOR PLAN
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE:	AUGUST 2016
SCALE:	3/16" - 1'-0"
SHEET:	- OF - SHEETS
PROJ No: 1655500023.0001.0004	M120

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 - M120.dwg
Plot Time: Sep 30, 2016 - 2:44pm, Plotted By: Admin



FLAG NOTES THIS SHEET:

1. ALL TYPE "C" FIXTURES TO BE MOUNTED EVEN WITH BOTTOM OF STRUCTURE.
2. FIXTURE TO BE PROVIDED WITH EMERGENCY BATTERY PACK.

GENERAL NOTES:

1. SEE LUMINARIE SCHEDULE ON ONE-LINE/SCHEDULES SHEET FOR FIXTURE DESCRIPTIONS.

LIGHTING FLOOR PLAN:
3/16" = 1'-0"

SCALE BAR (3/16" = 1'-0")
0 5' 10' 15'

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	AUG 2016
DESIGNED	R.S.	AUG 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

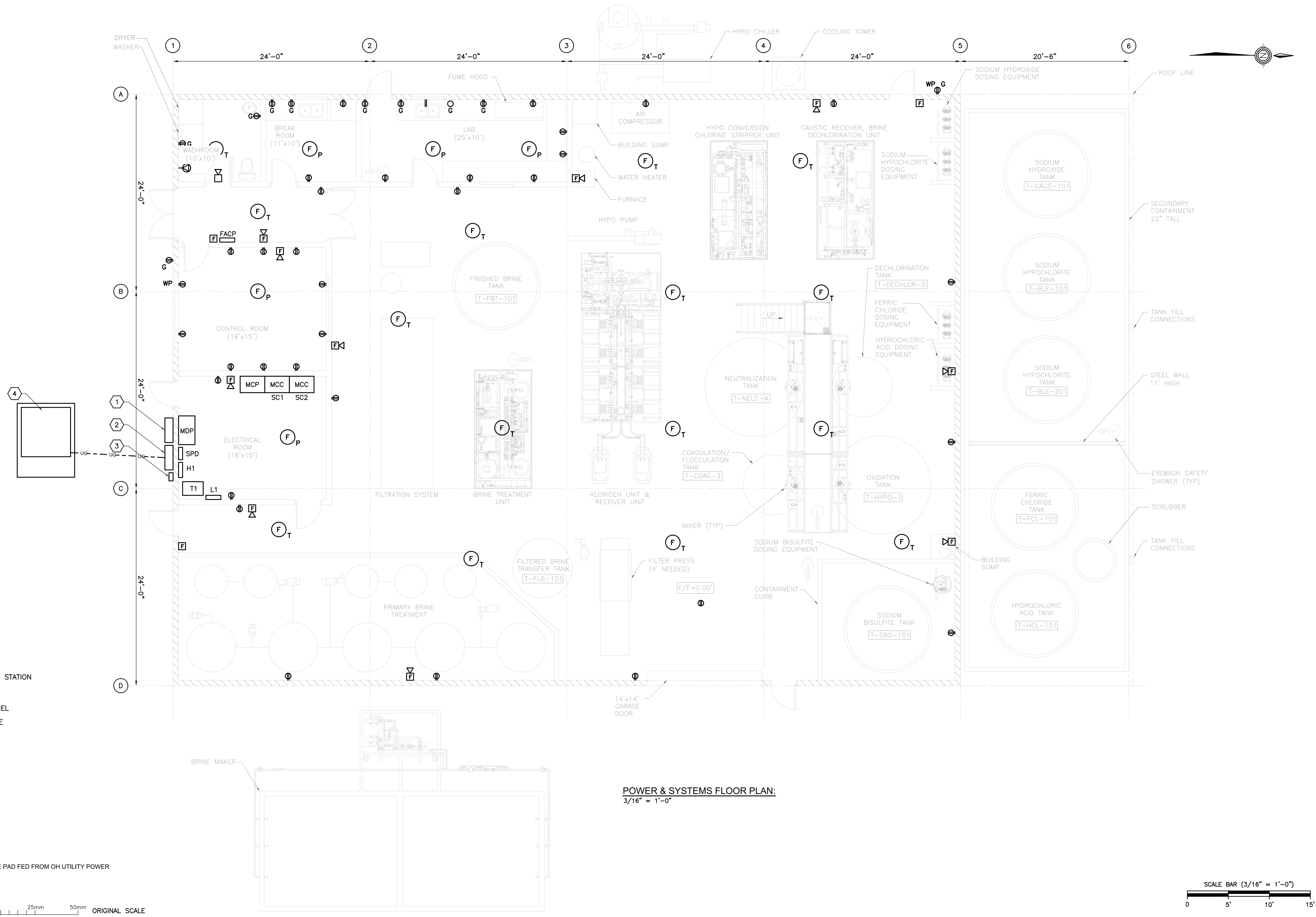
AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

ELECTRICAL
LIGHTING FLOOR PLAN
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORATION PONDS EVALUATION
USBR PARADOX VALLEY UNIT

DATE: AUGUST 2016
SCALE: 3/16" = 1'-0"
SHEET: - OF - SHEETS
PROJ No: 1655500023.0001.0004
E101

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 - E101.dwg
Plot Time: Sep 30, 2016 - 2:46pm, Plotted By: Admin



POWER & SYSTEMS FLOOR PLAN:
3/16" = 1'-0"

LEGEND & ABBREVIATIONS:

G	GFI
F T	THERMAL DETECTOR
I P	PHOTOELECTRIC DETECTOR
	STROBE
F	FIRE ALARM MANUAL PULL STATION
F	HORN STROBE
FACP	FIRE ALARM CONTROL PANEL
SPD	SURGE PROTECTION DEVICE
MCC	MOTOR CONTROL CENTER
MDP	MAIN DISTRIBUTION PANEL
MCP	MOTOR CONTROL PANEL

FLAG NOTES THIS SHEET:

1. MAIN SERVICE DISCONNECT
2. CT ENCLOSURE
3. UTILITY METER
4. UTILITY TRANSFORMER ON CONCRETE PAD FED FROM OH UTILITY POWER

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	SEPT 2016
DESIGNED	R.S.	AUG 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

ELECTRICAL
POWER & SYSTEMS FLOOR PLAN
HYDROGEN SULFIDE TREATMENT SYSTEM 50% DESIGN
EVAPORATION PONDS EVALUATION
USBR PARADOX VALLEY UNIT

DATE:	SEPTEMBER 2016
SCALE:	3/16" = 1'-0"
SHEET:	- OF - SHEETS
PROJ No: 1655500023.0001.0004	E102

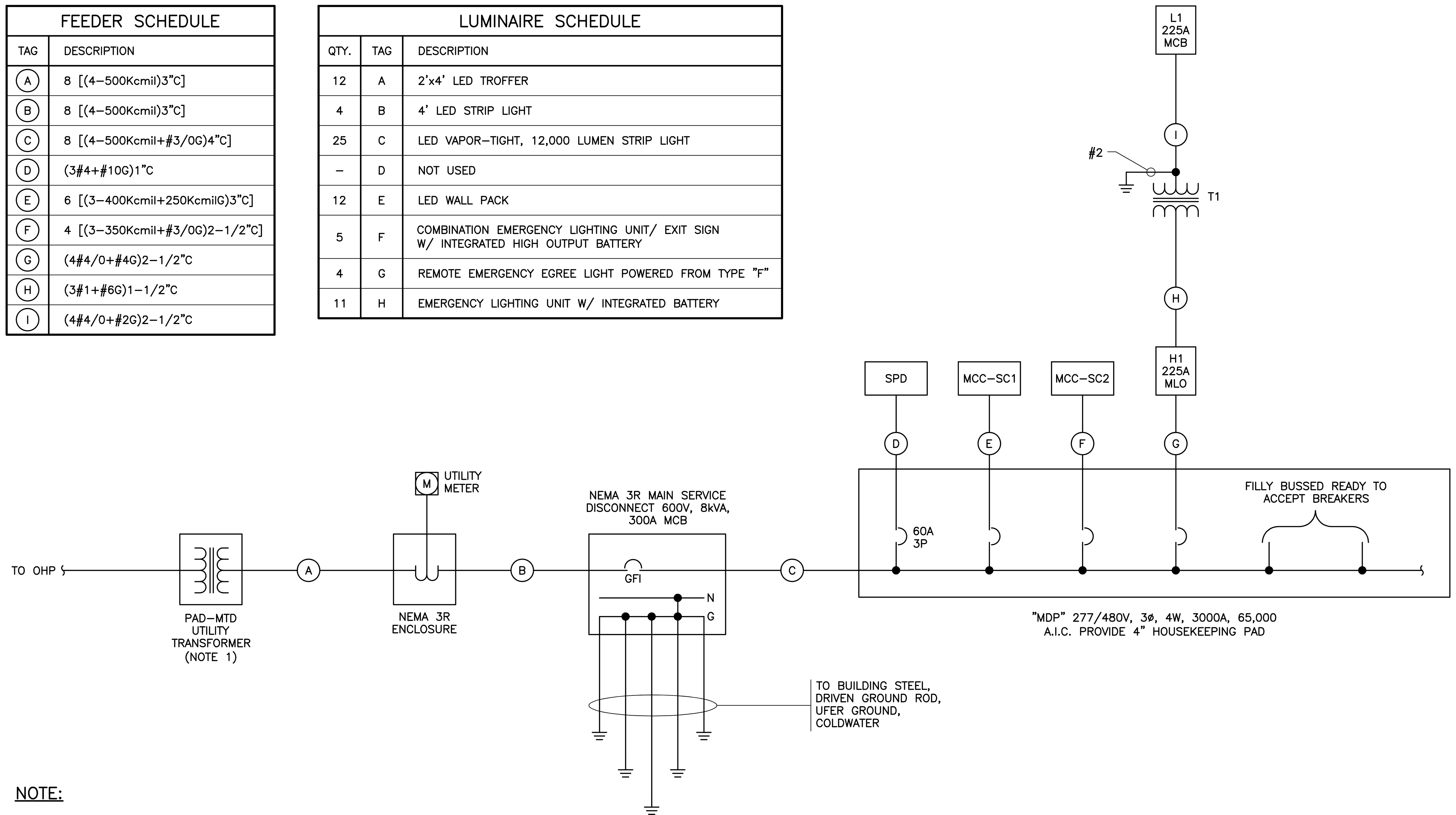
Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 - E102.dwg
Plot Time: Sep 30, 2016 - 2:46pm, Plotted By: Admin

FEEDER SCHEDULE

TAG	DESCRIPTION
A	8 [(4-500Kcmil)3"C]
B	8 [(4-500Kcmil)3"C]
C	8 [(4-500Kcmil+#3/0G)4"C]
D	(3#4+#10G)1"C
E	6 [(3-400Kcmil+250KcmilG)3"C]
F	4 [(3-350Kcmil+#3/0G)2-1/2"C]
G	(4#4/0+#4G)2-1/2"C
H	(3#1+#6G)1-1/2"C
I	(4#4/0+#2G)2-1/2"C

LUMINAIRE SCHEDULE

QTY.	TAG	DESCRIPTION
12	A	2'x4' LED TROFFER
4	B	4' LED STRIP LIGHT
25	C	LED VAPOR-TIGHT, 12,000 LUMEN STRIP LIGHT
-	D	NOT USED
12	E	LED WALL PACK
5	F	COMBINATION EMERGENCY LIGHTING UNIT/ EXIT SIGN W/ INTEGRATED HIGH OUTPUT BATTERY
4	G	REMOTE EMERGENCY EGREE LIGHT POWERED FROM TYPE "F"
11	H	EMERGENCY LIGHTING UNIT W/ INTEGRATED BATTERY



NOTE:

1. UTILITY TRANSFORMER TO BE PROVIDED AND SPECIFIED BY UTILITY COMPANY.

Filepath: T:\Pete\Amec FW\2016\163421-S Wastren Advantage Inc. (1655500023.0001.0002)\1655500023 - E103.dwg
Plot Time: Sep 30, 2016 - 2:48pm, Plotted By: Admin

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	SEPT 2016
DESIGNED	G.H.	AUG 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

ELECTRICAL
SINGLE LINE DIAGRAM
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE: JULY 2016
SCALE: N.T.S.
SHEET: - OF - SHEETS
PROJ No: 1655500023.0001.0004
E103

PANEL "H1"

225 AMP BUS
225 AMP MAIN LUGS ONLY
277 / 480 VOLT 3 PHASE 4 WIRE
SC RATING: SEE ONE-LINE

NEW PANEL
SURFACE MOUNTED
100% NEUTRAL BUS

GROUND BUS
FEED THRU LUGS

CKT	DESCRIPTION	LOAD CLASS	BKR	PHASE A LOAD (VA)		PHASE B LOAD (VA)		PHASE C LOAD (VA)		BKR	LOAD CLASS	DESCRIPTION	CKT
1	EF-1	M	15	831	4298					125	T	T-1	2
3	--	M	|			831	6693			|	T	--	4
5	--	M	|					831	4548	|	T	--	6
7	SUMP PUMP 1	M	20	2020	2020					20	M	BRINE TANK MIXER	8
9	--	M	|			2020	2020			|	M	--	10
11	--	M	|					2020	2020	|	M	--	12
13	SUMP PUMP 2	M	20	2020	2675						L	PROCESS LIGHTING	14
15	--	M	|			2020	500				L	EXTERIOR LIGHTING	16
17	--	M	|					2020	600		L	OFFICE LIGHTING	18
19	OXIDATION MIXER	M	15	903									20
21	--	M	|			903							22
23	--	M	|					903					24
25	DECHLORINATION MIXER	M	15	903									26
27	--	M	|			903							28
29	--	M	|					903					30
31	COAGULATION MIXER	M	15	797									32
33	--	M	|			797							34
35	--	M	|					797					36
37	NEUTRALIZATION MIXER	M	20	2020									38
39	--	M	|			2020							40
41	--	M	|					2020					42
	TOTAL LOAD/PHASE (VA)			18487		18707		16662					

A = APPLIANCE E = EQUIPMENT H = HEATING K = KITCHEN L = LIGHTING M = MOTOR O = OTHER R = RECEPTACLE S = SUBFEED T = TRANSFORMER W = WELDER SP = SPACE SPR = SPARE ALL CIRCUIT BREAKERS ARE 20 AMP, 1 POLE UNLESS NOTED OTHERWISE.

LOAD CLASSIFICATION	CONN. LOAD (KVA)	D.F.	EST. DEMAND LOAD (KVA)
APPLIANCE	0.0	1.00	0.0
EQUIPMENT	0.0	1.00	0.0
HEATING	0.0	1.25	0.0
KITCHEN	0.0	1.00	0.0
LIGHTING	3.8	1.25	4.7
MOTOR	28.5	1.00	28.5
LARGEST MOTOR	6.1	1.25	7.6
OTHER	0.0	1.00	0.0
RECEPTACLE (1ST 10KW)	0.0	1.00	0.0
RECEPTACLE (REMAINDER)	0.0	0.50	0.0
TRANSFORMER	15.5	1.00	15.5
WELDER	0.0	1.00	0.0

PANEL TOTALS
KVA
CONNECTED: 53.9
DESIGN: 56.3
DEMAND: 56.3
SPARE: 0.0
AMPS
DESIGN: 225.0
DEMAND LOAD 67.7
SPARE: 157.3
PHASE BALANCE
A TO B: 98.8%
B TO C: 89.1%
C TO A: 90.1%

NOTES: [1]

PANEL "L1"

225 AMP BUS
225 AMP MAIN CIRCUIT BREAKER
120 / 208 VOLT 3 PHASE 4 WIRE
SC RATING: SEE ONE-LINE

NEW PANEL
SURFACE MOUNTED
100% NEUTRAL BUS

GROUND BUS
FEED THRU LUGS

CKT	DESCRIPTION	LOAD CLASS	BKR	PHASE A LOAD (VA)		PHASE B LOAD (VA)		PHASE C LOAD (VA)		BKR	LOAD CLASS	DESCRIPTION	CKT
1	EF-2	M	20	81	1200					20	A	WASHER	2
3	UH-1	M	20			1176	2500			30	A	DRYER	4
5	UH-2	M	20					204	2500	|	A	--	6
7	UH-3	M	20	204	1440						R	RECEPTACLES	8
9	UH-4	M	20			204	1440				R	RECEPTACLES	10
11	FURNACE	M	20					204	1440		R	RECEPTACLES	12
13	EUH-1	M	20	1373									14
15	--	M	|			1373							16
17	FUME HOOD	M	20					200					18
19													20
21													22
23													24
25													26
27													28
29													30
31													32
33													34
35													36
37													38
39													40
41													42
	TOTAL LOAD/PHASE (VA)			4298		6693		4548					

A = APPLIANCE E = EQUIPMENT H = HEATING K = KITCHEN L = LIGHTING M = MOTOR O = OTHER R = RECEPTACLE S = SUBFEED T = TRANSFORMER W = WELDER SP = SPACE SPR = SPARE ALL CIRCUIT BREAKERS ARE 20 AMP, 1 POLE UNLESS NOTED OTHERWISE.

LOAD CLASSIFICATION	CONN. LOAD (KVA)	D.F.	EST. DEMAND LOAD (KVA)
APPLIANCE	6.2	1.00	6.2
EQUIPMENT	0.0	1.00	0.0
HEATING	0.0	1.25	0.0
KITCHEN	0.0	1.00	0.0
LIGHTING	0.0	1.25	0.0
MOTOR	2.3	1.00	2.3
LARGEST MOTOR	2.7	1.25	3.4
OTHER	0.0	1.00	0.0
RECEPTACLE (1ST 10KW)	4.3	1.00	4.3
RECEPTACLE (REMAINDER)	0.0	0.50	0.0
TRANSFORMER	0.0	1.00	0.0
WELDER	0.0	1.00	0.0

PANEL TOTALS
KVA
CONNECTED: 15.5
DESIGN: 16.2
DEMAND: 16.2
SPARE: 0.0
AMPS
DESIGN: 225.0
DEMAND LOAD 45.0
SPARE: 180.0
PHASE BALANCE
A TO B: 64.2%
B TO C: 68.0%
C TO A: 94.5%

NOTES: [1]

PANEL "MCC-SC1"

1200 AMP BUS
1200 AMP MAIN LUGS ONLY
277 / 480 VOLT 3 PHASE 3 WIRE
SC RATING: SEE ONE-LINE

NEW PANEL
SURFACE MOUNTED
100% NEUTRAL BUS

GROUND BUS
FEED THRU LUGS

CKT	DESCRIPTION	LOAD CLASS	BKR	PHASE A LOAD (VA)		PHASE B LOAD (VA)		PHASE C LOAD (VA)		BKR	LOAD CLASS	DESCRIPTION	CKT
1	HYDR. DILUTION BLOWER	M	15	1330									2
3	--	M	|			1330							4
5	--	M	|					1330					6
7	HYDR. DILUTION BLOWER	M	15	1330									8
9	--	M	|			1330							10
11	--	M	|					1330					12
13	STRIPPER BLOWER	M	15	831									14
15	--	M	|			831							16
17	--	M	|					831					18
19	CAUSTIC INJECTION PUMP	M	15	942									20
21	--	M	|			942							22
23	--	M	|					942					24
25	HYPO PUMP	M	60	9422									26
27	--	M	|			9422							28
29	--	M	|					9422					30
31	3KVA STEPDOWN XFMR	T	15	800									32
33	--	T	|			800							34
35	--	T	|					800					36
37	COMPRESSOR	M	60	10000									38
39	--	M	|			10000							40
41	--	M	|					10000					42
	TOTAL LOAD/PHASE (VA)			24655		24655		24655					

A = APPLIANCE E = EQUIPMENT H = HEATING K = KITCHEN L = LIGHTING M = MOTOR O = OTHER R = RECEPTACLE S = SUBFEED T = TRANSFORMER W = WELDER SP = SPACE SPR = SPARE ALL CIRCUIT BREAKERS ARE 20 AMP, 1 POLE UNLESS NOTED OTHERWISE.

LOAD CLASSIFICATION	CONN. LOAD (KVA)	D.F.	EST. DEMAND LOAD (KVA)
APPLIANCE	0.0	1.00	0.0
EQUIPMENT	0.0	1.00	0.0
HEATING	0.0	1.25	0.0
KITCHEN	0.0	1.00	0.0
LIGHTING	0.0	1.25	0.0
MOTOR	41.6	1.00	41.6
LARGEST MOTOR	30.0	1.25	37.5
OTHER	0.0	1.00	0.0
RECEPTACLE (1ST 10KW)	0.0	1.00	0.0
RECEPTACLE (REMAINDER)	0.0	0.50	0.0
TRANSFORMER	2.4	1.00	2.4
WELDER	0.0	1.00	0.0

PANEL TOTALS
KVA
CONNECTED: 74.0
DESIGN: 81.5
DEMAND: 81.5
SPARE: 0.0
AMPS
DESIGN: 1200.0
DEMAND LOAD 98.0
SPARE: 1102.0
PHASE BALANCE
A TO B: 100.0%
B TO C: 100.0%
C TO A: 100.0%

NOTES: [1]

PANEL "MCC-SC2"

2000 AMP BUS
2000 AMP MAIN LUGS ONLY
277 / 480 VOLT 3 PHASE 3 WIRE
SC RATING: SEE ONE-LINE

NEW PANEL
SURFACE MOUNTED
100% NEUTRAL BUS

GROUND BUS
FEED THRU LUGS

CKT	DESCRIPTION	LOAD CLASS	BKR	PHASE A LOAD (VA)		PHASE B LOAD (VA)		PHASE C LOAD (VA)		BKR	LOAD CLASS	DESCRIPTION	CKT
1	FINISHED BRINE PUMP	M	15	942	443					15	M	ANOLYTE TRANSFER PUMP	2
3	--	M	|			942	443			|	M	--	4
5	--	M	|					942	443	|	M	--	6
7	BRINE SUPPLY PUMP	M	15	1330	13333					70	H	BRINE HEATER	8
9	--	M	|			1330	13333			|	H	--	10
11	--	M	|					1330	13333	|	H	--	12
13	BRINE MAKER PUMP	M	15	942	40333					225	E	121 KVA RECTIFIER R-5A-01	14
15	--	M	|			942	40333			|	E	--	16
17	--	M	|					942	40333	|	E	--	18
19	STRIPPER PUMP	M	15	1330	40333					225	E	121 KVA RECTIFIER R-5A-02	20
21	--	M	|			1330	40333			|	E	--	22
23	--	M	|					1330	40333	|	E	--	24
25	DECHOLRINATION XFER PUMP	M	15	1330									26
27	--	M	|			1330							28
29	--	M	|					1330					30
31	CAUSTIC TRANSFER PUMP	M	15	942									32
33	--	M	|			942							34
35	--	M	|					942					36
37	CATHOLYTE TRANSFER PUMP	M	15	443									38
39	--	M	|			443							40
41	--	M	|					443					42
	TOTAL LOAD/PHASE (VA)			101701		101701		101701					

A = APPLIANCE E = EQUIPMENT H = HEATING K = KITCHEN L = LIGHTING M = MOTOR O = OTHER R = RECEPTACLE S = SUBFEED T = TRANSFORMER W = WELDER SP = SPACE SPR = SPARE ALL CIRCUIT BREAKERS ARE 20 AMP, 1 POLE UNLESS NOTED OTHERWISE.

LOAD CLASSIFICATION	CONN. LOAD (KVA)	D.F.	EST. DEMAND LOAD (KVA)
APPLIANCE	0.0	1.00	0.0
EQUIPMENT	242.0	1.00	242.0
HEATING	40.0	1.25	50.0
KITCHEN	0.0	1.00	0.0
LIGHTING	0.0	1.25	0.0
MOTOR	19.1	1.00	19.1
LARGEST MOTOR	4.0	1.25	5.0
OTHER	0.0	1.00	0.0
RECEPTACLE (1ST 10KW)	0.0	1.00	0.0
RECEPTACLE (REMAINDER)	0.0	0.50	0.0
TRANSFORMER	0.0	1.00	0.0
WELDER	0.0	1.00	0.0

PANEL TOTALS
KVA
CONNECTED: 305.1
DESIGN: 316.1
DEMAND: 316.1
SPARE: 0.0
AMPS
DESIGN: 2000.0
DEMAND LOAD 380.2
SPARE: 1619.8
PHASE BALANCE
A TO B: 100.0%
B TO C: 100.0%
C TO A: 100.0%

NOTES: [1]

PANEL "MDP"

3000 AMP BUS
3000 AMP MAIN LUGS ONLY
277 / 480 VOLT 3 PHASE 4 WIRE
SC RATING: SEE ONE-LINE

NEW PANEL
SURFACE MOUNTED
100% NEUTRAL BUS

GROUND BUS

CKT	DESCRIPTION	LOAD CLASS	BKR	PHASE A LOAD (VA)		PHASE B LOAD (VA)		PHASE C LOAD (VA)		BKR	LOAD CLASS	DESCRIPTION	CKT
1	SPD	E	60										2
3	--	E	|										4
5	--	E	|										6
7	MCC-SC1	S	2000	24655									8
9	--	S	|			24655							10
11	--	S	|					24655					12
13	MCC-SC2	S	600	101701									14
15	--	S	|			101701							16
17	--	S	|					101701					18
19	H1	S	225	18487									20
21	--	S	|			18707							22
23	--	S	|					16662					24
25													26
27													28
29													30
31													32
33													34
35													36
37													38
39													40
41													42
	TOTAL LOAD/PHASE (VA)			144843		145063		143018					

A = APPLIANCE E = EQUIPMENT H = HEATING K = KITCHEN L = LIGHTING M = MOTOR O = OTHER R = RECEPTACLE S = SUBFEED T = TRANSFORMER W = WELDER SP = SPACE SPR = SPARE ALL CIRCUIT BREAKERS ARE 20 AMP, 1 POLE UNLESS NOTED OTHERWISE.

LOAD CLASSIFICATION	CONN. LOAD (KVA)	D.F.	EST. DEMAND LOAD (KVA)
APPLIANCE	0.0	1.00	0.0
EQUIPMENT	242.0	1.00	242.0
HEATING	40.0	1.25	50.0
KITCHEN	0.0	1.00	0.0
LIGHTING	3.8	1.25	4.7
MOTOR	49.1	1.00	49.1
LARGEST MOTOR	40.1	1.25	50.1
OTHER	0.0	1.00	0.0
RECEPTACLE (1ST 10KW)	0.0	1.00	0.0
RECEPTACLE (REMAINDER)	0.0	0.50	0.0
TRANSFORMER	17.9	1.00	17.9
WELDER	0.0	1.00	0.0

PANEL TOTALS
KVA
CONNECTED: 432.9
DESIGN: 413.8
DEMAND: 413.8
SPARE: 0.0
AMPS
DESIGN: 3000.0
DEMAND LOAD 497.8
SPARE: 2502.2
PHASE BALANCE
A TO B: 99.8%
B TO C: 98.6%
C TO A: 98.7%

NOTES: [1]

MECHANICAL EQUIPMENT SCHEDULE

KEY	DESCRIPTION	LOAD		VOLT-PH	FEEDER			O.C. PROTECTION C.B	O.C. PROTECTION FUSE	REMARKS
1	Finished Brine Pump	2	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC2
2	Brine Supply Pump	3	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC2
3	Brine Maker Pump	2	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC2
4	Stripper Pump	3	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC2
5	Brine decholorination transfer pump	3	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC2
6	Caustic Transfer Pump	2	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC2
7	Catholyte Transfer Pump	3/4	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC2
8	Anolyte transfer pump	3/4	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC2
9	Brine Heater	40000	W	480-3	(3#4+#8G)	1	"C	80A3P	N/A	MCC-SC2
10	121 kVA Rectifier R-5A-01	121000	W	480-3	(3-3/0+#4G)	2	"C	225A3P	N/A	MCC-SC2
11	121 kVA Rectifier R-5A-02	121000	W	480-3	(3-3/0+#4G)	2	"C	225A3P	N/A	MCC-SC2
12	Hydr. Dilution Blower	3	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC1
13	Hydr. Dilution Blower	3	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC1
14	Stripper Blower	2	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC1
15	Caustic Injection Pump	2	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC1
16	Hypo Pump	25	HP	480-3	(3#6+#10G)	1	"C	60A3P	N/A	MCC-SC1
17	3kV step down xfmr	2400	W	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	MCC-SC1
18	Compressor	30000	W	480-3	(3#6+#10G)	1	"C	60A3P	N/A	MCC-SC1
19	EF-1 (Process Area)	2	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	H1
20	EF-2 (Restroom)	81	W	120-1	(2#12+#12G)	3/4	"C	20A1P	N/A	L1
21	Unit heater	1	HP	120-1	(2#10+#10G)	3/4	"C	20A1P	N/A	L1
22	Unit heater	0	HP	120-1	(2#12+#12G)	3/4	"C	20A1P	N/A	L1
23	Unit heater	0	HP	120-1	(2#12+#12G)	3/4	"C	20A1P	N/A	L1
24	Unit heater	0	HP	120-1	(2#12+#12G)	3/4	"C	20A1P	N/A	L1
25	Furnace	1	HP	120-1	(2#10+#10G)	3/4	"C	20A1P	N/A	L1
26	Electric Unit Heater	2	HP	208-1	(2#12+#12G)	3/4	"C	20A2P	N/A	L1
27	Fume Hood	200	W	120-1	(2#12+#12G)	3/4	"C	20A1P	N/A	L1
28	Sump Pump 1	3	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	H1
29	Sump Pump 2	3	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	H1
30	Oxidation Mixer	2	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	H1
31	Decholorination Mixer	2	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	H1
32	Coagulation Mixer	2	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	H1
33	Neutralization Mixer	3	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	H1
34	Brine Tank Mixer	3	HP	480-3	(3#12+#12G)	3/4	"C	15A3P	N/A	H1

NOTES:

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	ISSUED FOR CLIENT REVIEW	SEPT 12/16	S.T.A.

DRAWN	C.P.F.	SEPT 2016
DESIGNED	G.H.	AUG 2016
CHECKED	H.B.S.	SEPT 2016
REVIEWED	G.H.	SEPT 2016

AMEC FOSTER WHEELER
10940 WHITE ROCK ROAD, SUITE 190
RANCHO CORDOVA, CA 95670
PHONE: (916) 636-3200

amec foster wheeler

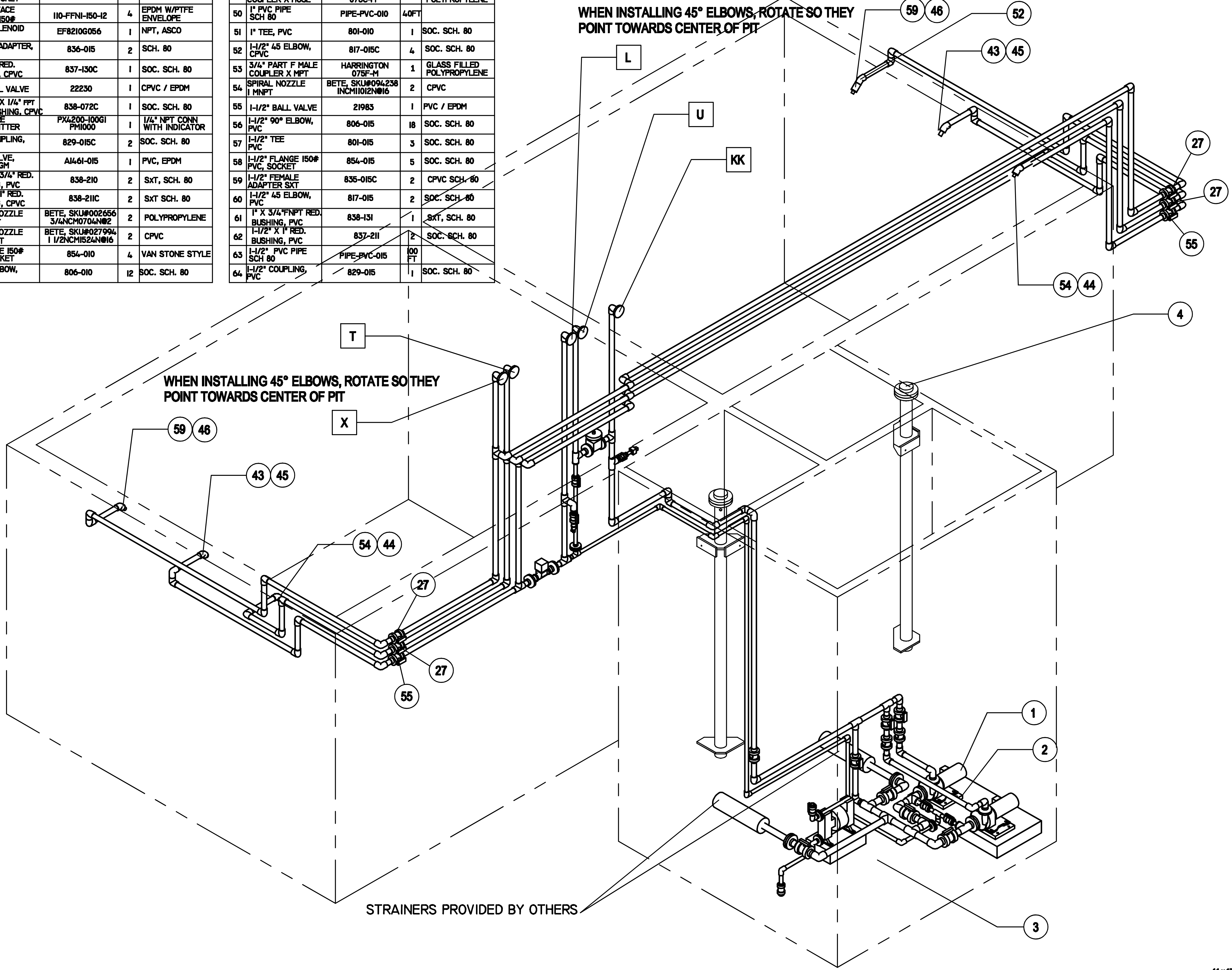
ELECTRICAL
ELECTRICAL SCHEDULES
HYDROGEN SULFIDE MANAGEMENT 50% DESIGN
EVAPORATION PONDS EVALUATION

USBR PARADOX VALLEY UNIT

DATE: JULY 2016
SCALE: N.T.S.
SHEET: – OF – SHEETS
PROJ No: 1655500023.0001.0004
E104

33	1" FLANGE 150# CPVC, SOCKET	854-010C	2	VAN STONE STYLE
34	1" FULL FACE GASKET,150#	110-FFN1-150-12	4	EPDM W/PTFE ENVELOPE
35	1-1/2" SOLENOID VALVE	EF8210G056	1	NPT, ASCO
36	1-1/2" M ADAPTER, PVC	836-015	2	SCH. 80
37	1" X 1/2" RED. BUSHING, CPVC	837-130C	1	SOC. SCH. 80
38	1/2" BALL VALVE	22230	1	CPVC / EPDM
39	1/2" SLIP X 1/4" FPT RED. BUSHING, CPVC	838-072C	1	SOC. SCH. 80
40	PRESSURE TRANSMITTER	PX4200-100GI PM1000	1	1/4" NPT CONN WITH INDICATOR
41	1-1/2" COUPLING, CPVC	829-015C	2	SOC. SCH. 80
42	1-1/2" VALVE, DIAPHRAGM	A1461-015	1	PVC, EPDM
43	1-1/2" X 3/4" RED. BUSHING, PVC	838-210	2	SxT, SCH. 80
44	1-1/2" X 1" RED. BUSHING, CPVC	838-211C	2	SxT SCH. 80
45	SPIRAL NOZZLE 3/4 MNPT	BETE, SKU#002656 3/4NCM0704N@2	2	POLYPROPYLENE
46	SPIRAL NOZZLE 1-1/2 MNPT	BETE, SKU#027994 1 1/2NCM1524N@16	2	CPVC
47	1" FLANGE 150# PVC, SOCKET	854-010	4	VAN STONE STYLE
48	1" 90° ELBOW, PVC	806-010	12	SOC. SCH. 80

49	3/4" PART C FEMALE COUPLER X HOSE	HARRINGTON 075C-M	1	GLASS FILLED POLYPROPYLENE
50	1" PVC PIPE SCH 80	PIPE-PVC-010	40FT	
51	1" TEE, PVC	801-010	1	SOC. SCH. 80
52	1-1/2" 45 ELBOW, CPVC	817-015C	4	SOC. SCH. 80
53	3/4" PART F MALE COUPLER X MPT	HARRINGTON 075F-M	1	GLASS FILLED POLYPROPYLENE
54	SPIRAL NOZZLE 1 MNPT	BETE, SKU#094238 1NCM1012N@16	2	CPVC
55	1-1/2" BALL VALVE	21983	1	PVC / EPDM
56	1-1/2" 90° ELBOW, PVC	806-015	18	SOC. SCH. 80
57	1-1/2" TEE PVC	801-015	3	SOC. SCH. 80
58	1-1/2" FLANGE 150# PVC, SOCKET	854-015	5	SOC. SCH. 80
59	1-1/2" FEMALE ADAPTER SXT	835-015C	2	CPVC SCH. 80
60	1-1/2" 45 ELBOW, PVC	817-015	2	SOC. SCH. 80
61	1" X 3/4"FNPT RED. BUSHING, PVC	838-131	1	SxT, SCH. 80
62	1-1/2" X 1" RED. BUSHING, PVC	837-211	2	SOC. SCH. 80
63	1-1/2" PVC PIPE SCH 80	PIPE-PVC-015	100 FT	
64	1-1/2" COUPLING, PVC	829-015	1	SOC. SCH. 80



MATERIAL LIST

#	DESCRIPTION	DWG / PART #	QTY	NOTES
1	PUMP, 2HP, 132 GPM 63' TDH	MX-403CV6	2	IWAKI
2	PUMP BASE	4-800-PBP-015	2	
3	PUMP FLANGE, PPE	LJPT-B1	1	LUTZ-JESCO
4	LEVEL PROBE ASSY	SHEET 4 OF 5 SHEET 5 OF 5	2	
5	1" BALL VALVE	21981	2	PVC / EPDM
6	1" CHECK VALVE (FOOT VALVE)	27362	1	PVC / EPDM WITH VALVE SCREEN
7	2" FLANGE 150# CPVC, SOCKET	854-020C	6	VAN STONE STYLE
8	2" FULL FACE GASKET,150#	110-FFN2-150-12	4	EPDM W/ PTFE ENVELOPE
9	5/8" HEX HD BOLT	F015/8X3	16	316 SS, 3" LG
10	5/8" HEX NUT	F10F5/8	16	316 SS
11	5/8" WASHER	F215/8	32	316 SS
12	2" TEE, CPVC	801-020C	5	SOC. SCH. 80
13	2" X 1" RED. BUSHING, CPVC	837-249C	2	SOC. SCH. 80
14	2" CPVC PIPE SCH 80	PIPE-CPVC-020	20FT	
15	2" 90° ELBOW, CPVC	806-020C	5	SOC. SCH. 80
16	2" BALL VALVE	22235	4	CPVC / EPDM
17	2" X 1-1/2" RED. BUSHING, CPVC	837-251C	1	SOC. SCH. 80
18	1-1/2" FLANGE 150# CPVC, SOCKET	854-015C	12	VAN STONE STYLE
19	1-1/2" FULL FACE GASKET,150#	110-FFN1.50-150-12	6	EPDM W/PTFE ENVELOPE
20	1/2" HEX HD BOLT	F011/2X21/2	36	316 SS, 2-1/2" LG
21	1/2" HEX NUT	F10F1/2	36	316 SS
22	1/2" WASHER	F211/2	72	316 SS
23	1-1/2" 90° ELBOW, CPVC	806-015C	47	SOC. SCH. 80
24	1-1/2" TEE, CPVC	801-015C	7	SOC. SCH. 80
25	1-1/2" CHECK VALVE	27384	3	CPVC / EPDM
26	1-1/2" CPVC PIPE SCH 80	PIPE-CPVC-015	200 FT	
27	1-1/2" BALL VALVE	22234	7	CPVC / EPDM
28	1-1/2" X 1" RED. BUSHING, CPVC	837-211C	2	SOC. SCH. 80
29	1" BALL VALVE	22232	3	CPVC / EPDM
30	1" CPVC PIPE SCH 80	PIPE-CPVC-010	5FT	
31	1" TEE, CPVC	801-010C	1	SOC. SCH. 80
32	1" 90° ELBOW, CPVC	806-010C	1	SOC. SCH. 80

		DATE
.	.	
.	.	
.	.	
.	.	
.	.	.
B	SUPPORT BRACKETS CHANGED SHEET 4	05/20/10
A	ORIGINAL ISSUE	

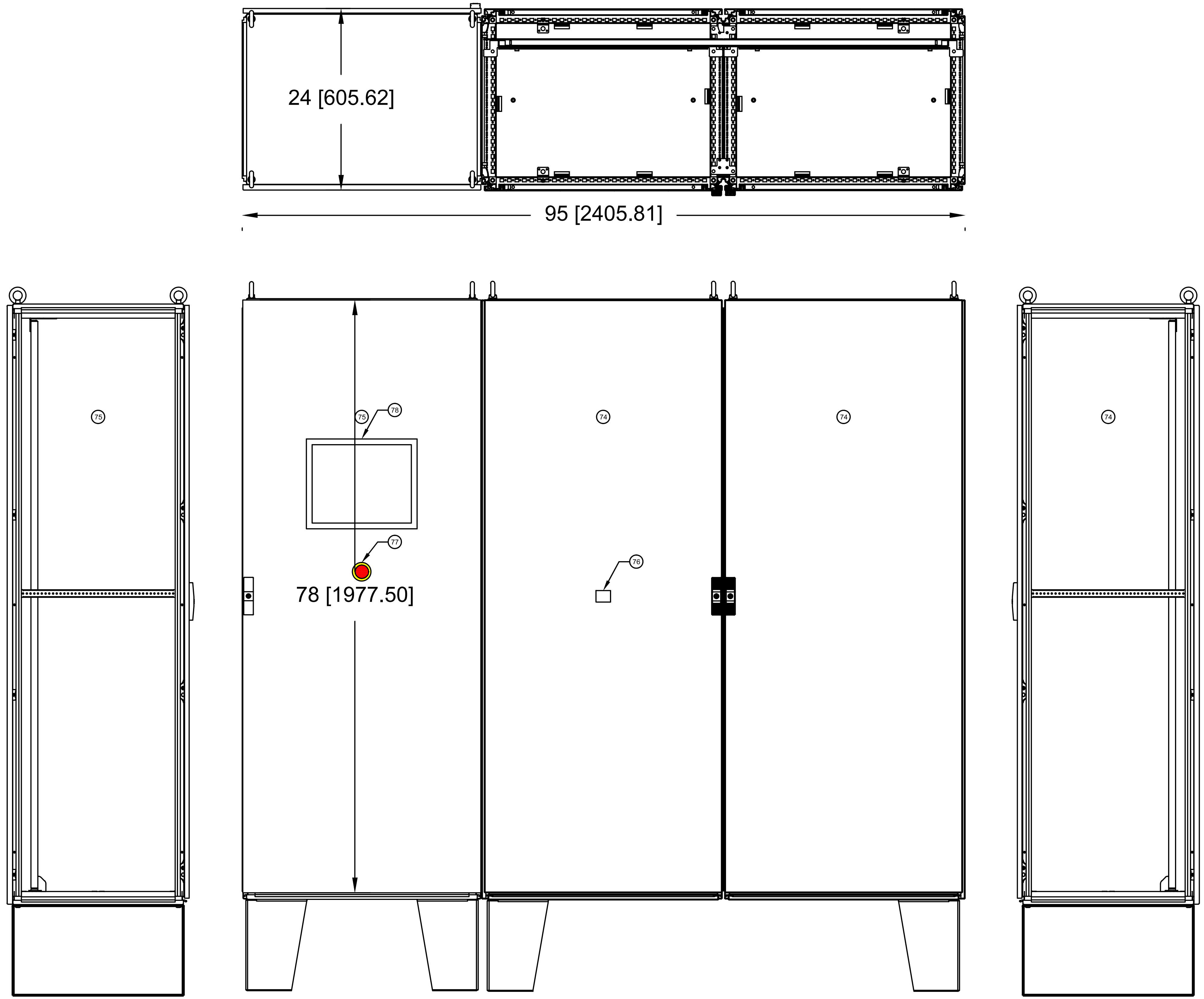
REVISIONS

PRIMARY DIMENSIONS IN INCHES, SECONDARY DIMENSIONS IN MILLIMETERS

DRAWN P.LYNN	TITLE BRINE MAKER PIT
CHECKED	
APPROVED	DRAWING NO. 8-100-AMM-033
DATE 3.18.10	
SHEET 1 OF 5	SCALE N.T.S. REV B

Electrolytic Technologies Corporation

11 x 17



REVISIONS	DATE
. .	.
. .	.
. .	.
. .	.
. .	.
. .	.
. .	.
. .	.
A ORIGINAL	01/27/15

WIRE COLOR CODE

+ 24 VDC = SOLID BLUE
0 VDC = WHITE / BLUE STRIPE
120 VAC CONTROL = SOLID RED
120 VAC POWER = SOLID BLACK
VAC NEUTRAL = SOLID WHITE
YELLOW = FOREIGN VOLTAGE
GROUND = GREEN

WIRE TAG DETAIL

TAG P&ID REFERENCE DEVICE NO.
XX-XX-XX/XX
TERMINAL BASE NO.

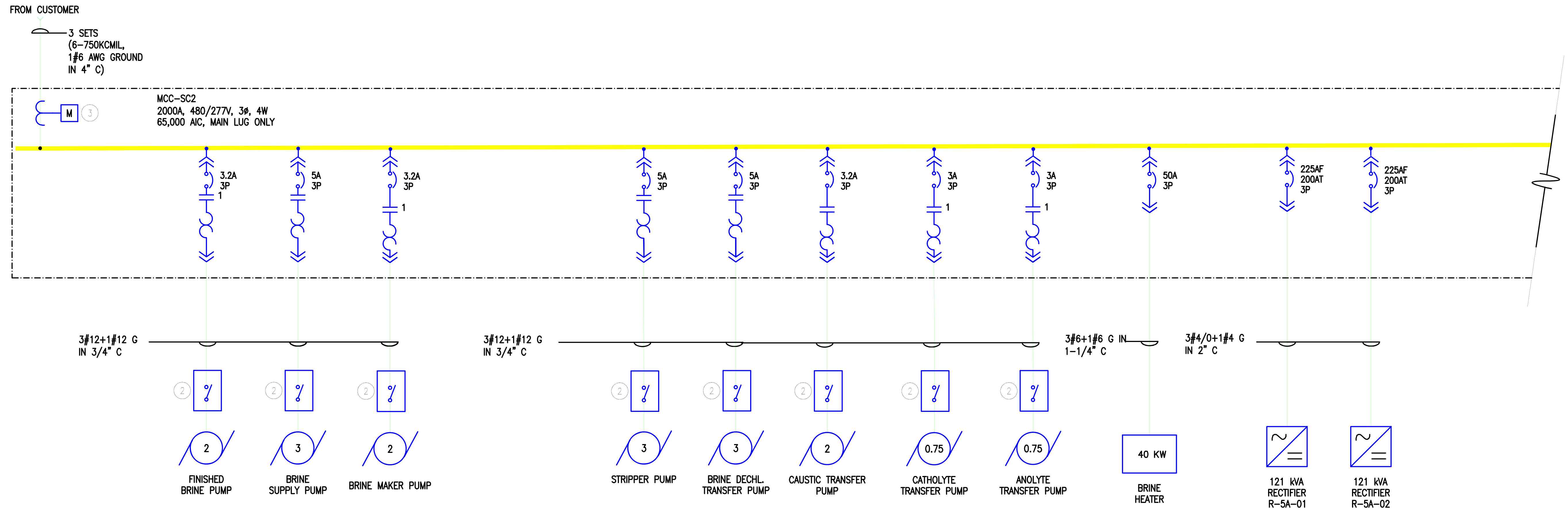
DRAWING TRANSMITTAL NO. :-
DRAWING TRANSMITTAL DATE:-
DRAWING REVIEW DATE:-
REVIEWING PERSON:-
APPROVAL:-
COMMENTS:-

DRAWN O.S
CHECKED
APPROVED
DATE 3/2/2016
SHEET 1 OF 1

TITLE MCP-MCC
KLORIGEN MAIN CONTROL
For 5,000 - 10,000 PPD System

DRAWING NO. 8-910-HON-001
SCALE NTS
REV A

Electrolytic Technologies LLC



GENERAL NOTES

1. BASIC OF DESIGN OF MCC IS ALLEN–BRADLEY WITH INTEGRATED DEVICENET CABLING AND PLUG–IN UNITS.
2. UNITS COMMUNICATE OVER DEVICENET VIA COMPONENTS SUCH AS SOLID–STATE OVERLOAD RELAY (E3 PLUS) , DEVICENET STARTER AUXILIARY (DSA) OR DEVICENET COMMUNICATIONS MODULES.

DRAWING NOTES:

(1) EXTERNAL DEVICENET CONNECTORS WITH 120 VAC RECEPTACLES (REDUNDANT) FED FROM REMOTELY LOCATED DEVICENET POWER SUPPLIES (UPS POWER).

(2) LOCAL DISCONNECTS PROVIDED WITH THE EQUIPMENT.

(3) SURGE PROTECTIVE DEVICE WITH STATUS MONITORING CIRCUITRY. MINIMUM 160kA PER PHASE AND 0.5 ns RESPONSE TIME.

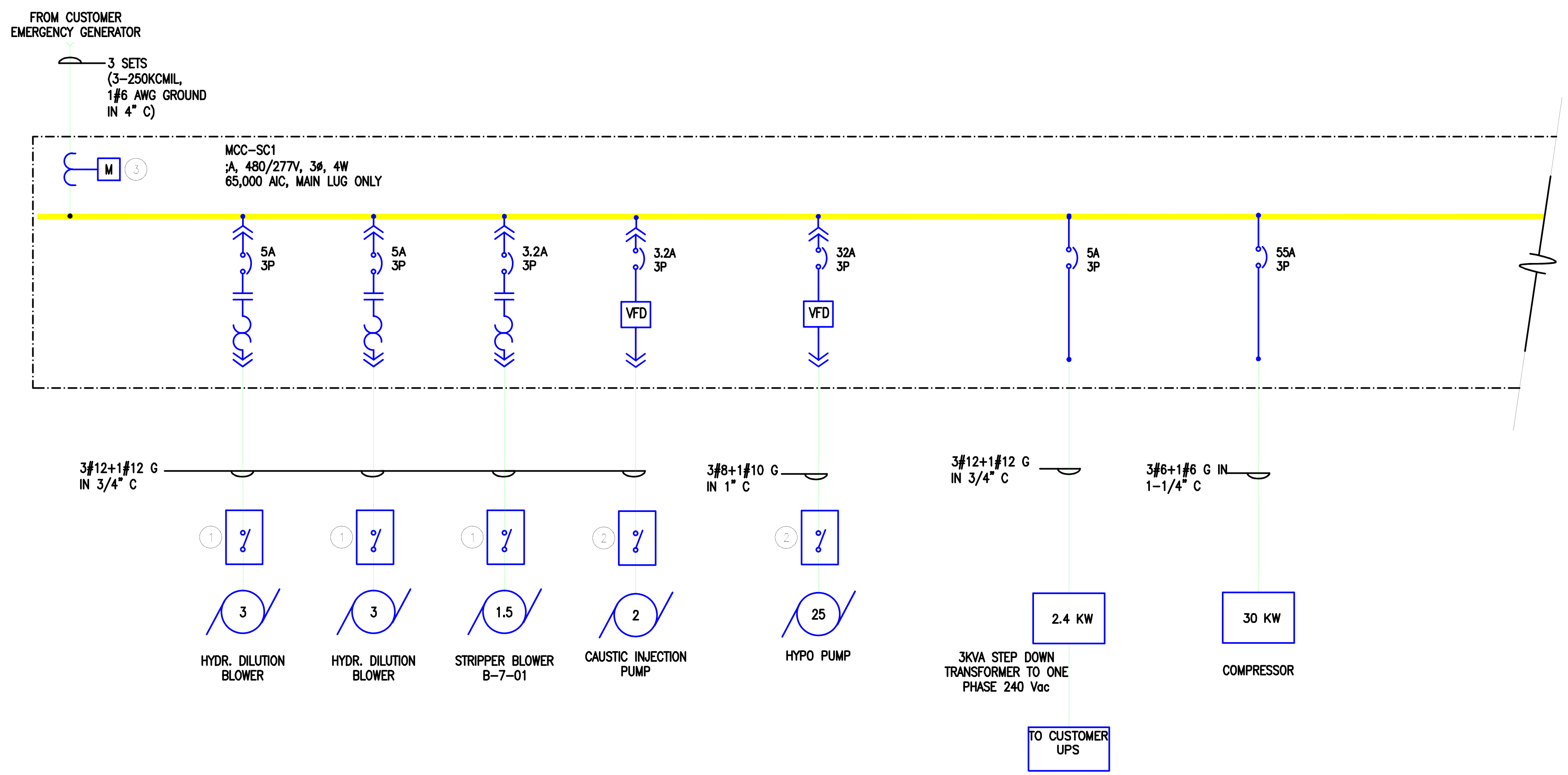
REVISIONS		DATE
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
A	ORIGINAL	8.24.16

WIRE COLOR CODE
+ 24 VDC = SOLID BLUE
0 VDC = WHITE / BLUE STRIPE
120 VAC = SOLID RED
VAC NEUTRAL = SOLID WHITE
480 VAC = BLACK
GROUND = GREEN

WIRE TAG DETAIL
TYPE P&ID REFERENCE DEVICE NO. WIRE NO.
XX-XX-XX-XX

DRAWING TRANSMITTAL NO. :-
DRAWING TRANSMITTAL DATE:-
DRAWING REVIEW DATE:-
REVIEWING PERSON:-
APPROVAL:-
COMMENTS:-

DRAWN O.S	TITLE SINGLE-LINE DIAGRAM MCC MAIN POWER
CHECKED FRC	DRAWING NO. 8-950-COL-000
APPROVED JM	Electroly Technolo Corporat
DATE 08.24.2016	SCALE NTS
SHEET 1 OF 2	REV A



SINGLE LINE DIAGRAM
NOT TO SCALE

GENERAL NOTES

1. BASIC OF DESIGN OF MCC IS ALLEN-BRADLEY CENTERLINE 2100 WITH INTEGRATED DEVICENET CABLING AND PLUG-IN UNITS.
2. UNITS COMMUNICATE OVER DEVICENET VIA COMPONENTS SUCH AS SOLID-STATE OVERLOAD RELAY (E3 PLUS) , DEVICENET STARTER AUXILIARY (DSA) OR DEVICENET COMMUNICATIONS MODULES.

DRAWING NOTES:

(1) LOCAL DISCONNECTS PROVIDED WITH THE EQUIPMENT.

REVISIONS		DATE
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
A	ORIGINAL	9.26.11

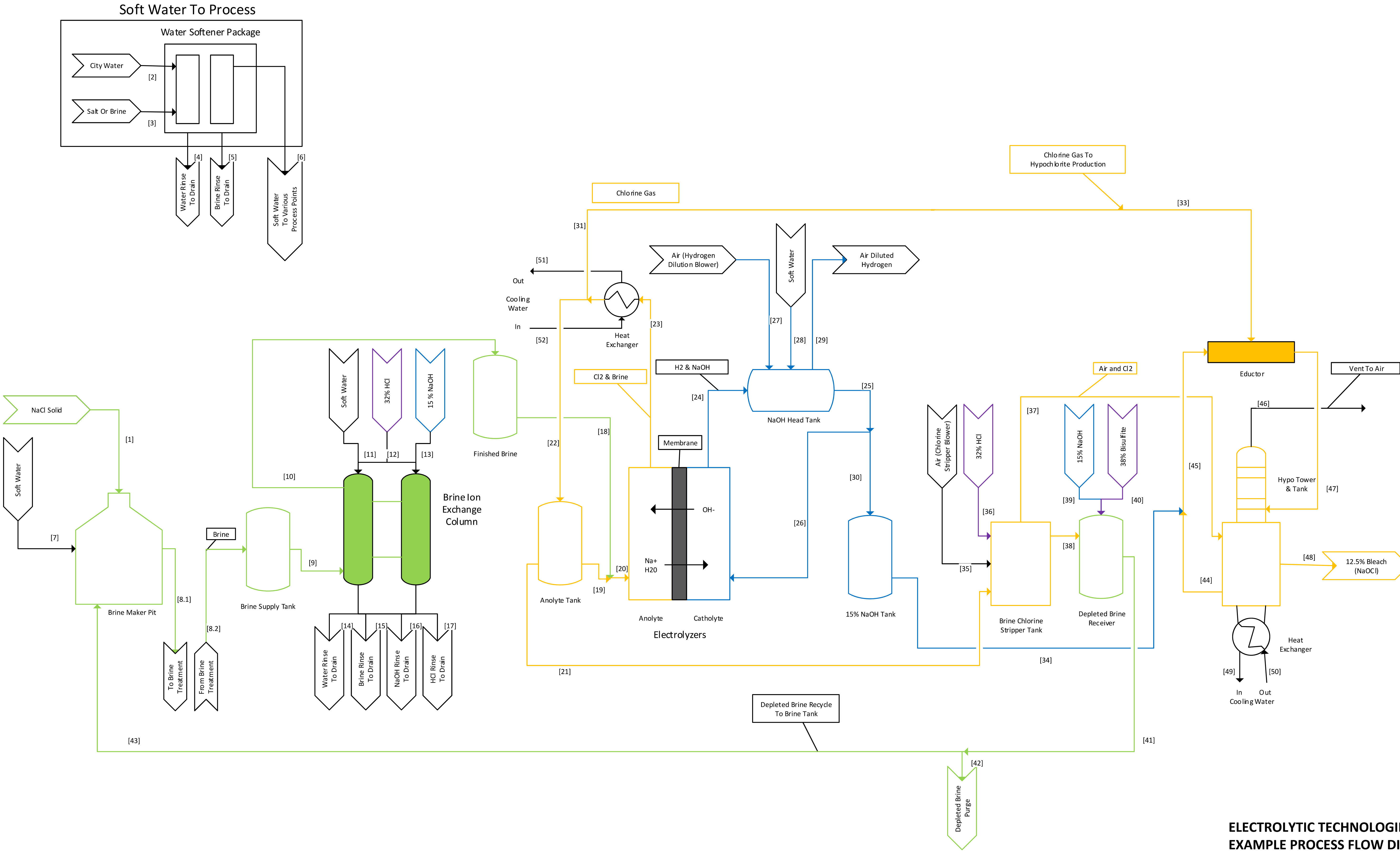
WIRE COLOR CODE
+ 24 VDC = SOLID BLUE
0 VDC = WHITE / BLUE STRIPE
120 VAC = SOLID RED
VAC NEUTRAL = SOLID WHITE
480 VAC = BLACK
GROUND = GREEN

WIRE TAG DETAIL
TYPE P&ID REFERENCE DEVICE NO. WIRE NO.
XX-XX-XX-XX

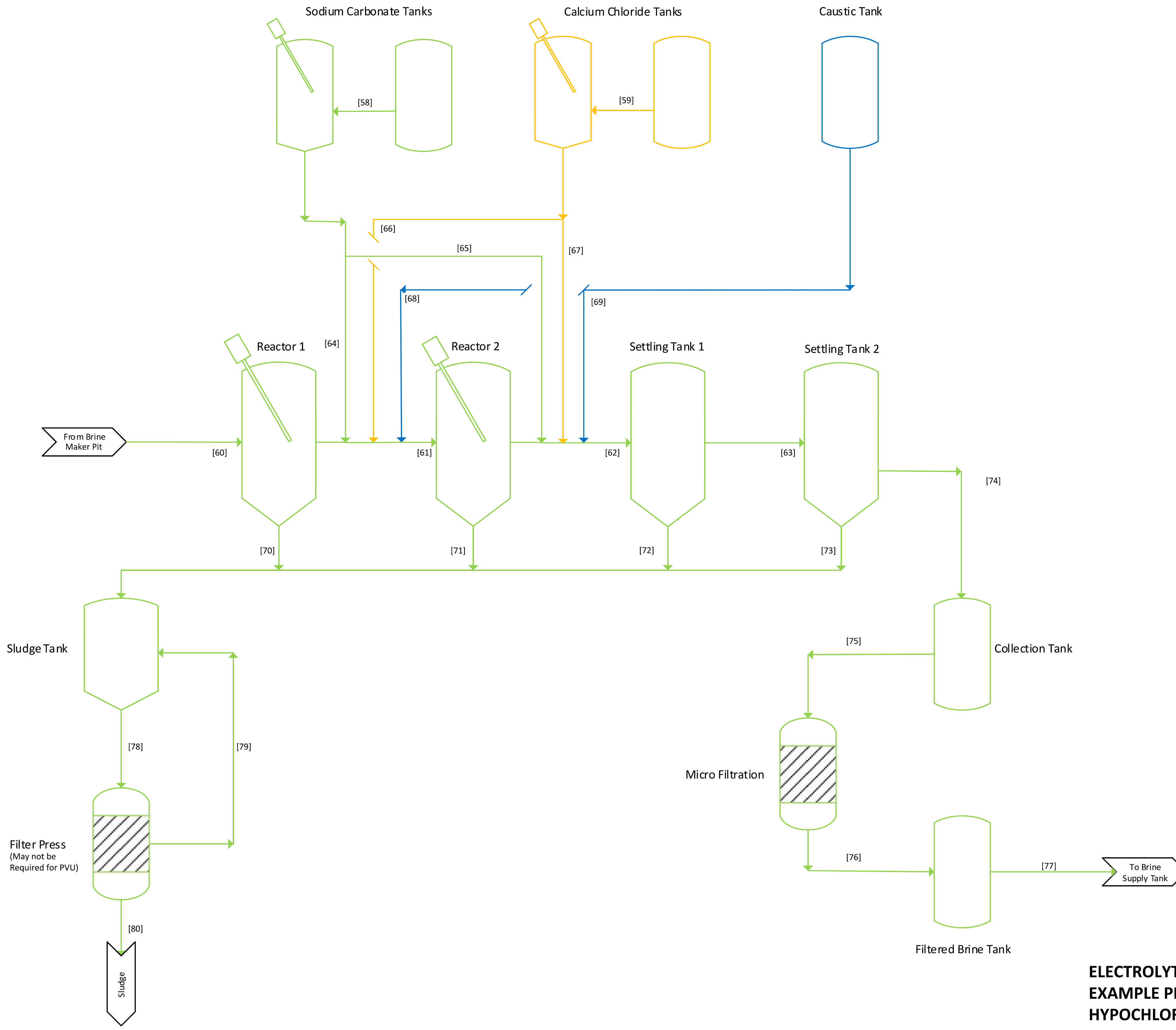
DRAWING TRANSMITTAL NO. :-
DRAWING TRANSMITTAL DATE:-
DRAWING REVIEW DATE:-
REVIEWING PERSON:-
APPROVAL:-
COMMENTS:-

DRAWN O.S
CHECKED FRC
APPROVED JM
DATE 08.24.2016
SHEET 2 OF 2

TITLE SINGLE-LINE DIAGRAM MCC-SC3 MAIN POWEI
DRAWING NO. 8-950-ASP-000
SCALE NTS
REV A
Electroly Technolo Corporat



ELECTROLYTIC TECHNOLOGIES
EXAMPLE PROCESS FLOW DIAGRAM
HYPOCHLORITE GENERATION SYSTEM
SHEET PFD102



ELECTROLYTIC TECHNOLOGIES
EXAMPLE PROCESS FLOW DIAGRAM
HYPOCHLORITE GENERATION SYSTEM
PRIMARY BRINE TREATMENT
SHEET PFD103

APPENDIX B

Vendor Quotes for Large Equipment

Date: August 2, 2016 **Proposal No. 160802**

Attention: Mr. Greg Harmer
AMEC Foster Wheeler

Reference/Application: On-Site Sodium Hypochlorite Generation – 1,125 kg Chlorine equivalent per day as 12.5/15% (125/150 g/L) Sodium Hypochlorite

Dear Mr. Harmer,

Electrolytic Technologies is pleased to provide the following quotation for the Colorado project per your request.

Electrolytic Technologies specializes in the manufacture of electrochemical chlor-alkali systems that bring value to customers through savings in installation, operation and life cycle maintenance. All systems are supplied in factory manufactured modules, pre-piped and pre-wired to maximum extent to facilitate cost effective installation and operability.

The attached proposal provides the base price of the 1,125 kg Klorigen sodium hypohlorite system. Additional data pertaining to our Klorigen technology and detailed descriptions of major components is included as addendums. Please note that salt and chemical storage tanks are not included in the Electrolytic Technologies scope of supply due to the high costs associated with international shipping and thus are to be provided by the customer. Electrolytic Technologies will supply detailed specifications to assist in the procurement of the tanks and will provide a supplementary quotation if the tanks are unavailable locally. Electrolytic Technologies will supply the pumps and controls for the tanks.

Thank you for your time, consideration and interest in Electrolytic Technologies. We take great pride in the design and performance of our equipment and the success of our customers. We will contact you to verify that you received this quotation and to answer any questions that you may have. We respectfully ask for your business and value the trust that it represents.

Sincerely,
Electrolytic Technologies LLC

Sean Laird
Sales Engineer

19597 NE 10th Avenue, North Miami Beach, FL 33179 Tel: 305 655-2755 Fax: 305655-2669
www.electrolytictech.com

SCOPE OF SUPPLY

Technological Approach

The Klorigen™ System specified in this proposal is capable of producing up to 1,125 kilograms of chlorine equivalent per day, based on 24-hour operation at 100% system capacity. Daily system output at the full production rate will be 9,500 liters of sodium hypochlorite at 12.5% (125 g/L) concentration.

The Klorigen™ system is designed for operation at any increment from 25% to 100% of designed capacity. Please note: to reduce the overall equipment and shipping costs, the chemical and brine tanks that are required by the Klorigen system will need to be provided by your company or the customer. For detailed technical and process information, refer to Addendum A.

System Description

Klorigen™ Systems are designed to generate elemental chlorine gas and very pure sodium hydroxide on-site using a state-of-the-art membrane cell-based process. During normal operation, chlorine (Cl_2) gas is produced in the anolyte compartments of the electrolyzers and sodium hydroxide is produced in the catholyte compartments as a co-product. They are then reacted together in a separate conversion module to produce sodium hypochlorite (NaOCl) on a continuous basis. The hypochlorite product concentration range is adjustable between 5 and 15 trade % (50 to 150 gm/L as NaOCl). The byproduct hydrogen co-produced in the catholyte compartments of the electrolyzers is immediately and safely diluted with ambient air to 2% v/v or less in concentration and is safely vented to the atmosphere.

The system proposed herein comprises a complete process package *with the exception of* feed salt handling and chemical storage tanks. Pumps and accessories for the tanks will be provided.

Deliverables to be supplied by Electrolytic Technologies LLC

Electrolytic Technologies will provide equipment and instruments per the attached equipment and instruments more fully described in the Addendums and as follows:

a. Qty 1: Electrolyzer Module each utilizing 8 electrolyzers
b. Qty 1: Receiver Unit incorporating Blower Module
c. Qty 1: Brine Treatment Unit
d. Qty 1: Caustic Receiver/Brine Dechlorination Unit
e. Qty 1: Hypo Conversion/Chlorine Stripper Unit
f. Qty 2: Transformer/Rectifier
g. Qty 1: Master Control Panel/Motor Control Center

PRICE for the 1,125 kg/day system: US $1,639,500.00 (ex-works)

Storage Tanks to be Supplied by the Customer (or others):

The following tanks are required to supply the operating consumables used by the Klorigen system, and are to be provided by the customer. Electrolytic Technologies will supply instrumentation, valves and pumps for the tanks as detailed in the Scope of Supply.

A. Brine Tank - Provides the saturated brine solution, which is pumped to the brine treatment module and on to the electrolyzers.

B. Finished Brine Storage Tank – Required by the system for storage of finished brine. Finished brine is stored in the Finished Brine tank before being sent to the electrolyzers. A finished brine storage capacity of at least 7,500 liters is recommended.

C. 32% Hydrochloric Acid Tank – Required for storage of 32% HCl. HCl is used in brine softener regeneration and in the chlorine stripper unit to dechlorinate the depleted brine in the brine recycle stream. Electrolytic Technologies recommends a storage capacity of at least 1,500 liters.

D. 40% Sodium Bisulfite Tank – Required for storage of 40% sodium bisulfite. The tank will supply sodium bisulfite used in the Klorigen process to dechlorinate the brine recycle stream. Electrolytic Technologies recommends a storage capacity of at least 1,500 liters.

E. 50% Caustic Tank(s) - Required for storage of 50% caustic (NaOH). The additional NaOH is required to convert all of the chlorine produced by the system into sodium hypochlorite. Electrolytic Technologies recommends a storage capacity of at least 1,500 liters.

Items not included in this proposal/Customer responsibilities

- Chemicals used during the commissioning phase;
- Chemicals and other consumables used during post-commissioning operation;
- Interconnecting piping or wiring between modules or individual pieces of equipment;
- Power distribution or circuit protection equipment feeding Electrolytic Technologies supplied equipment;
- DLO (Diesel Locomotive) cable for supplying power to electrolyzers;
- Sodium hypochlorite storage and injection pumps;
- Additional brine treatment (if necessary);
- Cooling tower and chiller (if necessary);
- Insulation or heat tracing (if necessary);
- Customs duties and bank charges;
- Provision of air and cooling water;
- Chemical tanks and feed pumps;
- Waste neutralization system;
- Boiler for water heating;
- Taxes and permits;
- Shipping and installation

Delivery Schedule
Delivery of the Klorigen system proposed herein will be approximately 16-20 weeks following receipt of all drawing approvals from Customer.

Validity Period
Quoted prices are firm for thirty (30) days from the date of this proposal and are subject to adjustment after that time.

Payment terms

Unless specified otherwise, progressive payments shall be as follows:

- 20% Paid with order;
- 25% Upon submittal of Drawings;
- 25% Upon Drawing Approval and Release for procurement / fabrication; and
- 30% At the time of shipment (presentation of shipping documents).

All payments shall be secured with confirmed irrevocable Letter of Credit via U.S. bank with remittances to Seller's bank via bank wire transfer. All bank charges shall be the responsibility of the Customer.

GENERAL CLARIFICATIONS AND EXCEPTIONS

Unless otherwise specified, the following conditions and exceptions apply to this proposal and any purchase order or sales contract for the supply of Klorigen® products.

Customer Responsibilities

1. All material and labor for interconnecting piping outside of Klorigen® "battery limits".
2. All material and labor for interconnecting electrical and control connections outside of Klorigen® "battery limits".
3. All materials and labor associated with chemicals and consumables required for testing, commissioning and operation of the Klorigen system.
4. All material and labor required for storage of materials at or off site, if required.
5. All receiving, offloading and rigging of skids and subsystem components related to the Klorigen installation.
6. All required utilities to and from the Klorigen® "battery limits". Customer must specify to Electrolytic Technologies their available power supply, e. g. 380VAC/50Hz/3 phase or 110VAC/60Hz/1 phase or other clean and stable electrical power supply, 120 psi/8.27 bar clean instrument air, potable water, etc.
7. Preparation of all foundations for housing the equipment, including but not limited to engineering design, civil, utilities, concrete work, etc.
8. Any bunding or secondary fluid containment (unless stated otherwise in the proposal) including, but not limited to individual tanks, equipment and or piping to meet local codes and standards.
9. Payment of all applicable customs duties, sales, use and excise taxes.
10. All required permits, regulatory and governmental authorizations for zoning variances, design, construction, testing, etc. related to this project.
11. Provide access to the Klorigen installation site and a safe work environment for Electrolytic Technologies LLC ("Electrolytic Technologies") representatives.

General

1. Electrolytic Technologies packaging methodology includes skid-mounted equipment and any selected options are supplied pre-piped and pre-wired to the fullest extent possible (within shipping restrictions and or limitations) to minimize shipping and installation costs and installation time on-site.
2. The Electrolytic Technologies labor rate for "time and materials" work will be determined as outlined in Electrolytic Technologies' Standard Terms and Conditions or at the onset of the contracting period.
3. Should Electrolytic Technologies through its performance of work under this contract, identify conditions or scope not previously known or specified in the executed contract documents (including but not limited to site conditions, product quality specifications, utilities, hidden or unknown circumstances, which would prevent Electrolytic Technologies from meeting its contractual obligations or creates a negative cost impact for Electrolytic Technologies), then Electrolytic Technologies shall have the right to negotiate a change order to address such conditions or scope.)
4. Any additional work required to achieve and maintain the performance of the system, which is outside the scope outlined herein will be considered by Electrolytic Technologies and the OWNER/PURCHASER to be a change condition and the scope and price will be adjusted accordingly and mutually agreed by Electrolytic Technologies and OWNER/PURCHASER in writing. Where possible, estimated hours, expenses and material costs will be provided to OWNER/PURCHASER for approval before commencement of work. Where emergency circumstances require immediate response by Electrolytic Technologies without time for pre-approval by OWNER/PURCHASER, these emergency repairs will be provided according to the time and material rates in affect at the time of event. All travel expenses for work performed at the site subsequent to the installation and commissioning phases will be for the account of the OWNER/PURCHASER.
5. Electrolytic Technologies reserves the right to supply any additional equipment or components required to meet contractual performance requirements in addition to that delineated in the scope of supply herein.
6. Electrolytic Technologies assumes no responsibility for work performed, materials supplied or repairs made by others or for damage to equipment due to inadequate supports, foundations, faulty related systems or controls provided by others.
7. Back charges: Electrolytic Technologies will not accept back charges without prior written authorization. Written notification must be provided to Electrolytic Technologies of any potential back charge condition and such notification must be received by Electrolytic Technologies at least 30 days in advance of any corrective action initiative.
8. Wage guidelines **-** all Electrolytic Technologies labor is nonunion. If union labor is required, OWNER/PURCHASER will be required to pay the additional costs for union scale wages, benefits and other related cost overruns. Electrolytic Technologies does not subscribe to any voluntary state or federal wage guidelines except those required by law. If required by the PURCHASER, the PURCHASER will pay the additional costs associated for wage scales, benefits and other associated cost overruns.
9. Electrolytic Technologies will ordinarily provide its own labor force to support the installation and commissioning phases, where applicable but reserves the right to employ qualified subcontractors when Electrolytic Technologies management deems appropriate.
10. Electrolytic Technologies has not included heat tracing, insulation or winterization of equipment, unless stated herein.
11. Electrolytic Technologies has not included any on-site utilities such as telephone, internet, electric or office space expenses.

12. Electrolytic Technologies has not included any reporting, sampling, testing or analytical analyses of influent or effluent fluids at the installation site. The cost and provision of such services shall be the responsibility of others.
13. Equipment decontamination and associated sampling and test shall be the responsibility of others.
14. Electrolytic Technologies has not provided as part of this proposal, compliance with special regulatory requirements, supply of P.E.-certified drawings or seismic calculations and Electrolytic Technologies makes no claims to meeting any seismic design or equipment or building codes if the specifications did not identify such requirements in advance of contract execution.
15. The design, supply of material, installation and management of the collection, transfer, treatment and storage of water and wastewater external to the Electrolytic Technologies-supplied equipment is the responsibility of others.
16. Electrolytic Technologies Standard Terms and Conditions are included as part of this proposal.

Delays: Any delays that occur through no fault of Electrolytic Technologies and which delay future manufacturing, delivery or installation milestones(s) or payments may be subject to price adjustment.

Freight: Unless specifically included in the proposal, all applicable freight charges and freight insurance are for the PURCHASER's account. Freight will be billed as an extra expense, either "prepay and add" or "collect". Domestic and export freight is FOB supplier or Electrolytic Technologies' plant.

Charges: Excess or special packaging, packing, shipping, transportation or other charges resulting from compliance with PURCHASER's request with respect to the use of any agency or method of transportation or any item routing other than that which would otherwise be designated by Electrolytic Technologies, shall be for PURCHASER's account.

Shipment and Delivery: Unless a firm delivery date is stated and agreed in the executed sales contracts, all shipment dates are approximate and shall be made within a reasonable time thereof and shall be deemed in full performance of this aspect of Electrolytic Technologies' obligations hereunder. Electrolytic Technologies will exert all possible effort to meet proposed shipping dates, but will not be liable for delay caused by reason of war, civil commotion, strike, fire, accident, "Acts of God", governmental order or regulation, shortage or curtailment of material, required pre-shipment inspections or any other contingency beyond Electrolytic Technologies' reasonable control; nor will any such delay be cause for cancellation or penalty. Electrolytic Technologies shall not be liable for consequential damages as a result of any delay.

Prices / Taxes: All prices quoted are payable in United States Dollars in North Miami Beach, Florida U.S.A. and exclude all taxes and customs duties. Sales, uses, federal, state, value added (VAT), occupational and excise taxes, import or export duties, and the like where applicable, will be the responsibility of the PURCHASER. Appropriate exemption certificates or direct pay permits must be supplied by the Purchaser at the time of the purchase order issuance for tax exempt purchases. The collection and remittance of taxes are the responsibility of others. All travel and freight expenses exclude taxes. Pricing indicated in this proposal is based on adherence to Electrolytic Technologies' terms & conditions and payment schedule. Any alteration may result in a pricing increase.

Cancellation Charges: In the event the sales contract is canceled, Electrolytic Technologies will invoice the PURCHASER at the following rates: 20% of the contract total price or for time and materials whichever is higher. The time and material charge will be calculated on net cost for materials, subcontractors, equipment and supplies less any allowance for returned goods (including freight, handling, storage, return costs and restocking charges) marked up by the factor of 1.5 for administration expenses, handling and reasonable anticipated profits. Electrolytic Technologies direct labor (fabrication, engineering and trades) will be billed at our published rates for work completed through the date of cancellation.

Warranty: Refer to addendum attached herein.

Performance - If the equipment furnished by Electrolytic Technologies does not meet stated performance guarantees, the PURCHASER agrees to advise Electrolytic Technologies promptly and to permit Electrolytic Technologies to make such inspections and tests as Electrolytic Technologies deems necessary. If Electrolytic Technologies-supplied equipment is at fault, Electrolytic Technologies reserves the right to make such alteration, changes or additions as it deems necessary to meet the guarantee. If any equipment or performance failure is determined by Electrolytic Technologies to be due to the PURCHASER's incorrect installation or operation or addition of third party-supplied peripheral equipment, the Purchaser agrees to pay Electrolytic Technologies the then current daily rate for the time expended by the investigating technical representative, together with travel and living costs. If the problem is due to a change in the raw water or influent characteristics from those determined in the water analysis on which the proposal was based, or due to the failure to supply salt of suitable quality as specified herein, or due to other operational conditions not attributable to Electrolytic Technologies, the PURCHASER agrees to pay for repair or replacement of any failed components and or purchase and install any additional or other equipment needed to meet such changed conditions; otherwise the performance guarantees will be void. The guarantees furnished with this proposal are in lieu of all other warranties and guarantees, express or implied including without limitation, warranties of merchantability and fitness for a particular purpose and in no event shall Electrolytic Technologies be liable for consequential damages.

Drawings: Proposal pages, catalogs, illustrations, schematics and other preliminary drawings are submitted only to show general layout and approximate dimensions. Electrolytic Technologies reserves the right to make such changes of design, construction or layout as it feels may represent improvements in practice over the specifications contained in the proposal. Fully dimensioned drawings of the equipment (with certification, if required), will be supplied after the PURCHASER's acceptance of this proposal. When requested by Electrolytic Technologies, the PURCHASER will furnish scaled drawings of all foundations, supports, concrete reinforcements and required housings or other drawings based upon Electrolytic Technologies' equipment drawings. The PURCHASER's drawings must be final and subject to Electrolytic Technologies' approval as they relate to the installation of Electrolytic Technologies-supplied equipment. Drawings and all information contained thereon is and shall remain the property of Electrolytic Technologies as an instrument of professional service. All disclosed technology remains the property of Electrolytic Technologies. This information is proprietary and shall not be reproduced or used in whole or in part without the full knowledge and prior written consent of Electrolytic Technologies.

Title: Title to equipment covered by this proposal shall remain vested in Electrolytic Technologies until the entire purchase price is received by Electrolytic Technologies. The PURCHASER assumes all risk of loss or damage from time of acceptance of shipment by transporting carrier unless otherwise expressly provided in this proposal.

Default: In the event of PURCHASER's breach of this contract, or upon the PURCHASER's failure to make payment of the purchase price or any part thereof when due, the entire unpaid balance, shall at Electrolytic Technologies' option, become immediately due and payable without notice. Electrolytic Technologies may thereupon, without process of law, enter upon the PURCHASER's premises and take possession, disconnect and remove the equipment and retain all previous payments as compensation for the use of the equipment and Electrolytic Technologies shall have no liability for damages arising out of repossession of the equipment. If Electrolytic Technologies must use legal means to collect funds due Electrolytic Technologies under this agreement, then PURCHASER agrees to pay all reasonable attorney fees and collection expenses.

PURCHASER's Labor and Materials: Subject to any exceptions specified herein or in any supplemental written agreement between the PURCHASER and Electrolytic Technologies, the PURCHASER will supply all labor, supervision, materials and interconnection piping except that which is integral with each unit from inlet to outlet or within "battery limits", as may be applicable. Electrolytic Technologies assumes no responsibility for work completed, materials supplied or repairs made by others, or for damage to equipment due to inadequate supports, foundations, faulty related systems or controls or improper connections.

Installation / Start-up Supervision: When ordered separately or as part of this contract, Electrolytic Technologies will furnish experienced supervisory personnel to advise the PURCHASER during installation and/or commissioning of the equipment. Unless expressly provided, the price for such service is not included in the purchase price. When quoted as part of this proposal or in a supplemental proposal, the quotation shall be made on the basis of the then current daily charge for such services, plus actual travel and living expenses from North Miami Beach, Florida to the PURCHASER's location and return. Supervisory services do not include manual labor and all materials normally furnished as part of the installation and and/or to remedy work performed (by others) deemed incomplete or defective. The PURCHASER agrees to have the equipment ready for the supervision service and to pay additional charges when the equipment or necessary labor is not ready or available. The PURCHASER must give Electrolytic Technologies at least two (2) weeks prior notice to dispatch a technician and or engineer to the job site by a specific date. The PURCHASER agrees that this contract will be determined to be fully performed by Electrolytic Technologies at the conclusion of a satisfactory starting date in accordance with the terms of acceptance delineated in the applicable addendum, attached herein.

Shortages: All claims for shortages must be made by the PURCHASER within five (5) days after receipt of shipment, otherwise such claims are deemed waived.

Indemnity: The products furnished by Electrolytic Technologies hereunder are sold or supplied without warranty against property damage or injuries resulting from their use. The PURCHASER indemnifies and holds Electrolytic Technologies, its employees, licenses, franchisees and agents harmless from and against any loss, cost, liability, claims, suits damage or injury resulting from the design or use or misuse of the products.

Tool Rental: Electrolytic Technologies supplies all normal hand tools to complete normal installation requirements. If any tools or equipment are required outside the scope of our normal inventory, these will be charged at cost plus 25%.

Applicable Law: These terms and conditions shall be governed by and constructed in accordance with the laws of the State of Florida, excluding rules relating to choice or confines of law.

Back Charges: Electrolytic Technologies will not accept back charges without prior written authorization. Written notification must be provided to Electrolytic Technologies of potential back charge condition and that notification must be at least thirty (30) days in advance of any corrective action initiative.

Agreement: This proposal, when accepted by the PURCHASER within the time specified, shall constitute the entire agreement between Electrolytic Technologies LLC (Electrolytic Technologies) and the PURCHASER. No modifications or changes shall be binding on Electrolytic Technologies unless they are in submitted in writing and approved by an officer or duly designated employee of Electrolytic Technologies. Any subcontract or purchase order submitted by the PURCHASER with respect to this proposal shall be subject to Electrolytic Technologies' acceptance and shall be deemed to include the Conditions of Sale, this General Clarifications and Exceptions and all provisions of this proposal. Any provisions of the purchase order inconsistent therewith shall be null and void.

ADDENDUM A.

Klorigen™ Process

The Electrolytic Technologies Klorigen System generates chlorine and sodium hydroxide on-site using a state of the art membrane cell based process. Chlorine (Cl_2) gas produced in the anolyte compartments of the electrolyzers and sodium hydroxide (with hydrogen gas) produced in the catholyte compartments are reacted together in a separate conversion module to continuously produce sodium hypochlorite (NaOCl). The hypochlorite product concentration range is adjustable between 5 and 15 trade % (50 to 150 gm/L as NaOCl). The byproduct hydrogen co-produced in the catholyte compartments of the electrolyzers is immediately diluted with air to 2% v/v or less in concentration and is safely vented to the atmosphere. The sodium hypochlorite meets the stringent quality requirements for drinking water treatment and complies with NSF/ANSI 60.

1. Brine System

The Klorigen process typically uses a food grade salt (Morton Culinox® 999 or equivalent) that is shipped by truck and pneumatically loaded into the brine dissolver ("briner"). In the briner, the solid salt is slowly dissolved using softened water to produce a saturated salt solution. The saturated salt solution is then pumped into the brine treatment module to remove hardness impurities from the salt solution so it can be converted to chlorine and NaOH in the electrolyzers.

2. Brine Softening Treatment

The saturated brine solution is then fed into a brine softening system located on the brine treatment module. A special chelating ion exchange resin is used to reduce the hardness in the saturated brine to a 30 ppb of Ca hardness equivalent or less. The unit consists of a set of twin brine softener units to remove Ca, Mg, Ba, and Sr. The special chelating resin used is the Bayer Lewatit TP208, Purolite S940, or equivalent. The requirements for proper resin operation are a brine pH of 9-10 and a temperature between 50 – 60°C.

The ion exchange columns require 7% HCl and 4% NaOH for the periodic regeneration of the resin columns to remove the accumulated Ca and Mg. The regeneration period depends on the amount of brine passed through the columns, the brine Ca hardness, and the volume of the resin in the softener units.

The purified, finished brine (30 ppb or less Ca) from the ion exchange columns is then sent into a finished brine storage tank. The finished brine storage tank is sized to provide enough purified brine to operate the electrolyzers for a period of 24 hours at full plant capacity.

3. Softened Water

The Klorigen system is designed to use softened water (5 ppm hardness or less) for preparing the saturated feed brine solution and for the electrolyzer catholyte system for NaOH concentration dilution control. The water softeners specified herein are simple to operate and require only salt solution for regeneration. The units are regenerated automatically. The salt used for regeneration depends on the water quality.

4. Electrolyzer Module Details

Electrolytic Technologies has its own proprietary electrolyzer design and is fabricated in the USA. The electrolyzer uses catalytic coated titanium anodes 316L SS cathodes. The cells are designed for use with DuPont Nafion 324 membranes. Cooling water is used to cool the electrolyzer anolyte loop to keep electrolyzer temperatures below 70°C.

5. Membranes

Special cationic ion membranes are used to separate the anode reaction (chlorine generation) from the cathode reaction (caustic and hydrogen). Electrolytic Technologies typically employs DuPont Nafion 324 membranes in the electrolyzers. These are perfluorinated sulfonic acid based membranes which tolerate chlorine and as well system process upsets and potential hardness "excursions" in the brine feed to the electrolyzers. Selected membranes such as Asahi Flemion membranes and others can also be specified or substituted for the Nafion membranes.

6. Anodes & Cathodes

The electrolyzer employs long life DSA titanium anodes with coating and 316L SS cathodes. The anode coating life is dependant on brine quality, operating current density, and other operational factors. The advantage of using 316L SS cathodes in place of nickel cathodes is reduced contamination of the NaOH with Ni during electrolyzer shutdowns.

Each electrolyzer module has an anolyte and catholyte tank. The anolyte loop has a titanium heat exchanger that uses cooling water to keep the circulating electrolyzer anolyte solution in the electrolyzers the optimum temperature. The catholyte tank collects the 18% NaOH produced from the electrolyzers.

The finished brine solution (saturated) is fed to the anolyte side of the electrolyzers where chlorine is produced. The chlorine is educted from the anolyte tank under vacuum. The vacuum is generated from a pump-operated eductor in the hypochlorite module.

7. Electrolyzer Anode Reactions

The major anode reaction is the two-electron transfer oxidation of the chloride ion as in reaction (1) as follows:

(1) $2Cl^- \text{ ---> } Cl_2 + 2e^-$

The major competing anodic side reaction is the electrolysis of water, forming byproduct oxygen gas and hydrogen ions as given in reaction (2):

(2) $2H_2O \text{ ---> } O_2 + 4H^+ + 4e^-$

The other inefficiency reaction in the anode compartment is the formation of $NaClO_3$. This reaction is caused by the back migration of NaOH through the membrane.

(3) $3Cl_2 + 6NaOH \text{ < --- > } NaClO_3 + 5NaCl + 3H_2O$

The chlorate formed in this reaction must be purged from the brine loop. Alternatively it can be destroyed by reacting a side stream with HCl, reducing the $NaClO_3$ back to Cl_2.

Chlorine hydrolyzes in water in the anolyte compartment to form HOCl (hypochlorous acid) and HCl (hydrochloric acid as shown in equation (3):

(4) $2Cl_2 + H_2O \text{ <---> } HOCl + HCl$

The pH of the anolyte solution is between 3 and 5. In this pH range, there is an equilibrium between HOCl and chlorine gas. The solubility of the gaseous chlorine in the anolyte is about 1 to 3 gpl depending on the solution temperature. In the Klorigen electrolyzer module headers, the solution volume is such that the total amount of chlorine in the system is only 3 lbs or less.

8. Electrolyzer Cathode Reactions

The reaction occurring at the cell cathode is the reduction of water, producing hydrogen gas (H_2) and hydroxide ions (OH^-) as in reaction (5):

(5) $2H_2O + 2e^- \text{ ---> } H_2 + 2OH^-$

Sodium ions (Na^+) in the anode compartment migrate across the cation membrane to the cathode compartment. Each sodium ion carries with it about 3.5 molecules of water.

The sodium ions and hydroxyl ions (OH^-) form NaOH in the cathode compartment. Softened water is metered into the compartment to dilute and control the concentration of caustic soda in the cathode compartment at about 15%. The caustic soda concentration can be varied between 5 – 20 wt% depending on the amount of soft water that is added. The caustic soda concentration determines the sodium hypochlorite strength in the hypochlorite conversion module.

The hydrogen gas produced is separated from the sodium hydroxide in the caustic head tank and is safely diluted with air to well below the explosive limits. Dual installed air blowers provide the dilution air. The installed spare blower turns on automatically in the event of failure of the operating blower.

9. Hypochlorite Conversion Module

The hypochlorite conversion module pulls the chlorine gas generated in the electrolyzers with a vacuum of about -5 to -20 inches of water. The Cl_2 reacts with a nominal 15% NaOH produced from the electrolyzers to form NaOCl. The reaction between chlorine and NaOH to form sodium hypochlorite (NaOCl) is shown in reaction (6):

(6) $Cl_2 + 2NaOH \text{ ---> } NaOCl + NaCl + H_2O$

The concentration of the sodium hypochlorite solution is determined by the NaOH concentration. If higher strength NaOCl concentrations are required, the NaOH strength can be adjusted in the electrolyzer operation up to about 20 wt% (with a small amount of membrane efficiency loss) or by vacuum evaporating the NaOH to get the desired concentration.

The hypochlorite conversion module uses a pump and eductor to provide the negative pressure to draw the chlorine gas from the electrolyzers and chlorine stripper tank into the hypochlorite module for the reaction with NaOH. The hypochlorite production is continuous, and is controlled using ORP electrodes. The sodium hypochlorite solution product is pumped to the hypochlorite storage tank on level control. A titanium plate and frame heat exchanger is used to remove the heat of reaction between the NaOH and chlorine gas. The hypochlorite heat exchanger uses cooling water to cool the reaction mixture to a temperature below 40°C. For hypochlorite concentrations of 150 gm/L and above, a chilled water supply is required for the hypochlorite module to maintain temperatures at about 20°C.

10. Depleted Brine De-chlorination

The depleted brine from the electrolyzers, which contains dissolved chlorine, is sent to the chlorine stripper tank on the hypo conversion module. HCl is added to the stripper tank to reduce the pH to about 2. The acidified solution is circulated with a pump. A regenerative blower is used to pass air co-current to the solution in order to strip the chlorine. The air stream, containing chlorine, is passed to the hypochlorite tower where it reacts with NaOH to produce bleach.

The chlorine-stripped solution is pumped to the brine dechlorination module.. The chlorine-stripped brine is adjusted to a pH of 10 with NaOH. Sodium bisulfite is added under ORP control to destroy residual chlorine left in the solution. The de-chlorinated brine is then recycled back to the briner for re-saturation. A portion of the depleted brine is purged to control the sodium chlorate ($NaClO_3$) concentration in the brine to a concentration of 30 gm/L or less.

ADDENDUM B.

Equipment Description

A. Electrolyzer Module and Electrolyzers

The purpose of the electrolyzer module is to supply the brine solution to the electrolyzers and remove the chlorine and caustic being produced. The electrolyzers are piped to common horizontal headers. Each electrolyzer will be comprised of up to eight individual cells. Liquid level, temperature, pressure and concentration parameters are controlled by instrumentation located on the electrolyzer module.

B. Receiver Unit incorporating Blower Module

The purpose of the blower module is to supply dilution air to reduce the discharged hydrogen to below the LEL. The blower module consists of two blowers (one is a standby blower) discharging into a common header. The blower motors are controlled by the PLC logic located in the central control panel. The blower piping is fitted with a flow sensor to assure that air is flowing at all times. Should the operating blower fail, the second blower would start to prevent the accumulation of hydrogen. The system will begin a shutdown process soon after the second blower begins to operate.

C. Brine Softener Module

The purpose of the brine purification module is to assure that the brine solution entering the electrolyzers is of a low hardness and is the proper pH. The brine purification module consists of two rubber-lined pressure vessels that contain high selectivity cation exchange resin beds. After adjustment of temperature and pH to optimum values, the brine is directed down flow to each of these columns in series in order to remove Ca/Mg impurities to a level of 20 ppb (part per billion) to ensure good performance of the membrane electrolyzers. The two columns are arranged in series flow so that any "break through" of hardness is captured in the second column, ensuring the integrity of the process. Regeneration of the spent ion exchange resin is done automatically in place with sequential addition of rinse water, HCl, Caustic Soda and Brine. The entire chemical regeneration process is controlled automatically by the PLC. The flow to the regenerated column is then redirected so that the freshly regenerated column is placed in a secondary flow position in the series arrangement. This design ensures that the feed brine to the electrolyzers always sees freshly regenerated resin as just before entry to the electrolyzers.

D. Sodium Hypochlorite Conversion Module

The purpose of the hypochlorite generation module is to allow the chlorine gas and caustic soda produced in the electrolyzers to be mixed under controlled conditions to produce 12.5% sodium hypochlorite. This module is fitted with pumps, tanks, heat exchanger, piping, pH and ORP controls.

E. Transformer/Rectifier

The rectifier feeds direct current to the electrolyzers located on the electrolyzer module. (Changing the current delivered to the electrolyzers changes the amount of chlorine and caustic being produced and ultimately the hypochlorite production. There is a direct relationship between the DC electrical current and chlorine production. The master control panel controls the rectifiers and adjustment of the current is made manually.

F. Master Control Panel

The control panel contains the imbedded logic controller that manages the entire Klorigen system when in the automatic mode. The PLC also allows for manual operation of each piece of equipment. When the control system is in the automatic mode, initiating the start command will allow the system to ramp up to a predetermined production level.

G. Motor Control Center

The MCC houses the motor starters (motor controllers) which supplies electrical power to the electric motors driving the pumps and blowers. Feeder breakers supplying other electrical loads are also located in the MCC. The master control panel controls the motor starters.

The following are not supplied by Electrolytic Technologies as part of this proposal:

H. Brine Dissolver

The brine dissolver ("briner") provides the saturated brine solution, which is pumped to the brine treatment unit and on to the electrolyzers. The briner will be supplied with automatic water level control and brine transfer pump(s).

I. Finished Brine Storage Tank

The finished brine storage tank temporarily stores purified brine following the ion exchange process. Purified brine is pumped from the finished brine tank to the electrolyzer module for electrolysis.

J. Hydrochloric Acid Tank

The hydrochloric acid tank supplies the brine purification units for the regeneration process and the stripper units for brine Ph control.

K. Sodium Bisulfite Tank

The sodium bisulfite tank supplies solution to the stripper units to de-chlorinate the stripped brine prior to it returning to the electrolyzer modules.

L. Sodium Hydroxide Storage Tank

The sodium hydroxide tank provides the additional NaOH required to react all of the generated chlorine into sodium hypochlorite.

Technical Support

Factory-trained technicians can be made available for installation support, if desired. Tasks to be performed as "Installation support" shall include supervision of the physical installation by Customer supplied personnel, interconnection of Klorigen components and final checkout and startup of the installed system. In addition, technical support shall include on-site and/or classroom training, which shall encompass fundamental and "hands-on" instruction in the operation, maintenance, troubleshooting and repair of the system. The cost of on-site technical support will be determined during contract negotiations. See Addendum D for more information on the commissioning process.

Documentation and Submittals

1. P&IDs
2. General Arrangement Drawings
3. Equipment literature
4. Manufacturers' literature
5. Electrical drawings
6. Operation and Maintenance Manual

NOTE: Items 1 thru 5 will be provided in the early phase of the project and will comprise the basis for the initial payment. Remaining documents and submittals will be provided at commissioning and will include "as built" changes to data previously submitted.

Materials of Construction

Process Contents	Pipe Materials and Gaskets Used on Modules Gaskets	 Piping	Isolation Valves	Specialty Valves and Comments
Brine, Hot Brine, Finished Brine, Depleted Brine (pH 10)	TEG*	CPVC	CPVC w/EPDM o-rings	
Depleted Brine (pH 10)	TEG*	CPVC	CPVC w/Viton o-rings	PTFE Diaphragm valve in a specific process location
Depleted Chlorinated Brine (anolyte to chlorine stripper tank, chlorine stripper tank loop)	TEG*	CPVC	PTFE Diaphragm valve and CPVC w/ Viton O-rings	PTFE Diaphragm valves
Chlorine Gas – operated under negative pressure	TEG*	CPVC	CPVC w/ Viton O-rings	PTFE Diaphragm valves
32% HCl	TEG* and 1/2" FEP Tubing	CPVC	CPVC w/Viton o-rings	FEP Tubing used for the metering pumps
Softened Water	TEG*	CPVC/PVC	CPVC w/EPDM o-rings	Inlet water lines may be PVC with PVC valves and EPDM gaskets
Electrolyzer Module Vent (caustic tank)	TEG*	CPVC/PVC	none	PVC to outside
Conversion Module Vent (hypo tower)	TEG*	PVC	none	PVC to outside
Sodium Hypochlorite	TEG*	PVC	PVC w/Viton O-rings	Ball valves are vented
Sodium Bisulfite	TEG* and 1/2" FEP Tubing	CPVC 3/8" FEP Tubing	CPVC w/Viton O-rings	FEP Tubing used for the metering pumps

TEG* - Teflon Envelope Gasket (PTFE with a 1/8" EPDM gasket backing is the main gasket material. Potable water and some other input streams may have EPDM gaskets without the PTFE envelope.

Piping, Module Construction, Connections and Gaskets:

All of the Electrolytic Technologies piping is constructed of NSF 61 approved schedule 80 CPVC and PVC. CPVC is the major construction material for piping. The piping uses flanged and union connections with a minimum of threaded connections.

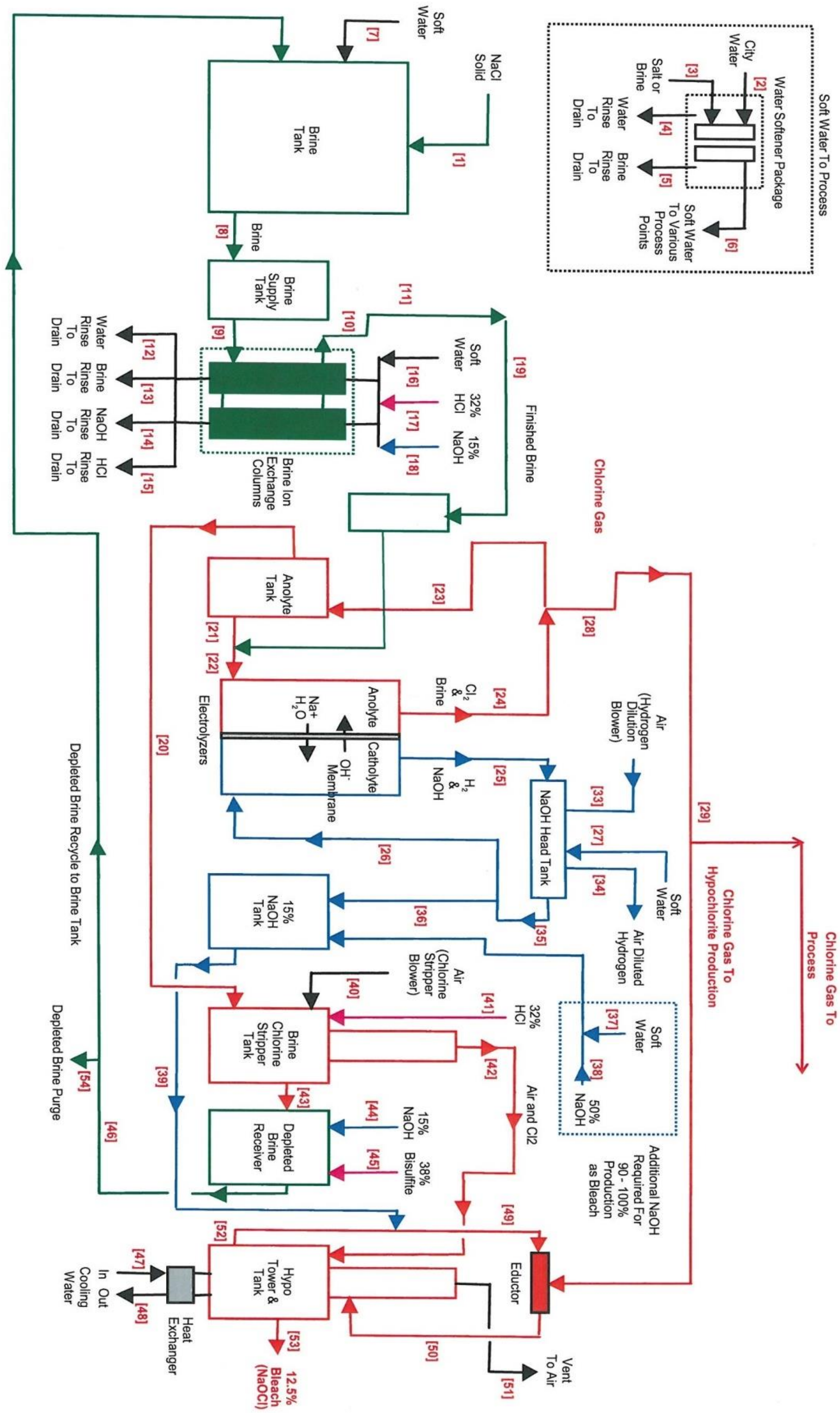
The Caustic head tanks on the electrolyzer modules are constructed of polypropylene. The fittings are either fusion bonded or welded.

The piping section connections are cemented (glued) with manufacturer approved cement (for Corzan brand CPVC and PVC) – IPS Weld On CPVC 724 and Weld On PVC 717 cements. In addition, Electrolytic Technologies does a thermal back weld of all of the cemented joints and connections in the system to reduce the possibility of solution leakage.

Electrolytic Technologies utilizes "TEG"s – Teflon Envelope Gaskets with a 1/8" EPDM rubber gasket backing - in the flanged connections. The Teflon envelope provides the chemical resistance to all of the chemicals used in the process.

ADDENDUM C.

Klorigen™ On-site Sodium Hypochlorite/Chlorine Process Flow Diagram



ADDENDUM D.
FIELD TESTING AND ACCEPTANCE

PART 1 GENERAL

1.01 PRELIMINARY CHECK OUT

A. The following operations are a prerequisite for the field test:
   1. Set, align and assemble all equipment and systems in conformance with the manufacturer's drawings and instructions.
   2. Check direct-coupled shafts with flexible or rigid couplings for parallel and angular misalignment using laser alignment equipment, as applicable. Maximum allowable misalignment in either direction shall be 0.002-inch unless otherwise required by the manufacturer.
   3. Check alignment and realign as necessary after all piping connections to equipment are made.
   4. Check equipment for proper rotation.
   5. Check motor for no-load current draw.
   6. Run the equipment dry if applicable and check equipment for vibration and noise outside of manufacturer's published limits.

1.02 FIELD TESTS OF EQUIPMENT, STRUCTURES AND SYSTEMS

A. Scope of System Testing: System testing is required to demonstrate that the equipment, interconnections and accessories perform as specified. In addition to specific requirements called for in the specific Sections of the Contract Specifications, the following are to be considered a part of all system test procedures.
   1. Variable capacity equipment is to be operated over the full capacity and at a minimum of 3 intermediate points.
   2. Headed and cross-connected groups of units are to be operated using all connecting combinations.
   3. All equipment items, including standby units are to be tested. It may be necessary to repeat systems tests at maximum condition to insure that standby units are included in system tests.
   4. All equipment, interconnecting piping, and accessories are to be checked for leakage and specified rate performance capability. Instrumentation and controls shall be tested as part of the equipment they relate to.

B. Field Tests:
   1. Preliminary Field Tests: These tests shall be made with water and air in lieu of the wastewater components and chemicals for which the equipment and systems are designed.
      a. Preliminary Field Tests of Equipment: Electrolytic Technologies shall prove that equipment and appliances meet their operating cycles and are free from defects such as overheating, overloading, and vibration outside of the manufacturer's specified tolerances or hydraulic institute standards which are most stringent.
      b. Preliminary Field Tests of Systems: Electrolytic Technologies shall prove that all equipment and appurtenances of each system are properly installed, free from defects. Meet their specified operating cycles and characteristics when operating as part of the system.
   2. Final Field Tests: These tests shall utilize all components, chemicals and air for which the equipment and Klorigen system are designed.

a. Final Field Tests of Equipment: Shall prove that equipment and appliances meet their operating cycles and are free from defects such as overheating, overloading and undue vibration.
b. Final Field Tests of Systems: Shall prove that all equipment and appurtenances of each system are properly installed free from defects, meet their specified operating cycles and characteristics when operating as part of the system.
c. Operate the equipment as a unit with all related piping, valves, ducting, electrical controls, instrumentation and mechanical operation.

3. Electrolytic Technologies' Responsibilities
   a. Prepare and submit testing schedule.
   b. Prepare and submit Test Procedures and Manpower Schedule for all equipment items and systems.
   c. Coordinate with customer and/or Owner representative.
   d. Furnish all labor, unskilled and skilled, necessary for testing.
   e. Ensure the presence of all manufacturers' representative(s).
   f. Conduct tests.
   g. Prepare and submit Test Reports.

4. Customers Responsibilities
   a. Review and approve Testing Schedules.
   b Review and approve Test Procedures
   c. Witness all tests.
   d. Certify Test results
   e. Review Test Reports
   f. Approve Test results.
   g. Provide lubricants, fuel and chemical as required for testing.
   h. Provide power, water and other process materials, plant and instrument air, as required for testing performance.
   i. Provide personnel as required for training.

5. Conduct of Tests: Electrolytic Technologies shall conduct the tests and be responsible for all operational decisions associated with the system.

6. Presence of Electrolytic Technologies' Representative(s): This is a prerequisite for the tests. No test shall be performed in the absence of the Electrolytic Technologies' Representative, who shall ensure availability for the entire duration of the test.

7. Field Test Reports: Test report forms will be prepared by the customers Engineer for the preliminary and final tests. These forms shall be used by the Electrolytic Technologies' Representative for data recording and notes during the tests. When the tests have been completed and accepted by the Engineer, the Electrolytic Technologies' Representative shall sign the Test Report; the witnessing Engineer will initial the report and take it with him/her for an analysis of the test data.

PART 2 - EXECUTION

2.01 PRELIMINARY FIELD TESTS

A. Preliminary Field Tests of Equipment: A successful test shall consist of at least one continuous hour, or longer if so specified, of trouble free operation.

B. Preliminary Field Tests of System:

1. Test all systems by operating the systems equipment together as a unit with all related piping, valves, electrical controls and mechanical operations.
2. For a successful test, run each system with water and air trouble free for four continuous hours.

2.02 FINAL FIELD TESTS AND ACCEPTANCE

A. Final Field Tests of the System: Test all systems by operating the equipment as a complete unit inclusive of all related piping, valves, ducting, electrical controls, instrumentation and mechanical operation. For a successful test, the Klorigen system shall run trouble free for a minimum of three (3) consecutive days, during which at least 12 continuous hours shall be at maximum designed capacity.

B. Acceptance: Completion of operations in accordance with Section 2.02, paragraph A. above shall be sufficient for release of any and all outstanding funds held by customer or customer's bank and due Electrolytic Technologies, excluding 5% retainer. Deficiencies associated with work conducted by others shall not prevent release of outstanding funds due Electrolytic Technologies.

ADDENDUM E.
SALT SPECIFICATIONS

Suitable salt procurement is the responsibility of others. Pre-treatment to establish brine purity of equal or better quality will be the sole responsibility of the end-user. Deviation from these specifications may void manufacturer's warranty.

Food grade salt is high purity, granulated sodium chloride produced in vacuum pans from chemically purified brine. The crystals are cubic in structure. Brine treatment, crystallizing technique, and post-crystallizing washing substantially reduce calcium, magnesium, iron, copper and other heavy metals, sulfate and carbonate impurities. High purity helps assure consistent saltiness intensity, and there are stringent standards on visible, insoluble extraneous material. There are no additives.

	Typical	Maximum
[1]Sodium Chloride (%)	99.98	>99.95
Sulfate (%)	0.01	<0.02
Ca/Mg as Ca (ppm)	12.00	<60
Insolubles (ppm)	-	<20.0
Moisture (%)	-	<0.1
Copper (ppm)	0.00	<0.2
Iron (ppm) Free	0.2	<0.7

1 By difference of impurities, moisture-free basis (ASTM procedures).

ADDENDUM F.
STANDARD WARRANTY

Electrolytic Technologies LLC (Electrolytic Technologies) warrants the equipment of its manufacture to be free from defects in workmanship and materials. Electrolytic Technologies also warrants that when installed and operated according to Electrolytic Technologies' written instructions, equipment and components will perform as specified for the following period of time:

System—Guaranteed for a period of eighteen (18) months from date of shipment or one year from first date of operation, whichever first occurs. "System" includes transformer/rectifier, piping, valves, motors, peripheral monitoring and salt handling equipment. Components not included in the above interval are:

- Anodes - Guaranteed for a period of five (5) years of operation on a pro-rata basis, Replacements shall be warranted for two (2) years thereafter on a straight-line pro-rata basis.
- Membrane - Guaranteed for a period of two (2) years of operation on a pro-rata basis. Replacements shall be warranted for one (1) year thereafter on a straight-line pro-rata basis.
- Operating supplies and consumables – such as filter elements, pH and ORP probes, replaceable fuses, indicators, parts made of glass, plastic or rubber, testing chemicals, gaskets, seals and sealants used during normal course of operation and maintenance.

Where equipment sold hereunder is used with attachments and/or modifications that were not recommended by, or have not been approved by Electrolytic Technologies in writing, such use shall not be considered normal and said warranty shall not apply.

Electrolytic Technologies' liability is limited to the supply or repair of defective parts returned, freight prepaid by buyer, to a location specified by Electrolytic Technologies. Repaired parts shall be returned to buyer free on board (f.o.b.) shipping point. On-site labor shall be the responsibility of the buyer. When circumstances permit, Electrolytic Technologies will invoke for the benefit of the buyer, the guarantee or warranty of Electrolytic Technologies' vendor for equipment or materials furnished but not manufactured by Electrolytic Technologies.

This warranty does not extend to and Electrolytic Technologies assumes no liability for consequential and/or secondary damages or losses of any kind (including but not limited to depreciation, damage in transit, lightening, water neglect, misuse or negligent action or omission, inadequate storage or other conditions due to circumstances by Electrolytic Technologies' control) or sustained directly or indirectly as a result of a defect in any equipment, material or installation or if repaired/modified/tampered without Electrolytic Technologies' prior written permission. Electrolytic Technologies shall in no event be liable in an amount exceeding the purchase price of the equipment.

Electrolytic Technologies makes no warranties regarding equipment manufactured by it or others (including without limitation, warranties as to merchantability and fitness for a purpose), either expressed or implied, except as provided herein. The foregoing shall constitute the exclusive remedies of purchaser for any breach by seller of its warranties herein.

Disclaimer of Warranties
Electrolytic Technologies LLC shall not under any circumstances be liable for any incidental or consequential damages arising from loss, damage to property, personal injury or other damage or losses owing to the failure of Electrolytic Technologies' products. The liability of Electrolytic Technologies LLC is limited as set forth above to the cost of repair or replacement of defective products within the time period set forth above. This warranty is made in lieu of all other warranties, either expressed or implied, whether of fitness for a particular purpose or merchantability, whether oral or written.

QUOTATION

PROCESS EQUIPMENT COMPANY
2635 Pine Street Boulder, CO 80302
TEL (303) 449-5702 FAX (303) 444-5093
CELL (303) 548-2416 • (303) 548-2517
(888) 279-7964
e-mail: info@pecboulder.com

Project: **Amec FW / Industrial Water Treatment Bedrock, CO/FRP Tanks / DTI PEC**

Your Inquiry #:
Our Proj Ref #: **12104**
Our Qte Ref #: **12007**
Manf Qte Ref #:
Quote Date: **9/8/2016**
Terms: **10% Order / 30% Drwgs / 60%**
FOB: **FOB Factory**
Approval Drawings: **2-3 WEEKS**
Ship After Approval: **7-8 WEEKS**
Ship After Order:
Quote Duration: Days

TO:
Hallie Beven Simpson
Amec Foster Wheeler
PO Box 3781
Telluride, CO 81435

Tel:
Fax:

Comments:

SPEC REF:

PART #	QUAN / WT EACH	DESCRIPTION	EACH	EXTENSION
T-HYPO-1A/B	2 0	Chemical Environment: 12.5% Sodium Hypochlorite Specific Gravity / Max Temperature: 1.3 / 110°F Corrosion Barrier: Vinyl Ester with Nexus Liner Structural Wall & Exterior: Vinyl Ester Pressure / Vacuum: Atmospheric Wind / Seismic: NA / IBC: Ss=0.194, Site Class=D, IMP Factor =1.25 Design / Specification: Fabricated to meet applicable sections of ASTM D-3299	0.00	
T-HYPO-1A/B	2 0	FBFT-10'-0" dia. X 8'-6" ht. 4,939 gallon vertical fiberglass tank/flat bottom/reinforced flat top/with the following accessories: 1.0 Pigmented (white) exterior with UV inhibitors 1.0 Post cure and rinse 7.0 2" conical gusseted flanges with (6) blind flanges/Type 304 SS bolting and (6) Viton gaskets 1.0 3" conical gusseted flange 3.0 8" non-gusseted flanges 1.0 12" non-gusseted flange with blind flange/Type 304 SS bolting and Viton gasket 1.0 24" top manway with bolt down cover/Type 304 SS bolting and Viton gasket 4.0 Type 304 SS heavy duty lift lugs 1.0 8" FRP load ledge with (4) Type 304 SS hold down dogs 1.0 Epoxy coated CS agitator support 1.0 Resin Surcharge**	19472.40	38,944.80

Total Wt {lbs}: 0 **Frt Ret #:** **Ship Via:**

TOTAL **$97,059.60**

Accepted in full by ______________________ **(signature)**

______________________ **(print name)**

date signed ______________________

SALES TAXES NOT INCLUDED. SUBJECT TO TERMS AND CONDITIONS IN EFFECT AT TIME OF SALE. FREIGHT, IF SHOWN, IS BEST ESTIMATE ONLY.

TOTAL NET PRICE. FOB Factory **$97,059.60**

FREIGHT ESTIMATE (Not Included in Total) **$8,129.00**

By ______________________

Mollie DeBolt
SALES REPRESENTATIVE

PROCESS EQUIPMENT COMPANY

QUOTATION

2635 Pine Street Boulder, CO 80302
TEL (303) 449-5702 FAX (303) 444-5093
CELL (303) 548-2416 • (303) 548-2517
(888) 279-7964
e-mail: info@pecboulder.com

Project: **Amec FW / Industrial Water Treatment Bedrock, CO/FRP Tanks / DTI PEC**

Your Inquiry #:
Our Proj Ref #: **12104**
Our Qte Ref #: **12007**
Manf Qte Ref #:
Quote Date: **9/8/2016**
Terms: **10% Order / 30% Drwgs / 60%**
FOB: **FOB Factory**
Approval Drawings: **2-3 WEEKS**
Ship After Approval: **7-8 WEEKS**
Ship After Order:
Quote Duration: Days

TO:
Hallie Beven Simpson
Amec Foster Wheeler
PO Box 3781
Telluride, CO 81435

Tel:
Fax:

Comments:

SPEC REF:

PART #	QUAN / WT EACH	DESCRIPTION	EACH	EXTENSION
T-DECHLOR-2	1 0	Chemical Environment: 38% Sodium Bisulfite Specific Gravity / Max Temperature: 1.3 / 110°F Corrosion Barrier: Vinyl Ester Structural Wall & Exterior: Vinyl Ester Pressure / Vacuum: Atmospheric Wind / Seismic: NA / IBC: Ss=0.194, Site Class=D, IMP Factor =1.25 Design / Specification: Fabricated to meet applicable sections of ASTM D-4097	0.00	
T-DECHLOR-2	1 0	FBFT-90" dia. X 94" ht. 2,536 gallon vertical fiberglass tank/flat bottom/flat top/with the following accessories: 1.0 Pigmented (white) exterior with UV inhibitors 1.0 Post cure and rinse 5.0 2" conical gusseted flanges with (4) blind flanges/Type 304 SS bolting and (4) EPDM gaskets 1.0 3" conical gusseted flange 2.0 8" non-gusseted flanges 1.0 12" non-gusseted flange with blind flange/Type 304 SS bolting and EPDM gasket 1.0 24" top manway with bolt down cover/Type 304 SS bolting and EPDM gasket 4.0 Type 304 SS heavy duty lift lugs 4.0 Type 304 SS heavy duty hold down lugs with 7/8" mounting hole (seismic rated 2,000# each) 1.0 Epoxy coated CS agitator support 1.0 Resin Surcharge**	12188.40	12,188.40
T-COAG-3	1 0	Chemical Environment: 40% Ferric Chloride Specific Gravity / Max Temperature: 1.3 / 110°F Corrosion Barrier: Vinyl Ester Structural Wall & Exterior: Vinyl Ester Pressure / Vacuum: Atmospheric Wind / Seismic: NA / IBC: Ss=0.194, Site Class=D, IMP Factor =1.25 Design / Specification: Fabricated to meet applicable sections of ASTM D-4097	0.00	
T-COAG-3	1 0	FBFT-90" dia. X 94" ht. 2,536 gallon vertical fiberglass tank/flat bottom/flat top/with the following accessories: 1.0 Pigmented (white) exterior with UV inhibitors 1.0 Post cure and rinse 5.0 2" conical gusseted flanges with (4) blind flanges/Type 304 SS bolting and (4) EPDM gaskets 1.0 3" conical gusseted flange 2.0 8" non-gusseted flanges 1.0 12" non-gusseted flange with blind flange/Type 304 SS bolting and EPDM gasket 1.0 24" top manway with bolt down cover/Type 304 SS bolting and EPDM gasket 4.0 Type 304 SS heavy duty lift lugs 4.0 Type 304 SS heavy duty hold down lugs with 7/8" mounting hole (seismic rated 2,000# each) 1.0 Epoxy coated CS agitator support 1.0 Resin Surcharge**	12188.40	12,188.40

QUOTATION

PROCESS EQUIPMENT COMPANY
2635 Pine Street Boulder, CO 80302
TEL (303) 449-5702 FAX (303) 444-5093
CELL (303) 548-2416 • (303) 548-2517
(888) 279-7964
e-mail: info@pecboulder.com

Project: **Amec FW / Industrial Water Treatment Bedrock, CO/FRP Tanks / DTI PEC**

Your Inquiry #:
Our Proj Ref #: **12104**
Our Qte Ref #: **12007**
Manf Qte Ref #:
Quote Date: **9/8/2016**
Terms: **10% Order / 30% Drwgs / 60%**
FOB: **FOB Factory**
Approval Drawings: **2-3 WEEKS**
Ship After Approval: **7-8 WEEKS**
Ship After Order:
Quote Duration: Days

TO:
Hallie Beven Simpson
Amec Foster Wheeler
PO Box 3781
Telluride, CO 81435

Tel:
Fax:

Comments:

SPEC REF:

PART #	QUAN / WT EACH	DESCRIPTION	EACH	EXTENSION
T-NEUT-4	1 0	Chemical Environment: 50% Sodium Hydroxide Specific Gravity / Max Temperature: 1.6 / 110°F Corrosion Barrier: Vinyl Ester with Nexus Liner Structural Wall & Exterior: Vinyl Ester Pressure / Vacuum: Atmospheric Wind / Seismic: NA / IBC: Ss=0.194, Site Class=D, IMP Factor =1.25 Design / Specification: Fabricated to meet applicable sections of ASTM D-3299	0.00	
T-NEUT-4	1 0	FBFT-12'-0" dia. X 11'-2" ht. 9,438 gallon vertical fiberglass tank/flat bottom/reinforced flat top/with the following accessories: 1.0 Pigmented (white) exterior with UV inhibitors 1.0 Post cure and rinse 6.0 2" conical gusseted flanges with (5) blind flanges/Type 304 SS bolting and (5) EPDM gaskets 1.0 3" conical gusseted flange 2.0 8" non-gusseted flanges 1.0 12" non-gusseted flange with blind flange/Type 304 SS bolting and EPDM gasket 1.0 24" top manway with bolt down cover/Type 304 SS bolting and EPDM gasket 4.0 Type 304 SS heavy duty lift lugs 1.0 8" FRP load ledge with (4) Type 304 SS hold down dogs 1.0 Epoxy coated CS agitator support 1.0 Resin Surcharge**	17666.40	17,666.40
T-FBT-5	1 0	Chemical Environment: Brine Water Specific Gravity / Max Temperature: 1.3 / 110°F Corrosion Barrier: Vinyl Ester Structural Wall & Exterior: Vinyl Ester Pressure / Vacuum: Atmospheric Wind / Seismic: NA / IBC: Ss=0.194, Site Class=D, IMP Factor =1.25 Design / Specification: Fabricated to meet applicable sections of ASTM D-4097	0.00	
T-FBT-5	1 0	FBDT-90" dia. X 135" ht. 3,484 gallon vertical fiberglass tank/flat bottom/dome top/with the following accessories: 1.0 Pigmented (white) exterior with UV inhibitors 1.0 Post cure and rinse 6.0 2" conical gusseted flanges with (5) blind flanges/Type 304 SS bolting and (5) EPDM gaskets 2.0 3" conical gusseted flanges 1.0 8" non-gusseted flange 1.0 12" non-gusseted flange with blind flange/Type 304 SS bolting and EPDM gasket 1.0 24" top manway with bolt down cover/Type 304 SS bolting and EPDM gasket 1.0 4.0 Type 304 SS heavy duty lift lugs 8.0 Type 304 SS heavy duty hold down lugs with 7/8" mounting hole (seismic rated 2,000# each) 1.0 Epoxy coated CS ladder 1.0 Epoxy coated CS agitator support 1.0 Resin Surcharge**	16071.60	16,071.60

Quotation

NOV Process & Flow Technologies US, Inc.
Chemineer™ | Kenics™
5870 Poe Avenue
P.O. Box 1123
Dayton, OH 45401-1123
Phone: (937) 454-3200
Fax: (937) 454-3379
E-mail: ChemineerSales@nov.com

Representative:

Attn:

Quotation Number: 244RPEC16

Date Issued: 8/31/2016

Customer:
Hallie Beven Simpson
Amec Foster Wheeler

Terms: Net 30 Days
Warranty: Standard

FOB: Dayton
Freight: P.P.A.
Ship Via: Best Way

Item	Name	Description	Unit	Qty	Extended
1	M-01A/B-1 Oxidation Tank Mixer	CHEMINEER AGITATOR Model: 21GTD-2 Ref: M-01A/B-1 Oxidation Tank Mixer / Oxidation Tank Mixer	$10,815	2	$21,631
2	M-02-1 Dechlorination Mixer	CHEMINEER AGITATOR Model: 21GTD-2 Ref: M-02-1 Dechlorination Mixer / Dechlorination Mixer	$10,043	1	$10,043
3	M-03-1 Coag/Flocc Mixer	CHEMINEER AGITATOR Model: 21GTD-1.5 Ref: M-03-1 Coag/Flocc Mixer / Coag/Flocc	$10,021	1	$10,021
4	M-04-1 Neutralization Mixer	CHEMINEER AGITATOR Model: 21GTD-3 Ref: M-04-1 Neutralization Mixer / Mixer A	$12,120	1	$12,120
5	M-05-1 Finished Brine Tank	CHEMINEER AGITATOR Model: 21GTD-2 Ref: M-05-1 Finished Brine Tank / Finished Brine Mixer	$10,346	1	$10,346
				TOTAL	$64,160

Currency: USD **Shipment:** 13 Weeks ARO **(Negotiated)**

Please issue purchase order to 'NOV Process & Flow Technologies US, Inc.'

Notes:

NOV accepts no responsibility for the compatibility of its products and the materials used in the construction thereof with Customer’s process. Compatibility of the products and materials with Customer’s process shall be determined by Customer, and NOV disclaims all liability concerning compatibility.

NOV PROCESS & FLOW TECHNOLOGIES US, INC. AND ITS AFFILIATES TERMS AND CONDITIONS FOR THE PROVISION OF EQUIPMENT, PARTS, SERVICES, OR RENTAL APPLY TO THIS QUOTE.

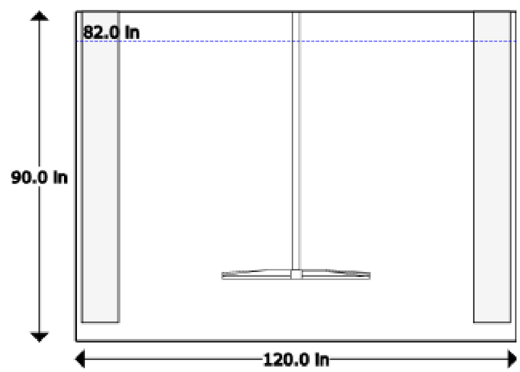
CHEMINEER™ AGITATOR DATASHEET

Mixer Ref:	**M-01A/B-1 Oxidation Tank Mixer / Oxidation Tank Mixer**
Printed By:	**MMILES 31-Aug-2016 03:11PM**
Software:	**CEDS.NET AgSolver 0.5.5.152**

Model No.:	**21GTD-2**	Shipping Weight:	**577.1 lb**
Type of Application:	**Unspecified**	Design Conditions:	**0.0 PSIG at 72.0 °F**
Industry:	**Unspecified**	Hazardous Area:	**No**

TANK DETAILS

Tank Configuration:	**Cylindrical**
Tank Size:	**120.0 in dia.**
Straight Side:	**90.0 in**
Top Shape:	**Flat**
Bottom Shape:	**Flat**
No. Baffles:	**(3) @ 120°**
Baffles Width:	**10.0 in**
Baffles Wall Clearance:	**1.7 in**
Baffles Height:	**85.0 in**
Agitator Orientation:	**Vertical, on-center**
Agit. Mounting Surface:	**Flat Structure or Beams**
Agit. Mounting Height:	**12.0 in above tank top**



DRIVE CONFIGURATION

Type and Options:	**Gear Drive; Nominal Speed: 84 RPM; Rotation Direction: Clockwise; Paint: Sherwin-Williams Polane HS Plus**
Motor:	**Power: 2 HP; Speed: 1800 RPM; Frame: NEMA 145TC; Supply: AC; Voltage: 230/460V; Phase: 3 Ph; Frequency: 60 Hz; Efficiency: Premium; Service Duty: Severe; Enclosure: TEFC; Service Factor: 1.15+; Max. Ambient: 104.0 °F; Mounting: CFACE**
Gearbox:	**Type: Chemineer 20GT; Size: #21; Lubricant: Oil (R&O); Dipstick: Yes; Service Rating: Class III**
Shaft-Tank Seal:	**None**
Drive Mounting:	**Type: Foot Mount**

WETTED PARTS CONFIGURATION

Shaft Diameter:	**2 in**	Material:	**Steel**
Fasteners:	**Lock-washer and nut**	Finish:	**NatR coated**

Station:	Location from Mounting:	Diameter:	Pumping Direction:	Options:
Impeller, XE-3	**85.0 in**	**40.00 in**	**Down**	**Hub Attachment: Welded to shaft; Blade Attachment: Bolted to hub**

PROCESS DATA

Process Stage:	Level:	Volume:	Pressure:	Temp.:	Viscosity:	SG:
Stage 1	**82.0 in**	**4,015 gal**	**0.0 PSIG**	**72.0 °F**	**1.0 cp**	**1**

MIXER PERFORMANCE

Process Stage:	ChemScale:	Pumping:	Blend Time:	Uniformity:	G-Value:	Flow:
Stage 1	**4.01**	**10,956 gpm**	**68 s**	**99%**		**Turbulent**

EQUIPMENT MOUNTING LOADS

Static Weight:	**427.1 lb**
Bending Moment:	**685 ft·lb**
Torque Reaction:	**346 ft·lb**

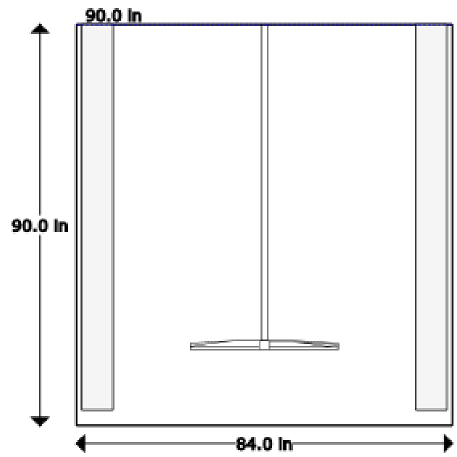
CHEMINEER™ AGITATOR DATASHEET

Mixer Ref:	**M-02-1 Dechlorination Mixer / Dechlorination Mixer**
Printed By:	**MMILES 31-Aug-2016 03:11PM**
Software:	**CEDS.NET AgSolver 0.5.5.152**

Model No.:	**21GTD-2**	Shipping Weight:	**520.4 lb**
Type of Application:	**Unspecified**	Design Conditions:	**0.0 PSIG at 72.0 °F**
Industry:	**Unspecified**	Hazardous Area:	**No**

TANK DETAILS

Tank Configuration:	**Cylindrical**
Tank Size:	**84.0 in dia.**
Straight Side:	**90.0 in**
Top Shape:	**Flat**
Bottom Shape:	**Flat**
No. Baffles:	**(3) @ 120°**
Baffles Width:	**7.0 in**
Baffles Wall Clearance:	**1.2 in**
Baffles Height:	**86.5 in**
Agitator Orientation:	**Vertical, on-center**
Agit. Mounting Surface:	**Flat Structure or Beams**
Agit. Mounting Height:	**12.0 in above tank top**



DRIVE CONFIGURATION

Type and Options:	**Gear Drive; Nominal Speed: 84 RPM; Rotation Direction: Clockwise; Paint: Sherwin-Williams Polane HS Plus**
Motor:	**Power: 2 HP; Speed: 1800 RPM; Frame: NEMA 145TC; Supply: AC; Voltage: 230/460V; Phase: 3 Ph; Frequency: 60 Hz; Efficiency: Premium; Service Duty: Severe; Enclosure: TEFC; Service Factor: 1.15+; Max. Ambient: 104.0 °F; Mounting: CFACE**
Gearbox:	**Type: Chemineer 20GT; Size: #21; Lubricant: Oil (R&O); Dipstick: Yes; Service Rating: Class III**
Shaft-Tank Seal:	**None**
Drive Mounting:	**Type: Foot Mount**

WETTED PARTS CONFIGURATION

Shaft Diameter:	**1.5 in**	Material:	**Steel**
Fasteners:	**Lock-washer and nut**	Finish:	**NatR coated**

Station:	Location from Mounting:	Diameter:	Pumping Direction:	Options:
Impeller, XE-3	**85.0 in**	**33.00 in**	**Down**	**Hub Attachment: Welded to shaft; Blade Attachment: Welded to hub**

PROCESS DATA

Process Stage:	Level:	Volume:	Pressure:	Temp.:	Viscosity:	SG:
Stage 1	**90.0 in**	**2,159 gal**	**0.0 PSIG**	**72.0 °F**	**1.0 cp**	**1**

MIXER PERFORMANCE

Process Stage:	ChemScale:	Pumping:	Blend Time:	Uniformity:	G-Value:	Flow:
Stage 1	**3.13**	**5,667 gpm**	**65 s**	**99%**		**Turbulent**

EQUIPMENT MOUNTING LOADS

Static Weight:	**370.4 lb**
Bending Moment:	**164 ft·lb**
Torque Reaction:	**346 ft·lb**

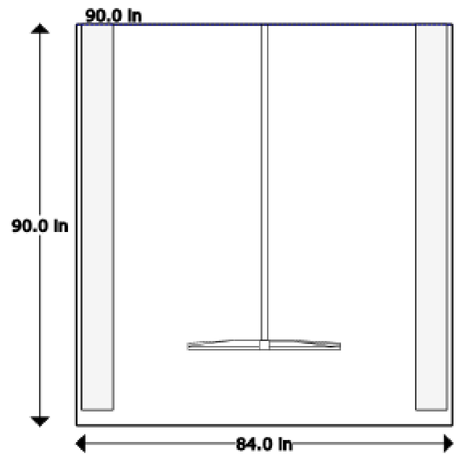
CHEMINEER™ AGITATOR DATASHEET

Mixer Ref:	**M-03-1 Coag/Flocc Mixer / Coag/Flocc**
Printed By:	**MMILES 31-Aug-2016 03:11PM**
Software:	**CEDS.NET AgSolver 0.5.5.152**

Model No.:	**21GTD-1.5**	Shipping Weight:	**520.6 lb**
Type of Application:	**Unspecified**	Design Conditions:	**0.0 PSIG at 72.0 °F**
Industry:	**Unspecified**	Hazardous Area:	**No**

TANK DETAILS

Tank Configuration:	**Cylindrical**
Tank Size:	**84.0 in dia.**
Straight Side:	**90.0 in**
Top Shape:	**Flat**
Bottom Shape:	**Flat**
No. Baffles:	**(3) @ 120°**
Baffles Width:	**7.0 in**
Baffles Wall Clearance:	**1.2 in**
Baffles Height:	**86.5 in**
Agitator Orientation:	**Vertical, on-center**
Agit. Mounting Surface:	**Flat Structure or Beams**
Agit. Mounting Height:	**12.0 in above tank top**



DRIVE CONFIGURATION

Type and Options:	**Gear Drive; Nominal Speed: 45 RPM; Rotation Direction: Clockwise; Paint: Sherwin-Williams Polane HS Plus**
Motor:	**Power: 1.5 HP; Speed: 1800 RPM; Frame: NEMA 145TC; Supply: AC; Voltage: 230/460V; Phase: 3 Ph; Frequency: 60 Hz; Efficiency: Premium; Service Duty: Severe; Enclosure: TEFC; Service Factor: 1.15+; Max. Ambient: 104.0 °F; Mounting: CFACE**
Gearbox:	**Type: Chemineer 20GT; Size: #21; Lubricant: Oil (R&O); Dipstick: Yes; Service Rating: Class III**
Shaft-Tank Seal:	**None**
Drive Mounting:	**Type: Foot Mount**

WETTED PARTS CONFIGURATION

Shaft Diameter:	**1.5 in**	Material:	**Steel**
Fasteners:	**Lock-washer and nut**	Finish:	**NatR coated**

Station:	Location from Mounting:	Diameter:	Pumping Direction:	Options:
Impeller, XE-3	**85.0 in**	**34.00 in**	**Down**	**Hub Attachment: Welded to shaft; Blade Attachment: Bolted to hub**

PROCESS DATA

Process Stage:	Level:	Volume:	Pressure:	Temp.:	Viscosity:	SG:
Stage 1	**90.0 in**	**2,159 gal**	**0.0 PSIG**	**72.0 °F**	**1.0 cp**	**1**

MIXER PERFORMANCE

Process Stage:	ChemScale:	Pumping:	Blend Time:	Uniformity:	G-Value:	Flow:
Stage 1	**2.11**	**3,824 gpm**	**98 s**	**99%**		**Turbulent**

EQUIPMENT MOUNTING LOADS

Static Weight:	**370.6 lb**
Bending Moment:	**159 ft·lb**
Torque Reaction:	**414 ft·lb**

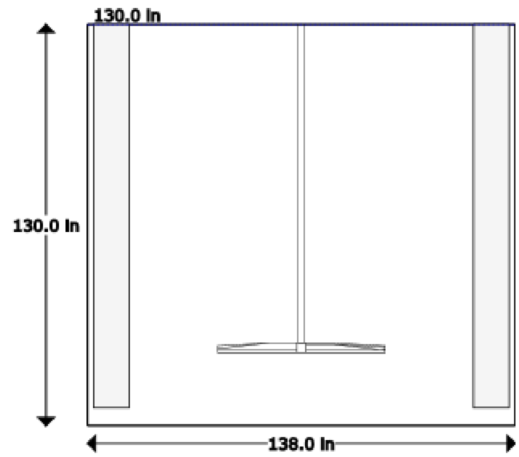
CHEMINEER™ AGITATOR DATASHEET

Mixer Ref:	**M-04-1 Neutralization Mixer / Neutralization Mixer**
Printed By:	**MMILES 31-Aug-2016 03:12PM**
Software:	**CEDS.NET AgSolver 0.5.5.152**

Model No.:	**21GTD-3**	Shipping Weight:	**673.7 lb**
Type of Application:	**Unspecified**	Design Conditions:	**0.0 PSIG at 72.0 °F**
Industry:	**Unspecified**	Hazardous Area:	**No**

TANK DETAILS

Tank Configuration:	**Cylindrical**
Tank Size:	**138.0 in dia.**
Straight Side:	**130.0 in**
Top Shape:	**Flat**
Bottom Shape:	**Flat**
No. Baffles:	**(3) @ 120°**
Baffles Width:	**11.5 in**
Baffles Wall Clearance:	**1.9 in**
Baffles Height:	**124.3 in**
Agitator Orientation:	**Vertical, on-center**
Agit. Mounting Surface:	**Flat Structure or Beams**
Agit. Mounting Height:	**12.0 in above tank top**



DRIVE CONFIGURATION

Type and Options:	**Gear Drive; Nominal Speed: 68 RPM; Rotation Direction: Clockwise; Paint: Sherwin-Williams Polane HS Plus**
Motor:	**Power: 3 HP; Speed: 1800 RPM; Frame: NEMA 182TC; Supply: AC; Voltage: 230/460V; Phase: 3 Ph; Frequency: 60 Hz; Efficiency: Premium; Service Duty: Severe; Enclosure: TEFC; Service Factor: 1.15+; Max. Ambient: 104.0 °F; Mounting: CFACE**
Gearbox:	**Type: Chemineer 20GT; Size: #21; Lubricant: Oil (R&O); Dipstick: Yes; Service Rating: Class III**
Shaft-Tank Seal:	**None**
Drive Mounting:	**Type: Foot Mount**

WETTED PARTS CONFIGURATION

Shaft Diameter:	**2 in**	Material:	**Steel**
Fasteners:	**Lock-washer and nut**	Finish:	**NatR coated**

Station:	Location from Mounting:	Diameter:	Pumping Direction:	Options:
Impeller, XE-3	**118.3 in**	**54.00 in**	**Down**	**Hub Attachment: Welded to shaft; Blade Attachment: Bolted to hub**

PROCESS DATA

Process Stage:	Level:	Volume:	Pressure:	Temp.:	Viscosity:	SG:
Stage 1	**130.0 in**	**8,417 gal**	**0.0 PSIG**	**72.0 °F**	**1.0 cp**	**1**

MIXER PERFORMANCE

Process Stage:	ChemScale:	Pumping:	Blend Time:	Uniformity:	G-Value:	Flow:
Stage 1	**4.57**	**20,480 gpm**	**75 s**	**99%**		**Turbulent**

EQUIPMENT MOUNTING LOADS

Static Weight:	**523.7 lb**
Bending Moment:	**564 ft·lb**
Torque Reaction:	**630 ft·lb**

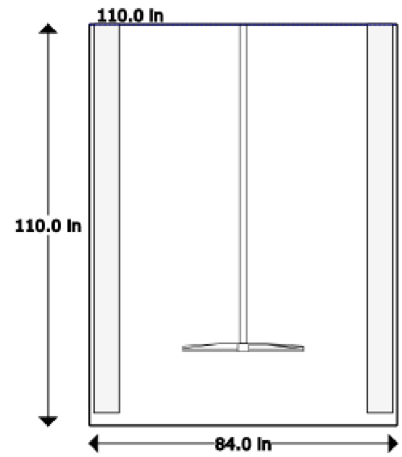
CHEMINEER™ AGITATOR DATASHEET

Mixer Ref:	**M-05-1 Finished Brine Tank / Finished Brine Mixer**
Printed By:	**MMILES 31-Aug-2016 03:12PM**
Software:	**CEDS.NET AgSolver 0.5.5.152**

Model No.:	**21GTD-2**	Shipping Weight:	**568.7 lb**
Type of Application:	**Unspecified**	Design Conditions:	**0.0 PSIG at 72.0 °F**
Industry:	**Unspecified**	Hazardous Area:	**No**

TANK DETAILS

Tank Configuration:	**Cylindrical**
Tank Size:	**84.0 in dia.**
Straight Side:	**110.0 in**
Top Shape:	**Flat**
Bottom Shape:	**Flat**
No. Baffles:	**(3) @ 120°**
Baffles Width:	**7.0 in**
Baffles Wall Clearance:	**1.2 in**
Baffles Height:	**106.5 in**
Agitator Orientation:	**Vertical, on-center**
Agit. Mounting Surface:	**Flat Structure or Beams**
Agit. Mounting Height:	**12.0 in above tank top**



DRIVE CONFIGURATION

Type and Options:	**Gear Drive; Nominal Speed: 100 RPM; Rotation Direction: Clockwise; Paint: Sherwin-Williams Polane HS Plus**
Motor:	**Power: 2 HP; Speed: 1800 RPM; Frame: NEMA 145TC; Supply: AC; Voltage: 230/460V; Phase: 3 Ph; Frequency: 60 Hz; Efficiency: Premium; Service Duty: Severe; Enclosure: TEFC; Service Factor: 1.15+; Max. Ambient: 104.0 °F; Mounting: CFACE**
Gearbox:	**Type: Chemineer 20GT; Size: #21; Lubricant: Oil (R&O); Dipstick: Yes; Service Rating: Class III**
Shaft-Tank Seal:	**None**
Drive Mounting:	**Type: Foot Mount**

WETTED PARTS CONFIGURATION

Shaft Diameter:	**2 in**	Material:	**Steel**
Fasteners:	**Lock-washer and nut**	Finish:	**NatR coated**

Station:	Location from Mounting:	Diameter:	Pumping Direction:	Options:
Impeller, XE-3	**101.7 in**	**33.00 in**	**Down**	**Hub Attachment: Welded to shaft; Blade Attachment: Bolted to hub**

PROCESS DATA

Process Stage:	Level:	Volume:	Pressure:	Temp.:	Viscosity:	SG:
Stage 1	**110.0 in**	**2,639 gal**	**0.0 PSIG**	**72.0 °F**	**1.0 cp**	**1**

MIXER PERFORMANCE

Process Stage:	ChemScale:	Pumping:	Blend Time:	Uniformity:	G-Value:	Flow:
Stage 1	**3.78**	**7,808 gpm**	**52 s**	**99%**		**Turbulent**

EQUIPMENT MOUNTING LOADS

Static Weight:	**418.7 lb**
Bending Moment:	**207 ft·lb**
Torque Reaction:	**251 ft·lb**

September 1, 2016

Hallie Bevan Simpson
Amec Foster Wheeler
PO Box 3781
Telluride, CO 81435

Dear Hallie:

We are pleased to offer the following Budget Quotation for you current project named PVU-Bedrock. Below you will find our HDXLPE Tanks for you review. In separate attachments I will include the tank drawing and products data sheets.

Tag Number: T-BLE-101
Chemical: Sodium Hypochlorite 12.5%

1 Each
6100 Gallon IMFO Tank, 10'-0" Diameter X 12'-7" Height
1.9 Specific Gravity. XLPE / OR-1000. 24" 16-Bolt Manway.
Fiberglass Ladder with Return (No-Cage). Tanks will be Heat-Traced
With Insulation (Delta T 60°F). Galvanized Seismic Outside Restraints.
Drop Pipe and Internal Support for Outlet Fittings Only.
3 Each 2" PVC/ EPDM/Titanium Bolted Spool Fittings.
1 Each 4" PVC/ EPDM/Titanium Bolted Spool Fittings
4 Each 2" PVC/EPDM Self-Aligning Fittings

Total Budget Price $34,100.00 Net Each, FOB Factory

Tag Number: T-BLE-201
Chemical: Sodium Hypochlorite 12.5%

1 Each
6100 Gallon IMFO Tank, 10'-0" Diameter X 12'-7" Height
1.9 Specific Gravity. XLPE / OR-1000. 24" 16-Bolt Manway.
Fiberglass Ladder with Return (No-Cage). Tanks will be Heat-Traced
With Insulation (Delta T 60°F). Galvanized Seismic Outside Restraints.
Drop Pipe and Internal Support for Outlet Fittings Only.
3 Each 2" PVC/ EPDM/Titanium Bolted Spool Fittings.
1 Each 4" PVC/ EPDM/Titanium Bolted Spool Fittings
4 Each 2" PVC/EPDM Self-Aligning Fittings

Total Budget Price $34,100.00 Net Each, FOB Factory

Tag Number: T-SBS-101
Chemical: Sodium Bisulphite

1 Each	4600 Gallon Tank, 10'-2" X 9'-7" Height 1.65 Specific Gravity. XLPE. 24" 16 Bolt Manway. Fiberglass Ladder with Return (No-Cage). Galvanized Seismic Indoor Restraints. No Heat Trace or Insulation Drop Pipe and Internal Support for Outlet Fittings Only. 3 Each 2" PVC/ EPDM/316 Stainless Steel Bolted Spool Fittings. 1 Each 4" PVC/ EPDM/316 Stainless Steel Bolted Spool Fittings 4 Each 2" PVC/EPDM Self-Aligning Fittings

Total Budget Price $17,900.00 Net Each, FOB Factory

Tag Number: T-CAUS-101
Chemical: Sodium Hydroxide

1 Each	4600 Gallon Tank, 10'-2" X 9'-7" Height 1.65 Specific Gravity. XLPE. 24" 16 Bolt Manway. Fiberglass Ladder with Return (No-Cage). Tanks will be Heat-Traced With Insulation (Delta T 100°F). Galvanized Seismic Outside Restraints. Drop Pipe and Internal Support for Outlet Fittings Only. 3 Each 2" PVC/ EPDM/316 Stainless Steel Bolted Spool Fittings. 1 Each 4" PVC/ EPDM/316 Stainless Steel Bolted Spool Fittings 4 Each 2" PVC/EPDM Self-Aligning Fittings

Total Budget Price $26,700.00 Net Each, FOB Factory

Tag Number: T-FCL-101
Chemical: Ferric Chloride

1 Each	4600 Gallon Tank, 10'-2" X 9'-7" Height 1.65 Specific Gravity. XLPE. 24" 16 Bolt Manway. Fiberglass Ladder with Return (No-Cage). Tanks will be Heat-Traced With Insulation (Delta T 60°F). Galvanized Seismic Outside Restraints. Drop Pipe and Internal Support for Outlet Fittings Only. 3 Each 2" PVC/ EPDM/Titanium Steel Bolted Spool Fittings. 1 Each 4" PVC/ EPDM/Titanium Steel Bolted Spool Fittings 4 Each 2" PVC/EPDM Self-Aligning Fittings

Total Budget Price $25,400.00 Net Each, FOB Factory

Tag Number: T-HCL-12
Chemical: Hydrochloric Acid

1 Each 6100 Gallon Vertical Tank, 10’-0” Diameter X 12’-8” Height
1.9 Specific Gravity. XLPE / OR-1000. 24” Fume Tight Manway.
Fiberglass Ladder with Return (No-Cage). Galvanized Seismic Outside.
Restraints. No Heat Trace or Insulation on this tank.
Drop Pipe and Internal Support for Outlet Fittings Only.
3 Each 2” PVC/ EPDM/C-276 Bolted Spool Fittings.
1 Each 4” PVC/ EPDM/C-276 Bolted Spool Fittings
4 Each 2” PVC/EPDM Self-Aligning Fittings

Total Budget Price $24,100.00 Net Each, FOB Factory

ESTIMATED FREIGHT FROM FACTORY TO BEDROCK COLORADO $8250.00

Notes:

- Prices quoted are firm for 30 days.
- Lead-time is 6-8 Weeks
- FOB Factory, Freight Additional
- See separate attachment for warranty information.
- Estimated Lifetime (use 12-15 years)
- Exception Taken: Blind Flanges, Additional Gaskets or Hardware are NOT Included.
- All sales are subject to Tank Equipment Terms & Conditions which can be viewed on our website at www.tankequipment.com.

Please let me know if I can answer any questions or be of further assistance.

Sincerely,

Frank Loffreda
Phone: 303-833-9200
Direct: 303-962-7817
Email: frank@tankequipment.com

APPENDIX C

Reference Information

High Density Crosslinked Polyethylene

High-density crosslinked polyethylene, or XLPE, is a thermoset resin that is specifically designed for critical applications like chemical storage. During the XLPE manufacturing process, a catalyst (peroxide) is built into the resin, which creates a free radical. The free radical generates the crosslinking of the polymer chain, so the tank essentially becomes one giant molecule. The result is a resin that is specifically designed for critical chemical applications.

XLPE versus Linear Polyethylene

- XLPE has 20 times the environmental stress crack resistance of HDPE.
- It has 10 times the molecular weight of HDPE.
- It has 5 times the impact and tensile strength of HDPE.

XLPE versus Fiberglass-Reinforced Plastic (FRP)

- XLPE offers seamless construction for greater strength.
- With FRP, chemicals can wick into the fiber, compromising tank life.
- XLPE can have a lower cost of ownership, due to the low amount of required maintenance compared to FRP.
- FRP often requires special handling to avoid cracking.

XLPE versus Carbon and Stainless Steel

- XLPE has seamless one-piece construction, which eliminates the potential for chemical attack points and bad welds.
- Unlike carbon and stainless steel, XLPE has very broad chemical resistance capabilities without the need for high-cost coatings.
- XLPE does not require ongoing maintenance and inspection.
- XLPE is a cost-effective solution to high-priced alloys.

Ferrics, Alums and Polymers.

Containing chemicals that react to their environment.

FE+AL+()n
FERRICS,ALUMS,POLYMERS

Ferrics, alums and polymers are commonly used to treat water and wastewater. There are several reasons why these substances require specialized storage:

- Separation, settling and coagulation are major issues with these chemicals – and those conditions can be compounded by temperature variations.
- Settling and separation issues can lead to difficulty in pumping the chemicals.
- The chemicals are often delivered at elevated temperatures, testing the expansion and contraction capabilities of a tank.
- Ferrics create fumes that can defoliate surrounding trees and plants.
- Polymers can act as an environmental stress-cracking agent.

By providing the right kind of storage for these chemicals, safety can be maintained – and the integrity of the product can be preserved.

FE+AL+()n
FERRICS, ALUMS, POLYMERS

The Poly Processing System For Ferrics, Alums And Polymers

Several of Poly Processing's features can make your storage system work for handling ferrics, alums and polymers. An IMFO® system is ideal for **sludge control and ease of cleaning**, since the tank drains at its true bottom. Heat pads and insulation can help keep the chemicals at the optimal temperature, **greatly reducing the chance of separation and settling.**

A mixing system can also be installed to **keep the chemicals from separating** – and a scrubber can help **reduce the effects on foliage** if you're venting outdoors. As for handling elevated temperatures – this is where the strength of the XLPE tank comes in. The crosslinked construction of these tanks allows for **greater expansion and contraction**, while maintaining structural integrity, lessening your risk for tank failure.

CHEMICAL	RESIN TYPE	SPECIFIC GRAVITY RATING	FITTING MATERIAL	GASKET MATERIAL	BOLT MATERIAL
Aluminum Sulfate	XLPE	1.65	PVC	EPDM	316SS
Ferric Chloride	XLPE	1.65	PVC	EPDM	Titanium
Ferric Sulfate	XLPE	1.65	PVC	EPDM	Titanium
Ferrous Chloride	XLPE	1.9	PVC	EPDM	Titanium
Ferrous Sulfate	XLPE	1.65	PVC	EPDM	Titanium
Polymers	XLPE	1.35–1.9*	PVC	EPDM	316SS

*Based on type of polymer, amount of solids, etc., specific gravities can vary. Consult the specific MSDS for correct weight.

»» See our website for a complete Chemical Resistance Chart.

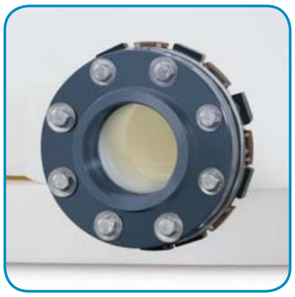
NOTE: To meet NSF-61 certification, use OR-1000™.

Tank Specifications

- **High-density crosslinked polyethylene (XLPE)** to handle the expansion and contraction of elevated temperatures
- **IMFO®** for the handling of sludge and easier cleaning (where secondary containment is already available)
- **Mixing brackets** for maintaining chemical integrity
- **Scrubbers** for reducing defoliation potential
- **SAFE-Tank®** if secondary containment is needed

Recommended System Components

Secondary containment: SAFE-Tank® if concrete containment is not available
Alternative: PPC secondary containment basin or other secondary containment suitable for chemical, of adequate size for use



Fittings: IMFO® eliminates the need for confined space entry.

Plumbing: Requires flexible connections [see page 54] to allow for lateral and vertical tank contraction and expansion and to reduce vibration stress

Venting: SAFE-Surge™ manway cover is recommended on pneumatically loaded systems to support tank longevity.

The above components are just a few of the many options offered by Poly Processing. See pages 38–63 for additional information and products, or talk to your Poly Processing representative.

Technical Overview:
Ferrics, Alums And Polymers Storage Tanks

TANK

IMFO® Vertical Flat Bottom of XLPE with OR-1000™:

- 230–13,650 gallons
- Appropriate spg rating for chemical as shown in Chemical Resistance Chart

NON-IMFO® ALTERNATIVES:

Standard Vertical Flat Bottom XLPE:

- 30-13,650 gallons
- Appropriate spg rating for chemical as shown in Chemical Resistance Chart

SAFE-Tank® XLPE:

- 55–8,700 gallons
- Appropriate spg rating for chemical as shown in Chemical Resistance Chart
- Spg ratings for secondary tanks ≥ 3,000 gallons may be equal to or 1 less spg than primary tank.

All other tank sizes must equal primary tank spg rating.

SECONDARY CONTAINMENT

Recommend **SAFE-Tank®** secondary XLPE as shown above

Non-SAFE-Tank® Alternatives:

- PPC secondary containment basin
- Other secondary containment suitable for hydrochloric acid, of adequate size for use

PLUMBING TO THE TANK

- Required use of **flexible connections** with fittings on lower third of sidewall
  - » Allows for lateral and vertical expansion and contraction of the tank
  - » Reduces pump and piping vibration stress on the tank
- Expansion joints must meet the following minimum requirements:
  - » Axial Compression ≥ 0.67″
  - » Axial Extension ≥ 0.67″
  - » Lateral Deflection ≥ 0.51″
  - » Angular Deflection ≥ 14°
  - » Torsional Rotation ≥ 4°

VENTING

Please refer to the venting chart on www.polyprocessing.com/pdf/technical/Venting.pdf

FOUNDATION AND RESTRAINTS

- PPC IMFO® tank pad or smooth concrete, asphalt or steel foundation designed to accommodate IMFO®, SAFE-Tank® or vertical tank
- No restraint or ladder attachment bands circumscribing the tank are allowed. Cable restraint systems must pass cables over the top of the tank.

TEMPERATURE

Product should not exceed 100°F at delivery or during storage to maintain ASTM D1998 design parameters. Contact Customer Support if chemical is to exceed 100°F.

LID

SAFE-Surge™ manway cover for pneumatically loaded tanks; bolted manway cover for all other applications

OPTIONS

Restraint systems for wind and seismic, level gauges, ladders, heating pads, insulation, fume-tight manway cover, NSF-61 certification and engineering stamp

CALIFORNIA
8055 S. Ash St.
French Camp, CA 95231
Tel: 877.325.3142

LOUISIANA
P. O. Box 4150
2201 Old Sterlington Rd.
Monroe, LA 71203
Tel: 866.590.6845

VIRGINIA
161 McGhee Rd.
Winchester, VA 22603
Tel: 866.590.6845

sales@polyprocessing.com

Hydrochloric Acid.

Controlling a chemical – and its fumes.

HCl

HYDROCHLORICACID

Also known as muriatic acid, hydrochloric acid is used to acidize petroleum wells, remove scales from boilers, aid in ore reduction and serve as a chemical intermediate, among other applications. This pungent liquid is a strong, highly corrosive acid, and it presents serious storage challenges.

- Hydrochloric acid has an extremely low pH, making it highly corrosive.
- The chemical creates toxic fumes that can deteriorate equipment – and these fumes can be fatal to employees. To control the chemical's fumes, the tank's venting system must be exact.
- Tank maintenance can also be an issue because of fuming. Entering the tank must be avoided at all costs, and part replacement must be minimized.

By creating a strong, corrosion-resistant tank system that ties into a scrubber system, all of these issues can be addressed.

HCL
HYDROCHLORICACID

The Poly Processing Hydrochloric Acid System

Storing a chemical as corrosive and fuming as HCL takes a truly specialized system. Poly Processing resolves these issues with its tank, venting and fittings solutions. An Integrally Molded Flanged Outlet, or IMFO®, allows for complete drainage of the tank, **which eliminates the need to enter the tank for cleaning**. This is imperative when dealing with such a strongly fuming chemical. The IMFO® design also reduces chances of having to replace parts, as the drainage system is part of the tank's mold.

Poly also incorporates **airtight lids** and **customized scrubbers** to accommodate the fuming of HCL.

CHEMICAL	RESIN TYPE	SPECIFIC GRAVITY RATING	FITTING MATERIAL	GASKET MATERIAL	BOLT MATERIAL
Hydrochloric Acid ≤ 37%	XLPE	1.9	PVC	EPDM	C-276

»» See our website for a complete Chemical Resistance Chart.

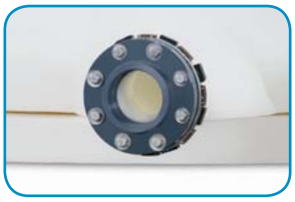
HCL
HYDROCHLORIC ACID

Tank Specifications

- **IMFO® construction** eliminates the need to enter the tank for cleaning, helping employees avoid HCL's toxic fumes.
- **High-density crosslinked polyethylene (XLPE)** ensures the strength of the tank.

Recommended System Components

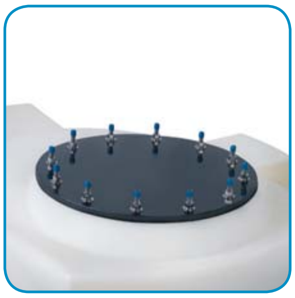
Secondary containment:
SAFE-Tank® is recommended where secondary containment is not available.



Fittings:
IMFO® system is recommended.

Fittings:
B.O.S.S.™ fitting is also recommended to prevent leaks.

Plumbing:
Requires flexible connections with fittings on lower third of sidewall to accommodate expansion and contraction and reduce vibration stress on the tank



Fume-tight manway cover:
17″, 19″ or 24″ with EPDM gaskets

Scrubbers:
Individually designed to support the reduction of dangerous fumes into the environment

The above components are just a few of the many options offered by Poly Processing. See pages 38–63 for additional information and products, or talk to your Poly Processing representative.

Technical Overview:
Hydrochloric Acid Storage Tanks

TANK

IMFO® Vertical Flat Bottom XLPE

- 1,000–13,650 gallons
- 1.9 spg rating

Non-IMFO® alternative:

Standard Vertical Flat Bottom XLPE

- 1,000–13,650 gallons
- 1.9 spg rating

SAFE-Tank® XLPE:

- 1,500–8,700 gallons
- 1.9 spg rating for primary tank
- Spg ratings for secondary tanks ≥ 3,000 gallons may be equal to or 1 less spg than primary tank.
- All other tank sizes must equal primary tank spg rating.

SECONDARY CONTAINMENT

Recommend **SAFE-Tank®** secondary XLPE as shown above

Non-SAFE-Tank® Alternatives:

- PPC secondary containment basin
- Other secondary containment suitable for hydrochloric acid, of adequate size for use

FITTINGS

Sidewall: Recommend 3″ maximum B.O.S.S.™ fitting

Dome: No restrictions

PLUMBING TO THE TANK

- Required use of **flexible connections** with fittings on lower third of sidewall
  - » Allows for lateral and vertical expansion and contraction of the tank
  - » Reduces pump and piping vibration stress on the tank
- Expansion joints must meet the following minimum requirements:
  - » Axial Compression ≥ 0.67″
  - » Axial Extension ≥ 0.67″
  - » Lateral Deflection ≥ 0.51″
  - » Angular Deflection ≥ 14°
  - » Torsional Rotation ≥ 4°

VENTING

See chart on page 63.

FOUNDATION AND RESTRAINTS

- PPC IMFO® tank pad or smooth concrete, asphalt or steel foundation designed to accommodate IMFO®, SAFE-Tank® or vertical tank
- No restraint or ladder attachment bands circumscribing the tank are allowed. Cable restraint systems must pass cables over the top of the tank.

TEMPERATURE

Product should not exceed 100°F at delivery or during storage to maintain ASTM D1998 design parameters.

LID

Fume-tight manway cover to manage release of chemical gases

OPTIONS

Restraint systems for wind and seismic, level gauges, ladders, heating pads, insulation and engineering stamp

CALIFORNIA
8055 S. Ash St.
French Camp, CA 95231
Tel: 877.325.3142

LOUISIANA
P. O. Box 4150
2201 Old Sterlington Rd.
Monroe, LA 71203
Tel: 866.590.6845

VIRGINIA
161 McGhee Rd.
Winchester, VA 22603
Tel: 866.590.6845

Sodium Hypochlorite.

An aggressive oxidizer that presents a major storage challenge.

NaOCl
SODIUM HYPOCHLORITE

Commonly known as bleach, sodium hypochlorite is used in a variety of applications, particularly for the disinfection of drinking water and wastewater. When it comes to storage of this chemical, three factors must be considered:

- UV can degrade sodium hypochlorite, so special precautions must be taken to reduce this effect.
- Sodium hypochlorite typically contains transition metals such as nickel, iron and copper, which can buildup in a storage tank creating off-gassing.
- "Hypo" is a potent oxidizer, so all materials in the chemical's storage tank must be up to the task.

By addressing all three of these issues, this caustic chemical can be contained in a more secure and effective manner, with a tank system that meets NSF/ANSI Standard 61 for chemical storage.

NaOCl
SODIUM-HYPOCHLORITE

The Poly Processing Hypo System

Poly Processing's Sodium Hypochlorite Storage Systems are specifically designed for containment of this challenging chemical. By using carbon black, white or gray compound XLPE resin, **UV degradation of the chemical can be dramatically reduced**. Mastic coatings and insulation are other ways to reduce UV's effect on the chemical.

To **prevent the potential buildup of transition metals in the tank**, Poly has developed the IMFO® system. This special design allows for full drainage of the tank, which can greatly increase the half-life of the chemical.*

*Natural tanks are available for indoor use.

Poly's OR-1000™ system is another key component of the Hypo System. OR-1000™ is the result of our exclusive rotomolding process, which creates a seamless bond between an inner surface of medium-density polyethylene and an outer surface of high-density crosslinked polyethylene. OR-1000™ allows **four times the antioxidant strength** of a normal polyethylene. In any application where OR-1000™ is used, all wetted surfaces – including covering the face of the IMFO® drain – are completely covered by the material, eliminating any opportunity for a chemical attack on the structural portion of the tank.

CHEMICAL	RESIN TYPE	SPECIFIC GRAVITY RATING	FITTING MATERIAL	GASKET MATERIAL	BOLT MATERIAL
Sodium Hypochlorite 9%–15%	XLPE with OR-1000™	1.9	PVC	EPDM/Viton®	Titanium

»» See our website for a complete Chemical Resistance Chart.

NOTE: To meet NSF-61 certification, use EPDM or Viton® GF.

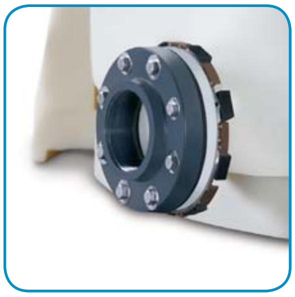
NaOCl
SODIUM HYPOCHLORITE

Tank Specifications

- **High-density crosslinked polyethylene (XLPE)** outer surface ensures maximum corrosion protection through molecular bonding.
- **OR-1000™** molecularly bonds XLPE with an antioxidant inner surface that resists the heavily oxidizing nature of sodium hypochlorite.
- **Integrally Molded Flanged Outlet (IMFO®)** constructed as part of tank ensures complete drainage. Non-IMFO® options also available
- **UV protection** for the chemical is achieved by using compounded black, white or gray resin or insulation coating to help maximize the half-life of the chemical for outdoor applications.

Recommended System Components

Secondary containment: Recommended.
Alternative: PPC secondary containment basin of XLPE, or SAFE-Tank® if concrete containment is not available.



Fittings: IMFO® to prevent transition metal buildup

NOTE: Do NOT use stainless steel or Alloy C-276 due to nickel content reaction.

Plumbing: Requires flexible, Hypo-resistant connections [see page 54] to allow for lateral and vertical tank contraction and expansion, and to reduce vibration stress

Venting: SAFE-Surge™ manway cover is recommended on pneumatically loaded systems to support tank longevity.

The above components are just a few of the many options offered by Poly Processing. See pages 38–63 for additional information and products, or talk to your Poly Processing representative.

NaOCl
SODIUM HYPO-

CAUTION! The life of a Sodium Hypochlorite Storage System is greatly affected by the quality of the chemical itself. Tank owners are cautioned to use high-quality sodium hypo with low iron, nickel and copper content, to avoid decomposition of the chemical and acceleration of the oxidization and degradation of the tank.

Technical Overview:
Sodium Hypochlorite Storage Tanks

TANK

IMFO® Vertical Flat Bottom of XLPE with OR-1000™:

- 1,000–13,650 gallons
- 1.9 spg rating

NOTE: 230–1,000 gallons do not require OR-1000™.

Non-IMFO® alternative*:

Standard Vertical Flat Bottom XLPE with OR-1000™:

- 1,000–13,650 gallons
- 1.9 spg rating

NOTE: 30–1,000 gallons do not require OR-1000™.

*Three-year warranty offered on Non-IMFO® alternatives.

SAFE-Tank® XLPE:

- 1,500–8,700 gallons
- 1.9 spg rating for primary tank with OR-1000™
- Spg ratings for secondary tanks ≥ 3,000 gallons may be equal to or 1 less spg than primary tank.
- All other tank sizes must equal primary tank spg rating.

NOTE: 55–1,000 gallons do not require OR-1000™.

Black, white or gray color or insulation with mastic coating required in outdoor applications to minimize bleach degradation and maximize chemical half-life.

SECONDARY CONTAINMENT

Recommend **SAFE-Tank®** secondary XLPE as shown above.

Non-SAFE-Tank® Alternatives:

- PPC secondary containment basin
- Other secondary containment suitable for sodium hypochlorite, of adequate size for use

FITTINGS

Sidewall: Recommend 3″ maximum B.O.S.S.™ fitting

Dome: No restrictions

PLUMBING TO THE TANK

- Required use of **flexible connections** with fittings on lower third of sidewall
  - » Allows for lateral and vertical expansion and contraction of the tank
  - » Reduces pump and piping vibration stress on the tank
- Expansion joints must meet the following minimum requirements:
  - » Axial Compression ≥ 0.67″
  - » Axial Extension ≥ 0.67″
  - » Lateral Deflection ≥ 0.51 "
  - » Angular Deflection ≥ 14°
  - » Torsional Rotation ≥ 4°

VENTING

See chart on page 63.

FOUNDATION AND RESTRAINTS

- PPC IMFO® tank pad or smooth concrete, asphalt or steel foundation designed to accommodate IMFO®, SAFE-Tank® or vertical tank
- No restraint or ladder attachment bands circumscribing the tank are allowed. Cable restraint systems must pass cables over the top of the tank.

TEMPERATURE

Product should not exceed 100°F at delivery or during storage to reduce the decomposition of the chemical and maintain ASTM D1998 design parameters.

LID

SAFE-Surge™ manway cover for pneumatically loaded tanks; bolted manway cover for all other applications

OPTIONS

Restraint systems for wind and seismic, level gauges, ladders, heating pads, insulation, fume-tight manway cover, NSF-61 certification and engineering stamp

ADDITIONAL SPECIAL REQUIREMENTS:

On-site generation (.08%) max size : 4000 gallons without engineering review. **0.8% may require OR1000 system depending on the installation parameters.**

CALIFORNIA
8055 S. Ash St.
French Camp, CA 95231
Tel: 877.325.3142

LOUISIANA
P. O. Box 4150
2201 Old Sterlington Rd.
Monroe, LA 71203
Tel: 866.590.6845
sales@polyprocessing.com

VIRGINIA
161 McGhee Rd.
Winchester, VA 22603
Tel: 866.590.6845

Sodium Hydroxide.

Defying a chemical that "finds" leaks.

NaOH
SODIUMHYDROXIDE

Also known as caustic soda or liquid lye, sodium hydroxide is used to adjust pH in water and wastewater treatment and in the manufacture of chemicals, rayon, cellophane, pulp and paper, aluminum, detergents, soaps and a wide range of other products. As for storage:

- Sodium hydroxide is a "slippery" chemical that tries to find leak paths.
- This chemical is extremely corrosive to tissue. It is also highly toxic if ingested.
- If sodium hydroxide is not kept at a specific temperature, it will crystallize and go solid.

A tank system and proper fittings from Poly Processing can reduce your risk with this hazardous chemical.

NaOH
SODIUMHYDROXIDE

The Poly Processing Sodium Hydroxide System

The key to storing sodium hydroxide properly is strong, safe containment. Since the chemical is so corrosive, secondary containment is an absolute.

If secondary containment is already available, the IMFO® tank is recommended. IMFO® systems are ideal for Sodium Hydroxide Systems, since their flange is actually a molded part of the tank, not an insert that could leak or fail. The IMFO® also **ensures long-term performance of the overall system**, since it eliminates the need to drill into the sidewall of the tank and install a mechanical fitting, which can create a maintenance issue for this chemical.

When secondary containment is not available, a SAFE-Tank® can meet this requirement. This "tank within a tank" extends the margin of safety by providing a system with **110% secondary containment**.

The tank's high-density crosslinked polyethylene construction means greater strength. It is so strong, in fact, that Poly offers a **warranty of five full years** on all tanks.

CHEMICAL	RESIN TYPE	SPECIFIC GRAVITY RATING	FITTING MATERIAL	GASKET MATERIAL	BOLT MATERIAL
Sodium Hydroxide 50%	XLPE	1.65	PVC	EPDM	316SS

»» See our website for a complete Chemical Resistance Chart.

NOTE: To meet NSF-61 certification, use OR-1000™.

Tank Specifications

- **IMFO®** system completely eliminates the need for a mechanical fitting, which means reduced maintenance. (Recommended where secondary containment is already available)
- **SAFE-Tank®** design greatly reduces the risk of leaking for this highly corrosive chemical. (Recommended where secondary containment is not available)
- **High-density crosslinked polyethylene (XLPE)** construction ensures strength to match this aggressive substance.

Recommended System Components

Secondary containment: Recommended.
Alternative: PPC secondary containment rectangular or cylindrical basin of XLPE, or SAFE-Tank® if concrete containment is not available

Fittings: IMFO® eliminates the need for confined space entry.

Plumbing: Requires flexible connections to allow for lateral and vertical tank contraction and expansion and to reduce vibration stress

Venting: SAFE-Surge™ manway cover is recommended on pneumatically loaded systems to support tank longevity.

The above components are just a few of the many options offered by Poly Processing. See our website or talk to your Poly Processing representative to find out more.

NaOH
SODIUM HYDROXIDE

CAUTION! Heating pad and insulation are highly recommended to prevent crystallization of the chemical.

Technical Overview:
Sodium Hydroxide Storage Tanks.

TANK

IMFO® Vertical Flat Bottom of XLPE:

- 230–13,650 gallons
- 1.65 spg rating

Non-IMFO® alternatives:

SAFE-Tank® XLPE:

- 55–8,700 gallons
- 1.65 spg rating for primary tank
- Spg ratings for secondary tanks must be equal to primary tank.
- All other tank sizes must equal primary tank spg rating.

Standard Vertical Flat Bottom XLPE:

- 30–13,650 gallons
- 1.65 spg rating

SECONDARY CONTAINMENT

Recommend **SAFE-Tank®** secondary XLPE as shown above.

Non-SAFE-Tank® alternatives:

- PPC secondary containment basin
- Other secondary containment suitable for sodium hydroxide, of adequate size for use

PLUMBING TO THE TANK

- Required use of **flexible connections** with fittings on lower third of sidewall
  - » Allows for lateral and vertical expansion and contraction of the tank
  - » Reduces pump and piping vibration stress on the tank
- Expansion joints must meet the following minimum requirements:
  - » Axial Compression ≥ 0.67″
  - » Axial Extension ≥ 0.67″
  - » Lateral Deflection ≥ 0.51″
  - » Angular Deflection ≥ 14°
  - » Torsional Rotation ≥ 4°

VENTING

Please refer to the venting chart on www.polyprocessing.com/pdf/technical/Venting.pdf

FOUNDATION AND RESTRAINTS

- PPC IMFO® tank pad or smooth concrete, asphalt or steel foundation designed to accommodate IMFO®, SAFE-Tank® or vertical tank
- No restraint or ladder attachment bands circumscribing the tank are allowed. Cable restraint systems must pass cables over the top of the tank.

TEMPERATURE

Product should not exceed 100°F at delivery or during storage or drop below 50°F to prevent damage to the chemical.

LID

SAFE-Surge® manway cover for pneumatically loaded tanks; bolted manway cover for all other applications.

OPTIONS

Restraint systems for wind and seismic, level gauges, ladders, heating pads, insulation, mixer mounts, OR-1000™ for NSF-61 certification and engineering stamp.

CALIFORNIA
8055 S. Ash St.
French Camp, CA 95231
Tel: 877.325.3142

LOUISIANA
P. O. Box 4150
2201 Old Sterlington Rd.
Monroe, LA 71203
Tel: 866.590.6845

VIRGINIA
161 McGhee Rd.
Winchester, VA 22603
Tel: 866.590.6845

sales@polyprocessing.com

Chemineer

Model 20 HT and GT Agitators

Reliable Performance

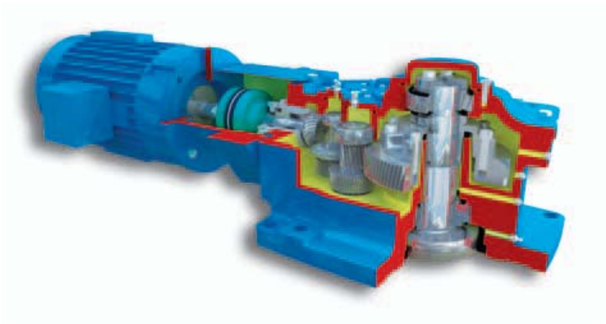
and Value

Premium Performance

The Model 20 HT and GT units feature a gearbox designed specifically for agitator service. Available in right angle (HT) and parallel shaft (GT) configurations, this rugged performer can be tailored to meet virtually any process, from critical chemical reactor systems to storage applications.

Combining the benefits of the HT and GT time proven agitators into a modular design package, Chemineer provides solutions to optimize your mixing applications today and flexibility to handle your changing requirements in the future.

The Model 20 HT/GT is designed to meet AGMA, OSHA, ANSI, IEC, DIN, EU and ATEX standards and requirements.



How is the Chemineer Model 20 HT/GT Gearbox Superior?

Output Shaft Requirements

Commercial gearboxes usually have smaller output shafts that are poorly suited for agitator duties, leading to higher gear deflections, more noise and lower reliability. For optimum mechanical integrity, it is beneficial to design the low speed shaft so that the shaft diameter between the bearings is large and the distance between the bearings is small. Commercial gearboxes tend to use smaller shaft diameters, resulting in the need to select larger and more expensive units to handle the bending moments associated with overhung loads.

AGMA Ratings when Applied to Agitators

AGMA established a general purpose standard intended to be applied to gearboxes used in a wide range of industrial applications. Agitators have particular duties that make reliance on AGMA service factors inappropriate. A standard commercial gearbox tends to use smaller shafts and larger bearing spans that result in higher deflection, wear and shorter lifespan. To obtain adequate drive life a high service factor must be applied.

The Chemineer Solution

The Chemineer Model 20 HT/GT gearbox is unique and superior because it is designed specifically for agitator duties. In comparison with a general purpose gear-drive of the same nominal AGMA torque rating, it has much longer bearing and gear lives, which translate to lower maintenance costs and greater productivity. It also has an oversized output shaft, which reduces gear deflection and noise, with a true dry well seal to avoid the risk of leaking lubricant down the shaft.

Drive Features and Benefits

Internal Shafting

Features	Benefits
• Oversized low speed shaft diameter and short bearing span	• Time proven design to handle shaft/impeller bending loads, reducing deflection and gear misalignment, thereby extending bearing and gear life
• Recessed low speed coupling half	• Simplifies installation with no requirement to install the extension shaft up through the gearbox

Gearing

Features	Benefits
• Double and triple reduction options	• Double/triple reduction decreases gear loads, lowers noise levels and allows for non-synthetic lubrication over competitive single reduction designs
• Helical/spiral bevel (HT) and all helical (GT)	• Most efficient gearing available; reduces energy costs
• Case carburized gearing	• Reduces wear rate for 20+ year service life
• Reverse rotation capability	• Available option for process flexibility

Housing and Lubrication

Features	Benefits
• Cast gearbox housing	• Modular design with right angle (HT) and parallel shaft (GT) configurations • Reduces noise level
• Dry well seal	• Eliminates lubrication leaks which are common in commercial gearboxes with no dry well
• Bath lubrication	• Ensures vital lubrication to gears and bearings at all operating speeds, eliminating internal/external lubrication pumps
• Standard R&O oils and grease	• No synthetic lubrication is required, saving installation and maintenance costs
• Extra seal over dry well	• Keeps oil out of dry well while moving gearbox

Bearing Design

Features	Benefits
• Tapered roller output bearings with short bearing span, grease lubricated	• High capacity to handle bending and thrust loads while providing long life
• Tapered roller/cylindrical roller bearings, oil lubricated	• Ensures cool operation, long life and low maintenance

Seal Features and Benefits

Features	Benefits
• Drop collar shaft support during seal change	• Shaft drops easily by loosening coupling bolts, and engages by tightening the coupling bolts • Shaft only drops 1/2" eliminating steady bearing disengagement
• Optional throttle bushing and debris well design	• Clean fluid flush eliminates process build-up in seal area improving seal life • Eliminates particle shedding from entering tank
• Swing out or spacer spool seal change designs	• No need to pull shaft up through gearbox or in-tank shaft supports • No labor or parts required for special shaft support system • No lifting and removing of gearbox, saving labor and downtime
• Variety of seal options from major mechanical seal vendors such as John Crane, Flowserve, Chesterton and AES	• Cartridge double and single seals, low pressure single seals, and cartridge ChemSeals provide performance and flexibility to meet agitator sealing needs
• Seal designs include cartridge single and double seals and split seals	• Reduces seal change out time and shaft wear as compared to non-cartridge (shaft mounted) designs
• Low height pedestal (swing out) and seal bearing (spacer spool) design options	• Seal located close to shaft support bearings (swing out) and integral seal bearing (spacer spool) reduces shaft deflections at seal, improving life
• Optional seal shut-off device	• Eliminates operator exposure to hazardous vapors without draining the vessel
• Jacks-n-Rails assembly available for large diameter seals	• Reduces labor time for seal change-out with no extra hoists required
• Optional lip seals and stuffing boxes	• Low cost lip seals available for low pressure applications • Self-lubricating packing offers low maintenance sealing options for pressures up to 100 ps

Swing Out Seal Change

Sealing and Mounting Options

Open Tank

• Drive Mounted to Beams

Using a heavy-duty, cast housing capable of handling maximum loads, the agitator mounts readily to support beams or similar structures for common open tank applications. Auxiliary seals are an option.

• Pedestal-Mounted to Beams

The rugged, cast iron pedestal of the agitator raises the gear drive 10 to 14 inches away from the support structure to prevent exposure of the drive to the fluid and to facilitate service.

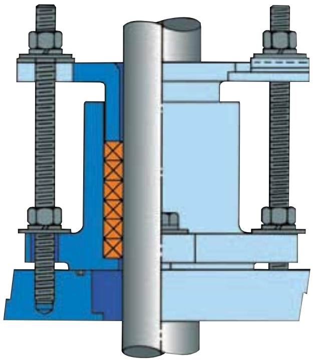
Closed Tank — Seal Options

• Lip Seal

The spring-loaded, nitrile rubber lip seal protects process fluid from contamination in lower pressure applications.

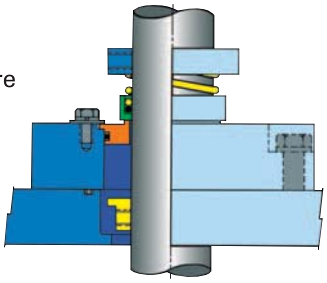
• Stuffing Box

The six-ring stuffing box utilizes standard PTFE/graphite-braided packing requiring no lubrication. Optional packing materials are available.



• Single Mechanical Seal

The single dry-running mechanical seal is the economical choice where a pressurized barrier between the tank contents and the outside environment is not necessary.

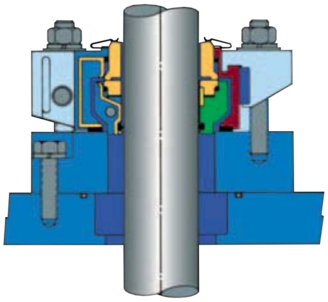


• Single Mechanical Cartridge ChemSeal

The single mechanical seal offers dry-running capability with an easily replaceable cartridge.

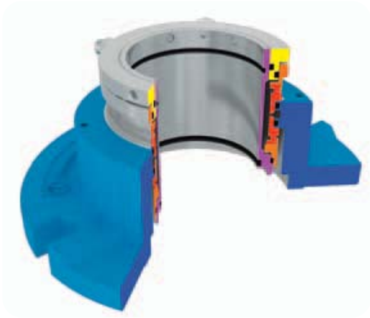
• Split Mechanical Seal

The two-piece design simplifies installation and maintenance.



• Double Mechanical Cartridge ChemSeal

Double mechanical cartridge seals offer excellent sealing capabilities, long life and minimum maintenance. An appropriate barrier fluid keeps tank contents from escaping.



Shaft Design

Both process and mechanical considerations determine shaft design. Shafts are sized to resist torsional loads and bending moments induced by hydraulic forces acting on the impeller, as well as to avoid excessive vibration due to the coincidence of critical frequencies and operating speed.

Shafting is straightened to tight tolerances for long seal life and smooth operation – less than 0.003 inches total run out per foot of shaft length (0.25 mm per meter).

Custom couplings, impellers, shafts and steady bearings are available upon request, including sanitary designs.

Standard Spacer-Spool Style Pedestal and Seal Arrangement

Types

Shafting is supplied in a single piece design or in rigidly coupled sections for easy installation. For large diameter shafts, pipe shafting is a viable option with couplings and impeller hubs welded to the shafting. A wide range of materials and coating options are available.

Couplings

To facilitate assembly in the field, extension shafts are attached to the drive shaft with flanged rigid couplings, eliminating the need for shafts to be installed through the gearbox. Optional in-tank couplings can either be removable tapered bore or welded simplifying installation of long shafts.

Welded Coupling

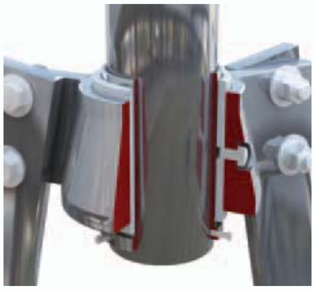
Removable Coupling

Steady Bearings

Steady bearings are available to help support extremely long shafts. Tripod, bracket and pad-type steady bearings are standard design options.

Extended Keyways

Extended keyways for adjusting impeller location offer process and design flexibility.



Tripod Steady Bearing

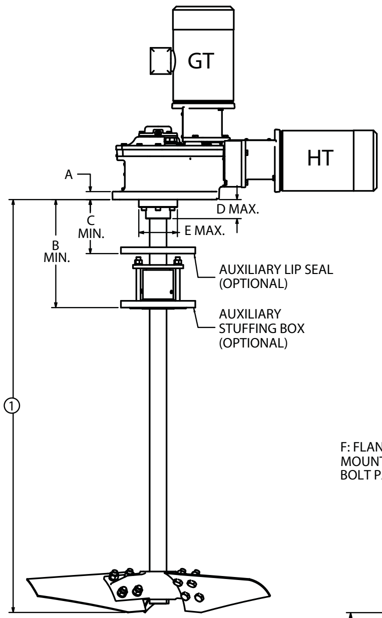
Bracket Steady Bearing

Impeller Technology

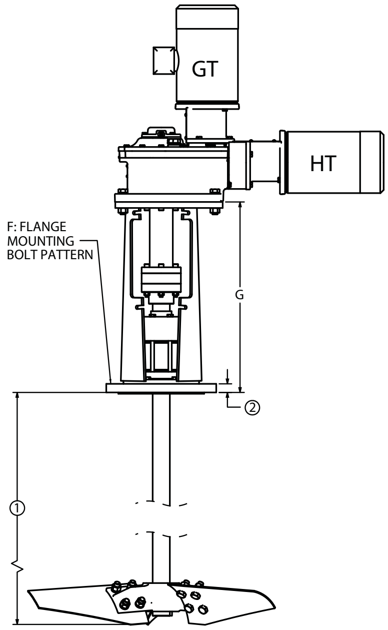
Chemineer's impeller technology is effectively applied across your spectrum of applications ensuring successful, repeatable results from lab scale to full scale operations.

Chemineer's mixing expertise includes high flow, low shear liquid-liquid agitation, solids suspension, gas dispersion, high shear blending and viscous mixing. Whether it is R&D or production phase, we have the expertise to solve your mixing challenges.

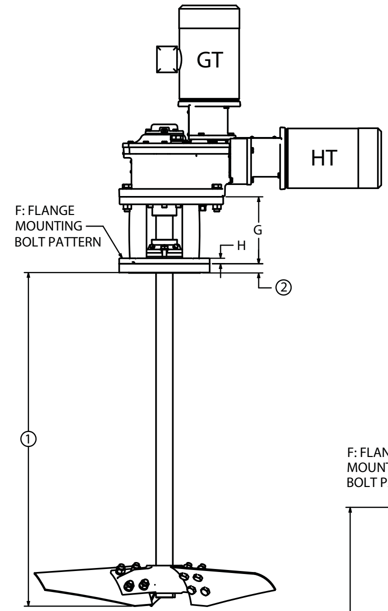
Impeller bulletin 710 is available with additional information.



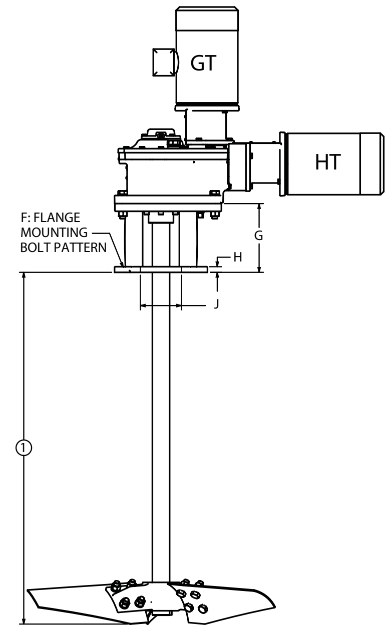
GT/HT D



GT/HT N
Spacer Spool



GT/HT A, L, N, NC, NS & NT
(N, NC & NS Drives Swivel)



GT/HT P

Agitator Dimensions

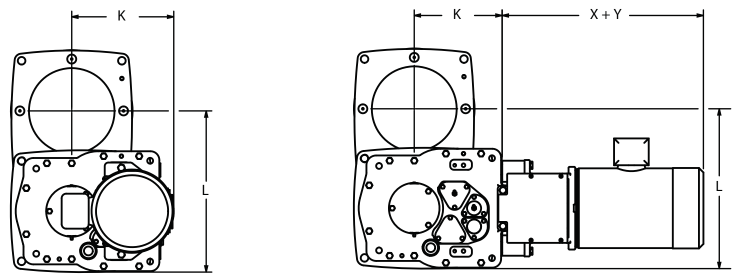
CASE SIZE	A	B	C	D	E	F	G		H	J
						Bolt Pattern	Spacer	Swivel		
21GT	1.18	13.94	6.94	2.94	5.71	8" - 150# ANSI (Holes Straddle C.L.)	26.19	10.00	0.75	9.50
22GT	1.38	18.00	8.00	4.00	7.48	10" - 150# ANSI (Holes On Center Line)	29.82	12.50	0.88	10.00
23GT	1.58	18.63	8.63	4.63	9.45	12" - 150# ANSI (Holes Straddle C.L.)	33.94	N/A	1.18	10.83
						14" - 150# ANSI (Holes Straddle C.L.)	N/A	14.06	1.46	12.80
21HT	1.18	13.94	6.94	2.94	5.71	8" - 150# ANSI (Holes Straddle C.L.)	26.19	10.00	0.75	9.50
22HT	1.38	18.00	8.00	4.00	7.48	10" - 150# ANSI (Holes On Center Line)	29.82	12.50	0.88	10.00
23HT	1.58	18.63	8.63	4.63	9.45	12" - 150# ANSI (Holes Straddle C.L.)	33.94	N/A	1.18	10.83
						14" - 150# ANSI (Holes Straddle C.L.)	N/A	14.06	1.46	12.80

1. Agitator output speed, shaft diameter and extension, impeller design and other optional features to suit application
2. Alternate flange sizes are available

Dimensions

Swivel Dimensions

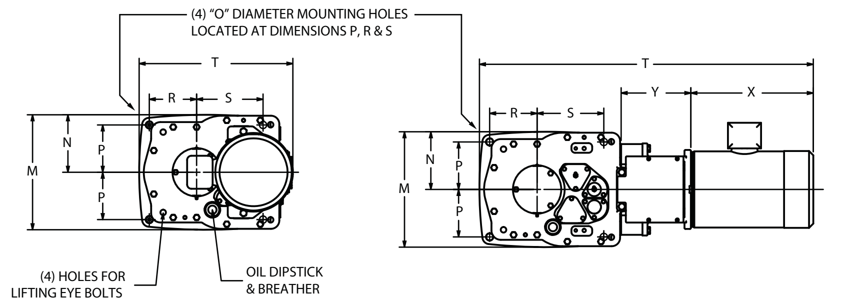
CASE SIZE	K	L
21GT	11.18	17.57
22GT	17.50	22.61
23GT	21.90	28.31
21HT	9.84	17.57
22HT	12.56	22.61
23HT	16.61	28.31

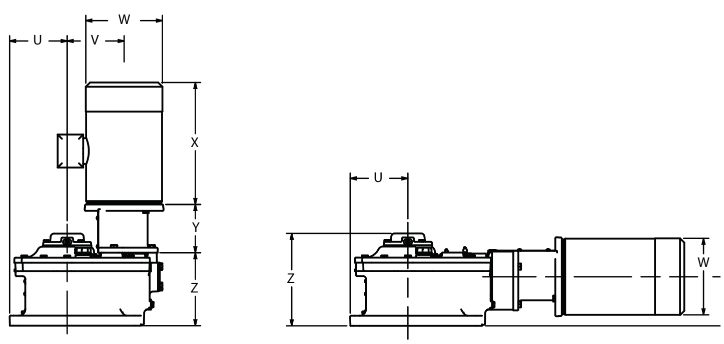


GT HT

Typical Drive Assembly
Swivel Dimensions

(Drive assembly pivots at top of pedestal to allow change-out of mechanical seals. See I.O.M. for special motor conduit instructions)





GT HT

Motor Dimensions

	FRAME SIZE	W	X	Y 21GT	22GT	23GT	21HT	22HT	23HT
NEMA	140	7.75	13.11	3.98	—	—	6.46	—	—
NEMA	180	9.25	16.24	5.51	6.02	—	7.99	9.41	—
NEMA	210	11.00	17.96	5.51	6.02	—	7.99	9.41	—
NEMA	250	12.75	22.25	—	6.85	7.01	—	10.24	11.43
NEMA	280	14.50	24.24	—	7.76	7.01	—	11.14	11.43
NEMA	320	16.88	27.00	—	8.23	8.27	—	11.61	12.69
NEMA	360	18.50	27.63	—	—	9.49	—	—	13.91
NEMA	400	20.88	31.75	—	—	10.83	—	—	15.25
IEC	80	6.61	10.66	3.58	—	—	6.06	—	—
IEC	90	7.40	11.18	4.13	—	—	6.62	—	—
IEC	100	7.72	13.15	4.92	5.35	—	7.40	8.74	—
IEC	112	9.45	13.03	4.92	5.35	—	7.40	8.74	—
IEC	132	10.16	16.73	5.39	6.22	6.10	7.88	9.61	10.52
IEC	160	12.52	21.26	—	7.87	7.48	—	11.26	11.90
IEC	180	14.37	23.31	—	7.87	7.48	—	11.26	11.90
IEC	225	17.64	30.51	—	—	9.53	—	—	13.95
IEC	250	20.00	35.04	—	—	9.53	—	—	13.95
IEC	280	22.17	38.39	—	—	9.53	—	—	13.95

Drive Assembly Dimensions

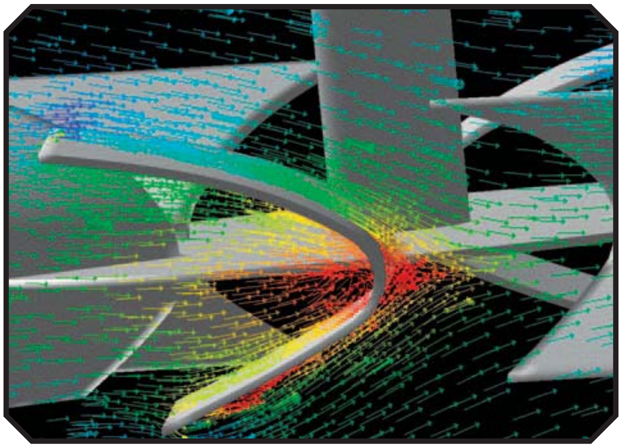
CASE SIZE	M	N	O	P	R	S	T	U	V	Z
21GT	12.77	6.45	0.84	5.56	5.56	7.81	17.91	6.73	6.69	8.47
22GT	16.97	8.48	1.00	7.06	7.06	10.06	26.00	8.50	9.06	10.75
23GT	21.97	10.99	1.00	9.65	7.68	2.17	31.15	9.25	11.41	14.80
21HT	12.77	6.45	0.84	5.56	5.56	7.81	38.75	6.73	5.75	10.83
22HT	16.97	8.48	1.00	7.06	7.06	10.06	59.70	8.50	7.23	12.91
23HT	21.97	10.99	1.00	9.65	7.68	2.17	73.47	9.25	9.77	16.50

Chemineer Advanced Design Initiative

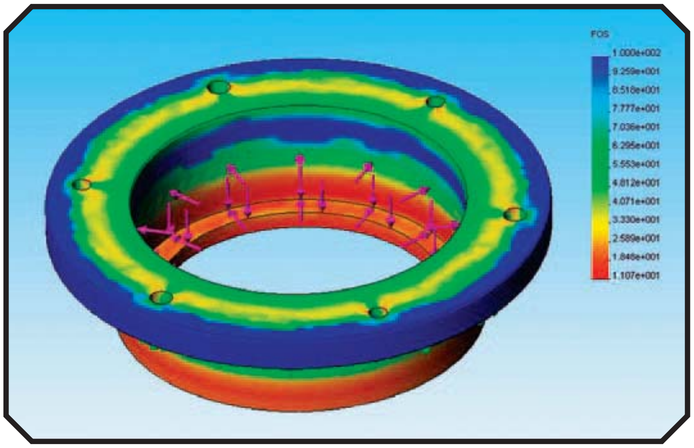
Research and Innovation in Mixing

The Chemineer Advanced Design Initiative brings proven technical expertise to each mixing solution, from basic mixer and impeller design through complex process application analysis. Continuing research in both mechanical and process aspects of mixing allows Chemineer to provide high quality and high value products and services. Combined with proprietary data evaluation methodology and extensive field experience, Chemineer provides the most accurate application evaluation possible. Let Chemineer optimize your application, saving you time and money, by applying our experience and state-of-the-art tools, such as:

- Chemineer's high-tech customer test lab–offers the most advanced testing techniques in the industry
- Chemineer's R&D lab provides advanced process and mechanical research which is incorporated into custom design packages to optimize your application
- Computational Fluid Dynamics (CFD)–provides visual projections of mixer performance by generating a series of mathematical models of fluid flows (see Bulletin 750)
- Digital Particle Image Velocimetry (DPIV)–provides instantaneous flow visualization and quantitative measurement of the fluid velocity field (see Bulletin 755)
- Laser Doppler Anemometry (LDA)–corroborates time averaged DPIV data, especially for velocity fields in the vicinity of the impeller
- Laser Induced Fluorescence (LIF)–enables the user to gain a fundamental understanding of mixing by tracking the path and diffusion of injectants in agitated vessels and static mixers
- CEDS® (Chemineer Expert Design System)–the industry leader in agitator design and analysis software. This proprietary program suite optimizes process performance, in addition to mechanical integrity, strength and reliability
- ChemScale®–the industry standard method for effective mixer selection that helps to optimize the agitator design for your specific process needs
- Finite Element Analysis (FEA)–dynamic vibrational and stress analysis of vessel and agitator support structures ensures proper design to handle agitator loads. Product design tool for stress and deformation analysis ensures product safety and reliability
- CAD 3-D Design–state of the art product and job design software, with customer specific mixer drawings available
- A library of Chemineer technical articles–available on the web site at www.chemineer.com



Example of CFD Modeled Flow Fields



Example of FEA Analysis

Chemineer
EXPRESS
Quality and Dependability in Mixer Parts and Service

Chemineer Express' mission is to offer customers immediate assistance to help achieve operating performance goals for agitation and mixing processes. This is accomplished in two ways: ensuring replacement parts and services are available on a timely basis to increase the "uptime" of your systems, and ensuring customers are offered the latest technology to improve the performance of agitation and mixing systems.

The Right Part Every Time

Chemineer Express provides drop-in replacement parts of standard and custom Chemineer agitator components, minimizing installation problems like improper fit-up or alignment. Chemineer replacement parts are made to original equipment specifications to ensure maximum reliability of your mixing equipment.

Technical Support

Chemineer Express technical support is just a phone call away. Whether you need assistance with installation, startup, maintenance, or replacement parts, our technical experts are ready to help.

Field Service is ready to assist your crew with installation, troubleshooting, reliability audits, or maintenance and operator training in your facility.

Installation

Chemineer offers expert help on installation, whether your application requires one or multiple agitators. Our sales and field service engineers can quickly and efficiently supervise the installation and start-up of your agitator.

Chemineer Express Service Center

Chemineer Express offers multiple options to get your process back up and running. Highly-Trained Field Service Engineers are ready to deploy for assisting maintenance crews in repair, diagnostic, and/or maintenance work. A Chemineer Authorized Service Center is located near your plant for quick responsiveness backed by the full support of the Chemineer manufacturing facility.

The Chemineer Express Service Center is located in the Chemineer manufacturing facility for more extensive failure analysis, fast replacement parts assemblies, and the most reliable agitator repair service in the world. New and refurbished parts options are available to suit your business requirements and get equipment back into operation.

Chemineer Express offers Customer Service Plans tailored to fit your needs. Contact your local representative or Chemineer Express (937-454-3200 or chemineerexpress@nov.com).

Parts

Our large inventory supports your stock and provides quick fulfillment of maintenance and repair needs. Emergency parts are shipped from our stock within 24 hours. In addition to a wide selection of standard replacement items such as bearings, seals and motors, we stock complete drives and internal subassemblies. Our drive exchange program offers a replacement drive for rapid conversion for Chemineer and competitive drives.

Warranty

For added peace of mind the Model 20 HT/GT agitator is backed by a comprehensive product warranty.

Other Quality Products from Chemineer

Kenics Prochem Greerco

Heat Exchanger

Colloid Mill

KMX-V Static Mixer

Homogenizer

Pipeline Mixer

PB Agitator

KM Static Mixer

Chemineer Prochem

Chemineer, Inc.
5870 Poe Avenue
Dayton, Ohio 45414
Telephone: (937) 454-3200
Email: chemineer@nov.com

Chemineer, Ltd.
7 Cranmer Road, West Meadows
Derby DE21 6XT, England
Telephone: 44-1-332-546700
Email: chemineeruk@nov.com

Chemineer China
Room 2006, Modern Plaza
369 Xianxia Road
Shanghai, CHINA 200336
Telephone: 86-21-61240001
Email: chemineercn@nov.com

Bulletin 705

Kenics Greerco

Chemineer, Inc.
125 Flagship Drive
North Andover, MA 01845
Telephone: (978) 687-0101
Email: navinfo@nov.com
www.kenics.com
www.greercomixers.com

Chemineer International Sales Offices:
Brazil
Mexico
Singapore

Your Local Contact:

For the nearest sales office call 1-800-643-0641 or go to www.chemineer.com

NOV Mono

Printed in U.S.A. 114

model 8760

FEATURES & BENEFITS

QUALITY CONTROL
Fully assembled and tested for quick placement and hook-up.

ALARM SYSTEM
Standard with audible and visible alarms controlled by a flow switch for immediate attention to an emergency.

BLENDING SYSTEM
Safe, fully engineered thermostatic mixing valve for mixing large volumes of hot and cold water guarded with anti-scald protection and full flow cold water bypass to provide tempered water in adverse situations.

TANK SYSTEM OPTIONS
119 Gallon (450 L) Tank (Option No. 21): Stores enough hot water to provide a single 15 minute shower and eye/face wash use. Also available in ASME - Option 22. 325 Gallon (1230 L) Tank (Option No. 23) stores enough hot water to provide two 15 minute shower and eye/face wash uses before tank recovery is required.

STEAM SYSTEMS
Steam Heat Exchanger (Option No. 24): Feed forward instantaneous heat exchanger. Requires 15 PSIG, max. 1300 lb./hr. steam supply.

EYE/FACE WASH
AXION® MSR eye/face wash head (patent pending) uses an inverted directional laminar flow to sweep contaminants away from the vulnerable nasal cavity.

EXPANDABLE/FLEXIBLE CAPABILITIES
System can be designed to a number of variations including the hot water supply, the electrical type, and the blending capabilities.

ELECTRICAL SYSTEM OPTIONS
Haws provides systems with various voltage options. Standard assemblies are built with 480V 3ph for quick shipment. NEMA 4 tank (Option 31), steam (Option 36). NEMA 7 Class I, DIV2, Group B, C, D tank (Option 32), steam (Option 38) (Class I, DIV I also available)

PERFORMANCE SERIES
Offering a standardized line of water tempering solutions providing shorter lead times, advanced compliance, cost efficiencies, and customizable configuration options.

MONITORING
Advanced Programmable Monitoring Control System provides real-time digital display with three modes; standard operating, alarm cycles and fault history. Capabilities include automatic alarm silencing reset, customer control room synchronization, seasonal operation scheduling, and more.

OPTIONS

For more information, visit www.hawsco.com or call (888) 640-4297.

SPECIFICATIONS

Model 8760 shower and eye/face wash shall include a membrane encapsulated, fiberglass channel reinforced 5' x 5' (1.5 x 1.5 m) wood skid with bright yellow elastomeric chemically resistant waterproof coating, protected with UV inhibitors. There is a 20 gpm (75.7 L) AXION shower head, an eyewash that features the medically acclaimed AXION® MSR eye/face wash head assembly (patent pending). This revolutionary inverted flow design is the only product on the market that provides a Medically Superior Response consistent with all EMT, emergency room and doctors' office protocols by sweeping contaminants away from the vulnerable nasal cavity, along with 3 gpm (11.4 L) to supply the side hanging drench hose. Chrome-plated brass stay-open shower, eyewash, and drench hose ball valves equipped with stainless steel ball and stem, and protected by scald and freeze bleed valves. The standard alarm system is flow switch activated, and provides local audible and visible alarms. This single shower and/or eyewash or multiple shower/eyewash feeder provides an operating temperature range of 40° to 100° F (4° to 37° C), and is designed to operate with a number of tempering and electrical options. The tempered water blending system will include an integral hot water supply, whether stored or supplied by steam, and will incorporate fail-safe features like anti-scald protection and full flow cold water bypass. The electrical system can be easily adapted to voltages upon request. Combination shower and eyewash is certified by CSA to meet the ANSI Z358.1 Standard for /emergency Eyewash and Shower Equipment.

APPLICATIONS

Perfect for indoor facilities that may encounter dangerous chemical hazards and need a complete decontamination station, and/or need a feeder to other remote booth substations, or other drench systems and/or eyewash stations.

Milamar Coatings, L.L.C.
A CASS Polymers Company

ICO-HI GUARD™

Product Description

ICO-Hi Guard™ is a solvent-free, 100% solids, three part epoxy novolac floor system hand trowelled in one pass in any thickness down to 3/16". It has excellent chemical resistance to many concentrated acids, including 98% sulfuric acid, as well as most alkalis and some solvents. The enhanced toughness of the formulation allows for better resistance to thermal and mechanical shock compared to harder, more brittle conventional materials. Applied at a typical quarter inch thickness, **Hi Guard™** will withstand frequent heavy mechanical wear without need of constant maintenance.

ICO-Hi Guard's™ resin rich formulation eliminates the need for a top sealer coat, thereby reducing the downtime and improving resistance to moisture penetration. Its high gloss facilitates cleaning. Anti-slip characteristics can be enhanced by the addition of silica quartz or aluminum oxide. **ICO-Hi Guard™** is particularly effective in damp conditions, even on slab-on grades.

Typical Application

ICO-Hi Guard™ is particularly recommended for chemical plants, secondary containment, chemical storage rooms in food and beverage plants, and other high corrosion areas. It is our recommended product for withstanding 98% sulfuric acid. Its resin-rich formulation provides a dense , impermeable barrier to liquid penetration, even if the top surface is gouged. Its excellent wetability allows it to adhere to both damp and dry concrete, metal, wood, brick and tile.

Chemical Resistance

ICO-Hi Guard™ has excellent resistance to virtually all caustics and such acids as 98% sulfuric, 85% phosphoric, 30% chromic, 30% nitric and 37% hydrochloric. A more complete list of chemical resistance is available in the **International Coatings Chemical Resistance Chart** or contact **ICO** Technical Assistance.

Physical Properties

Tensile Strength	(ASTM C-307)	:1285 psi
Tensile Elongation	(C-307)	:5%
Flexural Strength	(C-580)	:1940 psi
Compression Strength	(C-579)	:6165 psi
Hardness, Shore D	(D-2240)	:80
Bond Strength to Quarry Tile		:>1000 psi
Flammability	(D-635)	:Self Extinguishing
Vapor Transmission Rate	(E-96)	:.07 perms
Coefficient of Thermal Expansion	(D-696)	:5.9×10^{-5} per °F
Gardner Impact	(D-2794)	:160 in- lbs.
Water Absorption	(D-5790)	:0.1% in 24 hours

Physical Characteristics

Density, lbs/gal.

Pt. A	9.8
Pt. B	8.8
A&B Mixed	9.5

Viscosity@77°F, cps

Pt. A	450
Pt. B	600
A&B Mixed	500

Shelf Life

1 year at 77°F in unopened containers.

Mixing Ratios	By Volume	By Weight
Pt. A : Pt. B	2 : 1	2.2 : 1
Aggregate : Liquid	2.8 : 1	4.5 : 1

Curing Times @	50°F	70°F	90°F
Pot Life	35 min.	30 min.	25 min.
Work Time	35 min.	45 min.	30 min.
Hard, Foot Traffic	24 hrs.	10 hrs.	5 hrs.

Maximum Hardness achieved after 7 days @77°F.

Color Availability

Standard colors: gray, dark gray, beige, red, brown, black.

Packaging and Coverage Rates

Basic Kit	27 SF at 1/4"
Bulk Pack	270 SF at 1/4"
Drum Kit	2700 SF at 1/4"

Rev 06/2014

Installation

Please refer to our Application Specs for detailed instructions. Particular care must be taken to follow those instructions precisely to assure proper installation.

1. New concrete should be allowed to cure a minimum of 28 days or be checked with a rubber mat or plastic sheet to insure adequate curing time has occurred.
2. All surfaces to be covered should be power washed, shot blasted, acid etched, scarified or sanded to present a clean, sound substrate to which to bond to. The prepared surface should have a ph of 7.
3. The three ingredients should be mixed in the prescribed ratios, using a low speed paddle style mixer (maximum 750 rpm), until uniform in color and consistency. Mix Part A and Part B and then slowly add the aggregate and pigment.
4. Do not mix less than the prescribed amount of any ingredient or add any solvent to the mix.
5. **ICO-Hi Guard** is a self-priming mix. However, to reduce chances for out gassing, seal the concrete with **ICO-Primer LV** or **ICO-Primer LV FC** prior to application. Allow to dry.
6. The prepared mix may be spread using screed strips, gauge rakes or notched trowels to insure a nominal 1/4" average depth.
7. Allow the rough spread material to set a few minutes before finish troweling to allow the resin to come to the surface which facilitates the smoothing action of the trowel.
8. After the finish troweling the surface may be back rolled with a short nap roller to remove blemishes. The roller can be slightly damp with ice water, xylene, toluene or alcohol to prevent pickup.
9. A suitable aggregate may be broadcast onto the surface after back rolling to provide more anti-slip profile to the finished surface. It is advisable to test various types and sizes of aggregate to achieve the desired finish profile.

NOTE: **Failure to follow the above instructions, unless expressly authorized by an ICO Technical Service Representative, will void our material warranty.**

Precautions

1. **Do not apply below 50°F.**

Product Specification

The specified area shall receive an application of **ICO-Hi Guard™** as manufactured by **International Coatings, Oklahoma City, Oklahoma.** The material shall be installed by precisely following the manufacturer's published recommendations pertaining to surface preparation, mixing, and application. The material shall be a low odor, three part, solvent-free 100% solids epoxy system with moderate resilience to resist thermal and mechanical shock. It should be trowel applied normally at 1/4" thickness in one application without needing a top coat. It shall be a resin rich mix ratio of 3.2:1, by volume **ICO-Fill** aggregate to resin and hardener. The compressive strength when tested in accordance with ASTM C-579 shall not exceed 6200 psi and a tensile strength of 1300 psi as measured against ASTM C-307. It shall have excellent adhesion to wood, metal, tile brick and damp as well as dry concrete. The system shall resist chemical attack from oils and greases and such acids as concentrated chromic, 30% nitric, 98% sulfuric, 85% phosphoric and 20% acetic.

Mission Statement

Our mission is to provide our customers the highest possible quality products and services and by so doing, build long term relationships based on mutual trust and respect..

The data statements and recommendations set forth in this product information sheet are based on testing, research and other development work which has been carefully conducted by us, and we believe such data. Statements and recommendations will serve as reliable guidelines. However, this product is subject to numerable uses under varying conditions over which we have no control, and accordingly we do NOT warrant that this product is suitable for any particular use. Users are advised to test the product in advance to make certain it is suitable for their particular production conditions and particular use or uses.

LIMITED WARRANTY

Milamar Coatings products are manufactured to be free of defects in material and workmanship in meeting the properties specified on its individual Product Data Sheets. Users and installers of Milamar Coatings products are solely responsible for determining the suitability of the products for specific product applications. Milamar Coatings makes no Warranty or Guarantee, express or implied, including warranties of fitness, design compatibility or merchantability, for any particular use and shall have no responsibility or liability, including direct, indirect or consequential damages, due to injury, delay or third party claims for installation or repair. Likewise, Milamar Coatings assumes no liability of any nature for products that are adjusted in the field or that do not utilize all specified Milamar Coatings components. Should any Milamar Coatings product be proved to be defective within one year from the date of shipment, Milamar Coatings will, at its sole discretion, either replace the material; issue a credit to the customer's account; or provide a cash refund for the initial, paid purchase price of the material. Potential claims regarding product quality must be received in writing by Milamar Coatings within 30 days of the discovery of such potential defect. This Warranty is exclusive of all other warranties, expressed or implied, and may only be adjusted in writing, signed by an officer of Milamar Coatings, L.L.C.

Milamar Coatings, L.L.C.
A CASS Polymers Company

311 NW 122nd St, #100 Oklahoma City, OK 73114
800.459.7659
www.milamar.com