Montrose Superfund Site
Los Angeles, California

Final Electrical Resistance Heating (ERH) Pilot Test Report

TRS
TRS Group, Inc.
Accelerating Value

Safe. Fast. Certain.
Guaranteed.
An Employee Owned Company

P.O. Box 737
Longview, WA 98632
www.thermalrs.com

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

Abbreviations and Acronyms

AOC	Administrative Order on Consent
°C	degrees Celsius
COC	contaminants of concern
CPVC	chlorinated polyvinyl chloride
DDT	dichlorodiphenyltrichloroethane
DNAPL	dense non-aqueous phase liquid
DOT	United States Department of Transportation
DQO	data quality objectives
DTSC	Department of Toxic Substances and Control
E-stop	emergency stop
ERH	electrical resistance heating
eV	electron volt
FDS	Field Data Solutions
FLUTe™	Flexible Liner Underground Technologies
FS	Feasibility Study
FTA	Focused Treatment Area
ft^2	square foot
ft bgs	feet below ground surface
gpm	gallons per minute
HASP	Health and Safety Plan
hp	horsepower
Hz	hertz
HSA	Hollow Stem Auger
ISO	International Organization for Standardization
ISTR	*in situ* thermal remediation
kVA	kilovolt-amperes
kW	kilowatt
kWh	kilowatt hour
kWh/yd	kilowatt hour per cubic yard
LADWP	Los Angeles Department of Water & Power
LGAC	liquid-phase granular activated carbon
MCB	monochlorobenzene
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
Montrose	Montrose Chemical Corporation of California
NAPL	non-aqueous phase liquid
OMM	Operations and Maintenance Manual
OSHA	Occupational Safety and Health Administration

pCBSA	para-chlorobenzene sulfonic acid
PCU	Power Control Unit
PEX	cross-linked polyethylene
PID	photoionization detector
PLC	process logic controller
PPE	personal protective equipment
ppm	parts per million
ppmv	parts per million by volume
psi	pounds per square inch
PUF	polyurethane foam
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RTD	resistance temperature detector
SAP/QAPP	Sampling and Analysis Plan/Quality Assurance Project Plan
SCAQMD	South Coast Air Quality Management District
SCH 40	schedule 40
scfm	standard cubic feet per minute
SOP	Standard Operating Procedure
SRGAC	Steam Regenerative Granular Activated Carbon
SUCL	Start-Up Checklist
SVE	soil vapor extraction
TGRS	Torrance Groundwater Remediation System
TMP	temperature monitoring point
TRS	TRS Group, Inc.
TSDF	Treatment, Storage, and Disposal Facility
UBA	Upper Bellflower Aquitard
ug/L	micrograms per liter
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
VAC	volts alternating current
VFD	variable frequency drive
VGAC	vapor-phase granular activated carbon
VR	vapor recovery
yd^3	cubic yard

EXECUTIVE SUMMARY

This report provides a summary of the design, installation, operation, confirmation sampling, and decommissioning of the electrical resistance heating (ERH) pilot test at the Montrose Superfund Site, located at 20201 Normandie Avenue, Los Angeles, California (Site). TRS Group, Inc. (TRS) prepared this report on behalf of Montrose Chemical Corporation of California (Montrose). The ERH pilot test was completed under the Administrative Order on Consent (AOC), United States Environmental Protection Agency (USEPA) Docket No. 85-04 (EPA, 1989), and in accordance with the *Electrical Resistance Heating Pilot Test Workplan* (TRS, 2018) conditionally approved by USEPA via letter on March 13, 2018.

The ERH pilot test used ERH technology, combined with a vapor recovery (VR) and treatment system, to demonstrate the ability of ERH technology to reduce mobile dense non-aqueous phase liquid (DNAPL) mass to the extent practicable within the ERH pilot test area and collect site-specific data to support the selection of a larger scale ERH system at the Site.

The ERH system used a single power control unit (PCU) with an output capacity of 500 kilowatts (kW), one steam condenser and cooling tower and a vapor recovery (VR) blower. Captured vapors were treated with a steam regenerated granulated activated carbon (SRGAC) unit and polishing vapor-phase granulated activated carbon (VGAC) units. All process water was treated via liquid-phase granular activated carbon (LGAC) prior to discharge to the Torrance Groundwater Remediation System (TGRS) at the Site.

The ERH pilot test system construction began on April 3, 2018 with baseline sampling occurring between May 21, 2018 and May 31, 2018. Vapor recovery system operations began on December 17, 2018, and were completed on May 23, 2019. ERH system heating operations began on December 19, 2018, and ended on April 30, 2019. The VR system operated for 153 days and 659,299 kilowatt hours (kWh) of energy were applied to the treatment volume over a total time period of 132 days of heating. On average, subsurface temperatures increased at a rate of approximately 0.5 to 2.3 degrees Celsius (ºC) per day as the average treatment area temperature increased from ambient to a maximum average temperature of 107.0°C.

The VR system operated at an average flow rate of 380 standard cubic feet per minute (scfm) during the operational period. Based on direct measurement of accumulated DNAPL and estimates of mass captured on polish VGAC, approximately 26,600 pounds (lbs) of total volatile organic compounds (VOCs) were recovered from the treatment volume during ERH heating. A total of 2,519 gallons of DNAPL were recovered by the SRGAC unit.

During ERH operations, a groundwater sample was collected from DNAPL extraction well UBE-05 in March 2019. The reported concentration of monochlorobenzene (MCB) was 2,500 µg/L, a value that is less than 1 percent of the solubility limit of that compound. This well was successfully purged for DNAPL in November 2019, approximately 6 months since the completion of the ERH pilot test, and no DNAPL was recovered (GES, 2020).

Baseline sampling during ERH subsurface component installation found the average concentration of MCB in soil within the pilot test treatment volume prior to ERH system operations was 970 milligrams per kilogram (mg/kg). Confirmatory sampling within the pilot test treatment volume indicated an average concentration of MCB of 1.37 mg/kg which equates to an average mass reduction of MCB of 99.86 percent.

MCB concentrations in the confirmation soil samples were found to be significantly below the concentrations equivalent to the residual DNAPL saturation for that soil type (27,900 mg/kg in sand and 17,000 mg/kg in silt). Within most of the pilot test treatment volume, concentrations of MCB were more than four orders of magnitude below the residual saturation levels indicating there is no mobile DNAPL.

1.0 INTRODUCTION

This report provides a summary of the design, installation, operation, sampling, and decommissioning of the electrical resistance heating (ERH) pilot test at the Montrose Superfund Site, located at 20201 Normandie Avenue, Los Angeles, California (Site). TRS Group, Inc. (TRS) has prepared this report on behalf of Montrose Chemical Corporation of California (Montrose). The ERH pilot test was completed under the Administrative Order of Consent (AOC), United States Environmental Protection Agency (USEPA) Docket No. 85-04 (EPA, 1989). Site work was conducted in accordance with USEPA-approved documents listed in **Table 1.** USEPA-Approved Site-Specific Documents

Table 1. USEPA-Approved Site-Specific Documents

Document Title	Final Version Submittal Date	USEPA Approval Date
Site-Specific Health and Safety Plan (HASP)	February 14, 2017	
Revision 1	March 3, 2017	
Revision 2	April 18, 2018	
Revision 3	May 24, 2018	
Revision 4	February 26, 2019	
Revised Mobile DNAPL Boundary Confirmation Work Plan	October 4, 2017	October 6, 2017
ERH Pilot Test Sampling and Analysis Plan/Quality Assurance Plan (SAP/QAPP)	October 4, 2017	October 6, 2017
ERH Pilot Test Workplan and Design	May 25, 2018	March 13, 2018[(1)]
Revised ERH Pilot Test Boundary Confirmation and Baseline Sampling Report	April 2, 2019	April 17, 2019
ERH Pilot Operations and Maintenance Manual	April 2, 2019	April 17, 2019
ERH Pilot Construction and Start-Up Report	January 29, 2019	
Memorandum: Determination of ERH Pilot Test Completeness	April 23, 2019	April 30, 2019

1. Conditional approval.

The ERH pilot test used ERH technology, combined with a vapor recovery (VR) and treatment system, to demonstrate the ability of ERH technology to reduce mobile dense non-aqueous phase liquid (DNAPL) mass to the extent practicable in the ERH Pilot test area depicted on **Figure Y-1**.

1.1. Site Description

From 1947 to 1982, the Site was the location of a Montrose facility that manufactured the pesticide dichlorodiphenyltrichloroethane (DDT). This process involved the use of monochlorobenzene (MCB) and other compounds. Operations at the Site ceased in 1982 and the buildings associated with Montrose operations were demolished and removed between 1983 and 1985. The lot was then graded and paved.

The Site is currently unoccupied, covered with asphalt, and fenced with an entrance located in the northeast corner of the property along Normandie Avenue. The Torrance Groundwater Remediation System (TGRS), is located in the northeast portion of the property with extraction and injection well infrastructure (i.e., wells and piping) extending to the south/southeast and northeast/northwest, respectively, from the facility, primarily along public rights-of-way. Jones Chemical, Inc. (JCI) property is located to the south of the Montrose property. A broader range of more toxic and carcinogenic volatile organic compounds (VOCs) have been detected on JCI including tetrachloroethylene (PCE), trichlorethylene (TCE), 1,1-dichloroethene (1,1-DCE), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichlorethane (1,1-DCA), 1,1,2-trichloroethane (1,1,2-TCA), and vinyl chloride (VC; AECOM, 2013).

DNAPL occurs at saturations that are both mobile and immobile in the environment. At lower or residual saturations, the DNAPL is immobile in the environment and bound to the soil pore space. When present in higher saturations, the DNAPL is mobile in the environment and can migrate. Analysis of capillary pressure data from baseline samples collected by TRS in May 2018 and analyzed by Core Laboratories found the DNAPL mobility threshold to be 27.1 percent residual saturation in sand samples and 14.1 percent in silt samples, corresponding to approximately 27,900 milligrams per kilogram (mg/kg) MCB in sand and 17,000 mg/kg MCB in silt at the Site.

Historical Site investigation activities identified the presence of a DNAPL composed of approximately 50 percent MCB and 50 percent DDT by weight. The DNAPL is approximately 25 percent more dense than water and occurs in the form of ganglia and pools over relatively thin intervals within the unsaturated zone and uppermost water-bearing zone at the Site, the Upper Bellflower Aquitard (UBA). The UBA is heterogeneous and interbedded with layers of fine-grained sand, silty sand, silt, and occasional clayey intervals, which vary in thickness and lateral continuity across the Site. The majority of the observed DNAPL is perched on low permeability silt or confining layers within the saturated UBA. DNAPL extends below and east of the former Central Process Area at the Montrose property and is potentially present within the saturated UBA over an area of approximately 160,000 square feet (ft^2)(**Figure Y-1**). For additional details regarding the nature and extent of DNAPL at the Site, please refer to Section 2 of the Final DNAPL FS (AECOM, 2013).

Mobile DNAPL was estimated to occur at the Site at two locations over an area of approximately 26,000 ft^2 as shown in **Figure Y-1**. The smaller of the two mobile DNAPL areas was located in the vicinity of DNAPL extraction well UBE-5. This was the location of the ERH pilot test described in this report.

DNAPL characterization data collected in 2003/2004 indicated the presence of mobile DNAPL at boring SSB-12. A DNAPL concentration of 105,000 mg/kg, was detected in a soil sample collected at 82.5 feet below ground surface (bgs) in boring SSB-12 (AECOM, 2013). To verify the occurrence of mobile DNAPL at this location, well UBE-5 was installed in September 2008 within 5 feet of soil boring SSB-12 as shown on **Figure Y-2**. Well UBE-5 was screened to coincide with the occurrence of

DNAPL in SSB-12 (Earth Tech, 2008j). DNAPL has passively accumulated in UBE-5 intermittently from the time of well installation in 2008, up to the time of DNAPL sample collection on June 5, 2018 for physical properties testing associated with ERH application. DNAPL recovery was unsuccessfully attempted as part of quarterly purging on September 19, 2018. This well was successfully purged for DNAPL in November 2019, approximately 6 months since the completion of the ERH pilot test, and no DNAPL was recovered (GES, 2020).

The approximate vertical extent of the ERH targeted volume within the pilot test area was from 60 feet below ground surface (ft bgs) to 90 ft bgs. The ERH pilot test focused on demonstrating the suitability of ERH technology for a future full-scale remedy by reducing mobile DNAPL mass, to the extent practicable, within the estimated 3,289 ft^2 area depicted on **Figure Y-1**. The following information was obtained from the DNAPL Feasibility Study (AECOM, 2013) and serves as the starting point for understanding the relationship of MCB and mobile DNAPL:

> *An area of approximately 26,000 square feet is estimated to contain DNAPL in concentrations which are potentially mobile at the Site. This area was defined based on DNAPL concentration data from numerous soil borings. For purposes of this Feasibility Study, the area containing potentially mobile DNAPL is defined as the "Focused Treatment Area".*

1.2. ERH Site-Specific Design

During ERH, electrical current is passed through the soil and groundwater requiring volatile organic compound (VOC) removal. As electrical power is applied to the treatment volume, the soil's natural resistance to flow of electrical current creates heat. In turn, the temperature of the soil and groundwater increases within the treatment volume. During ERH, electrical energy is applied such that groundwater is converted to steam. The phase change from liquid (including contaminants adsorbed onto soil particles) to vapor liberates the target contaminants into the vapor stream. The VR system collects the vapor steam (and target contaminants) for VOC removal in the above-ground, vapor treatment equipment. The *in situ* steam generated by ERH acts as a carrier gas to sweep contaminants to negative pressure VR screens.

Once steam and soil vapors are collected by the VR system and removed from the subsurface, the steam mixture is conveyed by chlorinated polyvinyl chloride (CPVC) piping headers to the ERH system condenser. At the ERH system condenser, the recovered mixture is passed through a primary vapor/liquid separator to remove entrained moisture. Next, the mixture is passed through a water-cooled, non-contact heat exchanger and is cooled to near ambient temperatures. This reduction in temperature causes the steam to condense and allows VOC vapors and air to continue to the vapor-phase granulated active carbon (VGAC) units to capture VOCs.

The soil at the Site is impacted with volatile organic compounds (VOCs) and pesticides, most notably MCB and DDT. TRS' heating approach targets the MCB using steam stripping as the primary removal mechanism and addresses other contaminants of concern (COCs) in the process. TRS estimated that approximately 700,000 kilowatt hours (kWh) of energy would be required to achieve the goals of the pilot test. The time required to apply this amount of energy to the subsurface was estimated to be 105 to 140 days. It was estimated that an extra 50,000 kWh of energy will be used by ERH surface equipment during the project for purposes of vapor recovery, vapor cooling, and vapor treatment.

The target energy density for this project was estimated at approximately 179 kWh of energy per cubic yard (yd^3) of soil. Completion of the pilot test was based on the reduction of mobile DNAPL mass, to the extent practicable, within the pilot test area. Based on data collected during the DNAPL Feasibility Study (FS), this was estimated to correspond to a concentration of MCB below 26,500 mg/kg. Additional samples were collected during baseline sampling of the ERH pilot test area to confirm historical findings. Analysis of capillary pressure data from the baseline sampling event analyzed by Core Laboratories found the DNAPL mobility threshold to be 27.1 percent residual saturation in sand samples and 14.1 percent in silt samples, corresponding to approximately 27,900 mg/kg MCB in sand and 17,000 mg/kg MCB in silt at the Site. Baseline sampling data is presented in the Revised ERH Pilot Test Boundary Confirmation and Baseline Sampling Report (TRS, 2018) and is discussed in **Section 3.0**. The key design parameters are included **Table 2** below. Key components of the design are described in the following subsections.

Table 2. ERH System Design Parameters

ERH System Parameter	Historical	Baseline
ERH Pilot Test Area	3,076 ft^2	3,289 ft^2
ERH Pilot Test Volume	3,418 yd^3	3,700 yd^3
Vertical Extent of Pilot Test	60 to 90 ft bgs	60 to 90 ft bgs (elements extend to 92 ft bgs)
Average Concentration of MCB in Soil	1,699 mg/kg	970 mg/kg
Maximum Concentration of MCB in Soil	50,000[1] mg/kg	13,000[2] mg/kg
Concentration Goal (MCB concentration corresponding with mobile DNAPL)	26,500[3] mg/kg	27,900[4] mg/kg (sand) 17,000[4] mg/kg (silt)
Estimated Total Energy		700,000 kWh
Estimated Energy Density		179 kWh/yd^3
Estimated Average Combined Air and Vapor Recovery Flow Rate		400 cu ft/min
Estimated Average Condensate Production Rate		0.8 gpm

Notes: [1]SSB-12, 82.5 ft bgs, 2003 (H+A, 2004). [2]TMP-C2, 81 ft bgs, 2018 (TRS, 2019). [3]Preliminary value estimated in DNAPL FS (AECOM, 2013). [4]Values refined based on results of ERH baseline sampling (TRS, 2019).

The ERH system consisted of the primary components listed in **Table 3** and are further described in the sections below.

Table 3. ERH Pilot System Primary Components

System Component	Quantity
500 kW Power Control Unit (PCU)	1
ERH Electrodes	21
Co-Located Vapor Recovery (VR) Wells	21
Interior Temperature Monitoring Points (TMPs)	6
Interior Resistance Temperature Detectors (RTDs)	54
Co-located Interior Vapor Piezometers	6
Exterior TMPs	6
Exterior RTDs	6
Co-located Exterior Vapor Piezometers	6
Steam Condenser and Cooling Tower	1
Liquid Phase Granular Activated Carbon (LGAC) Vessels	2
Steam Regenerated Granular Activated Carbon (SRGAC) System	1
Vapor Phase Granular Activated Carbon (VGAC) Vessels (polishing)	2

1.2.1. Power Control Unit

An ERH power control unit (PCU) is used to receive electrical power from the electrical utility and regulate power application to the treatment volume. A PCU is a variable voltage transformer system capable of providing three-phase at power at 60 hertz (Hz)to a maximum power output dependent on design. The PCU is housed in a weather-tight steel enclosure that provides security and electrical insulation. During ERH application, the output voltage can be regulated to the appropriate level for optimum subsurface heating. As the subsurface heats, this optimum voltage changes and the PCU can be adjusted to meet the changing Site subsurface conditions.

PCU control and data acquisition are performed on a dedicated computer and associated programmable logic controller (PLC). Remote data acquisition software is used to collect and store subsurface temperatures, power, voltage, amperage, and operational status data for the entire ERH system. Off-site project personnel are able to view and download this information in real-time using an on-site internet connection.

For the ERH pilot test, a 500 kilovolt-amperes (kVA), three-phase, 60 Hz PCU unit was used. The PCU was also equipped with an emergency stop (E-stop) button on the outside of the PCU, next to the main office entrance of the PCU. Three additional E-stop buttons were located adjacent to the north and south gates at the entrance to the ERH pilot test area, and to the west of the SRGAC unit (see **Figure Y-9)**.

1.2.2. ERH Electrodes

During ERH, electrical energy from the PCU is applied directly to the subsurface via ERH electrodes. The ERH Pilot design employed 21 dual-element electrodes at the Site, each with a "deep" and "shallow" electrode element. Electrode spacing was approximately 15 to 17 feet on center as shown on **Figure Y-3.** Electrodes were installed with hollow stem auger (HSA) drill rigs with a 12-inch auger head. Each electrode element consisted of two copper plates installed into the subsurface at the appropriate depth. The downhole electrode materials consisted of the copper elements, TRS' patented conductive backfill, sand, and controlled density fill. Conductive elements and TRS' patented conductive backfill were placed at depths of approximately 56 to 72 ft bgs and 76 to 92 ft bgs, separated by a sand layer to minimize flow of electrical current between the dual elements of an individual electrode. Electrode elements extended 2 feet below the treatment volume to a total depth of approximately 92 ft bgs. Construction details for downhole electrode design are shown in **Figure M-1.** At ground surface, electrode cables were within an electrically isolating 10-inch plastic oversleeve with cap. The oversleeve cap was fastened to the oversleeve to ensure a tool is required for entry and warning placard was be placed on the oversleeve indicating the presence of an electrical hazard. Electrode head and oversleeve details are shown in **Figure M-3.**

1.2.3. Electrode Drip System (Contingency)

The purpose of an electrode drip system is to keep the interface between the electrode and surrounding soil moist for optimum electrical conductivity, with special focus on electrode elements with conductive intervals targeted in the vadose or unsaturated zone. The depth to the top of the water table was expected to remain above the ERH Pilot electrode elements during ERH operations; thus, the need for an electrode drip system was unlikely. However, based on the possibility of groundwater drawdown due to operation of the TGRS, TRS installed drip tubes at each electrode location as a contingency. During electrode installation, a 20-foot copper tube was installed to a depth of approximately 54 ft bgs, capped with a stainless-steel screen to allow water flow, and brought to the surface using ½-inch cross-linked polyethylene (PEX) tubing. The PEX tubing exited the electrode head at the surface and valves were installed for future water supply installation, if necessary. Electrode performance data collection during operations did not indicate a loss of conductivity resulting from a lack of moisture at the electrode interface, and the electrode drip system was not utilized. Details of drip tube installation are shown on **Figures M-1** and **M-3.**

1.2.4. Interior Temperature Monitoring Points

As a means of monitoring the ERH process, TRS equipment provides continuous temperature data collection within the subsurface to system operators. Temperature data can be automatically recorded multiple times per day from the temperature monitoring point (TMP) locations located within the ERH treatment volume.

For the ERH pilot test, a total of six "interior TMPs" were installed within the treatment volume using a sonic drill rig and 1.5-inch carbon steel casing grouted in a 6-inch boring. Each interior TMP included a string of nine resistance temperature detectors (RTDs) to monitor subsurface temperatures at five-foot subsurface intervals from approximately 50 to 90 ft bgs. RTD cables came to the surface below an isolating 6-inch plastic oversleeve with cap.

The internal area of the oversleeve was considered an ERH Restricted Zone and no access was be granted into the electrode oversleeves while the electrode field is energized. The oversleeve cap was fastened to the oversleeve to ensure a tool is required for entry.

Construction details of interior TMPs are provided in **Figure M-2a** and TMP head details are shown in **Figure M-4.**

1.2.5. Exterior Temperature Monitoring Points

Six exterior TMPs were used to monitor temperatures at depth outside of the ERH pilot test area for monitoring hydraulic control. The exterior TMPs were installed at a distance of approximately 15 feet from the perimeter of the pilot test area. Temperatures were measured at depths identical to interior TMPs. The locations of the TMPs were based on the thermal penetration modeling completed during the ERH design process. Details regarding monitoring at the external TMPs are presented in **Section 5.3.2**.

Exterior TMPs were installed with an 8-inch HSA boring and were constructed with the same casing material as interior TMPs. Construction details of TMPs are provided in **Figure M-2b** and TMP head details are shown in **Figure M-4.**

1.2.6. Vapor Piezometers

Vapor piezometers measure and verify pneumatic control during application of ERH. For the ERH pilot test, a vapor piezometer was co-located with each of the six interior and six exterior TMP locations and installed concurrent with TMP installation. The vapor piezometers were constructed of 1-inch schedule 40 (SCH 40) CPVC with a 2-foot long screen of the same material. The screen material of TMP-P3 consisted of polyvinyl chloride (PVC). Construction details of the piezometers are provided in **Figure M-2**. Piezometers came to the surface below the isolating 6-inch plastic TMP oversleeve with cap. The piezometer tubing exited the TMP head at the surface and contained a valve and attachment for pressure monitoring. Temperature monitoring point head details are shown in **Figure M-4.**

1.2.7. Vapor Recovery Wells and Conveyance Piping

Each electrode was constructed with a co-located vertical VR well for removing air, steam, and contaminant vapors from the subsurface. A 5-foot long, 1.5-inch slotted stainless-steel screen was located from approximately 46 to 51 ft bgs at each electrode location. A 1.5-inch carbon steel riser conveyed the VR stream to the surface inside the electrode oversleeve. Construction details for the VR wells are included in the electrode design shown in **Figures M-1** and **M-3.**

Within the oversleeve, the conveyance piping transitioned to 1.5-inch Novaflex® hose prior to connecting individual VR wells to the VR header network. A Corzan® CPVC piping network conveyed the VR stream from the electrode field to the condenser as shown on **Figure Y-5**.

1.2.8. ERH Condenser

As the subsurface ERH treatment volume is heated, contaminants are volatilized and steam-stripped from the ERH pilot test volume soil and groundwater. Air, contaminant vapors, and steam is collected at the VR wells, which are co-located with electrodes throughout the ERH region. Vapor recovery is performed using a positive displacement blower placed downstream of the condenser and on the upstream side of the vapor treatment system. The blower is housed in an enclosure that provides security and noise insulation. Gauges and/or pitot tubes were installed to measure vacuum, flow, and temperature at the blower inlet and outlet.

The ERH steam condenser system consists of an inlet air/water separation vessel, a plate and frame heat exchanger, a condensate tank, cooling tower, outlet air/water separation system, and ancillary pumps and controls. Air, contaminant vapors, and steam are pulled through the condenser by the applied vacuum of the VR blower. The inlet separation vessel removes entrained water from the influent vapor stream. Air and steam then enter the air side of the heat exchanger, where steam is converted to condensate as heat is removed from the mixture. The vapor outlet of the condenser contains a mist eliminator that is approximately 99 percent efficient in removing droplets to a size of 10 microns. Automated condensate pumping functions are monitored, controlled, and recorded by the PCU computer and/or onboard PLC. The ERH condenser system is also equipped with remote monitoring capabilities. The ERH condenser is interlocked to the PCU to shut down power application to the subsurface, should it cease to operate for any reason. Potable water is supplied from the Site's main potable water supply for use in the cooling tower.

For the ERH Pilot, vapor recovery was performed using one 25-horsepower (hp) positive displacement blower. The combined steam and air recovery rate at full boiling conditions was estimated to be 400 standard cubic feet per minute (scfm) at design. See **Figures Y-5** and **Y-11** for piping construction details.

The condenser system sat within a manufactured, 40-mil polyethylene, secondary containment berm that was designed to hold over 110 percent of the liquid capacity of the system. An interlocked level switch within the secondary containment was installed, and TRS was notified if triggered.

1.2.9. Liquid Treatment System

Condensate exits the ERH condenser and is treated with a filtration system and liquid-phase granular activated carbon (LGAC). Total volume of water generated by the system is monitored using totalizers for each separate stream of water (i.e. condensate, makeup, electrode drip, and discharge). Pressure gauges are used to monitor pressure of the water lines. Locations of totalizers, temperature gauges, and pressure gauges in the condenser system are shown on **Figures P-5, P-6,** and **P-12.**

For the ERH pilot test, an estimated 133,000 gallons of water was expected to be removed from the subsurface in the form of condensed steam recovered from the VR wells. Condensate was treated with two vessels, connected in series, each containing 200 pounds of LGAC. After treatment, the water was discharged to the TGRS, located adjacent to the east of the ERH pilot test area.

The liquid treatment system sat within a manufactured, 40-mil polyethylene, secondary containment berm that is designed to hold over 110 percent of the liquid capacity of the system. An interlocked level switch was installed within the secondary containment to notify TRS if triggered.

1.2.10. Steam Regenerated Granular Activated Carbon System

The SRGAC system includes two vessels, each containing approximately 1,800 pounds of VGAC, which regenerate using steam from an on-site boiler system supplied by TRS. Vapor-phase contaminants adsorb to the carbon in the vessels and are flushed to the decanter tank upon a steaming recharge cycle of the vessel. Carbon within one vessel is regenerated while the other is used to capture contaminants from the vapor stream. This allows for uninterrupted operations. The decanter tank is used to separate the water from DNAPL, which is routed to a non-aqueous phase liquid (NAPL) storage tank via double-walled piping. Condensate from the decanter is routed to the ERH condenser and processed through the liquid treatment system.

The SRGAC system requires a dedicated boiler and cooling tower. The boiler is contained within a 20-foot International Organization for Standardization (ISO) container. The boiler requires a propane or natural gas fuel source and a water supply. A chemical feed tank located inside the boiler container supplies neutralizing amines for carbon dioxide control, potassium hydroxide to prevent corrosion, and sodium sulfite as an oxygen scavenger. Steam is supplied to the SGRAC via carbon steel piping and fed to the decanter after GAC vessel regeneration, as described above. Boiler start-up and maintenance was conducted by a local, licensed boiler vendor. TRS field staff attended a Boiler Operations course prior to start-up of the boiler system, and only trained field staff are permitted to operate the boiler. Details of boiler process and design are shown on **Figures P-13** to **P-15.**

The SRGAC cooling tower is similar to the condenser cooling tower and requires a make-up water supply and blowdown of potable water to TGRS. A recycle pump located in the SRGAC support skid circulates cooling water through the cooling tower and to/from the SRGAC. Details of the SRGAC cooling tower are shown on **Figure P-7.**

For the ERH pilot test, treated vapor exited the SRGAC system and was treated with the two, 1,000-pound polishing VGAC vessels prior to discharge via the effluent stack. The effluent stack was 20 feet tall and was equipped with a sample port, temperature gauge, pressure gauge, and pitot tube for monitoring. Sample ports were located at the influent of the SRGAC system, the influent of the primary polishing VGAC vessel, midpoint between the VGAC vessels, effluent of polishing VGAC vessels, and discharge stack. Details of sample port, temperature, and pressure gauge locations are shown on **Figures P-7** through **P-11.**

The primary SRGAC skid and decanter were placed within a secondary containment berm. An interlocked level switch on the secondary containment was installed to notify TRS staff. In addition to the nearby field E-stop, an E-stop button was located on the SRGAC user interface.

1.2.11. Ambient Air Monitoring

Four active ambient air monitoring stations were deployed at the Site at the perimeter of the ERH pilot test fencing on August 16, 2018, by Field Data Solutions (FDS). Each unit consisted of a stand-alone, solar powered, datalogging photoionization detector (PID) and meteorological station. Locations of the monitoring stations are depicted on **Figure Y-3**. The intent of the air monitoring stations was to monitor ambient air and alert project personnel to the presence of any fugitive emissions during operations. PID readings were continuously automatically compared to a threshold alarm value each minute in real-time and average hourly readings recorded. The PIDs were programmed with an alarm to alert project personnel immediately via cell phone if concentrations exceed action levels defined in the site-specific HASP (TRS, 2019).

In addition to the four standalone PID stations, monthly ambient air samples were collected during operations from each of the standalone station vicinities using laboratory supplied and certified clean Radiello® passive samplers. Passive samplers were installed within a shelter in accordance with the sampling guide provided by the laboratory and provided in the TRS Pilot Study Operations and Maintenance Manual (OMM) (TRS, 2019).

Ambient air monitoring results are discussed in **Section 5.4**.

1.2.12. Site Security

Site security during construction, operations, and demobilization was monitored using a cellular-based, infrared, motion-detecting, battery operated camera system. The security system provided cameras which alert TRS of breach with an e-mailed video and a phone call from a manned alarm center. One 360-degree camera located on a mast above the PCU allows remote viewing of the Site. For the operational phase of the remediation, a motion-detecting security system monitored the perimeter fence lines. This system consists of motion-detecting sensors which, if movement is detected within the coverage area, opens the PCU load contactor and immediately discontinues electrical energy application to the subsurface. TRS is notified of this action by automated text message, e-mail, and automated phone call. No breaches of site security were documented during ERH operations, as discussed in **Section 5.5.**

The Montrose Site is surrounded by an iron fence, topped with barbed wire, and a locking gate. For the ERH Pilot, an additional, temporary chain link fence surrounded the ERH Pilot area. Signs indicating “Danger, High Voltage” and “Do Not Dig” signs were placed every 20 feet around the treatment area perimeter fence. Access to the ERH compound was controlled by a locked gate. Security system details are provided on **Figure Y-9**.

2.0 GOALS AND PILOT TEST OBJECTIVES

The primary goal of the ERH pilot test was to apply ERH and VR to reduce mobile DNAPL mass to the extent practicable. The ERH pilot test also presented an opportunity to collect site-specific data to support the selection of a larger scale ERH system at the Site. The ERH pilot test objectives established prior to operations included the following, and results are evaluated in **Section 9.3**:

1. Reduce mobile DNAPL mass, to the extent practicable, in the subsurface within the pilot test treatment volume. Based on preliminary data prior to the ERH pilot test, this was estimated to correspond to a concentration of MCB below 26,500 mg/kg. This concentration equates to half of the 53,000 mg/kg residual DNAPL concentration used to establish the Focused Treatment Area (FTA) in Section 2.5.3 of the Final DNAPL FS (AECOM, 2013). Additionally, collect data to refine the estimated MCB concentration at which DNAPL is mobile.
2. Analyze site-specific ERH system data and refine the evaluation of multiple lines of evidence used to determine when ERH system operations are complete at the Montrose site. Data to be evaluated includes subsurface temperatures, total energy use, MCB removal rates, cumulative mass removal, and confirmatory sampling results.
3. Document homogeneous/uniform heating within each depth interval throughout the pilot test treatment volume. Analyze site-specific operational data of the pilot test to optimize electrode design, electrode spacing, and operational approach of “bottom-up heating”.
4. Document actual energy usage and compare to that estimated in the DNAPL FS (AECOM, 2013) (200 kWh per yd^3).
5. Demonstrate ERH will not result in uncontrolled lateral or vertical DNAPL migration.
    a. Absence of lateral migration will be determined by measuring temperatures at external temperature monitoring points (TMPs). It is not possible for heat to push contamination without also leaving evidence in the form of elevated temperatures. The Operations and Maintenance Manual (OMM) will present threshold temperature rise over time based on conduction for the external TMPs.
    b. Absence of downward vertical migration will be determined by collecting an additional sample from each confirmatory sampling location (at completion of the ERH pilot test) at a depth of 5 ft below the deepest extent of DNAPL identified during baseline sampling to confirm that MCB concentrations remain below the DNAPL mobility threshold (TRS, 2017).
6. Demonstrate the VR system effectively collects MCB without cooling and condensing in the subsurface. This will be demonstrated by collected soil samples near 55 ft bgs, the depth of maximum MCB VR.
7. Demonstrate cost-effective disposal of condensed liquid wastes. Develop a water management plan for the focused mobile DNAPL area based on water treatment plant capabilities and limitations and actual condensation production from the ERH pilot test.
8. Confirm the ERH power demands are within design expectations and determine scalability to apply ERH in the focused mobile DNAPL area.
9. Evaluate temperature data from TMPs located outside of the ERH pilot test area to monitor the rate and direction of groundwater flow outside of the pilot test ERH treatment volume.

10. Monitor pressure data from vapor piezometers within and outside of the ERH pilot test area to demonstrate the flow of air toward the pilot test treatment volume during ERH system operation and provide additional assurance that contaminant mass is not condensing.
11. Complete air monitoring during ERH pilot test construction, operation, and demolition to confirm safe breathing levels are maintained during the ERH pilot test.

Discussion and analysis of project goals versus performance is presented in **Section 9.3**.

3.0 ERH PILOT TEST BOUNDARY CONFIRMATION AND BASELINE SAMPLING

Boundary confirmation of the ERH pilot test treatment volume was conducted from October 9, 2017, to October 13, 2017. Soil boring logs and laboratory data packages from the ERH pilot test Boundary Confirmation event are provided in **Appendix A-1** and **Appendix A-2**, respectively. Data is presented on **Figure Y-2.** Baseline sampling of the ERH pilot test treatment volume was conducted concurrently with interior TMP installation from May 21, 2018, to May 31, 2018. Soil boring logs and laboratory data packages from the ERH pilot test baseline sampling event are provided in **Appendix B-1** and **Appendix B-2**, respectively. Data is presented on **Figure Y-2B.** For details of the sampling events and results, please refer to the Revised ERH Pilot Test Boundary Confirmation and Baseline Sampling Report (TRS, 2019). Baseline concentrations are compared to confirmatory sampling results in **Section 6.2.**

The extent of mobile DNAPL within the Pilot ERH treatment volume was characterized by six boundary confirmation borings, soil borings “MON1803-1” through “MON1803-6”, and MCB concentrations were determined at each sample location. Based on the findings of the boundary confirmation sampling event, the Pilot ERH treatment volume was shifted slightly to the northeast due to higher concentrations of MCB observed in MON1803-2, as shown on **Figure Y-2**. Although mobile DNAPL is not believed to occur at MON1803-2 based on comparison with residual DNAPL saturations determined during capillary pressure testing of representative soil samples, the surface area of the treatment volume was expanded slightly during construction from the estimated 3,076 to 3,289 ft^2.

Analysis of capillary pressure data from the baseline sampling event found the DNAPL mobility threshold to be 27.1 percent residual saturation in sand samples and 14.1 percent in silt samples, corresponding to approximately 27,900 mg/kg MCB in sand and 17,000 mg/kg MCB in silt at the Site (TRS, 2019). Physical properties analysis from baseline sampling is presented in **Table 4**, and the laboratory data packages are provided in **Appendix A-3.**

Table 4. Soil Physical Properties Data Analysis
Montrose Superfund Site, ERH Pilot Test, Baseline Soil Sampling

Sands

Boring	Depth (feet bgs)	Grain Density (g/cc)	Total Porosity (%)	Water Saturation (%PV)	NAPL Saturation (%PV)	Wet Bulk Density (g/cc)	Dry Bulk Density (g/cc)	Moisture Content (% volume)	Moisture Content (% weight)	Equivalent DNAPL (mg/kg)	Equivalent MCB (mg/kg)
Method		API RP 40				Calculated	API RP 40				
TMP-B3	83.3	2.66	30.4%	77.2%	22.3%	2.16	1.85	23.5%	16.8%		
TMP-C2	80.3	2.66	34.7%	83.9%	10.8%	2.07	1.74	29.1%	18.9%		
TMP-D4	80.8	2.65	40.9%	78.1%	4.1%	1.90	1.57	31.9%	21.1%		
Method		API RP 40		ASTM D6836M		Calculated	API RP 40	Calculated			
TMP-B3	83.1	2.68	28.7%	71.7%	28.3%	2.21	1.91	20.5%	15.7%	45,779	22,889
TMP-C2	80.1	2.67	33.0%	74.9%	25.1%	2.13	1.79	24.7%	19.1%	48,476	24,238
TMP-D4	80.6	2.66	41.8%	72.1%	27.9%	1.99	1.55	30.1%	28.2%	73,192	36,596

Mean Residual NAPL Saturation =	27.1%
Standard Deviation of Mean Residual NAPL Saturation =	1.4%
% Deviation of Mean Residual NAPL Saturation =	5.3%

Mean Concentration =	55,816	27,908
Standard Deviation =	12,336	6,168
% Deviation =	22.1%	22.1%

Silts

Boring	Depth (feet bgs)	Grain Density (g/cc)	Total Porosity (%)	Water Saturation (%PV)	NAPL Saturation (%PV)	Wet Bulk Density (g/cc)	Dry Bulk Density (g/cc)	Moisture Content (% volume)	Moisture Content (% weight)	Equivalent DNAPL (mg/kg)	Equivalent MCB (mg/kg)
Method		API RP 40				Calculated	API RP 40				
TMP-B3	84.3	2.71	40.7%	97.0%	3.0%	2.00	1.61	39.5%	24.7%		
TMP-C2	84.3	2.72	36.6%	93.0%	7.0%	2.09	1.72	34.0%	20.9%		
TMP-D4	82.3	2.71	40.9%	92.9%	3.2%	1.99	1.60	38.0%	24.0%		
Method		API RP 40		ASTM D6836M		Calculated	API RP 40	Calculated			
TMP-B3	84.1	2.74	40.9%	75.8%	24.2%	2.04	1.62	31.0%	26.2%	60,438	30,219
TMP-C2	84.1	2.75	35.5%	87.1%	12.9%	2.13	1.77	30.9%	20.1%	26,818	13,409
TMP-C4	81.6	2.73	41.8%	89.0%	11.0%	2.01	1.59	37.2%	26.3%	28,588	14,294
TMP-C5	81.6	2.74	36.4%	82.7%	17.3%	2.11	1.74	30.1%	21.2%	37,184	18,592
TMP-D4	82.1	2.75	42.9%	85.6%	14.4%	2.00	1.57	36.7%	27.5%	38,478	19,239
TMP-E4	82.6	2.75	42.8%	85.3%	14.7%	2.00	1.57	36.5%	27.5%	39,147	19,573

Mean Residual NAPL Saturation =	15.8%
Standard Deviation of Mean Residual NAPL Saturation =	4.2%
% Deviation of Mean Residual NAPL Saturation =	26.9%

Mean Concentration =	38,442	19,221
Standard Deviation =	10,940	5,470
% Deviation =	28.5%	28.5%

Mean Residual NAPL Saturation* =	14.1%
Standard Deviation of Mean Residual NAPL Saturation* =	2.1%
% Deviation of Mean Residual NAPL Saturation* =	14.8%

Mean Concentration* =	34,043	17,021
Standard Deviation* =	5,245	2,622
% Deviation* =	15.4%	15.4%

Notes:
*Excludes outlier TMP-B3
Water Density = 0.9678 g/cc
NAPL Density = 1.2474 g/cc
bgs = below ground surface
g/cc = grams per cubic centimeter
%PV = percent of pore volume
mg/kg = milligrams per kilogram
DNAPL = dense non-aqueous phase liquid
MCB = monochlorobenzene

4.0 SYSTEM CONSTRUCTION

Construction of the ERH pilot test began on April 3, 2018. Photos of the ERH pilot test equipment compound at the completion of equipment mobilization and construction are provided in **Appendix C-1**.

4.1. Site Mobilization

Construction activities of the ERH system began on April 3, 2018, with Site set-up, materials receipt, and subsurface component prefabrication. CalVada Survey completed a survey and marked all electrode and temperature monitoring point (TMP) locations on April 11, 2018. Survey data is included in **Appendix C-2**. Pacific Coast Locators completed a private utility locate survey for the ERH Pilot test Area and future electrical utility installation areas on April 12, 2018. Each electrode and TMP drilling location was cleared with ground penetrating radar, an electro-magnetic sensor, and a magnometer. CSI Electrical Contractors, Inc. (CSI) was engaged to perform the electrical utility connection to Los Angeles Department of Water and Power (LADWP) and performed a Site walk on April 19, 2018.

4.2. Subsurface Installation

The subsurface portion of the ERH system installation began on May 8, 2018, with the installation of 21 electrodes via HSA by Yellow Jacket Drilling. A temporary chain link fence was erected surrounding the pilot test area on May 10, 2018. During drilling, an abandoned sewer main was encountered and required slight movement of several electrode locations. Electrode D2 was offset approximately 3 feet to the north, electrode E3 was offset approximately 1 foot to the northwest, and electrode E4 was offset approximately 3 feet to the north-northwest. Electrode D4 was also offset 2.5 feet to the south-southeast to avoid the existing extraction well UBE-5. Final electrode locations are presented on **Figure Y-1**. Electrode installation was completed on June 8, 2018. Concurrent installation of six interior TMPs and baseline sampling were completed by Yellow Jacket Drilling from May 21 to 31, 2018, via sonic drilling methods. Details regarding the baseline sampling event were provided in the Revised ERH Pilot Test Boundary Confirmation and Baseline Sampling Report (TRS, 2019). Installation of the exterior TMP locations was completed with HSA on June 14, 2018.

One existing, passive DNAPL extraction well is present in the ERH pilot test treatment volume, UBE-5. The UBE-5 well is constructed of 6-inch stainless steel and screened at an interval of 75 to 85 ft bgs. Prior to initiating ERH, TRS retrofitted UBE-5 with a threaded, stainless steel cap. The well vault was sealed, covered, and labeled with a “High Voltage” warning. UBE-5 was considered an exclusion zone for the duration of ERH operations and no access was permitted while the electrode field was energized.

4.3. Equipment Mobilization

On June 28, 2018, Bragg Crane delivered the ERH Pilot test Area surface equipment to the Site and set the equipment in the designated locations. Installation of the surface components began on July 2, 2018, which included conveyance piping, water supply and discharge lines, communication wiring, electrical connections, and additional equipment deliveries. Four active ambient air monitoring stations via PID and meteorological station were deployed at the Site on August 16, 2018, by FDS. Surface construction was completed on August 30, 2018.

4.4. Power Drop

Due to delays encountered with electrical utility installation, a temporary generator was mobilized to the Site for initial start-up testing procedures. The generator was delivered to the ERH Pilot test Area on August 29, 2018. Temporary electrical connections were established, and start-up testing commenced on August 31, 2018. The temporary generator was demobilized from the Site on September 26, 2018. A temporary generator was also mobilized for the week of November 5, 2018, for additional start-up testing. See **Section 5.1** for additional details.

Approval of the LADWP design was received by CSI via postal service on August 21, 2018, and construction of the electrical utility connection to the Pilot test Area was initiated on September 7, 2018. Construction of the ERH Pilot test electrical connection was completed on November 15, 2018. An inspection of the electrical installation was completed by Intertek on November 29, 2019, and the switchgear was energized by LADWP on December 12, 2018.

5.0 SYSTEM OPERATIONS

ERH system start-up for the pilot test involved the inspection, testing, and adjustment of all ERH system components, process equipment and controls.

5.1. Pre-Start-Up Activities

Prior to energization of ERH equipment, a final quality assurance inspection of all piping and electrical connections was conducted. Quality assurance inspections were completed on the electrode cable connections, TMP field box connections, PCU, condenser components, liquid and vapor treatment systems, and interlock connections. All tanks were visibly inspected for weld cracks or breaks, scrapes of protective coating, corrosion, structural damage, and inadequate installation or construction such as cracks, punctures, and damaged fittings. The ERH condenser, VR system, and SRGAC were inspected in accordance with TRS internal equipment start-up checklists.

Due to delays encountered with electrical utility installation, start-up activities occurred in multiple phases. Initial shakedown activities were initiated with a temporary generator mobilized to the Site on August 29, 2018. This phase of start-up testing consisted of energizing the condenser, blower, boiler, SRGAC unit, TMPs, and control systems to perform equipment tests, programming, and optimization. Routine maintenance was performed on the boiler, water softener, and air compressor units. Functionality testing of the ERH equipment and interlocks was also completed. Items inspected included leak checks, functionality (hand/off/auto switches, float switches, valves), and proper operational parameters on applicable gauges and valves. Upon completion of initial start-up and equipment testing, the temporary generator was demobilized from the Site on September 26, 2018. A temporary generator was also mobilized for the week of November 5, 2018, for additional start-up testing.

During start-up preparation and testing, TRS used a Type “T” thermocouple with a hand-held reader and a thermometer to independently verify that RTD sensors and the associated programming were recording temperature data accurately.

Start-up procedures resumed with utility power on December 13, 2018, in addition to final equipment checks and optimization adjustments for continuous operations. Once proper operations of all components were confirmed, ERH equipment interlocks were re-tested. Testing of the ERH equipment interlocks was completed and operation of the VR blower initiated on December 17, 2018, at approximately 17:00. Testing of the ERH PCU and electrode systems began on December 18, 2018.

5.2. Start-Up

Prior to energizing electrodes, the TRS Start-Up Checklist (SUCL) Part I was completed, which is provided in the Site HASP (TRS, 2019). The SUCL ensures the Site is ready and safe for energy application to the subsurface. ERH start-up was initiated by energizing the electrodes at a low applied voltage. With the electrode field energized, operating parameters in the PCU were compared against known standards. Step-and-touch and voltage-ground voltage surveys (see **Section 5.2.2**) were then completed throughout the area overlying and surrounding the pilot test region. Initial power application and voltage survey protocols were performed consistent with TRS’ internal standard operating procedures (SOPs) 1-2 (*Application of Electrical Power to ERH Sites*) and

1.3 (*Voltage Surveys*), respectively. All TRS SOPs were located in a binder and maintained on-Site in the PCU.

Once all operating conditions were determined to be within accepted standards as outlined in design documents and TRS SOPs, the voltage to the electrode field was slowly increased. With each significant increase in applied voltage, operating parameters were reviewed, and voltage surveys were performed again. Operating conditions were all found to be within acceptable limits.

Once power application levels reached optimum design conditions, final safety inspections and data quality checks were completed. The internal TRS SUCL Part II was completed by on-site TRS personnel and reviewed and approved by TRS senior management to establish that the system is ready for unattended operations. During this process, operation of the PCU was observed while optimum voltage is applied to the electrode field. Remote capabilities of the PCU and data acquisition system were verified. The ERH system was cleared for uninterrupted operations on December 19, 2019.

5.2.1. Initiating Vapor Recovery

The commissioning of the VR well field began with vapor recovery from the co-located electrode/VR wells and occurred prior to continuous application of energy to the subsurface. The procedures for this initial start-up consisted of:

- opening the valves to each VR point
- verifying vacuum at the end of each pipe run on the ground surface in the electrode field and vacuum switch interlock
- measuring VOC vapor concentrations and flow at the discharge in the vapor recovery and treatment system
- verifying vacuum readings prior to and after the condenser
- recording all initial flow totalizer values to prepare for measuring volume of condensate collected by the condenser and treated by the process equipment
- measuring vacuum from each of the interior and exterior piezometers to determine vacuum influence in and around the ERH well field

5.2.2. Voltage Surveys

To ensure the safe application of electrical energy to subsurface soils, TRS performed voltage safety surveys initially, and as power was increased. These surveys are referred to as "step-and-touch" and "extension cord" voltage surveys. The purpose of these voltage safety surveys was to identify the location(s) of possible voltage hazards on or directly adjacent to an operating ERH site. In recording step-and-touch potentials, extra readings are taken at locations where objects that could carry voltage extend from the subsurface.

TRS has established 10 volts alternating current (VAC) as the maximum allowable step-and-touch condition inside the property line fence and 5 VAC outside the property fence line. No voltage potentials greater than these limits are permitted outside of any ERH exclusion zone during operations.

TRS initiated electrical energy application to the subsurface for voltage safety testing on December 18, 2018. These tests were done to evaluate surface conditions for the presence of accessible voltage potentials. Areas where the personnel may walk and/or contact surfaces were evaluated for exposed voltage potential. Tested areas included the ERH Pilot test area, surrounding area, and TGRS exterior compound. No areas exceeding the TRS administrative safety limits were identified. The Site was established as electrically safe and cleared for uninterrupted operations on December 19, 2018. During initial energy application, TRS monitored cable/electrode amperages, applied voltages to the subsurface, and the overall application of ERH to the treatment volume.

5.3. ERH System Operations

A summary of ERH system operational parameters for the ERH pilot test are presented in **Table 5.** ERH System Operating Parameters Summary. Each parameter is discussed in further detail in the following sections.

Table 5. ERH System Operating Parameters Summary

Parameter	Design	Operations
Total Vapor Recovery Operational Days (days)	112 to 147	153
Total Heating Operational Days (days)	105 to 140	93[1]
Applied Average Daily Power During Heating (kW[2])	320	281
Cumulative Energy Applied to Subsurface (kWh[3]) (Percentage of Design Energy Applied)	700,000	659,299 (94.2%)
Cumulative Total Energy Usage (kWh)	750,000	773,760
Energy Density (kWh/yd[3])	179	168 (Average)
		83 to 217 (Range)
Average Subsurface Temperature (°C[4])	95.0	107.0
Average Vapor System Flow Rate (scfm[5])	400	380
Estimated Total VOC Mass Recovered (lbs)	22,500	26,600
Total DNAPL Recovered (gallons)	2,100	2,519
Total Water Discharge to TRGS (gallons)	280,000	175,000

Notes:[1]Prior to confirmatory sampling; [2]kW = kilowatt; [3]kWh = kilowatt hours; [4]°C=degrees Celsius; [5]scfm = standard cubic feet per minute

TRS personnel were on-site throughout operational period collecting system operational data and optimizing system performance and completing safety surveys. The PCU, VR, and vapor abatement systems operated within design parameters. Based on stack effluent PID readings and the Rule 1401 Tier II screening risk assessments completed in accordance with the South Coast Air Quality Management District (SCAQMD), the ERH system operated within the substantive air permit conditions for the duration of operations.

5.3.1. Power and Energy

During operations, TRS routinely monitored power, energy, voltage, amperage, resistance, subsurface temperatures, and VOC recovery data to evaluate system performance. Incremental adjustments were made to the ERH system to maintain an optimal energy application rate within the ERH system limitations as necessary. A total of 659,299 kWh of energy was applied to the treatment volume over a period of 132 days of heating (including downtime), starting on December 19, 2018, and ceasing on April 30, 2019.

The average power applied to the remediation volume during the operational phase was 281 kW when power was applied. The maximum power applied during the operation phase was 419 kW on March 3, 2019.

In accordance with ERH Pilot Workplan (TRS, 2018), a “bottom-up” heating method with dual-element electrodes was implemented in the ERH treatment volume, where only the deep electrode elements were initially energized to allow for the deep region to initially heat 20 degrees Celsius (°C) warmer than the shallow region. Upon initial energization on December 19, 2019, only the deep electrode elements were energized. The shallow electrode elements were connected to the PCU and energized on January 8, 2019. On March 4, 2019, energy to the treatment volume was suspended to all electrode elements, as indicated below. On March 15, 2019, energy application to the treatment volume was resumed only to the shallow electrode elements.

Scheduled/planned shutdowns of durations less than one day included electrode optimization/cabling changes and routine equipment maintenance. In addition, the following scheduled and unscheduled shutdowns occurred:

- December 24, 2018: Power was discontinued due to a variable frequency drive (VFD) failure in the main blower. The auxiliary blower remained operational. Power application was resumed December 28, 2018.
- January 15, 2019: Power was temporarily discontinued due to breakthrough identified in the polish VGAC. See **Section 5.3.4** for details. Power application resumed on January 16, 2019.
- March 4, 2019: Power application was discontinued due to elevated temperatures identified at exterior TMPs. The VR system remained operational. See **Section 5.3.2** for details.
- March 15, 2019. Power application resumed to the shallow elements only.
- April 8, 2019: Power application was discontinued for confirmatory soil sampling activities. The VR system remained operational. See **Section 6.0** for details. Power application resumed on April 15, 2019.
- April 20, 2019: Power application was temporarily discontinued due to a water discharge tank pump malfunction. The auxiliary blower remained in operation during the shutdown. Power application resumed on April 21, 2019.

5.3.2. Electrode Energy Density

VOC removal during *in situ* thermal remediation (ISTR) is driven by distillation and steam stripping processes. The amount of steam and VOCs volatilized from the subsurface is proportional to the amount of energy applied. The term used to evaluate remedial progress is referred to as "energy density" and it is reported in terms of kilowatt-hours per cubic yard (kWh/yd^3) of treated soil. VOC removal from the subsurface is modeled similar to a steam stripping system where the percentage of VOC removal correlates to the applied energy density. Soil with higher VOC impacts may draw more energy density due to higher electrical conductivity whereas less impacted soils may draw less. Approximately 33 percent of the total energy for this pilot test was used to heat the subsurface, approximately 37 percent was used for boiling and approximately 30 percent was attributed to heat loss to the surroundings. An illustration of the energy applied to each electrode element per unit volume in kWh/yd^3 is presented in **Figure 1.**

5.3.3. Temperatures

The average subsurface temperature in the treatment volume prior to the start of power application was 23.4°C. Upon initial energy application, the average subsurface temperature increased rapidly, advancing at between 0.5 to over 2.3°C per day. The heat-up rate then naturally slowed as the subsurface within the treatment volume attained steaming conditions. This slowing of the heat-up rate is an indication of a significant change in subsurface conditions as more of the applied energy is used to accomplish phase change from liquid to vapor rather than increase subsurface temperatures.

At the peak of Site heating, the average subsurface temperature throughout the treatment volume was 107.0°C on March 4, 2019. The highest individual temperature measurement from within the ERH treatment volume was 122.1°C, recorded at TMP D4 at a depth of 85 ft bgs on February 25, 2019.

To illustrate the temperature change at each location over time, the data is broken into six separate graphs based on the TMP location. Temperatures versus depth for each TMP are presented in **Figures 2a** through **2f.** Average subsurface temperature for the entire treatment volume, shallow regions, and deep regions over time is presented in **Figure 3**.

5.3.4. Vapor Recovery and Treatment

The vapor stream flow rate as measured after the VR blower averaged approximately 380 standard cubic feet per minute (scfm) throughout the duration of operations.

Monitoring and analysis of the VR system and effluent stack by EPA Method TO-15 was initiated on December 17, 2018, two days prior to start of heating, and continued throughout operations. This data and information was used to measure system performance (i.e. pounds of contaminant removed), substantive air permit compliance, and was factored into system operations and adjustments.

A summary of SRGAC influent vapor analyses by TO-15 is provided in **Table 6**. All vapor recovery laboratory analyses by TO-15 data packages are included as **Appendix D-1.**

VOC monitoring of the VR system influent at the SRGAC and effluent stack was initiated on December 17, 2018. Vapor stream flow rate and SRGAC Influent PID data are presented on **Figure 4**.

Table 6. Vapor Recovery Influent TO-15 Data Summary

Date	Influent MCB (ppmv)	Total VOC (ppmv)	Vapor Recovery Flowrate (scfm)	MCB Recovery Rate (lbs/day)	Cumulative MCB Recovered (lbs)	Total VOC Recovery Rate (lbs/day)	Total VOC Cumulative Mass Recovered (lbs)
12/19/2018	830	1,322	380	133	21	227	35
1/10/2019	250	397	365	38	1,603	64	2,719
1/24/2019	590	749	380	94	2,569	123	4,071
1/31/2019	3	85	375	1	2,817	14	4,455
2/7/2019	290	416	379	46	3,017	69	4,791
2/14/2019	290	424	367	45	3,336	68	5,274
2/21/2019	300	406	375	47	3,663	66	5,745
2/28/2019	1,500	2,017	368	232	4,784	323	7,307
3/7/2019	790	1,242	375	125	5,982	206	9,117
3/14/2019	630	908	380	101	6,735	151	10,294
3/21/2019	650	1,047	390	107	7,438	181	11,432
3/28/2019	560	798	378	89	8,088	131	12,455
4/4/2019	750	1,004	380	120	8,836	166	13,512
4/26/2019	660	850	405	112	11,350	149	16,912
5/7/2019	290	360	390	48	12,211	61	18,036

Notes: ppmv = parts per million by volume; scfm = standard cubic feet per minute; lbs = pounds. *Sample results anomalously low, cause unknown.

The VR system was screened using a MiniRAE 3000 PID with an 11.7 electron volt (eV) lamp with industry-standard moisture trap disc. Grab samples were collected from locations under vacuum via Tedlar® bag and battery-operated vacuum box.

MCB and total VOC mass removal was estimated and measured using two, independent methods. Influent vapor analysis by TO-15, as presented in **Table 6**, estimated a total of 12,211 pounds of MCB were recovered and 18,036 pounds of total VOCs were recovered by May 7, 2019, one week after the end of powered operations. Concentrations of influent MCB, chloroform, tetrachloroethene (PCE), and m,p-xylenes for each sampling event are presented on **Figure 5a.** A comparison of influent concentrations as a function of site average temperature in the treatment volume is presented on **Figure 5b.** Total VOC mass recovered and individual MCB mass recovered are generated using calculations based on laboratory analytical data at the SRGAC influent are presented on **Figure 6**.

The second method of estimating total VOC mass removal uses direct measurements of the recovered DNAPL volume in the SRGAC system DNAPL storage tank. This value also includes mass loading on polish VGAC based on an assumed mass loading of 10 percent per spent vessel. Total cumulative mass recovered calculated by this method is also presented on **Figure 6.** Total VOC mass recovered based on direct measurement of the recovered DNAPL is a more definitive estimate and serves as the reported cumulative mass recovery value. Approximately 2,519 gallons of DNAPL were recovered**.** TRS field measurements found recovered DNAPL to have a density of approximately 1.16 to 1.20 grams per cubic centimeter (g/cc). Average DNAPL density reported in the DNAPL FS was 1.25 g/cc at 20°C. Assuming an average DNAPL density of 1.2 g/cc for calculations, and approximately 1,300 pounds of total VOCs captured on spent polish VGAC, a total of 26,600 pounds of total VOCs were recovered. A summary of MCB and total VOC mass removal estimates using both methods is provided in **Table 7**. Composition of recovered DNAPL was found to be composed of a majority of MCB, chloroform, and PCE, and is discussed in further detail in **Section 8.4.**

Table 7. Mass Removal Summary

Mass Removal Estimate by Influent Analytical Data[1]	
Estimated Total MCB Recovered(1)	12,211 lbs
Estimated Total VOCs Recovered(1)	18,036 lbs
Mass Removal Estimate by Direct Measurement and VGAC Loading	
Measured Total DNAPL Recovered in NAPL Tank	2,519 gallons
Estimated Total DNAPL Recovered in NAPL Tank	25,300 lbs
Estimated Total VOCs Recovered on polish VGAC	1,300 lbs
Total VOCs Recovered	26,600 lbs

Notes: [1]Data as of May 7, 2019. Additional data not collected during vapor recovery shutdown process.

Emissions from the VR effluent stack were monitored routinely with PID and analyzed by EPA Method TO-15 with each corresponding influent sample. Compliance with SCAQMD substantive air permit requirements were verified with each sample collected from the effluent stack by running a SCAQMD Tier 2 Risk Analysis Report. Reports from each analysis are provided in **Appendix D-2.** In addition, with each analytical sample, a theoretical stack effluent limit was calculated. Routine PID screening of the effluent concentrations were compared to the theoretical limit in the absence of laboratory analytical data. A summary of effluent stack PID screening levels and emission limits is provided on **Figure 7**. The drop in the theoretical emission limit in January 2019 was a result of trace vinyl chloride concentrations observed in the stack effluent sample collected on January 10, 2019. No PID screening levels were found to be above theoretical emission limits at the corresponding time and no SCAQMD Tier 2 Risk Analysis reports identified any unacceptable risk due to effluent concentrations.

During operations, one spare 2,000-pound polish vessel was maintained to allow for fresh polish VGAC to be brought online with minimal vapor recovery downtime. However, on January 15, 2019, routine monitoring of the VR system identified breakthrough of both polish VGAC vessels. The VR system was immediately and temporarily shut down. A fresh polish VGAC was brought into service and only the auxiliary blower brought back online until a clean secondary VGAC polish could be brought into service on January 16, 2019. TRS performed a SCAQMD Tier 2 Risk Analysis of the stack emissions based on PID values and composition assumptions based on available analytical data, and confirmed no unacceptable risks were realized based on the temporary breakthrough. The main blower was restarted on January 16, 2019.

In addition to analysis of VOCs by TO-15, two vapor recovery sampling events also included analysis of pesticides by EPA Method TO-10A. Vapor samples were collected on polyurethane foam (PUF) cartridges from the SRGAC influent and effluent stack on January 24, 2019, and March 21, 2019, for analysis of pesticides in vapor. Sample dates were selected to correspond to heat-up and peak heating phases, respectively. Analytical data is included as **Appendix D-3.** As the TO-10A method is designed for ambient air monitoring, the method was slightly modified to collect samples from the VR system using stainless steel and chlorinated polyvinyl chloride (CPVC) adapters to connect to the VR piping. A data summary of pesticide analysis in vapor is presented in **Table 8**. Pesticides were detected in the SRGAC influent sample, and all reported analytes were below detection limits in the stack effluent.

5.3.1. Process Water Management

The ERH Pilot system utilized potable water available at the Site. Potable water was used for cooling systems, steam boiler for the SRGAC, and general Site usage. The ERH system generated approximately 46,000 gallons of condensate from the condenser and SRGAC unit during operations. Condensate water was treated through the ERH liquid treatment system prior to discharge to TGRS. Additional wastewater was composed of cooling water blowdown, boiler blowdown, process condensate, and collected rainwater from the system's secondary containment. All wastewater was collected and temporarily stored in the ERH discharge tank prior to discharge to TGRS. Approximately 260,000 gallons of potable make-up water was utilized over the duration of operations. Approximately 175,000 gallons of water was discharged to TGRS. Differences between make-up and discharge are primarily due to evaporation of potable water to the atmosphere from cooling towers.

Analytical data of the ERH discharge to TGRS, collected monthly throughout operations and laboratory data packages are provided in **Appendix E**. Wastewater was analyzed for VOCs by EPA Method 8260B, pesticides by EPA Method 8081, and para-chlorobenzene sulfonic acid (pCBSA) by EPA Method 314.0. Data was provided during operations and determined to be acceptable for discharge by TGRS operational staff.

Table 8. Pesticide Analysis of Vapor Recovery Data Summary

EPA Method TO-10A	January 24, 2019			
Sample Name	**MON1803-SRGAC-IN-20190124**		**MON1803-STACK-20190124**	
Volume of air sampled (m^3)	1.010		1.000	
	Result	**Concentration**	**Result**	**Concentration**
Compound	**ug/PUF[1]**	**ug/m^3**	**ug/PUF**	**ug/m^3**
4,4'-dichlorodiphenyldichloroethane (DDD)	0.067 J[3]	0.066 J	< 0.30	< 0.30
4,4'-dichlorodiphenyldichloroethylene (DDE)	0.17 J	0.17 J	< 0.30	< 0.30
4,4'-dichlorodiphenyltrichloroethane (DDT)	0.12 J	0.12 J	< 0.30	< 0.30
alpha-BHC[2]	1.8	1.8	< 0.15	< 0.15
beta-BHC	0.046 J p[4]	0.046 J p	< 0.15	< 0.15
delta-BHC	0.076 J	0.075 J	< 0.15	< 0.15
gamma-BHC	1.1	1.1	< 0.15	< 0.15

EPA Method TO-10A	March 21, 2019			
Sample Name	**MON1803-SRGAC-IN-20190321**		**MON1803-STACK-20190321**	
Volume of air sampled (m^3)	1.000		1.000	
	Result	**Concentration**	**Result**	**Concentration**
Compound	**ug/PUF**	**ug/m^3**	**ug/PUF**	**ug/m^3**
4,4'-dichlorodiphenyldichloroethane (DDD)	< 0.56	< 0.56	< 0.028	< 0.028
4,4'-dichlorodiphenyldichloroethylene (DDE)	9.6	9.6	< 0.028	< 0.028
4,4'-dichlorodiphenyltrichloroethane (DDT)	0.68 J	0.68 J	< 0.033	< 0.033
alpha-BHC	2.7 J	2.7 J	< 0.013	< 0.013
beta-BHC	< 0.40	< 0.40	< 0.020	< 0.020
delta-BHC	< 0.32	< 0.32	< 0.016	< 0.016
gamma-BHC	1.2 J	1.2 J	< 0.015	< 0.015

1. PUF = polyurethane foam sample cartridge

2. BHC = benzene hexachloride

3. J = Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

4. p = The %RPD between the primary and confirmation column/detector is >40%. The lower value has been reported.

Analysis of performance of the LGAC system was also conducted monthly with corresponding wastewater discharge sampling. One LGAC changeout occurred on March 6, 2019. A total of 800 pounds of LGAC was utilized for water treatment during the ERH Pilot.

Bag filters prior to LGAC treatment were initially specified at 50 microns and 25 microns, in series. On March 22, 2019, sample material from groundwater collected at UBE-5 was re-analyzed with a laboratory, 8-micron filter prior to extraction (see **Section 5.3.2** for description of UBE-5 sampling, and **Appendix F** for laboratory data). Results suggested filtering of groundwater was effective at reducing pesticide concentrations in water. To reduce particulate and pesticide concentrations in wastewater, bag filter sizes were reduced to 25 microns and 10 microns, in series, in the ERH liquid treatment system. Analytical data collected on April 4, 2019, suggest that the smaller bag filter size assisted in reducing pesticide concentrations in wastewater prior to LGAC treatment by the capture of entrained particles.

5.3.2. Hydraulic Control Monitoring

Exterior TMP locations were monitored weekly to determine the maximum temperature from 60 to 90 ft bgs with a single RTD sensor. The maximum observed temperature was then compared against expected temperature due to conductive heating as determined by modeling and a baseline groundwater temperature of 23.4°C, as described in the ERH Pilot Workplan (TRS, 2018). The comparison of expected temperature and maximum observed temperatures at exterior TMPs is presented in **Table 9** and on **Figure 8**. Vertical temperature profiles of exterior TMP locations are presented on **Figure 9.**

Based on this comparison, on March 1, 2019, the temperatures measured at TMP P5 and TMP P6 were higher than expected, both at a depth of 70 ft bgs. The potential for DNAPL migration from the ERH pilot test area was evaluated and determined to not be a concern for the following reasons:

- Baseline soil sampling results within the ERH pilot test area indicated that the extent of mobile DNAPL was likely limited to the area immediately around well UBE-5.
- Boring logs of boundary confirmation sampling locations (Revised ERH Pilot Test Boundary Confirmation and Baseline Sampling Report; TRS, 2019) indicated interbedded sand and silt layers in the depths surrounding the observed temperature increases. This supports TRS's conclusion that steam was migrating laterally when cooler temperatures above the boiling deep elements was encountered.
- DNAPL was historically observed in the treatment volume at depths between 79 and 84 ft bgs. Depths exhibiting temperatures above modeled expectations were 65 to 70 ft bgs; shallower than the depth where DNAPL was previously found.

On March 4, 2019, power application to the treatment volume was suspended to allow for installation of hydraulic control measures, in accordance with the OMM (TRS, 2019). On March 10, a QED AP4+ high-temperature, stainless steel, pneumatic, bottom loading pump was installed in UBE-5. Pumping of UBE-5 was conducted in an attempt to see if migration of hot groundwater could be controlled through active groundwater extraction from UBE-5 and to collect a sample from UBE-5 to confirm that MCB concentrations were below concentrations indicative of mobile DNAPL. The pump inlet was set at approximately 75 ft bgs and approximately 554 gallons of groundwater were pumped, processed through the ERH liquid treatment system, and stored in a separate tank for analysis. The concentration of MCB in the groundwater sample collected from UBE-5 was 2,500 micrograms per liter (µg/L). This concentration is less than one percent of the solubility of MCB in water, thus indicating that DNAPL was no longer present in this well. Data from UBE-5 groundwater and treatment analysis is provided in **Appendix F**. Treated groundwater was discharged to TGRS on April 5, 2019, after receipt of analytical results and coordination with TGRS operational staff.

On March 15, 2019, energy application to the treatment volume was resumed, and power was applied to only the shallow electrode elements. Continued heating of the shallow electrode elements was elected to further increase temperatures in the shallow region and further facilitate groundwater removal from the treatment volume, above the depth of elevated temperatures observed in TMP P5 and TMP P6. On March 22, 2019, increases in temperature at TMP P5 and TMP P6 were observed and electrode power configuration changes were made to reduce power application rates near those regions and further minimize heat transfer from the treatment volume. Decreases in temperatures were observed at 70 ft bgs at TMP P5 and TMP P6 in response to the change in power application. On April 5, 2019, increase in temperature was observed at 65 ft bgs at

Table 9. Hydraulic Control Monitoring by Maximum Exterior TMP Temperatures

Date	Week of Operations	Expected Temperature (°C)[1]	TMP-P1	TMP-P2	TMP-P3	TMP-P4	TMP-P5	TMP-P6
12/21/2018	1	23.4	23.3	23.7	22.6	22.6	23.5	24.0
12/27/2018	2	23.5	23.3	23.6	22.6	22.6	23.6	23.8
01/04/2019	3	24.0	23.7	25.0	22.8	22.7	23.6	23.8
01/11/2019	4	25.1	24.0	25.6	22.9	22.9	23.6	23.8
01/18/2019	5	27.1	24.3	26.4	23.1	23.0	23.8	24.2
01/25/2019	6	30.3	25.0	27.6	23.4	23.2	24.0	24.7
02/01/2019	7	34.6	25.8	28.8	23.7	23.5	24.3	25.5
02/08/2019	8	40.4	26.8	30.9	24.1	23.7	24.9	28.2
02/15/2019	9	46.0	28.1	35.1	24.5	24.1	25.9	31.9
02/22/2019	10	52.0	33.2	46.2	25.4	25.0	32.5	63.4
03/01/2019	11	58.6	40	56	26.4	26.1	108.6	106.6
03/08/2019	12	64.8	41.2	54.3	25.3	25.4	86.2	88.5
03/15/2019	13	66.0	47	52.8	25.4	26.0	79.9	87.1
03/22/2019	14	67.5[2]	56.9	56.9	26.4	28.3	96.8	105.1
03/29/2019	15	68.5[2]	69.9	56.4	27.5	30.0	94.9	104.2

Date	Week of Operations	Expected Temperature (°C)[1]	TMP-P1	TMP-P2	TMP-P3	TMP-P4	TMP-P5	TMP-P6
04/05/2019	16	69.5[2]	100.7	61.9	28.6	39.6	96.6	105.8
04/12/2019	17	70.8[2]	75.6	58.4	27.0	29.7	81.5	85.0
04/19/2019	18	71.7[2]	79.3	61.1	30.5	35.3	83.5	88.7
04/26/2019	19	72.5[2]	86.9	60.3	31.7	38.1	79.9	85.5
05/03/2019	20	70.2[2]	81.0	59.7	30.3	35.6	74.9	79.1

Notes: [1]Expected temperature increase is based on thermal penetration modeling completed by TRS and documented in the OMM. Expected temperature model output updated based on actual sub-surface temperatures on 2/9/19.; [2]Folloing sampling of UBE-5, the established action temperature for TMPs P1, P5, and P6 at 65 ft bgs and 70 ft bgs was 107°C and 110°C, respectively with depth.

TMP P6 and represented the maximum temperature observed in TMP P6. On April 5, 2019, the observed temperature at TMP P1 at 70 ft bgs increased to a temperature above the modeled value, but below boiling temperatures. Hydraulic control monitoring by exterior temperature readings ceased on May 3, 2019.

In accordance with the ERH Pilot OMM (TRS, 2019), soil borings were advanced during confirmatory sampling as close as possible to the nearest pre-ERH boundary confirmation sampling locations. Soil samples were collected at the depth of the observed temperatures above the conductive heat model in the exterior TMPs at the nearest pre-ERH boundary confirmation sample location for the following exterior TMPs: TMP P1 70 ft bgs, TMP P5 70 ft bgs, TMP P6 65 ft bgs, and TMP P6 70 ft bgs. Laboratory detections of MCB were compared with the equivalent MCB concentration to the residual DNAPL saturation for that soil type. Confirmatory soil samples collected outside the treatment volume in regions of elevated temperatures confirmed DNAPL was not mobilized laterally. Please see **Section 6.3** for details.

5.3.3. Pneumatic Control Monitoring

Vacuum applied to the subsurface was monitored manually utilizing a digital manometer at each piezometer (co-located with the TMPs). Measurements from each vapor piezometer were collected weekly during operations to confirm vapor capture by demonstrating there is no uncontrolled lateral or vertical vapor migration through the vadose zone. As described in the OMM (TRS, 2019), pneumatic control of the ERH pilot test volume was assessed as a vacuum of 0.1 inches of water or greater within the ERH treatment volume and as a lack of pressure outside of the ERH treatment volume. Applied vacuum was increased to its maximum point during operations on February 26, 2019 and remained unchanged through April 11, 2019.

A summary of pneumatic control monitoring data is presented in **Table 10.** Data collected at interior and exterior piezometer locations demonstrated that pneumatic control was maintained throughout operations.

Table 10. Average Weekly Piezometer Readings

Date	Average Interior Vacuum (inches of water)	Average Exterior Vacuum (inches of water)
12/17/18	8.9	5.5
12/18/18	13.3	9.5
12/21/18	9.3	6.7
12/28/18	8.7	6.1
01/04/19	3.7	2.5
01/11/19	4.5	3.0
01/18/19	5.8	4.0
01/25/19	5.2	3.6
02/01/19	4.9	3.4
02/08/19	5.3	3.4
02/15/19	6.5	4.4
02/22/19	8.4	5.6
03/01/19	20+	13.3
03/08/19	20+	16.3
03/15/19	20+	14.7
03/22/19	20+	14.2
03/29/19	20+	14.8
04/05/19	19.0	13.7
04/12/19	20+	13.6
04/19/19	17.6	13.4
04/26/19	17.8	13.1
05/03/19	12.7	8.3
05/13/19	6.9	4.6
05/17/19	3.3	1.7
05/23/19	3.8	2.2

5.4. Ambient Air Monitoring

5.4.1. Perimeter Monitoring with PIDs

Active background ambient air monitoring via PID commenced on August 20, 2018, and continued for two weeks. Background PID data for the four stations surrounding the Study Area ranged from 0.0 to 0.2 parts per million (ppm) on average, with a peak recording of 1.2 ppm at the north unit. Continuous monitoring of ambient air with the four PIDs surrounding the ERH Pilot test Area was initiated on December 17, 2018. Weekly summaries of all data collected from the continuous air monitoring before, during, and after operations is presented in **Appendix G**.

Ambient PID data at the Site exceeded the 5-ppm action threshold for the only time during operations on December 17, 2018. In accordance with the ERH HASP (TRS, 2019), TRS deployed Drager™ colorimetric tubes to screen for benzene at the east and west PID locations where concentrations above 5 ppm were recorded. Drager™ colorimetric tube screening was negative and no further action was needed. TRS performed a side-by-side comparison of all PID units on December 20, 2019, and determined that the east and west PID stations were malfunctioning and replaced with new units on December 21, 2018.

In response to anomalous PID screening levels or calibration errors, stationary PID units were replaced on the following dates:

- December 21, 2018: East and west units replaced
- January 9, 2019: North unit replaced
- March 5, 2019: West unit replaced
- April 1, 2019: South unit replaced
- May 8, 2019: East unit replaced

Due to cellular connection losses or network errors, data gaps greater than one hour were experienced on December 18, 2018, December 20, 2018, January 18, 2019, and from April 8, 2019, to April 10, 2019. During significant data gaps such as the one experienced in April, TRS personnel monitored PID units multiple times daily to ensure screening values did not exceed threshold levels.

With the exception of the anomalous readings discussed above, no readings above action levels were measured by the ambient PID stations before, during, or after ERH operations.

5.4.2. Radiello® Passive Samplers

The first 30-day Radiello® sample was deployed prior to ERH system operation to collect background data at the Site. The second Radiello® sample began on the first day of operations and was replaced on the 30th day of exposure duration, continuing throughout operations. A total of seven rounds of passive samplers were deployed: one prior to operations, five during operations, and one after completion of ERH operations.

Samples were submitted to Eurofins Air Toxics in Folsom, California for VOC analysis by gas chromatography-mass spectrophotometry, using Method TO-17. Laboratory data packages are provided in **Appendix H.**

A summary of passive ambient air data is provided in **Table 11. No reported values from any sample collected prior to, during, or after ERH operations exceeded action levels as defined in the HASP** (TRS, 2019).

5.5. Site Security

TRS maintained strict control of access to the Site for the duration of system operations. Site staff maintained constant vigilance throughout the project and challenged on-site visitors they did not recognize.

All security systems functioned as designed during the operational period. **No unauthorized access to the ERH pilot test area occurred during unattended operations.**

Table 11. Ambient Air Passive Sampler TO-17 Summary

Sample Location	Start Date	Finish Date	Result (ppb); Method EPA TO-17																								
			1,1,1-Trichloroethane	1,2-Dichloroethane	1,4-Dichlorobenzene	2-Butanone (Methyl Ethyl Ketone)	4-Methyl-2-pentanone	Acetone	Benzene	Carbon Tetrachloride	Chlorobenzene	Chloroform	Cyclohexane	Ethanol	Ethyl Acetate	Ethyl Benzene	Heptane	Hexane	m,p-Xylene	Methyl tert-butyl ether	Naphthalene	o-Xylene	Propylbenzene	Styrene	Tetrachloroethene	Toluene	Trichloroethene
East																											
Background	7/26/2018	8/25/2018	ND	ND	ND	0.051	ND	0.064	0.076	0.030	0.012	ND	0.043	ND	ND	0.030	0.047	0.093	0.091	ND	ND	0.035	ND	ND	0.023	0.16	ND
Operations 1	12/17/2018	1/16/2019	ND	0.012	0.011	0.13	0.024	NR	0.31	0.036	0.23	0.064	0.13	ND	0.088	0.12	0.17	0.31	0.40	ND	ND	0.14	0.023	0.022	0.063	0.70	0.0094
Operations 2	1/16/2019	2/15/2019	ND	0.012	0.0091	0.079	ND	NR	0.22	0.045	0.39	0.52	0.13	ND	0.069	0.086	0.13	0.24	0.29	ND	ND	0.098	0.016	ND	0.047	0.54	ND
Operations 3	2/15/2019	3/16/2019	ND	0.010	ND	0.031	0.030	NR	0.16	0.041	0.58	0.35	0.069	0.27	0.050	0.050	0.072	0.12	0.16	ND	ND	0.058	0.0094	0.012	0.049	0.35	0.0097
Operations 4	4/15/2019	4/15/2019	ND	0.012	ND	0.040	ND	NR	0.12	0.041	0.77	0.27	0.081	ND	0.047	0.041	0.073	0.15	0.13	ND	ND	0.046	ND	ND	0.051	0.26	ND
Operations 5	4/15/2019	5/15/2019	ND	0.012	ND	0.051	ND	NR	0.083	0.058	0.86	0.17	0.057	ND	ND	0.026	0.052	0.11	0.081	0.013	ND	0.030	ND	ND	0.049	0.18	ND
Post-ops	5/15/2019	6/14/2019	ND	0.010	ND	0.034	ND	NR	0.066	0.049	0.19	0.069	0.044	ND	ND	0.018	0.042	0.10	0.059	0.014	ND	0.022	ND	ND	0.012	0.12	ND
North																											
Background	7/26/2018	8/25/2018	ND	ND	ND	0.045	ND	0.061	0.076	0.030	ND	ND	0.040	ND	ND	0.031	0.046	0.12	0.091	ND	ND	0.033	ND	ND	0.012	0.16	ND
Operations 1	12/17/2018	1/16/2019	ND	0.012	0.010	0.14	0.027	NR	0.30	0.035	0.076	0.050	0.12	ND	0.086	0.11	0.16	0.29	0.37	ND	ND	0.13	0.021	0.017	0.041	0.66	0.0090
Operations 2	1/16/2019	2/15/2019	ND	0.011	0.0086	0.094	0.020	NR	0.21	0.037	0.15	0.37	0.11	ND	0.066	0.082	0.12	0.23	0.27	ND	ND	0.094	0.015	0.012	0.028	0.53	ND
Operations 3	2/15/2019	3/16/2019	ND	0.010	ND	0.030	ND	NR	0.15	0.040	0.18	0.29	0.064	0.27	0.046	0.049	0.070	0.12	0.16	ND	ND	0.057	0.0093	0.013	0.025	0.34	0.0087
Operations 4	4/15/2019	4/15/2019	ND	0.012	ND	0.048	ND	NR	0.13	0.043	0.22	0.079	0.084	ND	0.046	0.044	0.078	0.16	0.14	ND	ND	0.050	ND	ND	0.022	0.28	ND
Operations 5	4/15/2019	5/15/2019	ND	0.0080	ND	0.048	ND	NR	0.061	0.034	0.22	0.046	0.035	ND	ND	0.019	0.036	0.076	0.059	ND	ND	0.022	ND	ND	0.015	0.13	ND
Post-ops	5/15/2019	6/14/2019	ND	0.011	ND	0.039	ND	NR	0.071	0.053	0.12	0.043	0.044	ND	ND	0.021	0.044	0.11	0.063	0.015	ND	0.023	ND	ND	0.010	0.13	ND
South																											
Background	7/26/2018	8/25/2018	ND	ND	ND	0.030	ND	0.060	0.087	0.034	0.022	ND	0.046	ND	ND	0.035	0.048	0.12	0.11	ND	ND	0.040	ND	ND	0.014	0.18	ND
Operations 1	12/17/2018	1/16/2019	ND	0.014	0.011	0.14	0.022	NR	0.32	0.038	0.069	0.12	0.16	ND	0.092	0.12	0.17	0.33	0.39	ND	ND	0.14	0.022	0.019	0.036	0.70	0.0090
Operations 2	1/16/2019	2/15/2019	ND	0.014	0.012	0.094	0.020	NR	0.28	0.050	0.28	0.081	0.15	ND	0.092	0.11	0.16	0.32	0.35	0.013	ND	0.12	0.019	0.014	0.031	0.69	ND
Operations 3	2/15/2019	3/16/2019	ND	0.013	ND	0.017	ND	NR	0.17	0.052	0.075	0.051	0.082	0.24	0.061	0.054	0.081	0.14	0.18	ND	ND	0.062	0.010	0.011	0.016	0.38	0.0080
Operations 4	4/15/2019	4/15/2019	ND	0.011	ND	0.041	ND	NR	0.12	0.041	0.039	0.028	0.076	ND	0.048	0.039	0.070	0.14	0.12	ND	ND	0.044	ND	ND	0.011	0.25	ND
Operations 5	4/15/2019	5/15/2019	ND	0.0092	ND	0.057	ND	NR	0.069	0.040	0.031	0.015	0.039	ND	ND	0.021	0.042	0.088	0.065	0.011	ND	0.024	ND	ND	0.0077	0.15	ND
Post-ops	5/15/2019	6/14/2019	ND	0.011	ND	0.041	ND	NR	0.073	0.058	0.020	0.021	0.048	ND	ND	0.022	0.047	0.11	0.069	0.015	ND	0.026	ND	ND	0.0067	0.14	ND
West																											
Background	7/26/2018	8/25/2018	ND	ND	ND	0.028	ND	0.059	0.080	0.033	ND	ND	0.040	ND	ND	0.034	0.055	0.14	0.10	ND	ND	0.037	ND	ND	0.0090	0.18	ND
Operations 1	12/17/2018	1/16/2019	ND	0.013	0.012	0.14	0.027	NR	0.34	0.041	0.068	0.13	0.15	ND	0.10	0.12	0.18	0.36	0.41	ND	ND	0.14	0.024	0.020	0.037	0.75	0.0084
Operations 2	1/16/2019	2/15/2019	ND	0.013	0.010	0.090	0.018	NR	0.26	0.047	0.23	0.090	0.14	ND	0.078	0.098	0.15	0.28	0.33	0.012	ND	0.11	0.018	0.012	0.027	0.64	ND
Operations 3	2/15/2019	3/16/2019	ND	0.014	ND	0.028	ND	NR	0.20	0.054	0.065	0.083	0.088	0.29	0.069	0.059	0.094	0.17	0.19	ND	ND	0.070	0.011	0.014	0.018	0.42	0.0091
Operations 4	4/15/2019	4/15/2019	ND	0.011	ND	0.034	ND	NR	0.12	0.041	0.041	0.038	0.075	ND	0.049	0.040	0.071	0.14	0.13	ND	ND	0.046	ND	ND	0.012	0.26	ND
Operations 5	4/15/2019	5/15/2019	ND	0.0088	ND	0.055	ND	NR	0.066	0.038	0.017	0.014	0.036	ND	ND	0.021	0.040	0.084	0.065	0.011	ND	0.024	ND	ND	0.0069	0.15	ND
Post-ops	5/15/2019	6/14/2019	ND	0.011	ND	0.043	ND	NR	0.074	0.056	0.016	0.017	0.046	ND	ND	0.021	0.046	0.12	0.064	0.016	ND	0.024	ND	ND	0.0066	0.14	ND

Notes:

ND = Analyte not detected above laboratory reporting limits

NR = Analyte not reported

6.0 CONFIRMATORY SAMPLING

Upon determination the ERH pilot test was complete, confirmation soil sampling was used to determine the effectiveness of ERH at rendering DNAPL immobile in the pilot test area. All soil samples collected within the ERH pilot test volume during this event were treated as confirmatory samples. Confirmatory soil sampling activities began on April 8, 2019, and were completed on April 15, 2019. Soil cores for confirmation sampling were collected by BC^2 Environmental using sonic drilling methods.

ERH operations would be deemed complete and effective at sufficiently reducing mobile DNAPL mass when TRS, *de maximis*, and the EPA concurred that MCB concentrations from confirmatory samples are below the DNAPL concentration equivalent to residual saturation for the soil type as defined in the Revised ERH Pilot Test Boundary Confirmation and Baseline Sampling Report (TRS, 2019).

6.1. Determination of ERH Pilot Test Completeness

TRS notified *de maximis,* who notified EPA on April 4, 2019, via memorandum, that the pilot test appeared to be complete (TRS, 2019). EPA provided verbal authorization on April 5, 2019 to begin confirmation soil sampling. The EPA-approved Operations and Maintenance Manual, Section 7.1 Determination of ERH Pilot Test Completeness (TRS, 2019), states:

> *TRS will notify de maximis, who will notify EPA, when the pilot test appears to be complete. TRS' determination will be based on multiple lines of evidence, including subsurface temperatures, energy density, mass extraction rates of MCB, and total energy applied to the subsurface. The mass removal rate of MCB should reach peak extraction as a line of evidence. At a minimum, the following lines of evidence will be met prior to TRS recommendation for soil sampling:*
>
> - *A minimum of 60 percent of the total design energy has been applied to the subsurface. This equates to a total of 420,000 kWh.*
> - *The average subsurface temperature in groundwater between 60 and 90 ft bgs within the ERH pilot test volume is 95°C.*

6.1.1. Critical Lines of Evidence

TRS evaluated the following multiple lines of evidence and concluded that the ERH Pilot system would be at project completion by approximately April 1, 2019.

Subsurface Temperatures. The measured co-boiling point for the Montrose DNAPL was determined to be 96° (AECOM, 2013). The heteroazeotropic boiling temperatures for MCB varies from 92°C at the top of the water table to 108°C at 85 feet below grade. The minimum goal established in the OMM was 95°C. Based on experience, TRS typically operates at or above the heteroazeotropic boiling temperature for a period of approximately 2 weeks to target NAPL removal.

- The average temperature across RTD depths within the deep element region exceeded the heteroazeotropic boiling temperatures for their respective depths on February 14, 2019. Application of energy to the deep elements was stopped on March 4, 2019. Duration of temperatures above heteroazeotropic boiling points exceeded the 2-week target.

- The system was restarted with a focus on energy application to the shallow elements only. Heteroazeotropic boiling temperatures of 101°C for the average temperature across RTD depths within the shallow region on March 16, 2019. Duration of temperatures above heteroazeotropic boiling points exceeded the 2-week target.
- Average subsurface temperatures reached a maximum of 115°C on March 3, 2019, across the deep elements and 106°C on March 29, 2019, across the shallow elements during the ERH pilot test.
- Given this analysis, the line of evidence for subsurface temperature criteria was met. TRS anticipated that the mobile DNAPL mass was reduced to the extent practicable in the ERH pilot area as of approximately April 1, 2019, and proposed initiation of confirmatory sampling activities.

Mass Extraction Rates of MCB. As depicted on **Figure 5,** during the first month of ERH operations, before the treatment volume was heated to heteroazeotropic boiling temperatures, influent MCB concentrations were typically in the range of 300 to 400 parts per million by volume (ppmv). The deeper subsurface temperatures began reaching the heteroazeotropic boiling temperature around day 57 of operations and within one week the MCB vapor concentrations began to increase substantially until reaching a peak vapor concentration of 1,500 ppmv on day 67 of operations. By day 71 of operations, heteroazeotropic boiling temperatures had been achieved across the targeted depths and vapor concentrations began to decrease. By day 86, the MCB concentrations had decreased to 630 ppmv which is a 58 percent drop in vapor concentrations from peak concentrations. This line of evidence has been met. Additional influent vapor samples collected further documented the continued decline of MCB concentrations up to the soil confirmation sampling event.

Total Energy. The OMM documented a total design energy of 700,000 kWh. Once at design temperatures, the amount of energy required to remediate a site is directly related to the amount of mass in place. As noted above, the OMM minimum requirement for confirmation sampling was 60 percent of the design energy, or 420,000 kWh, given the lower than anticipated concentrations observed during baseline sampling. A total of 609,000 kWh was applied to the subsurface by April 8, 2019 (87.0 percent of the design energy of 700,000 kWh), corresponding the beginning of confirmatory soil sampling activities. This line of evidence was met.

Energy Density. The OMM documented a target energy density of 179 kWh/yd^3. Energy density relies on the total energy estimate. Because baseline concentrations were so much lower than historical data, the assumed total MCB mass was biased high. This resulted in the design energy density that also was biased high. The average energy density as of April 8, 2019, was 168 kWh/yd^3 with a range from 83 to 217 kWh/yd^3.

6.1.2. Other Lines of Evidence

As part of the recommendation for confirmation sampling, TRS also evaluated a recent groundwater sample collected from UBE-5, total operational days, and mass removal against the ERH pilot test design.

Groundwater Concentrations in UBE-5. While not anticipated in the OMM, TRS was able to collect a groundwater sample from UBE-5, located within the ERH pilot test area on March 10, 2019, as described in **Section 5.3.2**. The concentration of MCB in the groundwater sample collected from

UBE-5 was 2,500 µg/L. This concentration is less than one percent of the solubility of MCB in water, thus indicating that DNAPL is no longer present in this well.

Operational Days. The OMM documented a target period of operations between 105 and 140 days. This estimate was biased high given the lower than anticipated MCB mass within the ERH pilot test treatment volume. With removal of downtime from the calculation, the confirmatory sampling date of April 8, 2019, was the 93rd operational day of the ERH Pilot System.

Total Mass Removal. DNAPL mass estimates for the ERH pilot test area ranged from 18,500 to 26,500 pounds of MCB (AECOM, 2013). At the completion of vapor recovery operations, a total of 26,600 lbs of mass had been recovered, with approximately 66% of that being MCB.

6.1.3. Data Quality Objectives

All data collection was performed in accordance with the data quality objectives (DQOs) described in the Section 7.1.1 of the OMM (TRS, 2019). Details are summarized below.

State the Problem - Determine the effectiveness of ERH at rendering DNAPL immobile within the ERH pilot test area.

Identify the Decision – Is DNAPL immobile within the ERH pilot test area?

Identify the Inputs to the Decision –

1) **Sample Collection Timing:** As documented in the memo to EPA dated April 4, 2019, TRS evaluated multiple lines of evidence, including the critical lines of evidence identified in the OMM, such as subsurface temperatures, energy density, mass extraction rates of MCB, and total energy applied to the subsurface. Based on this analysis, TRS concluded that the mobile DNAPL mass within the ERH pilot study treatment volume had been reduced to meet project objectives by approximately April 1, 2019, subject to confirmatory soil sampling. Confirmatory sampling began on April 8, 2019, and was completed on April 15, 2019.

2) **Sample Location:** Baseline samples were collected during subsurface installation of the interior temperature monitoring points (TMPs) within the ERH pilot test area. Confirmation sample borings were advanced as close as possible to the interior TMPs and baseline sample locations. Sample collection was optimized in accordance with Section 7.1.1 of the OMM. Confirmation sampling was completed in the same manner as the ERH pilot test baseline sampling and in concurrence with *TRS Standard Operating Procedure (SOP 3-1), Hot Soil Sampling.* Based on elevated temperatures in the subsurface, polycarbonate liners were selected to collect soil cores within the treatment volume. After observing several failures of the polycarbonate liners, it was determined that the liners could not withstand the conditions encountered during sample retrieval. Sample core collection was reverted to the standard core collection method of containerizing soil cores in polyethylene sleeves from the core barrel. The exterior of the core barrel was cooled with potable water before emptying the soil core into polyethylene sleeves, and the sleeves were further cooled on ice until the soil temperature was adequately reduced for sampling. No evidence of melting of the polyethylene sleeves was observed.

3) **Soil Type:** The soil cores were logged under the direction of a California registered Professional Geologist in accordance with the Unified Soil Classification System. The boring logs are provided in **Appendix I-1.** Samples collected during the confirmation sampling event were determined to be either generalized saturated UBA sand or saturated UBA silt, consistent with the established geology of the pilot test area.

4) **MCB Concentration:** All samples submitted to the laboratory were analyzed for both MCB and DDT by EPA methods 8260B and 8081A, respectively. The laboratory analytical results for MCB and total DDT are presented in **Section 6.2** for each collected sample. Laboratory data packages are provided in **Appendix I-2**.

Define the Boundaries of the Study – DNAPL mobility was determined by comparing the MCB concentration of a collected sample with the MCB concentration equivalent to residual DNAPL saturation for a given soil type, as determined in the Revised ERH Pilot Boundary Confirmation and Baseline Sampling Report (TRS, 2019).

Develop a Decision Rule – Laboratory detections of MCB collected between 60 ft bgs and 90 ft bgs were compared with the equivalent MCB concentration to the residual DNAPL saturation for that soil type to determine if mobile DNAPL is present. Mobile DNAPL mass was considered to be sufficiently reduced when analytical results for MCB were less than the MCB concentration that is equivalent to the residual saturation for that soil type.

Specify Tolerable Limits on Decision Errors – No results of confirmatory samples were found to exceed the equivalent residual DNAPL concentration value for MCB.

Optimize the Design for Obtaining Data – Confirmatory soil borings were advanced as close as possible to the six interior TMP locations, which were located mid-way between electrodes. Soil sampling methodologies and characterization were performed in accordance with the boundary confirmation and baseline sampling procedures described in the Workplan (TRS, 2017). Soil cores were collected continuously between 50 ft bgs and 90 ft bgs and screened in the field for the presence of DNAPL. In the absence of visual evidence suggesting mobile DNAPL within a soil core, TRS sampled at the location within the core having the highest concentration of contaminants based on PID field screening. No soil cores exhibited visual evidence of DNAPL presence, therefore, no samples were preferentially collected based on visual observations.

6.2. Confirmatory Soil Sampling Results

6.2.1. Field Observations

The headspace concentrations and Flexible Liner Underground Technologies (FLUTe™) ribbon detections from the confirmation borings are compared against the baseline soil borings and presented in **Table 12.** Baseline and Confirmatory Sampling Headspace and FLUTe™ Observations**.** **No evidence of DNAPL was observed during confirmatory sampling activities.**

Table 12. Baseline and Confirmatory Sampling Headspace and FLUTe™ Observations

Boring Location	PID Headspace Concentrations, 50 to 90 feet bgs (ppmv)		FLUTe™ Ribbon DNAPL Detections, 50 to 90 feet bgs	
	Baseline Sampling Event	Confirmation Sampling Event	Baseline Sampling Event	Confirmation Sampling Event
TMP-B3	0.5 to >2000	0 to 58	83.5-84 feet bgs	None
TMP-C2	0.4 to >2000	0 to 21	79.25-81 feet bgs	None
TMP-C4	0.1 to >2000	0 to 35	81 feet bgs	None
TMP-C5	0.5 to 848	0 to 31	None	None
TMP-D4	0.2 to 728	0 to 16	81.5 feet bgs	None
TMP-E4	0.2 to 988	0 to 131	None	None

6.2.2. Analytical Results

Confirmatory boring locations adjacent to TMPs were named with the corresponding TMP location and the amendment "B". In the case of TMP B3, two adjacent borings were advanced due to poor recovery from 70 to 80 ft bgs, as indicated on the soil boring log in **Appendix I-1** and **Figure Y-2C**, and labeled TMP B3B and TMP B3C, accordingly.

All samples submitted to Eurofins Test America in Irvine, California and analyzed for both VOCs and pesticides by EPA methods 8260B and 8081A, respectively. Results of baseline and confirmatory soil sampling for MCB and total DDT analysis are presented in **Table 13.** Baseline and Confirmatory Sampling MCB and Total DDT Concentrationsfor comparison. Laboratory data packages are provided in **Appendix I-2**.

Analytical data confirmed that concentrations of MCB in sand are below 27,900 mg/kg and concentrations of MCB in silt are below 17,000 mg/kg. MCB concentrations in the confirmation soil samples were found to be significantly below the concentrations equivalent to the residual DNAPL saturation for that soil type; in most instances, sampled concentrations were more than four orders of magnitude below the residual saturation levels. Comparison of maximum MCB concentrations observed at each baseline and confirmatory sampling location is presented on **Figure 10.**

Average MCB concentration of all soil samples collected within the treatment volume (60 to 90 ft bgs) within the pilot test area at the time of baseline sampling was 970 mg/kg, which was reduced to an average of 1.37 mg/kg in samples collected during confirmatory sampling, a 99.86 percent reduction. DNAPL impacts to the pilot test area were observed during baseline sampling in the four locations as indicated in **Table 12.** The maximum pre-ERH concentration of 13,000 mg/kg MCB observed at TMP C2 at a depth of 81 was reduced to 1.2 mg/kg MCB.

Table 13. Baseline and Confirmatory Sampling Results for MCB and Total DDT

Baseline Sampling							Confirmatory Sampling								
Baseline Sample ID MON1803-[location]-[depth (ft)]	Date/Time Collected	Soil Type	Field PID Headspace Screening (ppm)	MCB Concentration Result (mg/kg)		Total DDT Method 8081A Result (mg/kg)	Confirmatory Sample ID MON1803-[location]-[depth (ft)]	Date Collected	Time Collected	Soil Type	Field PID Headspace Screening (ppm)	MCB Concentration Method EPA 8260B Result (mg/kg)		MCB Concentration Method EPA 8260B Goal (mg/kg)	Total DDT Method 8081A Result (mg/kg)
MON1803-TMPB3-53	5/29/18 12:00 AM	UBA Sand	46.8	0.2		0.178	MON1803-TMPB3B-53	04/10/19	11:30 AM	UBA Sand	1.2	0.00084	J	27,900	0.0023
MON1803-TMPB3-57	5/29/18 12:00 AM	UBA Sand	49.2	0.024		0.15	MON1803-TMPB3B-58	04/10/19	11:35 AM	UBA Sand	1.1	0.014		27,900	0.012
MON1803-TMPB3-63	5/29/18 12:00 AM	UBA Sand	16.8	2.2		0.67	MON1803-TMPB3B-63	04/10/19	11:40 AM	UBA Sand	3.1	0.0056		27,900	0.0026
MON1803-TMPB3-69	5/29/18 12:00 AM	UBA Sand	81.1	3.5		0.016	MON1803-TMPB3B-69	04/10/19	11:45 AM	UBA Sand	1.2	0.00070	J	27,900	< 0.010
MON1803-TMPB3-73	5/29/18 12:00 AM	UBA Sand	44.0	1.9		0.4	MON1803-TMPB3C-73	04/10/19	3:45 PM	UBA Silt	0.7	0.025		17,000	0.23
MON1803-TMPB3-77	5/29/18 12:00 AM	UBA Sand	98.5	0.72		0.32	MON1803-TMPB3C-76	04/10/19	3:50 PM	UBA Sand	38.9	6.0		27,900	0.119
MON1803-TMPB3-84	5/29/18 12:00 AM	UBA Sand	1000	8700		6579	MON1803-TMPB3B-84	04/10/19	12:30 PM	UBA Sand	1.2	0.0091		27,900	0.113
MON1803-TMPB3-89	5/29/18 12:00 AM	UBA Silt	75.8	1.3		1.8	MON1803-TMPB3B-89	04/10/19	12:35 PM	UBA Sand	58.1	13		27,900	3063
MON1803-TMPC2-54	5/22/18 1:00 PM	UBA Sand	4.9	0.064	J	0.33	MON1803-TMPC2B-54	04/11/19	10:50 AM	UBA Sand	2.5	0.027		27,900	0.056
MON1803-TMPC2-57	5/22/18 1:10 PM	UBA Sand	47.4	0.14		0.170	MON1803-TMPC2B-57	04/11/19	10:55 AM	UBA Silt	1.0	0.0039		17,000	0.053
MON1803-TMPC2-65	5/22/18 1:15 PM	UBA Sand	90.8	1.8		0.6	MON1803-TMPC2B-64	04/11/19	11:05 AM	UBA Sand	0.6	0.0055		27,900	0.0110
MON1803-TMPC2-68	5/22/18 1:25 PM	UBA Sand	67.4	6.3		0.120	MON1803-TMPC2B-68	04/11/19	11:10 AM	UBA Sand	0.7	0.0060		27,900	0.018
MON1803-TMPC2-73	5/22/18 2:40 PM	UBA Sand	43.5	0.53		0.53	MON1803-TMPC2B-74	04/11/19	12:25 PM	UBA Sand	0.6	0.14		27,900	0.07
MON1803-TMPC2-79	5/22/18 2:50 PM	UBA Sand	72.9	0.17		0.75	MON1803-TMPC2B-79	04/11/19	12:30 PM	UBA Sand	0.7	0.0064		27,900	1.50
MON1803-TMPC2-81	5/22/18 2:30 PM	UBA Sand	1879	13000		7825	MON1803-TMPC2B-81	04/11/19	12:32 PM	UBA Sand	3.7	1.2		27,900	3251
MON1803-TMPC2-86	5/22/18 2:55 PM	UBA Silt	31.9	47		1.00	MON1803-TMPC2B-86	04/11/19	12:55 PM	UBA Sand	1.6	0.065		27,900	0.20
MON1803-TMPC4-52	5/25/18 2:05 PM	UBA Sand	11.0	0.011		0.0060	MON1803-TMPC4B-53	04/11/19	3:50 PM	UBA Sand	0.6	< 0.0004	ET	27,900	0.19
MON1803-TMPC4-59.5	5/25/18 2:20 PM	UBA Sand	20.3	1.2		0.0097	MON1803-TMPC4B-57	04/11/19	3:52 PM	UBA Sand	0.9	0.00029	J,ET	27,900	4.4
MON1803-TMPC4-63	5/25/18 2:25 PM	UBA Sand	21.9	0.68		0.0055	MON1803-TMPC4B-63	04/11/19	3:55 PM	UBA Sand	0.8	0.00029	J,ET	27,900	0.018
MON1803-TMPC4-67.5	5/25/18 2:30 PM	UBA Sand	40.7	2.3		0.12	MON1803-TMPC4B-66	04/11/19	4:55 PM	UBA Sand	2.1	0.00078	J	27,900	< 0.010
MON1803-TMPC4-74	5/25/18 3:00 PM	UBA Sand	117	2.5		0.54	MON1803-TMPC4B-73	04/11/19	5:00 PM	UBA Sand	1.5	0.0090		27,900	0.08
MON1803-TMPC4-79	5/25/18 2:51 PM	UBA Silt	202	30		59	MON1803-TMPC4B-79	04/11/19	5:05 PM	UBA Silt	5.1	0.68		17,000	1411
MON1803-TMPC4-81	5/25/18 2:50 PM	UBA Sand	> 2,000	10000		25055	MON1803-TMPC4B-80.5	04/11/19	5:07 PM	UBA Sand	19.4	5.8		27,900	16333
MON1803-TMPC4-87	5/25/18 3:05 PM	UBA Silt	125	20		0.080	MON1803-TMPC4B-86	04/11/19	5:10 PM	UBA Silt	6.0	0.72		17,000	28
MON1803-TMPC5-51	5/24/18 2:10 PM	UBA Sand	6.0	0.0011		0.1	MON1803-TMPC5B-51	04/15/19	9:28 AM	UBA Sand	0.0	< 0.0002		27,900	0.031
MON1803-TMPC5-59	5/24/18 2:50 PM	UBA Sand	9.0	0.83		0.35	MON1803-TMPC5B-58	04/15/19	9:30 AM	UBA Sand	0.5	0.0012		27,900	0.0028
MON1803-TMPC5-63	5/24/18 2:55 PM	UBA Sand	18.1	2.5		0.25	MON1803-TMPC5B-63	04/15/19	9:35 AM	UBA Sand	0.4	0.00089	J	27,900	0.0027
MON1803-TMPC5-67	5/24/18 3:00 PM	UBA Sand	33.9	4.4		0.074	MON1803-TMPC5B-67	04/15/19	9:38 AM	UBA Sand	1.5	0.026		27,900	0.0075
MON1803-TMPC5-72	5/24/18 3:05 PM	UBA Sand	29.4	1.7		18.5	MON1803-TMPC5B-74	04/15/19	10:10 AM	UBA Silt	3.4	0.086		17,000	4.1
MON1803-TMPC5-78	5/24/18 3:35 PM	UBA Silt	109	17		0.27	MON1803-TMPC5B-80	04/15/19	10:15 AM	UBA Silt	30.9	3.8		17,000	0.82
MON1803-TMPC5-81	5/24/18 3:55 PM	UBA Silt	848	25		95	MON1803-TMPC5B-83	04/15/19	10:18 AM	UBA Sand	19.4	1.4		27,900	1.3
MON1803-TMPC5-86	5/24/18 4:00 PM	UBA Silt	247	30		0.078	MON1803-TMPC5B-89	04/15/19	10:20 AM	UBA Silt	5.9	0.29		17,000	0.0573
MON1803-TMPD4-50	5/23/18 1:00 PM	UBA Sand	21.5	0.011		0.0061	MON1803-TMPD4B-50	04/15/19	2:08 PM	UBA Sand	0.3	< 0.00019		27,900	0.0024
MON1803-TMPD4-58	5/23/18 2:25 PM	UBA Sand	9.9	1.1		0.15	MON1803-TMPD4B-58	04/15/19	2:10 PM	UBA Sand	0.3	0.0031		27,900	0.017
MON1803-TMPD4-65	5/23/18 2:30 PM	UBA Silt	34.4	0.79		0.0079	MON1803-TMPD4B-61	04/15/19	2:15 PM	UBA Sand	1.2	0.0051		27,900	0.28
MON1803-TMPD4-69	5/23/18 2:20 PM	UBA Silt	25.6	3.3		0.0072	MON1803-TMPD4B-69	04/15/19	2:18 PM	UBA Silt	1.1	0.062		17,000	0.0065
MON1803-TMPD4-75	5/23/18 2:13 PM	UBA Sand	95.4	0.084		0.30	MON1803-TMPD4B-74.5	04/15/19	2:20 PM	UBA Sand	6.9	3.1		27,900	0.0111
MON1803-TMPD4-79	5/23/18 2:10 PM	UBA Silt	160	11		0.08	MON1803-TMPD4B-78	04/15/19	2:23 PM	UBA Sand	15.5	2.3		27,900	0.0774
MON1803-TMPD4-82	5/23/18 2:00 PM	UBA Silt	728	2900		1432	MON1803-TMPD4B-82	04/15/19	2:25 PM	UBA Sand	6.4	1.3		27,900	0.19
MON1803-TMPD4-87	5/23/18 2:15 PM	UBA Silt	176	7.5		0.49	MON1803-TMPD4B-87	04/15/19	2:28 PM	UBA Silt	7.8	2.6		17,000	7.0
MON1803-TMPE4-54	5/21/18 3:30 PM	UBA Sand	37.4	0.0086		0.022	MON1803-TMPE4B-54	04/12/19	11:15 AM	UBA Sand	1.1	0.019		27,900	0.48
MON1803-TMPE4-57	5/21/18 1:00 PM	UBA Sand	157	3		0.040	MON1803-TMPE4B-58	04/12/19	11:20 AM	UBA Sand	1.6	0.0042		27,900	0.08
MON1803-TMPE4-64	5/21/18 1:25 PM	UBA Sand	69.6	1.9		0.0027	MON1803-TMPE4B-64	04/12/19	11:22 AM	UBA Sand	1.3	0.0029		27,900	0.090
MON1803-TMPE4-67	5/21/18 1:30 PM	UBA Sand	120	3.8		0.073	MON1803-TMPE4B-70	04/12/19	11:25 AM	UBA Sand	3.4	0.0090		27,900	0.091
MON1803-TMPE4-75	5/21/18 2:50 PM	UBA Sand	100	13		1.04	MON1803-TMPE4B-72.5	04/12/19	12:30 PM	UBA Sand	34.3	1.2		27,900	0.095
MON1803-TMPE4-78	5/21/18 2:55 PM	UBA Sand	326	5.5		0.088	MON1803-TMPE4B-77	04/12/19	12:23 PM	UBA Sand	17.6	2.0		27,900	0.048
MON1803-TMPE4-84	5/21/18 3:00 PM	UBA Silt	988	42		<0.01	MON1803-TMPE4B-82	04/12/19	12:40 PM	UBA Sand	130.7	2.5		27,900	0.20
MON1803-TMPE4-86	5/21/18 3:10 PM	UBA Silt	826	40		<0.01	MON1803-TMPE4B-86	04/12/19	12:40 PM	UBA Sand	130.7	1.0		27,900	0.48

Average:	728

Average:	0.645
Average Percent Reduction:	99.91%

Notes:

1. ppm = part per million
2. mg/kg = milligram per kilogram
3. J = Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated.
4. ET = Sample was extracted past end of recommended maximum holding time.
5. Total DDT = 2,4'-DDD + 2,4'-DDE + 2,4'-DDT + 4,4'-DDD + 4,4'-DDE + 4,4'-DDT

A memorandum documenting confirmatory sampling results was submitted to EPA on April 23, 2019 (TRS, 2019). On April 30, 2019, EPA notified *de maximis* of concurrence that the ERH Pilot test was complete. Following concurrence from the EPA, TRS discontinued all energy application to the subsurface.

6.2.1. Quality Control and Quality Assurance

A total of six duplicate soil samples were collected as part of the confirmatory sampling event. Concentrations of MCB were found to be within 1.6 to 60.0 percent error for samples with values above 5x reporting limits. The maximum concentration of MCB reported in any parent or duplicate sample was 2.5 mg/kg. Duplicate samples were not split samples and collected from adjacent soils. Variability of MCB distribution would be expected to affect the reproducibility of duplicate sample results.

All seven trip blanks analyzed as part of confirmatory sampling activities reported no detection of MCB.

Four samples from the TMP C4 location were labeled with the qualifier “ET” to denote the extraction holding time was exceeded. Encore samplers require preservation at the lab within 48hrs of sample collection per EPA 5035 prep. The lab missed the extraction holding time for the 4 samples from C4 location by approximately 1 hour, but they were analyzed within the 14 days holding time requirement per EPA 8260.

For the samples that had the highest DDT concentrations, the surrogate recoveries were outside of the control limits. However, the surrogate percent recovery does not affect the sample data. Surrogate recoveries are used to assess sample matrix interference effects and laboratory performance. For example, sample TMP B3 89 ft bgs required a 1,000 times dilution in order to quantitate the target analytes within calibration range. The surrogate was spiked with a concentration of 100 ppm in the sample before digestion and when diluted 1000 times, the surrogate concentration was diluted out. Background interference occurred at the same retention time that the surrogate would have been. The integrated noise multiplied by the dilution factor of 1000 gave what appeared to be a very high recovery, but the surrogate recovery could not be reliably calculated at this high dilution.

6.3. Demonstrate No Lateral NAPL Migration

As described in **Section 1.2.5**, exterior TMP locations were monitored using a handheld meter to determine the maximum temperature from 55 to 90 ft bgs with a single, RTD sensor. Temperature data at the exterior TMPs was compared against expected temperature rise due to conductive heating and then utilized to demonstrate there is no uncontrolled lateral or vertical DNAPL migration through the water bearing zone from the ERH pilot test volume. As part of confirmatory soil sampling, additional samples were collected, as described in detail below

6.3.1. Data Quality Objectives

All data collection was performed in accordance with the DQOs described in the Section 7.2.1 of the OMM (TRS, 2019). Details are summarized below.

<u>State the Problem</u> - Demonstrate no NAPL lateral migration.

Identify the Decision – Does ERH result in lateral DNAPL migration.

Identify the Inputs to the Decision –

1. Exterior TMP temperature observations – During the design process, TRS completed thermal penetration modeling to determine the expected rise in temperature at the selected exterior TMP locations. Temperature readings that exceed the modeling could be indicative of contaminant migration.

2. MCB Concentration (if required per the decision rules below) - All samples were analyzed for both MCB and DDT. The analytical results were compared with the DNAPL MCB concentration that is equivalent to the residual saturation for the soil type as defined by the Revised Boundary Confirmation and Baseline Sampling Report (TRS, 2019).

Define the Boundaries of the Study – Temperature observations in an exterior TMP exceeded modeled values as shown in **Table 9** at the following locations: TMP P1 70 ft bgs, TMP P5 70 ft bgs, TMP P6 65 ft bgs, and TMP P6 70 ft bgs. Therefore, a sample was collected during confirmatory sampling at each location immediately adjacent to the pre-ERH boundary confirmation boring location located closest to the exterior TMP having the observed temperature increase. Samples will be analyzed for both MCB and DDT.

Develop a Decision Rule – If temperature observations in exterior TMPs did not exceed modeled values as shown in **Table 9**, it was determined that ERH did not mobilize DNAPL laterally during the ERH pilot test. In the event that temperature increases are observed in exterior TMPs above modeled anticipated temperatures and samples collected, laboratory detections of MCB were compared with the equivalent MCB concentration to the residual DNAPL saturation for that soil type to determine if mobile DNAPL is present. If analytical results for MCB less than the MCB concentration that is equivalent to the residual saturation for that soil type, it was determined that ERH did not mobilize DNAPL laterally during the ERH pilot test.

Specify Tolerable Limits on Decision Errors – Thermal penetration modeling was completed at the time of ERH pilot test design. Models require assumptions and application of general expectation of temperature movement through the subsurface. As such, temperatures observed above those expected from the thermal penetration model may have been indicative of either hydraulic control issues or adjustments required to the model. If the ERH pilot test area experienced significant down time or slower than anticipated heat-up, temperatures in exterior TMPs may have been well below thermal penetration modeling. TRS updated the thermal penetration model during operations based on heat-up rates of the ERH pilot test area.

Optimize the Design for Obtaining Data – Soil samples were collected at the depth of the highest observed temperature in the exterior TMP in accordance with TRS SOP 3-2. Samples were analyzed for both MCB and DDT. Laboratory detections of MCB were compared with the revised DNAPL mobility threshold, as defined in the Revised Boundary Confirmation and Baseline Sampling Report (TRS, 2019), to determine if mobile DNAPL was present. Mobile DNAPL mass was considered to be not present when analytical results for MCB are less than the MCB concentration that is equivalent to the residual saturation for that soil type.

6.3.2. Exterior Soil Samples Results

Soil samples were collected from the exterior of the treatment volume based on temperatures observed above modeled values at locations summarized in **Table 14**: Four soil samples were collected based on observed temperatures. An additional three samples were collected based on headspace readings observed during screening of the soil cores. Sample results are presented in **Table 14** and on **Figure Y-2C**.

Table 14. Exterior Soil Sample Collection Summary

Soil Sample Location	Motivation for Sample Collection	Confirmatory Sample Results	
		MCB (mg/kg)	DDT (mg/kg)[1]
MON1803-1B-70	Temperature at TMP P1 70 ft bgs	0.062	0.031
MON1803-1B-74	Highest observed headspace reading in 70 to 75 ft bgs	71	1.3
MON1803-5B-70	Temperature at TMP P5 70 ft bgs	9.5	0.055
MON1803-5B-73	Highest observed headspace reading in 70 to 75 ft bgs	41	1.2
MON1803-6B-65	Temperature at TMP P6 65 ft bgs	0.00087 J[2]	0.0058
MON1803-6B-70	Temperature at TMP P6 70 ft bgs	0.45	0.062
MON1803-6B-76	Highest observed headspace reading in 70 to 77 ft bgs	4.9	0.115

Notes: [1]Total DDT (mg/kg) is the sum of 2,4'-DDD, 2,4'-DDE, 2,4'-DDT, 4,4'-DDD, 4,4'-DDE, and 4,4'DDT detections.
[2]J=Estimated value. MCB was detected at a level less than the reporting limit (RL) and greater than or equal to the method detection limit (MDL). This data is of limited reliability.

No evidence of DNAPL was observed in any exterior soil sample collected. Concentrations of MCB in each sample were well below residual saturations for the corresponding soil type. **Therefore, it was determined that no lateral migration of DNAPL occurred during ERH application.**

6.4. Demonstrate No Downward NAPL Migration

TRS collected a sample from each confirmatory sampling location at a depth of 5 ft below the deepest extent of DNAPL identified during baseline sampling to determine there was no downward migration of mobile DNAPL. Locations identified as having DNAPL present during baseline sampling are presented in **Table 12.** No DNAPL was identified in any confirmatory sampling locations. **Confirmatory soil samples collected at the locations of TMP B3 89 ft bgs, TMP C2 86 ft bgs, TMP C4 86 ft bgs, and TMP D4 87 ft bgs demonstrated no downward NAPL migration occurred during ERH application.**

6.4.1. Data Quality Objectives

All data collection was performed in accordance with the DQOs described in the Section 7.3.1 of the OMM (TRS, 2019).

State the Problem - Demonstrate no NAPL downward migration.

Identify the Decision – Does ERH result in downward DNAPL migration.

Identify the Inputs to the Decision – All samples were analyzed for both MCB and DDT. The analytical results were compared with the DNAPL MCB concentration that is equivalent to the residual saturation for the soil type as defined by the Revised Boundary Confirmation and Baseline Sampling Report (TRS, 2019).

Define the Boundaries of the Study – During confirmatory sampling, soils were characterized, and samples were collected from each interior TMP location at a depth of five feet below the deepest extent of DNAPL, if determined as present during the baseline sampling event. Samples were analyzed for both MCB and DDT.

Develop a Decision Rule – Laboratory detections of MCB were compared with the MCB concentration equivalent to the residual DNAPL saturation for that soil type to determine if mobile DNAPL is present. If the analytical results for MCB were less than the MCB concentration that is equivalent to the residual saturation for that soil type, it was determined that ERH did not mobilize DNAPL downward during the ERH Pilot Study.

Specify Tolerable Limits on Decision Errors – Samples obtained to confirm no downward migration of DNAPL would not be obtained no deeper than 95 ft bgs. Confirmation borings did not penetrate into the Middle Bellflower C-Sand (MBFC).

Optimize the Design for Obtaining Data – During the confirmatory sampling event, samples were collected from each confirmatory sampling location at a depth of five feet below the deep extent of DNAPL, if determined present during the baseline sampling event.

6.5. Demonstrate No NAPL Condensation

Manual readings of vapor piezometers were collected weekly from both interior and exterior TMP locations to evaluate pneumatic control of the Site during ERH operations. Pneumatic control of the ERH pilot test volume was assessed as a vacuum of 0.1 inches of water or greater within the ERH pilot test volume and as a lack of pressure outside of the ERH pilot test volume. Vacuum throughout the ERH pilot test volume during operations provided assurance that vapor flow is toward the vapor recovery wells and that DNAPL was not condensing. To confirm no condensation of NAPL was occurring, soil samples were be collected between 50 to 55 ft bgs in the unsaturated zone from the depth exhibiting the highest headspace screening during the baseline and confirmatory sampling events. Samples were analyzed for MCB and compared against the revised DNAPL mobility threshold. **Confirmatory soil samples collected in the unsaturated zone demonstrated no NAPL condensation occurred during ERH application.**

6.5.1. Data Quality Objectives

All data collection was performed in accordance with the DQOs described in the Section 7.4.1 of the OMM (TRS, 2019).

State the Problem - Demonstrate no NAPL condensation.

Identify the Decision – Is the ERH vapor recovery process adequate to prevent NAPL condensation.

Identify the Inputs to the Decision –

1. Vapor Piezometer – Manual readings of vapor piezometers were collected weekly from both interior and exterior TMP locations to evaluate pneumatic control of the Site during ERH operations. To complete a subsurface vacuum reading, a digital manometer was connected to the piezometer and the piezometer valve opened.

2. MCB Concentration - All samples were analyzed for both MCB and DDT. The analytical results were compared with the DNAPL MCB concentration that is equivalent to the residual saturation for the soil type as defined by the Revised Boundary Confirmation and Baseline Sampling Report (TRS, 2019).

Define the Boundaries of the Study – Measurements from both interior and exterior vapor piezometers were collected weekly during operations to confirm vapor capture by demonstrating there is no uncontrolled lateral or vertical vapor migration through the vadose zone.

During confirmatory sampling, soil was characterized, and samples were collected from each interior TMP location at a depth of 50 to 55 ft bgs, or five feet above the uppermost extent of mobile DNAPL, whichever is shallower, as determined during the baseline sampling event. Samples were analyzed for both MCB and DDT.

Develop a Decision Rule – Pneumatic control of the ERH pilot study volume was assessed as a vacuum of 0.1 inches of water or greater within the ERH pilot study volume and as a lack of pressure outside of the ERH pilot study volume.

Laboratory detections of MCB were compared with the equivalent MCB concentration to the residual DNAPL saturation for that soil type to determine if mobile DNAPL is present. If the analytical results for MCB were less than the MCB concentration that is equivalent to the residual saturation for that soil type, it was determined that ERH did not mobilize DNAPL during the ERH Pilot Study.

Specify Tolerable Limits on Decision Errors – In the event that a primary and duplicate sample varied in concentration of MCB, the higher of the two results would have been used for comparison against the residual DNAPL saturation. Limits on recovery and relative percent difference will be in accordance with attached laboratory procedures. No duplicate samples were collected above 55 ft bgs.

Optimize the Design for Obtaining Data – During the confirmatory sampling event, samples were collected from each confirmatory sampling location between 50 and 55 ft bgs, as no mobile DNAPL was identified during baseline sampling. Soil sampling methodologies and characterization were in accordance with the boundary confirmation and baseline sampling procedures described in the Workplan (TRS, 2017).

7.0 DEMOBILIZATION

7.1. Vapor Recovery Shutdown

Power application to sub-surface was ceased on April 30, 2019. Gradual reduction of applied vacuum to the sub-surface was initiated on May 2, 2019. On May 15, 2019, all vapor recovery points on the perimeter of the ERH pilot test area (B2, B3, B4, B5, C2, C6, D2, D6, E3, E6, F4, F5, F6) were closed. On May 23, 2019, operation of the vapor recovery blower ceased and all remaining vapor recovery points were closed.

7.2. Equipment Decommissioning

Disconnections of electrical connections and decommissioning of the electrodes, power supply cables, and step-down transformers was initiated on May 6, 2019.

All pump components installed in UBE-5 were removed on May 17, 2019, and the well capped. The well was re-sealed with a threaded cap after pump removal due to remaining elevated subsurface temperatures. All disposable parts and tubing were decontaminated with a high-temperature, 3000 pounds per square inch (psi) pressure-washer and placed in the decommissioning roll-off bin for disposal (see **Section 8.0**). Water was captured by the ERH condenser and treated through the liquid treatment system and discharged to TGRS.

On May 29, 2019, decommissioning of the vapor recovery system was initiated. Vapor recovery hoses were disconnected and down-hole piping temporarily capped. Piping components were cut into sections, cleaned with the hot pressure washer and rotating brush, and water captured by the ERH condenser and treated through the liquid treatment system and discharged to TGRS.

As of the date of this report, the PCU, condenser, SRGAC, and boiler system remain on-site and have not yet been fully decommissioned.

7.3. Sub-surface Abandonment

On June 5, 2019, abandonment of all subsurface features was initiated. In accordance with the ERH Pilot Test Workplan (TRS, 2018), all electrodes and subsurface piping, including VR wells and vacuum piezometers were cut 1 ft bgs and grouted in place with neat cement grout. Excavated soil and grout mixture was placed in a covered roll-off for disposal. Grout was mixed to the manufacturer's specifications. Screened piping (vapor recovery, piezometers, and drip lines) were pressure grouted. TMP casings were gravity-filled. All grout volumes were measured and confirmed to meet or exceed estimated volumes required for complete abandonment. Existing inert materials such as graphite, cables, and copper plates remain in place. All abandoned locations were finished to the surface with 4,500 psi concrete. Severed electrode cable and other reusable materials were salvaged.

8.0 WASTE MANAGEMENT

8.1. Waste Handling and Disposal

Consistent with the Resource Conservation and Recovery Act (RCRA), U.S. Department of Transportation (DOT), and Occupational Safety and Health Administration (OSHA)/Cal-OSHA regulations, containers for accumulated hazardous waste were labeled with hazardous waste labels, indicating the appropriate waste designation, contents, accumulation period, Site address, and waste generator information. Prior to shipment, waste characterization analytical samples were collected as required for each waste stream. Analytical reports for each waste stream (if required) are provided in **Appendix J**. Licensed hazardous waste transport and disposal companies, Belshire Environmental Services and Stericycle, Inc., were retained by TRS to load, transport, and appropriately dispose of hazardous waste consistent with all local, state and federal waste regulations. Waste transported off-site for disposal was tracked using a standard Uniform Hazardous Waste Manifest form. All waste manifests from each waste stream are provided in **Appendix K.** All profiles were submitted electronically to *de maximis* for review and approval prior to off-site shipment of the waste. O&M, Inc. personnel inspected loads and signed manifests. The Generator's Initial Copy of the manifest was retained at the Site upon signing the manifest. A copy of the original signature page was made and sent by O&M Inc. to the California Department of Toxic Substances and Control (DTSC). The 'Designated Facility to Generator' copy was returned by the Treatment, Storage, and Disposal Facility (TSDF) to Montrose headquarters on Bainbridge Island, Washington. Montrose sent electronic copies to *de maximis*. A manifest package was compiled by *de maximis* and kept on-site in accordance with RCRA recordkeeping requirements. EPA was notified prior to each shipping event of hazardous waste and approved each disposal facility.

A summary of all ERH-associated waste streams and methods to be used for storage and disposal are presented on **Table 15**. Additional details are provided in the sections below.

Guidelines for waste disposal provided in TRS SOP 2-1: Waste Management were followed, unless Site or local regulatory requirements dictated otherwise. TRS SOPs are maintained in the TRS PCU in a separate compendium.

Table 15. Waste Summary

Waste Description	Process	Total ERH Pilot Amount	On-site Storage Method	Classification	Disposal Location
DNAPL-contaminated soil and cuttings	Drilling and trenching	185.2 tons[(1)]	20 yd^3, covered roll-off containers	U060, U061	Clean Harbors, Aragonite, UT
Decontamination water (no surfactants)	Equipment decontamination	2,800 gallons	275-gallon totes	N/A	TGRS
Liquid treatment system discharge	ERH operations	175,000 gallons	ERH liquid treatment system	N/A	TGRS
DNAPL	SRGAC discharge	2,519 gallons[(2)]	SRGAC NAPL tank	D018, D021, D022, D033	Clean Harbors, Aragonite, UT
Spent filters	ERH operations	1 drum	55-gallon drum	D021, D022, D039	US Ecology, Beatty, NV
Spent LGAC	ERH operations	800 lbs	LGAC vessels, 55-gallon drums	Non-hazardous	US Ecology, Beatty, NV
Spent VGAC	ERH operations	20,000 lbs[(3)]	VGAC vessels, supersacks	D022	Evoqua Water Technologies, Parker, AZ
Decontamination water (surfactants)	Equipment decommissioning	110 gallons	55-gallon drums	Non-hazardous	US Ecology, Beatty, NV
Plastic/PPE	Drilling and ERH operations	11 sacks, 2 drums	Supersacks (approx. 300 lbs ea), 55-gallon drums	D012, D018, D019, D021, D022	21st Century Environmental Management of Nevada, Fernley, NV
Decommissioning solid debris	ERH equipment decommissioning and demobilization	Estimated 3 tons	40 yd^3 roll-off bin	Non-hazardous	Waste Management, Simi Valley, CA

Notes: [(1)]Actual weight at disposal facility. [(2)]Manifested volumes include an additional 269 gallons of water, not included in reported project mass removal.
[(3)]GAC used in SRGAC was not completely spent at project completion and SRGAC went into service for the Vapor Barrier Pilot Test.

8.2. Electrode, TMP Installation, and Confirmatory Sampling

A total of approximately 172.8 tons of contaminated soils were generated during boundary confirmation, installation of the ERH Pilot electrodes and TMPs, collection of confirmatory samples, and demobilization activities. Soils were placed in multiple covered, 20-yd^3 soil bins for storage, profiling, and transportation to the disposal facility.

Prior to installation of the ERH liquid treatment system, decontamination water accumulated from cleaning drill tools and equipment was collected in a mobile containment unit assembled by the drilling subcontractor and transferred to 275-gallon totes. A total of approximately 2,800 gallons was discharged directly to the TGRS sump.

As a method of containment of soil wastes around drilling activities, plastic sheeting was placed on the ground surrounding the borehole and drill rig. Plastic sheeting and contaminated personal protective equipment (PPE) was collected in supersacks for storage and transportation to the disposal facility.

8.3. Condenser Waste

The ERH condenser produced condensate from the vapor recovery system and received condensate water from the SRGAC decanter. The streams were combined and treated through the ERH liquid treatment system. Liquids were pumped to a temporary storage tank prior to discharge. Blowdown water from the condenser cooling tower, SRGAC cooling tower, boiler, and water softener were also collected in the temporary storage tank. A total of approximately 175,000 gallons of combined wastewater was discharged to TGRS. The ERH pilot system did not discharge any wastewater to the municipal sewer system.

Additionally, a condensate filter is located within the condenser unit that required periodic replacement. Spent filters were stored on-Site in sealed, labeled, 55-gallon drums and characterized for disposal.

8.4. SRGAC Wastes

Operation of the SRGAC produced DNAPL extracted from the recovered vapor stream and condensate water from condensed steam during carbon vessel regeneration. Condensate water generated from the decanter was directed to the condenser and processed through the ERH liquid treatment system.

DNAPL collected in the SRGAC decanter was pumped to the non-aqueous phase liquid (NAPL) tank for on-site collection and storage. Accumulated DNAPL was removed from the Site by direct pump out from the NAPL tank as needed. A total of approximately 2,519 gallons of DNAPL and 269 gallons of water were removed from the NAPL tank and transported to the disposal facility. DNAPL collected on January 9, 2019, for waste characterization was analyzed for VOCs by EPA Method 8260B, SVOCs by EPA Method 8270C, and pesticides by EPA Method 8081A. Collected DNAPL was found to be composed of 86.0% MCB, 9.4% tetrachloroethene, and 3.6% chloroform, by mass. The remaining 1.0% by mass was found to be a mixture of VOCs and SVOCs including benzene, dichlorobenzene, and xylenes. No organochloride pesticides were detected in the sample. Analytical data is provided in **Appendix J-1.**

Additionally, a condensate filter is located within the SRGAC unit that required periodic replacement. Spent filters were stored on-Site in sealed, labeled, 55-gallon drums and characterized for disposal.

8.5. LGAC and VGAC Waste

In the event that contaminant breakthrough was observed in either an LGAC or VGAC vessel, activated carbon was removed and replaced with fresh carbon. One spare VGAC vessel was maintained on-site with fresh polish carbon to allow for rapid installation of fresh polish VGAC as necessary.

Spent LGAC was removed from the vessels and placed in 55-gallon drums for characterization and disposal. Spent VGAC was placed within double-walled supersacks for characterization and disposal.

8.6. Decommissioning Debris

Surface construction materials, removed subsurface components, and general decommissioning debris were decontaminated with a hot pressure washer, as needed, and placed into a roll-off for disposal. Decontamination water was processed through the ERH liquid treatment system. Decontamination water generated after the decommissioning of the ERH liquid treatment system was containerized in 275-gallon totes and will be discharged directly to TGRS.

Throughout operations and decommissioning, surfactants were occasionally needed for decontamination of tools and equipment. Discharge of surfactants to the TGRS would damage the TGRS system. Therefore, decontamination waters containing soap or surfactants were containerized in 55-gallon drums and stored separately for characterization and disposal.

9.0 CONCLUSIONS AND LESSONS LEARNED

9.1. ERH Performance Summary

The VR system operated for 153 days and 659,299 kilowatt hours of energy were applied to the treatment volume over 132 days of heating. On average, subsurface temperatures increased at a rate of approximately 0.5 to 2.3 degrees Celsius (°C) per day as the treatment volume temperature increased from ambient to a maximum average temperature of 107.0°C.

The VR system operated at an average flow rate of 380 scfm during the operational period. Recovered vapor samples were collected during operations and submitted for laboratory analysis. **Based on direct measurement of accumulated DNAPL and estimates of mass recovered on polish VGAC, approximately 26,600 pounds of total VOCs were recovered from the pilot test treatment volume during ERH heating. A total of 2,519 gallons of DNAPL were recovered by the SRGAC unit**.

Analytical data from confirmatory sampling confirmed that concentrations of MCB in sand are below 27,900 mg/kg and concentrations of MCB in silt are below 17,000 mg/kg. MCB concentrations in the confirmation soil samples were found to be significantly below the concentrations equivalent to the residual DNAPL saturation for that soil type; in most instances, sampled concentrations were more than four orders of magnitude below the residual saturation levels.

The ERH pilot test was conducted in accordance with all TRS safety protocols, the ERH HASP (TRS, 2019), and SOPs. No OSHA-reportable injuries or lost time occurred due to health and safety incidents during the ERH pilot test site assessment, installation, operation, or demobilization activities.

9.2. Schedule Deviations

Significant delays were experienced associated with the electrical utility installation by LADWP. It was originally anticipated that a new electrical service would not be necessary at the Site for the ERH pilot test but was required due to limitations of infrastructure installed prior to the ERH pilot test. Construction activities were suspended on September 26, 2018, awaiting LADWP construction of utility components. Generators were mobilized to the Site to initiate start-up activities when possible. Multiple inspections and construction crews were required during the construction process, and delays encountered at each phase of construction due to scheduling of LADWP crews. The electrical service installed for the ERH pilot was energized by LADWP on December 12, 2019, and scheduled activities resumed as expected.

9.3. Analysis of Goals and Pilot Test Objectives

The primary goal of the ERH pilot test was to apply ERH and VR to reduce mobile DNAPL mass to the extent practicable. The ERH pilot test also presented an opportunity to collect site-specific data to support the selection of a larger scale ERH system at the Site. A summary of the analysis of the ERH pilot test objectives, as described in **Section 2.0** and the ERH pilot test workplan (TRS, 2019), with applicability to ERH application in the FTA is as follows:

1. Mobile DNAPL mass was successfully reduced, to the extent practicable, in the subsurface within the pilot test area. Analysis of capillary pressure data from the baseline sampling event found the DNAPL mobility threshold to be 27.1 percent residual saturation in sand samples and 14.1 percent in silt samples, corresponding to approximately 27,900 mg/kg

MCB in sand and 17,000 mg/kg MCB in silt at the Site (TRS, 2019). **No evidence of DNAPL presence was identified during confirmatory sampling events**. A scaled-up system, as demonstrated by the ERH pilot test, is capable of effectively reducing mobile DNAPL mass to the extent practicable, in the FTA. This objective was met.

2. Site-specific ERH system data was analyzed and an evaluation of multiple lines of evidence was completed to determine when ERH system operations were complete at the Site (see **Section 6.1**). Data evaluated included subsurface temperatures, total energy use, MCB removal rates, cumulative mass removal, and confirmatory sampling results. Application of multiple lines of evidence to predict completion of ERH in the FTA are discussed in **Section 9.4.3**. The objective of analyzing multiple lines of evidence was completed and criterion met.

3. Homogeneous/uniform heating within each depth interval throughout the pilot test treatment volume was documented and criterion met. Based on electrode performance, no changes to subsurface electrode design and electrode spacing are recommended. Although design changes could be made to accommodate, the operational approach of "bottom-up heating" is not recommended for ERH application to the FTA due to the undesirable delay experienced in heating of the shallow regions. This contributed to a decrease in efficient removal of contaminant from the treatment volume by the vapor recovery system.

4. The DNAPL FS estimated the use of 200 kWh/yd^3 would be necessary to achieve ERH pilot test objectives (AECOM, 2013). TRS estimated an energy density of 179 kWh/yd^3 based on a total design energy of 700,000 kWh and a treatment volume of 3,900 yd^3. The treatment volume used in energy density calculations is based on a surface area of 3,289 ft^2 and an electrode array from 60 to 92 ft bgs. However, energy density required for site remediation is a function of treatment volume size, initial concentrations, and remedial goals. Given that capillary pressure testing had not been completed prior to design and baseline concentrations were below the single historical data point for residual saturation of MCB, TRS had to make assumptions regarding site cleanup goals and remedial goals. The design energy and corresponding energy density were biased high. The ERH pilot test applied a total of 659,299 kWh, resulting an energy density of 169 kWh/yd^3 applied to the ERH pilot test treatment volume.

5. Application of ERH did not result in uncontrolled lateral or vertical DNAPL migration. The following objectives were demonstrated:

    a. Absence of lateral migration was determined by measuring temperatures at external TMPs, and confirmatory soil samples collected at locations where temperatures above modeled expectations were observed. As described in **Section 6.3**, confirmatory soil samples collected at the perimeter of the treatment volume in locations of elevated temperatures demonstrated no evidence of DNAPL migration. All other exterior TMP locations observed increases in temperatures below modeled expectations.

    b. Absence of downward vertical migration was determined by collecting a sample from each confirmatory sampling location at a depth of 5 ft below the deepest extent of DNAPL identified during baseline sampling. As described in **Section 6.4**, samples collected 5 feet below the four locations of DNAPL identified during baseline sampling demonstrated no evidence of downward DNAPL migration.

6. As described in **Section 6.5,** samples were collected in the vadose zone between 50 and 55 feet to demonstrate the VR system effectively collected MCB without cooling and condensing in the subsurface. No samples collected in the vadose zone exhibited evidence of condensation of MCB.
7. Accumulated DNAPL was transported to Clean Harbors in Aragonite, Utah, for disposal by incineration at an average cost of $6.50 per gallon of disposed liquid. All other condensed liquid wastes were treated by the ERH liquid treatment system and sent to TGRS for additional treatment. Cost effective treatment of condensed liquids was demonstrated.
8. ERH pilot test power demands were within design expectations of the installed electrical utility service and electrical equipment. The data gathered during the pilot test indicates that ERH will scale to the FTA. The dual element electrodes were confirmed to be necessary as the resistance of the shallow and deep intervals required a different applied voltage.
9. Evaluate temperature data from TMPs located outside of the ERH pilot test area to monitor the rate and direction of groundwater flow outside of the pilot test ERH treatment volume. The temperature data from TMP P3 and P4 remained much cooler than predicted, indicating groundwater flow from this direction during operation of the pilot test. However, a corresponding elevation of temperature on the opposite side of the treatment area was not observed which indicated that groundwater flow within the subsurface was not significant to ERH operations. Typical groundwater flow to the southeast was replaced by removal of steam from the treatment volume. Figures 9a-9f show temperatures above modeled expectations were located predominantly in a layer surrounding 70 ft bgs. Vertical temperature profiles at exterior TMPs did not indicate evidence of groundwater movement through the entire treatment volume, but rather a preferential pathway in layer(s) at approximately 70 ft bgs. It is likely that the steam removal of the VR system contributed to a localized in flux of cooler water from this direction.
10. Pressure data from vapor piezometers located within and outside of the ERH pilot test area (see **Table 10**) were monitored weekly and demonstrated continuous flow of air toward the pilot test treatment volume during ERH system operation and provided additional assurance that contaminant mass did not condense.
11. Air monitoring during ERH pilot test construction, operation, and demolition, as described in **Section 5.4** and confirmed safe breathing levels were maintained during the ERH pilot test.

9.4. Lessons Learned and Scalability for FTA Remedy

9.4.1. Design and Construction

In regard to the design and construction of the FTA ERH remedy, TRS makes the following recommendations based on experience and data collected during the ERH pilot test:

- Site entrance: The entrance to the Montrose site from Normandie Avenue consists of a steep slope and two railroad track crossings and presents a significant challenge to large equipment mobilization and demobilization from the Site. Montrose is evaluating options to address site mobilization issues.

- Subsurface conditions: An abandoned sewer line was encountered during subsurface installation in the ERH pilot test area, which required slight shifts in electrode locations.

Additional subsurface obstructions such as building footers and concrete debris are expected to be encountered in the FTA. Locations will be evaluated for possible conflict during design and field modifications of locations may be required in the event of drilling refusal.

- Materials of construction: Materials of construction in the vapor recovery system were sufficient for handling contaminants of concern and will be suitable for the application of ERH in the FTA. No visual evidence of significant degradation or damage from material incompatibility was observed during demobilization activities. Carbon steel, CPVC piping, and VR hoses showed little to no evidence of chemical attack through visual observation. Stainless steel vessels and equipment pumps showed no visual evidence of corrosion and no malfunctions due to chemical attack occurred. Carbon steel displayed visual evidence of minor rusting due to steam contact. Teflon tubing and stainless-steel piping for DNAPL management and UBE-5 well pumping showed no visual evidence of chemical breakdown and materials will be selected accordingly for the FTA.

- Electrode design: The ERH pilot test treatment volume was constructed with dual element electrodes. To allow for optimization of power application to the subsurface, the dual element design is recommended for the FTA ERH application.

- Vapor recovery points: Supplemental vapor recovery points can be installed in the treatment volume independently from electrode locations to assist with vertical transport of contaminants to the vapor recovery screens. As described in **Section 6.3**, elevated groundwater temperatures were observed in exterior TMPs. With confirmation sampling, it was determined that DNAPL was not mobilized laterally during application of ERH to the pilot test area. Elevated temperatures in exterior TMPs is likely the result of bottom-up heating techniques and the existence of very thin sand layers in the upper portion of the saturated zone. Elimination of bottom-up heating techniques and the addition of supplemental vapor recovery points in the FTA will reduce the potential for elevated temperatures outside of the treatment volume.

- Electrode drip system: Subsurface components of the electrode drip system were installed as a contingency. Operational data did not indicate the need for electrode wetting, and the system was not used. It is not expected that use of an electrode drip system will be necessary for FTA ERH application. However, below grade infrastructure for drip will be installed as a contingency during FTA installation.

- Mass removal prior to heating: Based on high influent concentrations observed prior to heating the ERH pilot test area, the results of the soil vapor extraction (SVE) pilot test (Earth Tech AECOM, 2009), and mass-in-place estimates presented in the DNAPL FS (AECOM, 2013), vapor extraction above the focused ERH area is recommended prior to application of ERH.

- Mobilization of offsite contaminants onto Montrose property: Based on ERH operational data and ROI estimates determined during the SVE pilot test (Earth Tech AECOM, 2009), an engineering control to prevent vapor migration onto Montrose property is likely necessary. A passive barrier wall is recommended to be evaluated as a means of preventing the migration of chemicals from the JCI property onto the Montrose property during future vapor extraction activities. A separate workplan for a pilot test to evaluate the effectiveness of a passive barrier wall has been submitted to the EPA for review (TRS, 2019).

- Power: Power demands were within design expectations and TRS has determined that the ERH remedy could be scaled from the ERH pilot test. Design of future electrical service installations will be evaluated for FTA ERH application. Due to significant delays experienced associated with the electrical utility installation by LADWP, an evaluation of a phased approach to the application of ERH in the FTA should be evaluated for cost effectiveness and ease of installation and operation. Evaluation of schedule for any future electrical utility installations that may be required is recommended.

- Liquid treatment and disposal: Methods demonstrated by the ERH pilot test sufficiently treated condensed liquids from the ERH system for treatment and disposal to the TGRS facility. Specifically, a 10-micron bag filter was used to remove DDT-impacted particles from recovered groundwater and condensate prior to treatment with LGAC for VOC removal (Refer to **Section 5.3.5** for additional detail). Scaled-up application of this design would be sufficient for treating condensate during ERH operations in the FTA. TRS has provided estimated, scaled-up discharge concentrations to TGRS and received confirmation that discharge concentrations expected during ERH application in the FTA based on concentrations observed during the ERH pilot would be acceptable. Further analysis would be necessary in the event of a significant ERH application design modification.

- Elevated Temperatures in Exterior TMPs: Pumping from within the treatment volume is not the preferred response to temperatures observed at exterior TMP locations. Re-energization of only the shallow elements to expedite boiling temperatures is the preferred method to enhance hydraulic control by removing groundwater as steam from the treatment volume. This conclusion is based on the following: (1) Cessation of power application to electrodes produced an immediate decrease in temperatures observed at exterior TMPs, suggesting steam migration, not movement of groundwater, was responsible for the increased temperatures observed at exterior TMPs. (2) Pumping of well UBE-5 showed no significant effect on exterior temperatures. (3) Average temperature in the shallow region of the treatment volume was not yet at boiling temperatures and approximately 16°C lower than the deep region on March 4, 2019, due to the “bottom-up heating” approach, potentially hindering vapor migration upward for collection by vapor recovery screens.

- Hydraulic control: Pumping of groundwater from UBE-5 during the ERH pilot test was investigated as means of ensuring hydraulic control but was not the most effective approach for reducing elevated temperatures in exterior TMPs as described in the previous bullet. Additionally, pumping of UBE-5 presented challenges for water disposal. Pumping of groundwater as a means of hydraulic control during ERH application in the FTA will be further evaluated in the design of the ERH system.

- SRGAC: The SRGAC unit demonstrated effective and efficient vapor treatment during the ERH pilot test. Based on SRGAC regeneration cycles performed during the ERH pilot test, an equivalent of approximately 365,400 pounds of carbon were regenerated during ERH pilot test operations. SRGAC is scalable and applicable to future SVE and ERH in the FTA based on estimated mass recovery rates and vapor stream composition. Future SRGAC bed turnover rates as function of influent concentration have been estimated as part of the ERH pilot test. TRS expects turnover rates greater than twice daily will be necessary for the FTA. Additionally, initial turnover rates will be conservatively higher at project start-up and reduced as necessary. Once boundary and baseline sampling are completed within the focus area, an evaluation will be completed to determine if one or two SRGACs are necessary for treatment within the ERH FTA.

- NAPL Storage: One 1,000-gallon NAPL tank was sufficient for volume of NAPL collected during the ERH pilot test. Based on mass-in-place estimates of the FTA, additional NAPL tankage will be required and will be evaluated as part of FTA design. Multiple tanks will allow for coordination of cost-effective disposal while maintaining ERH operation uptime.

9.4.2. Operations

TRS makes the following recommendations for application of ERH within the FTA based on experience and data collected during the ERH pilot test:

- "Bottom-Up Heating": The ERH pilot test treatment volume was constructed with dual element electrodes. During startup operations, only the bottom elements were energized until temperatures in the deep zone were an average of 20°C above ambient subsurface temperatures. The initial increase in deep temperatures did not cause the inefficient vapor recovery and elevated temperatures observed in the exterior TMPs. However, temperatures exceeding the heteroazeotropic boiling temperature for MCB were reached across the deep electrode elements on February 14, 2019. Site data indicates that the cooler temperatures above the boiling deep elements resulted in increased resistance to vertical steam migration through the formation. This likely contributed to inefficient vapor recovery and elevated temperatures observed in exterior TMPs. As previously discussed via teleconference with USEPA, the "Bottom-Up Heating" approach is not recommended during treatment of the FTA.

- Influent TO-15 data: Vapor recovery influent analysis by EPA Method TO-15 was extremely valuable for assessing mass recovery rates and composition. A data collection schedule similar to the ERH pilot test is recommended for the FTA.

- Ambient air monitoring: Ambient air monitoring conducted before, during, and after ERH operations did not identify any risks to TRS personnel or the public at large. The pilot test ambient air monitoring program confirmed that the industry standard practice of monitoring ambient air during operations with a handheld PID is acceptable for ensuring Site and public safety. The asphalt cap will be maintained during ERH application in the FTA. The ERH pilot test demonstrated pneumatic control throughout operations and no significant changes to the ERH design are anticipated for application to the FTA.

- Removal characteristics of DDT: DDT and byproducts were observed in VR influent (TO-10 data), and condensate/waste water streams; however, did not appear to have any impact on the process equipment or materials of construction. TRS does not expect DDT to present an unreasonable challenge during ERH operations in the FTA.

- Removal characteristics of pCBSA: Analytical data of pCBSA concentrations were collected only from the waste water discharge stream to TGRS, in accordance with the OMM (TRS, 2019). Additional data was collected prior to LGAC treatment on April 4, 2019, and confirmed pCBSA was present in the condensate stream. Data collected on April 4, 2019, reported concentrations below detection limits on LGAC effluent, indicating effective capture of pCBSA by LGAC. Over the course of five monthly sampling events, pCBSA was only detected in one effluent sample, on May 2, 2019. TRS does not expect pCBSA to present an unreasonable challenge during ERH operations in the FTA .

9.4.3. Confirmatory Sampling and Completion

TRS makes the following recommendations for ERH application within the FTA based on experience and data collected during the ERH pilot test:

- Confirmatory soil sampling: The ERH pilot system was operated beyond what was required to achieve project goals. TRS estimates DNAPL was no longer present in the pilot test treatment volume on March 31, 2019, nine days prior to confirmatory soil sampling activities were initiated on April 9, 2019. TRS recommends soil sampling at greater frequency and earlier in operations during ERH operations in the FTA for assessment of project progress and optimization of ERH application.

- DNAPL mobility threshold: Data presented in **Section 3.0**, collected as part of ERH pilot test baseline sampling, further refined the DNAPL mobility threshold. No additional physical properties testing is warranted for ERH application in the FTA unless DNAPL-impacted soils exhibiting properties significantly different than the generalized UBA sand and UBA silt are encountered.

10.0 REFERENCES

AECOM, 2013. *Final DNAPL Feasibility Study.* September.

CalVada Survey, 2018. *Construction Staking, 20201 Normandie Avenue.* April 11.

Earth Tech AECOM, 2009. *Revised SVE Pilot Test Report.* June 3.

GES, 2020. *2019 Monitoring and Aquifer Compliance Report (MACR), Montrose Chemical and Del Amo Superfund Sites.* February.

Hargis + Associates, Inc., 2004. *Results of DNAPL Reconnaissance Investigation, Montrose Site, Torrance, California, Revision 1.0.* October 22.

TRS Group, Inc., 2017. *TRS Corporate Environmental, Health and Safety Program*, Revised. June.

TRS Group, Inc., 2017. *Standard Operating Procedure 1-3: Voltage Surveys*, Version 6. August.

TRS Group, Inc., 2017. *Standard Operating Procedure 1-2: Application of Electrical Power to ERH Sites*, Version 4. September.

TRS Group, Inc., 2017. *Revised Mobile DNAPL Boundary Confirmation Work Plan*, October.

TRS Group, Inc., 2017. *Sampling and Analysis Plan/Quality Assurance Project Plan*, *Mobile DNAPL Boundary Confirmation*. October.

TRS Group, Inc., 2017. *Standard Operating Procedure 1-1: Lockout/Tagout (LOTO)*, Version 5. October.

TRS Group, Inc., 2017. *Standard Operating Procedure 3-2: Hot Soil Sampling*, Version 4. December.

TRS Group, Inc., 2019. *ERH Pilot Construction and Start-Up Report.* January.

TRS Group, Inc., 2018. *Electrical Resistance Heating Pilot Test Work Plan*, May.

TRS Group, Inc., 2019. *Health and Safety Plan, Electrical Resistance Heating Pilot Test, Rev4*. February.

TRS Group, Inc., 2019. *ERH Pilot Operations and Maintenance Manual.* April.

TRS Group, Inc., 2019. *Revised ERH Pilot Test Boundary Confirmation and Baseline Sampling Report.* April.

TRS Group, Inc., 2019. *Memorandum: Anticipated Completion of ERH Pilot Study/Planned Confirmation Sampling.* April 4.

TRS Group, Inc., 2019. *Memorandum: Determination of ERH Pilot Test Completeness, Montrose Site*. April 23.

TRS Group, Inc., 2019. *Vapor Barrier Pilot Test Work Plan*. United States Environmental Protection Agency, 2018. *Email approval of the ERH Pilot Test Sampling and Analysis*

Plan/Quality Assurance Plan (SAPP/QAPP), Montrose Superfund Site, 20201 Normandie Ave., Los Angeles, California, October 2017. October 6.

United States Environmental Protection Agency, 2018. *Email approval of the Revised ERH Mobile DNAPL Boundary Confirmation Work Plan, Montrose Superfund Site, 20201 Normandie Ave., Los Angeles, California, October 2017.* October 6.

United States Environmental Protection Agency, 2018. *Conditional Approval and EPA Comments on the Electrical Resistance Heating Pilot Test Work Plan and the Electrical Resistance Heating Design Package, Montrose Superfund Site, 20201 Normandie Ave., Los Angeles, California, January 2018.* March 13.

United States Environmental Protection Agency, 2018. *EPA Comments on the Electrical Resistance Heating Pilot Test Boundary Confirmation Sampling Event Results, Montrose Superfund Site, 20201 Normandie Ave., Los Angeles, California, January 2018.* March 13.

FIGURES

ELECTRICAL RESISTANCE HEATING DESIGN PACKAGE

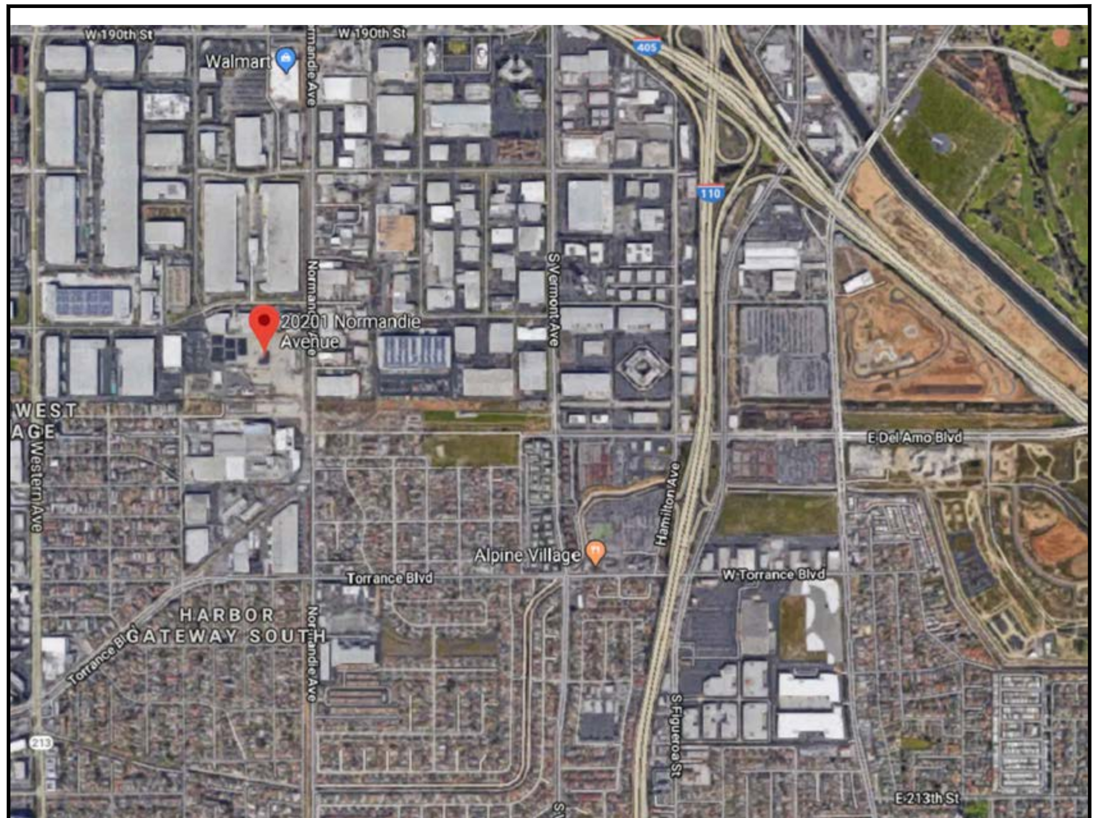
AS BUILTS

MONTROSE SUPERFUND SITE
20201 SOUTH NORMANDIE AVE.
LOS ANGELES, CA 90501

Prepared by:

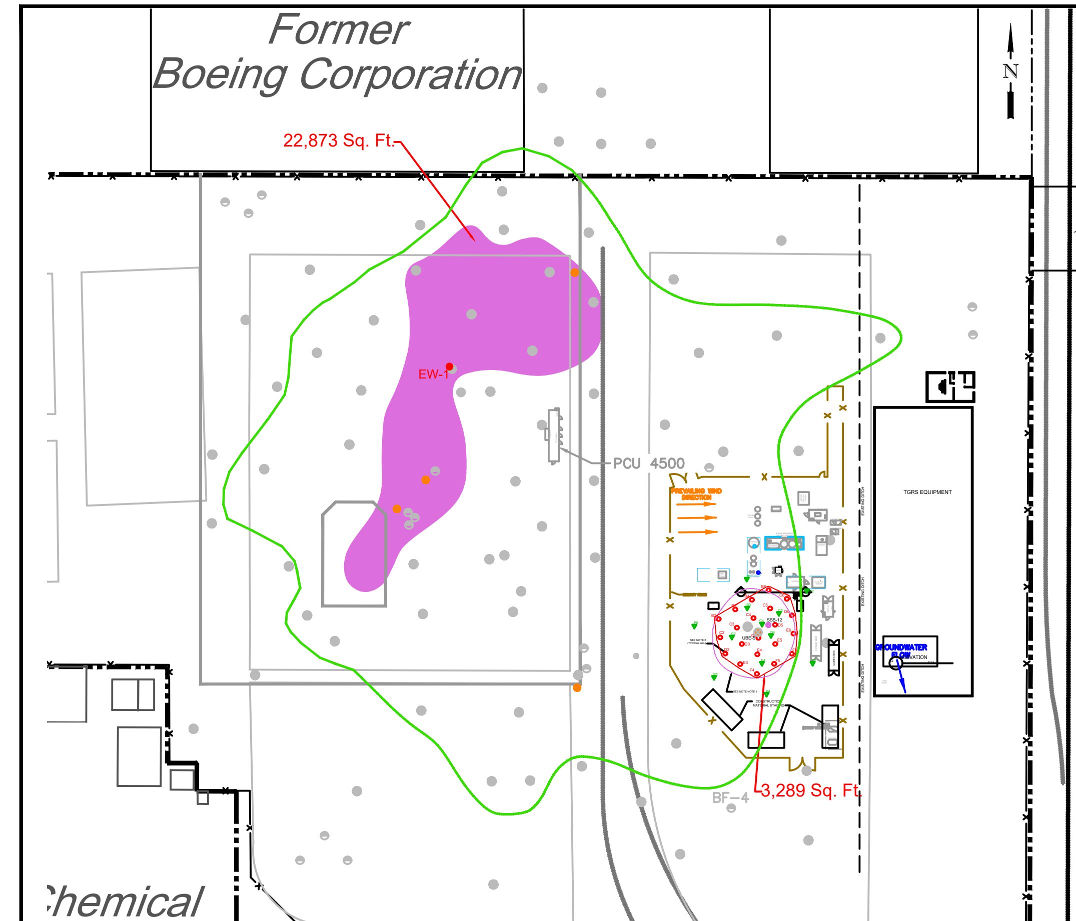
TRS
Accelerating Value

NOVEMBER 2018



SITE LOCATION MAP

DRAWING NUMBER	TITLE AND DESCRIPTION
SHEET INDEX	
Y–1	SITE PLAN
Y–2	PILOT STUDY BOUNDARY CONFIRMATION SAMPLING
Y–2B	BASELINE SAMPLING RESULTS
Y–2C	CONFIRMATORY SAMPLING RESULTS
Y–3	ELECTRODE AND EQUIPMENT LAYOUT
Y–4	ERH SUBSURFACE COMPONENT LOCATIONS
Y–5	VAPOR RECOVERY PIPING PLAN
Y–6	FIELD BOX PLACEMENT AND WIRING PLAN
Y–7	RESISTANCE TEMPERATURE DETECTOR WIRING PLAN
Y–9	SECURITY PLAN
Y–10	CONSTRUCTION MATERIAL STAGING PLAN
Y–11	EQUIPMENT PIPING PLAN
M–1	ELECTRODE DETAIL
M–2a	INTERNAL TEMPERATURE MONITORING POINT DETAIL
M–2b	EXTERNAL TEMPERATURE MONITORING POINT DETAIL
M–3	ELECTRODE HEAD DETAIL
M–4	TEMPERATURE MONITORING POINT HEAD DETAIL



SITE PLAN

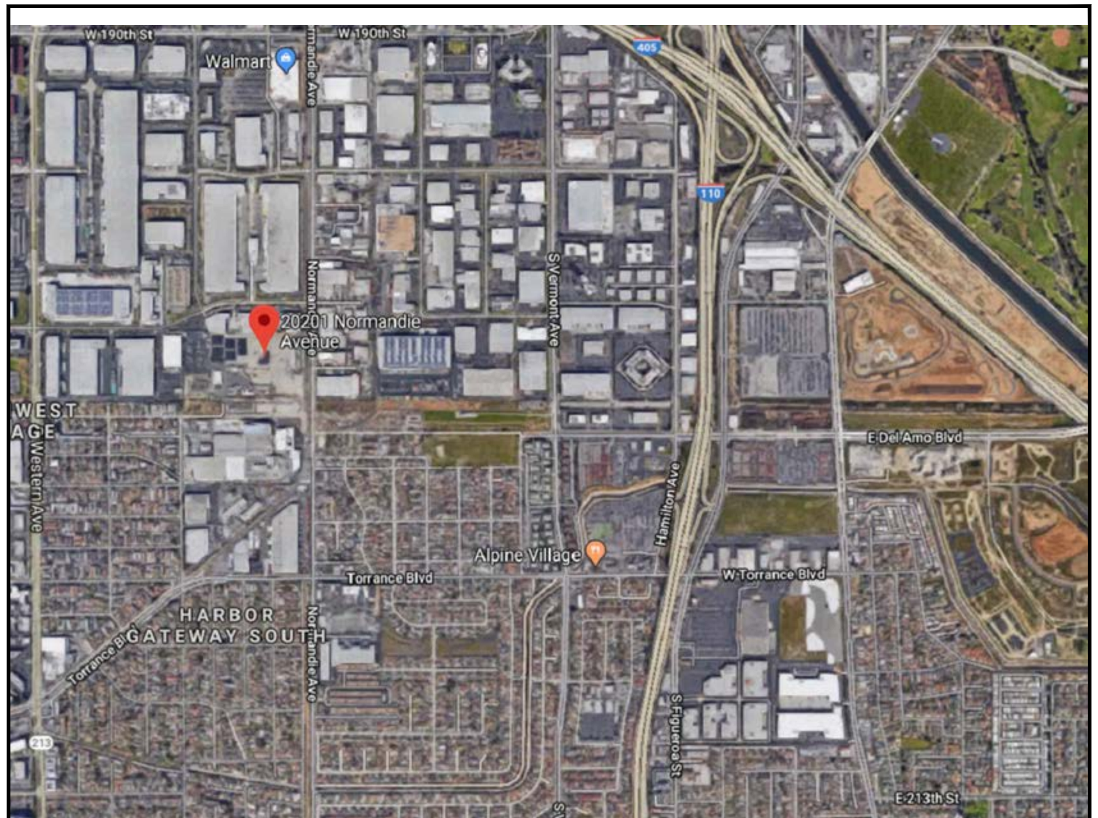
ELECTRICAL RESISTANCE HEATING DESIGN PACKAGE

AS BUILTS

MONTROSE SUPERFUND SITE
20201 SOUTH NORMANDIE AVE.
LOS ANGELES, CA 90501

Prepared by: TRS Accelerating Value

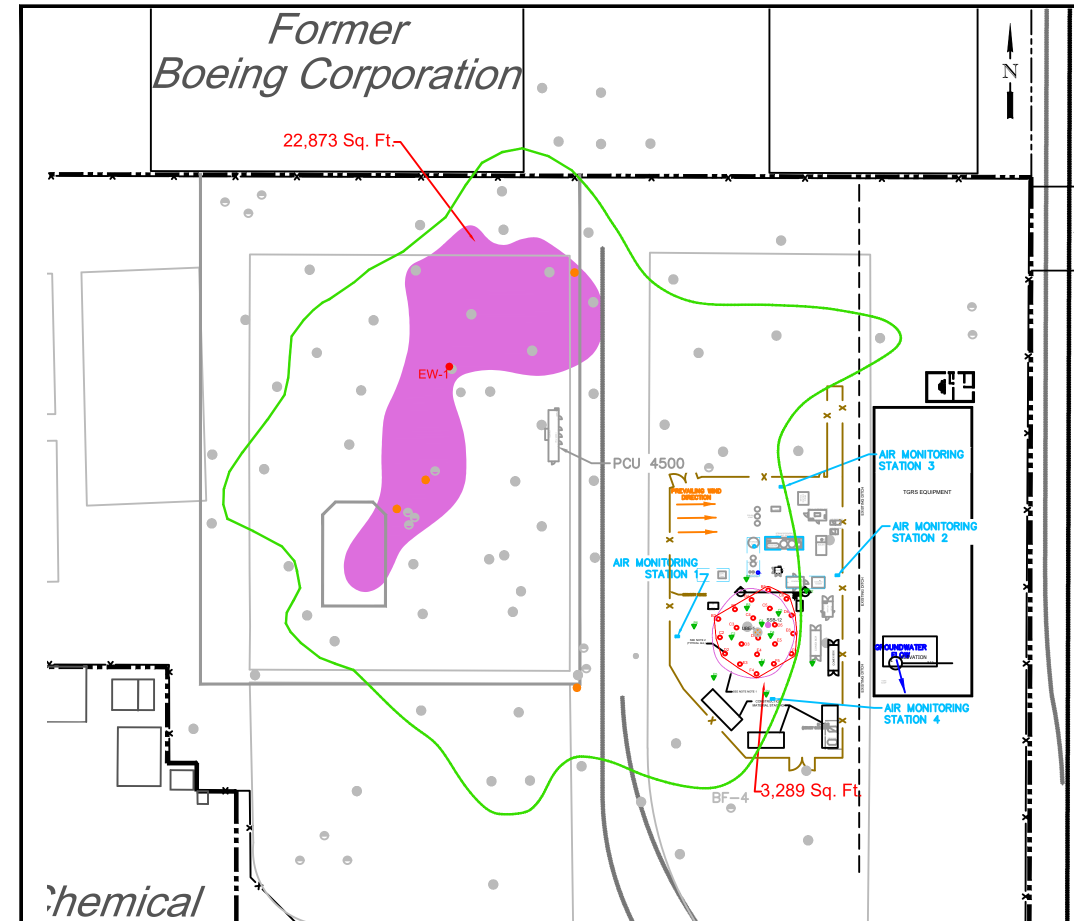
NOVEMBER 2018



SITE LOCATION MAP

SHEET INDEX

DRAWING NUMBER	TITLE AND DESCRIPTION
P–1	LEGEND PROCESS AND INSTRUMENTATION DIAGRAM
P–2	PROCESS FLOW DIAGRAM
P–3	PROCESS FLOW MASS BALANCE
P–4	FIELD PROCESS AND INSTRUMENTATION DIAGRAM
P–5	CONDENSER PROCESS AND INSTRUMENTATION DIAGRAM
P–6	COOLING TOWER PROCESS AND INSTRUMENTATION DIAGRAM
P–7	SRGAC COOLING TOWER PROCESS AND INSTRUMENTATION DIAGRAM
P–8	BLOWER PROCESS AND INSTRUMENTATION DIAGRAM
P–9	SRGAC PROCESS AND INSTRUMENTATION DIAGRAM
P–10	SRGAC CONDENSER AND DECANTER PROCESS AND INSTRUMENTATION DIAGRAM
P–11	POLISH VGAC PROCESS AND INSTRUMENTATION DIAGRAM
P–12	WATER TREATMENT AND DISCHARGE PROCESS AND INSTRUMENTATION DIAGRAM
P–13	BOILER WATER PRECONDITIONING PROCESS AND INSTRUMENTATION DIAGRAM
P–14	STEAM DELIVERY SYSTEM TO SRGAC PROCESS AND INSTRUMENTATION DIAGRAM
E–1	ELECTRICAL ONE LINE DIAGRAM LEGEND
E–2	ELECTRICAL ONE LINE DIAGRAM REQUIREMENTS
E–3	ELECTRICAL ONE LINE DIAGRAM
E–4	ELECTRICAL ONE LINE DIAGRAM



SITE PLAN

0 150
APPROXIMATE SCALE IN FEET

AS BUILTS

LEGEND

- LATERAL EXTENT OF DNAPL
- APPROXIMATE AREA OF MOBILE DNAPL FOCUSED AREA
- PILOT STUDY TREATMENT AREA
- HISTORICAL SOIL BORINGS IN PILOT STUDY BOUNDARY CONTAINING MOBILE DNAPL
- EXISTING MONITORING WELLS
- TGRS PUMPING WELLS
- HISTORICAL SOIL BORINGS
- DNAPL PASSIVE RECOVERY WELL

0 25 50 100

SCALE IN FEET

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx

SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

SITE PLAN

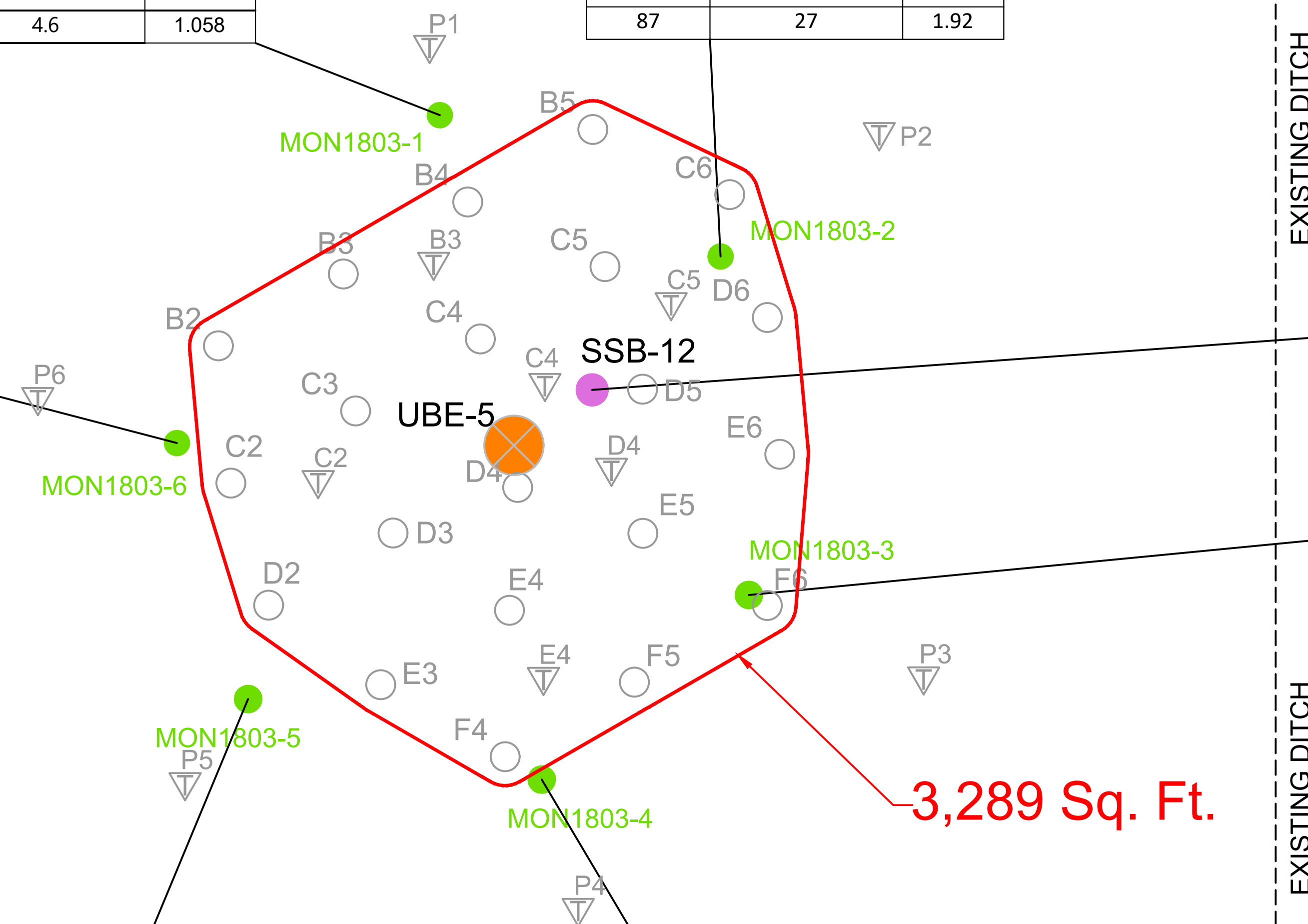
APPROVED FOR CONSTRUCTION

BY

DATE

DATE	2019.JUL.16
PROJECT	CA.MON.1803
SHEET	Y-1

AS BUILTS



MON1803-1 10/09/2017		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
62	0.086 J	0.1604
72	0.74	0.2505
77	17	0.1803
79	20	0.3117
81	12	0.456
84	3.2	0.5477
89	4.6	1.058

MON1803-2 10/10/2017		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
68	2.3	0.06
78	33	17.82
79	4400	5082
80.5	950	2429
82	2500	612.7
86	150	226.2
87	27	1.92

MON1803-6 10/13/2017		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
64	8.8	0.1876
77	0.95	2.516
78	31	748
80	7.7	0.6452
82	9.2	0.18
88	26	3.06
90	15	0.0357
92	17	0.0343

SSB-12 11/20/2003		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
64.9	<40	<40 J
82.5	50,000	53,000 J

MON1803-3 10/11/2017		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
16	0.095	3.161
17	170	1992
22	3400	4230
27	0.0023	0.378
68	1.8	0.0727
74	3.2	0.0695
78	7.9	0.0428
81	3.4	0.0064
84	19	0.016
86	11	0.0166
87	4.9	0.0778

MON1803-5 10/11/2017		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
66	2.5	0.0146
74	2.7	1.978
77	15	62.8
81	22	21.7
84	11	3.787
88	20	0.1163
90	27	0.0059

MON1803-4 10/12/2017		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
25	0.018	0.0082
72	2.1	1.207
77.5	2.5	0.0411
79.5	8.9	0.0154
83	45	0.0171
85	4.4	0.007
89	12	<0.0049
90	17	<0.0049

N

NOTES

1. J = ESTIMATED VALUE. ANALYTE DETECTED AT A LEVEL LESS THAN THE REPORTING LIMIT (RL) AND GREATER THAN OR EQUAL TO THE METHOD DETECTION LIMIT (MDL). THIS DATA IS OF LIMITED RELIABILITY.

2. TOTAL DDT (mg/kg) = SUM OF 4,4'-DDT; 4,4' DDD; 4,4'-DDE

3. LABORATORY ESTIMATED VALUES INCLUDED IN TOTAL DDT CALCULATION. DATA IS PRESENTED IN BOUNDARY CONFIRMATION SAMPLING EVENT RESULTS, ERH PILOT STUDY AREA, TABLE 2 (TRS, 2018).

LEGEND

- PILOT STUDY TREATMENT AREA
- HISTORICAL SOIL BORINGS CONTAINING MOBILE DNAPL
- PILOT STUDY BOUNDARY CONFIRMATION BORING
- DNAPL PASSIVE RECOVERY WELL

0 10 20 40

SCALE IN FEET

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY D. SEILER

DRAWN BY A. PEABODY

CHECKED BY D. OBERLE

PROJECT MANAGER L. STAUCH

QSAT REVIEW xx/xx/xx

SITE MONTROSE CHEMCIAL

LOCATION CALIFORNIA

CLIENT CONFIDENTIAL CLIENT

PILOT STUDY BOUNDARY
CONFIRMATION SAMPLING -AS BUILT

APPROVED FOR CONSTRUCTION

BY

DATE

DATE 2019.JUL.16

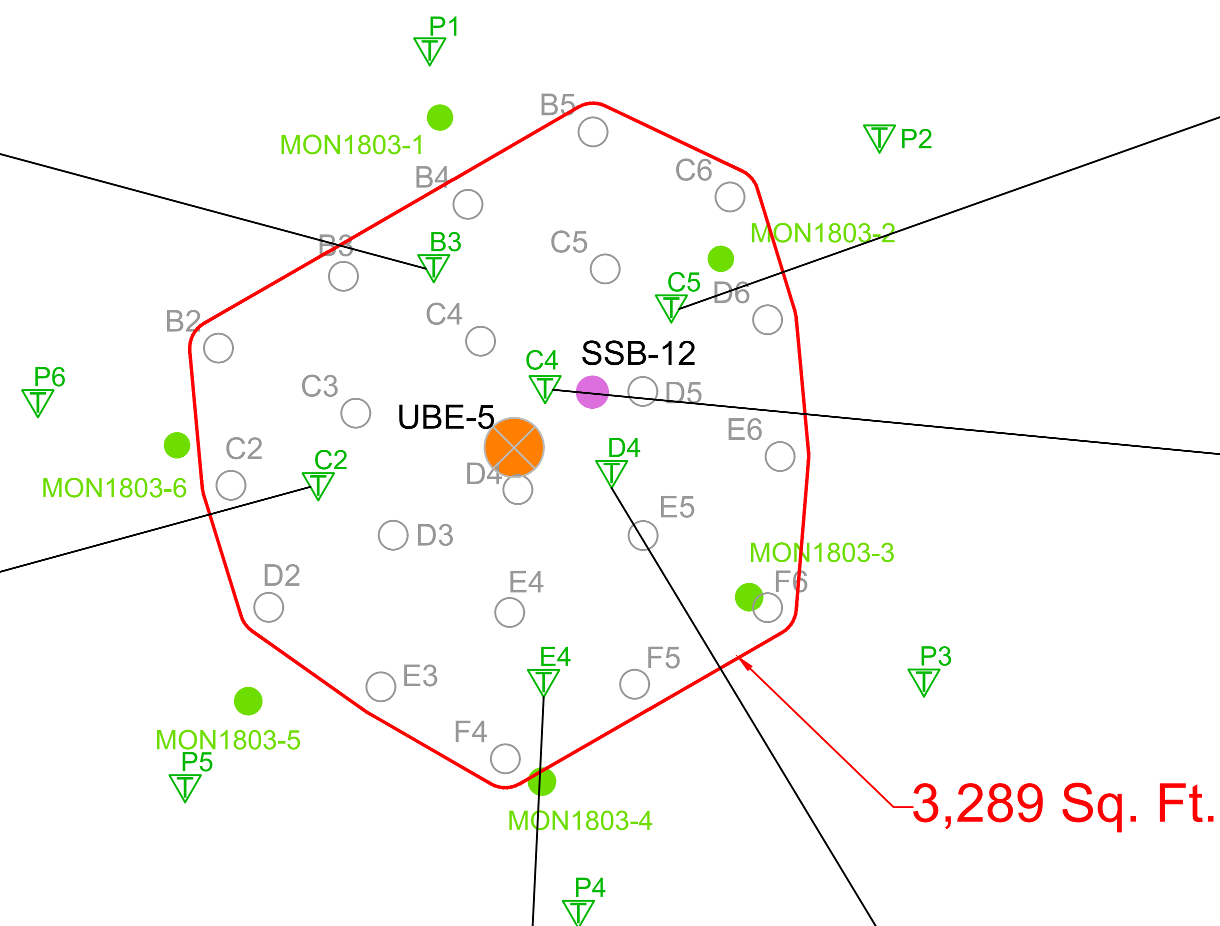
PROJECT CA.MON.1803

SHEET Y-2

AS BUILTS

MON1803-TMP-B3 5/29/2018		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
53	0.20	0.178
57	0.024	0.15
63	2.2	0.67
69	3.5	0.016
73	1.9	0.40
77	0.72	0.32
84	8700	6579
89	1.3	1.8

MON1803-TMP-C2 5/22/2018		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
54	0.064 J	0.33
57	0.20	0.170
65	1.8	0.6
68	6.3	0.120
73	0.53	0.53
79	0.17	0.75
81	13000	7825
86	47	1.00



EXISTING DITCH

EXISTING DITCH

N

MON1803-TMP-C5 5/24/2018		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
51	0.0011	0.1
59	0.83	0.35
63	2.5	0.25
67	4.4	0.074
72	1.7	19
78	17	0.27
81	25	95
86	30	0.078

MON1803-TMP-C4 5/25/2018		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
52	0.011	0.0060
59	1.2	0.0097
63	0.68	0.0055
67	2.3	0.12
74	2.5	0.54
79	30	59
81	10000	25055
87	20	0.080

MON1803-TMP-E4 5/21/2018		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
54	0.0086	0.0220
57	3	0.040
64	1.9	0.0027
67	3.8	0.073
75	13	1.04
78	5.5	0.088
84	42	<0.01
86	40	<0.01

MON1803-TMP-D4 5/23/2018		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
50	0.011	0.0061
58	1.1	0.150
65	0.79	0.0079
69	3.3	0.0072
75	0.084	0.30
79	11	0.08
82	2900	1432
87	7.5	0.49

NOTES

1. J = ESTIMATED VALUE. ANALYTE DETECTED AT A LEVEL LESS THAN THE REPORTING LIMIT (RL) AND GREATER THAN OR EQUAL TO THE METHOD DETECTION LIMIT (MDL). THIS DATA IS OF LIMITED RELIABILITY.

2. TOTAL DDT (mg/kg) =
SUM OF 2,4'-DDD + 2,4'-DDE + 2,4'-DDT + 4,4'-DDD + 4,4'-DDE + 4,4'-DDT

3. LABORATORY ESTIMATED VALUES INCLUDED IN TOTAL DDT CALCULATION.

LEGEND

- PILOT STUDY TREATMENT AREA
- HISTORICAL SOIL BORINGS CONTAINING MOBILE DNAPL
- PILOT STUDY BOUNDARY CONFIRMATION BORING
- DNAPL PASSIVE RECOVERY WELL

0 10 20 40

SCALE IN FEET

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY D. SEILER
DRAWN BY A. PEABODY
CHECKED BY D. OBERLE
PROJECT MANAGER L. STAUCH
QSAT REVIEW xx/xx/xx

SITE MONTROSE CHEMCIAL
LOCATION CALIFORNIA
CLIENT CONFIDENTIAL CLIENT

BASELINE SAMPLING RESULTS

APPROVED FOR CONSTRUCTION
BY
DATE

DATE 2019.JUL.16
PROJECT CA.MON.1803
SHEET Y-2B

AS BUILTS

MON1803-TMP-C4B 4/11/19		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
53	< 0.00040 ET	0.19
57	0.00029 J,ET	4.4
63	0.00029 J,ET	0.018
66	0.00078 J	< 0.010
73	0.0090	0.08
79	0.68	1411
80	5.8	16333
86	0.72	28

MON1803-TMP-B3B/C 4/10/19		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
53(B)	0.00084 J	0.0023
58(B)	0.014	0.012
63(B)	0.0056	0.0026
69(B)	0.00070 J	< 0.010
73(C)	0.025	0.23
76(C)	6	0.119
84(B)	0.0091	0.113
89(B)	13	3063

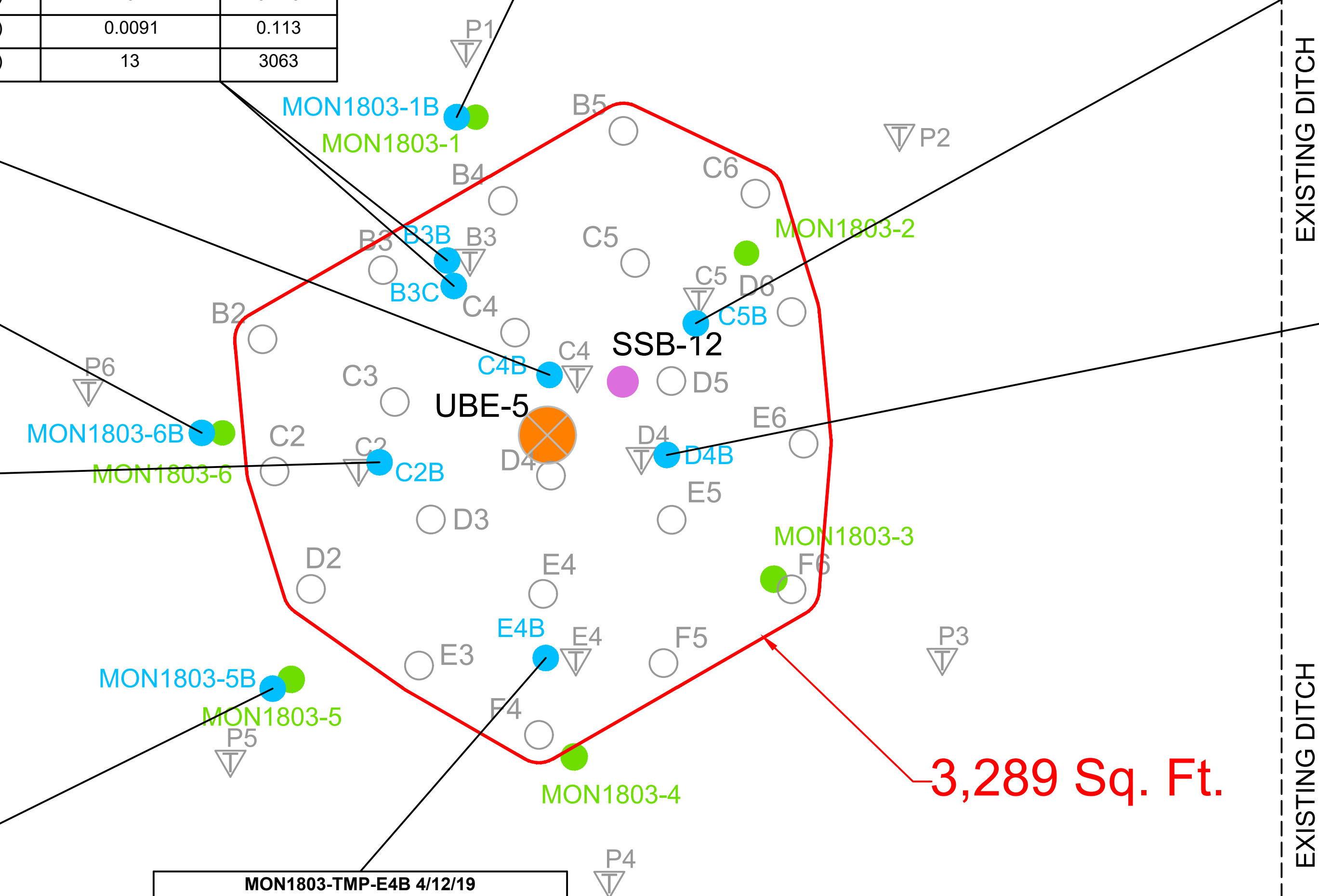
MON1803-1B 4/9/19		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
70	0.062	0.031
74	71	1.3

MON1803-TMP-C5B 4/15/19		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
51	< 0.00020	0.031
58	0.0012	0.0028
63	0.00089 J	0.0027
67	0.026	0.0075
74	0.086	4.1
80	3.8	0.82
83	1.4	1.3
89	0.92	0.0573

MON1803-6B 4/9/19		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
65	0.00087 J	0.0058
70	0.45	0
76	4.9	0.115

MON1803-TMP-D4B 4/15/19		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
50	< 0.00019	0.0024
58	0.0031	0.017
61	0.0051	0.28
69	0.062	0.0065
74	3.1	0.0111
78	2.3	0.0774
82	1.3	0.19
87	2.6	7

MON1803-TMP-C2B 4/11/19		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
54	0.027	0.056
57	0.0039	0.053
0	0.0055	0.011
68	0.006	0.018
74	0.14	0.07
79	0.0064	1.5
81	1.2	3251
86	0.065	0.20



MON1803-5B 4/8/19		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
70	9.5	0.055
73	41	1.2

MON1803-TMP-E4B 4/12/19		
SAMPLE DEPTH (ft)	CHLOROBENZENE (mg/kg)	TOTAL DDT (mg/kg)
54	0.019	0.48
58	0.0042	0.08
64	0.0029	0.09
70	0.009	0.091
72	1.2	0.095
77	2	0.048
82	2.5	0.2
86	0.49	0.48

NOTES

1. J = ESTIMATED VALUE. ANALYTE DETECTED AT A LEVEL LESS THAN THE REPORTING LIMIT (RL) AND GREATER THAN OR EQUAL TO THE METHOD DETECTION LIMIT (MDL). THIS DATA IS OF LIMITED RELIABILITY.

2. ET = SAMPLE WAS EXTRACTED PAST END OF RECOMMENDED MAXIMUM HOLDING TIME.

3. TOTAL DDT (mg/kg) =
SUM OF 2,4'-DDD + 2,4'-DDE + 2,4'-DDT + 4,4'-DDD + 4,4'-DDE + 4,4'-DDT

4. LABORATORY ESTIMATED VALUES INCLUDED IN TOTAL DDT CALCULATION.

LEGEND

- PILOT STUDY TREATMENT AREA
- HISTORICAL SOIL BORINGS CONTAINING MOBILE DNAPL
- PILOT STUDY BOUNDARY CONFIRMATION BORING
- DNAPL PASSIVE RECOVERY WELL
- PILOT STUDY CONFIRMATORY SAMPLING BORING

0 10 20 40
SCALE IN FEET

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMCIAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT
APPROVED FOR CONSTRUCTION	BY ______ DATE ______
DATE	2019.JUL.16
PROJECT	CA.MON.1803
SHEET	Y-2C

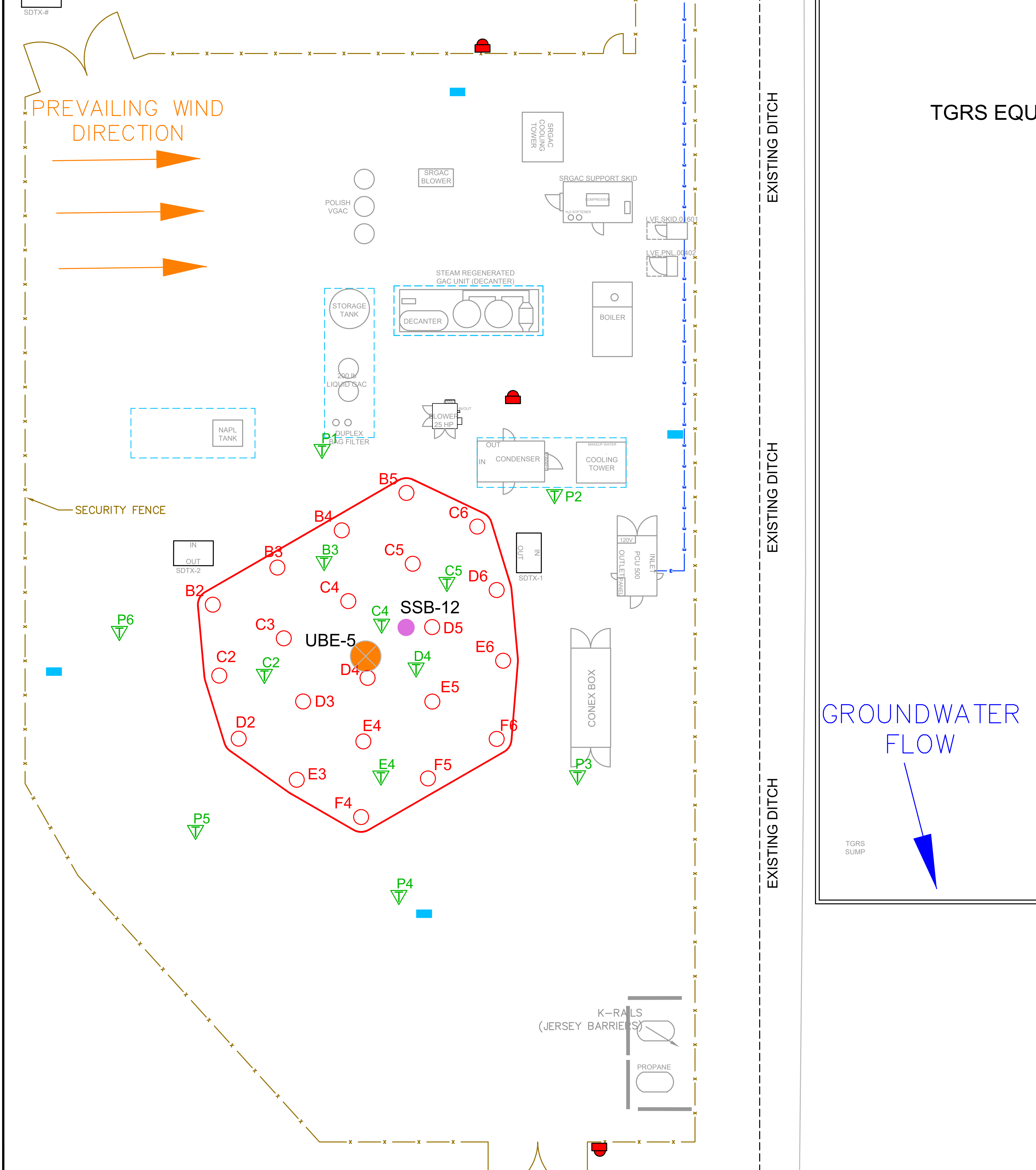
CONFIRMATORY SAMPLING RESULTS

AS BUILTS

LEGEND

- PILOT STUDY TREATMENT AREA
- HISTORICAL SOIL BORINGS CONTAINING MOBILE DNAPL
- ELECTRODE WITH CO-LOCATED VAPOR RECOVERY (QTY.21)
- TEMPERATURE MONITORING POINT WITH CO-LOCATED VAPOR PIEZOMETER (QTY.12)
- E-STOP (QTY.3)
- AIR MONITORING STATION (QTY.4)
- SURFACE ELECTRICAL
- UNDERGROUND ELECTRICAL
- SURFACE MOUNTED TEMPORARY FENCE
- STEP DOWN TRANSFORMER

SDTX-#



CONFIDENTIAL: INFORMATION CONTAINED IN THIS DOCUMENT IS CONFIDENTIAL AND THE PROPERTY OF TRS GROUP, INC. NO INFORMATION CONTAINED HEREIN MAY BE DUPLICATED, USED OR DISTRIBUTED WITHOUT THE EXPRESSED WRITTEN PERMISSION OF TRS GROUP, INC. LONGVIEW, WA.	DESIGNED BY D. SEILER	SITE MONTROSE CHEMICAL	
	DRAWN BY A. PEABODY	LOCATION CALIFORNIA	
	CHECKED BY D. OBERLE	CLIENT CONFIDENTIAL CLIENT	
	PROJECT MANAGER L. STAUCH	ELECTRODE AND EQUIPMENT LAYOUT	
	QSAT REVIEW xx/xx/xx	APPROVED FOR CONSTRUCTION BY DATE	DATE 2019.JUL.16 PROJECT CA.MON.1803 SHEET Y-3

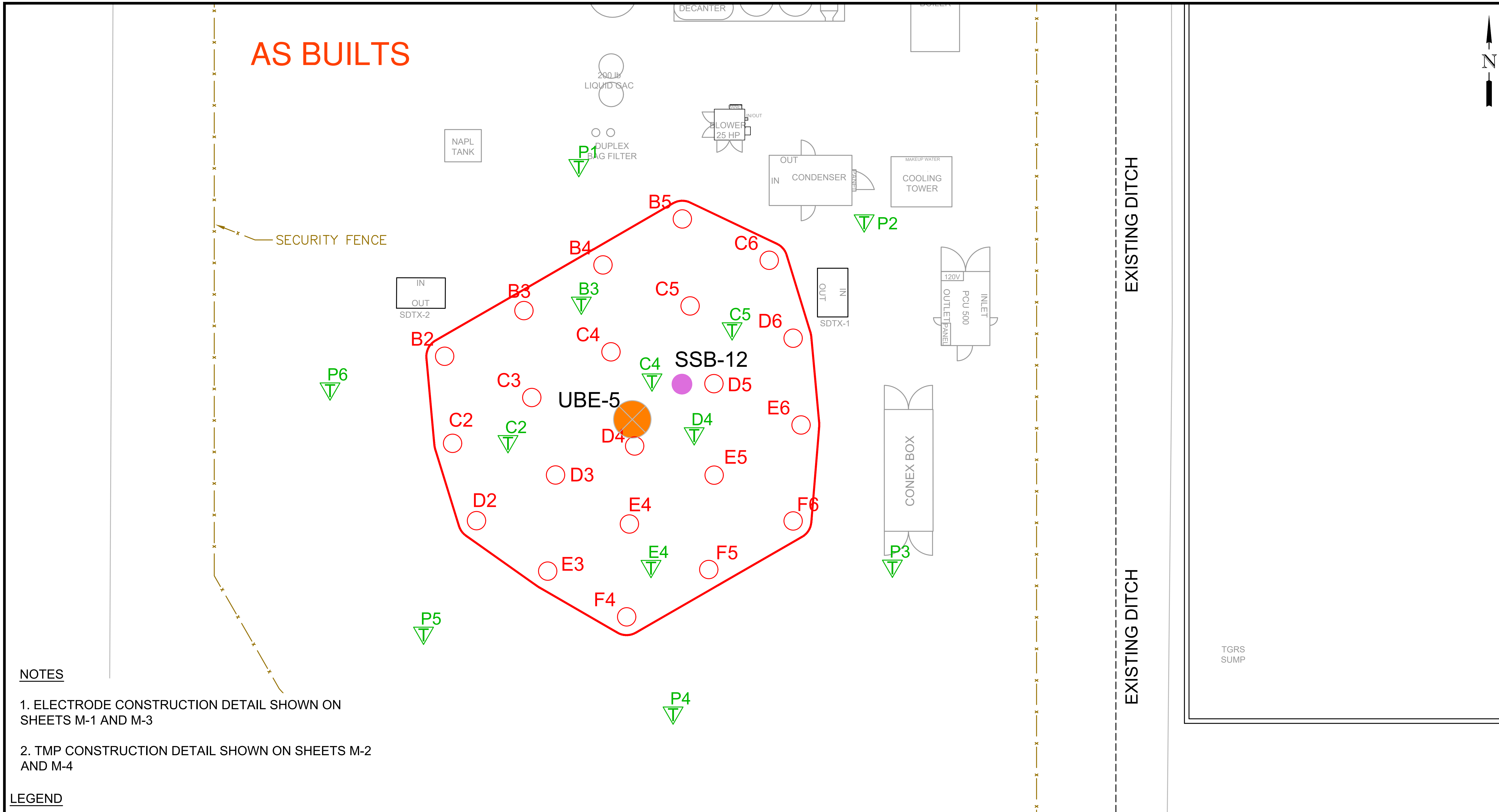
TRS Accelerating Value

0 10 20 40

SCALE IN FEET

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

AS BUILTS



NOTES

1. ELECTRODE CONSTRUCTION DETAIL SHOWN ON SHEETS M-1 AND M-3

2. TMP CONSTRUCTION DETAIL SHOWN ON SHEETS M-2 AND M-4

LEGEND

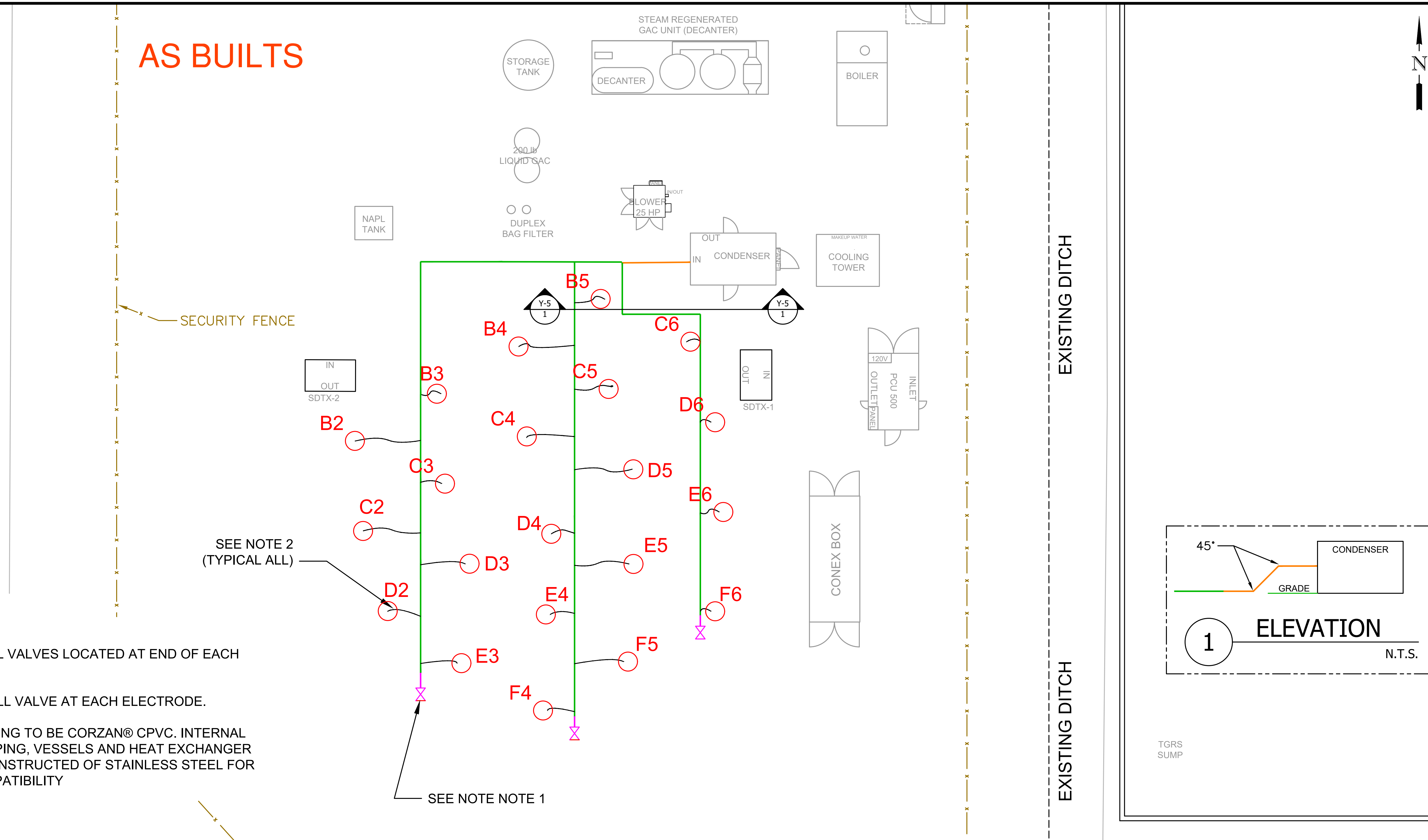
- PILOT STUDY TREATMENT AREA
- HISTORICAL SOIL BORINGS CONTAINING MOBILE DNAPL
- ELECTRODE WITH CO-LOCATED VAPOR RECOVERY
- TEMPERATURE MONITORING POINT WITH CO-LOCATED VAPOR PIEZOMETER
- SDTX-# STEP DOWN TRANSFORMER

0 15 30
SCALE IN FEET

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY: D. SEILER	SITE: MONTROSE CHEMICAL		
DRAWN BY: A. PEABODY	LOCATION: CALIFORNIA		
CHECKED BY: D. OBERLE	CLIENT: CONFIDENTIAL CLIENT		
PROJECT MANAGER: L. STAUCH	ERH SUBSURFACE COMPONENT LOCATIONS		
QSAT REVIEW: xx/xx/xx	APPROVED FOR CONSTRUCTION BY ____ DATE ____	DATE 2019.JUL.16	PROJECT CA.MON.1803
		SHEET Y-4	



NOTES

1. 1" BRASS BALL VALVES LOCATED AT END OF EACH HEADER.

2. INCLUDES BALL VALVE AT EACH ELECTRODE.

3. ALL CPVC PIPING TO BE CORZAN® CPVC. INTERNAL CONDENSER PIPING, VESSELS AND HEAT EXCHANGER PLATES ARE CONSTRUCTED OF STAINLESS STEEL FOR MATERIAL COMPATIBILITY

LEGEND

- ELECTRODE
- 1" SCH 40 CPVC
- 3" SCH 40 CPVC (1 TO 20 WELLS)
- 4" SCH 40 CPVC (21 WELLS)
- 1-1/2" NOVAFLEX (1 WELLS)
- STEP DOWN TRANSFORMER (SDTX-#)

0 15 30
SCALE IN FEET

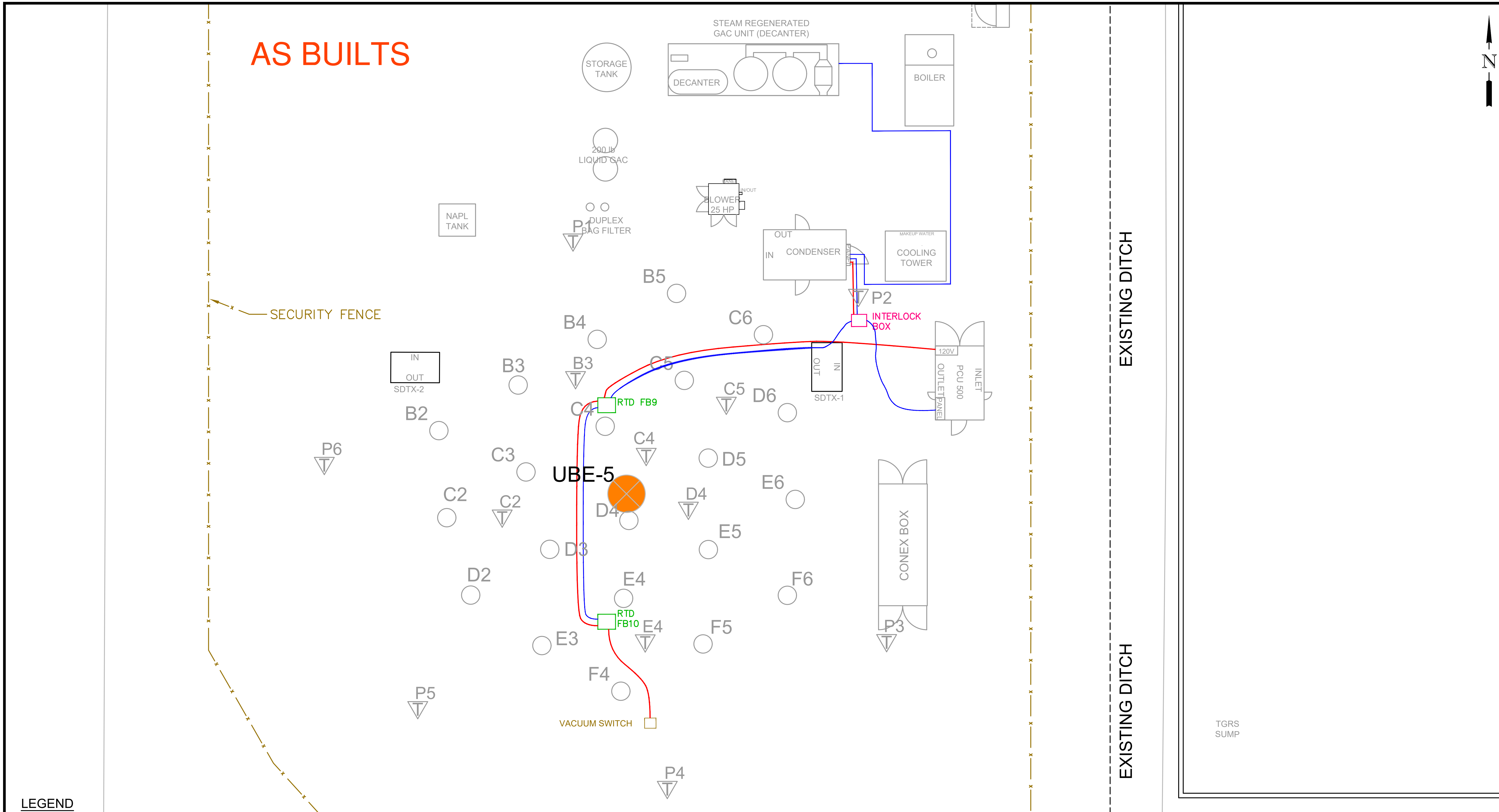
TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

VAPOR RECOVERY PIPING PLAN

APPROVED FOR CONSTRUCTION	
BY	
DATE	
DATE	2019.JUL.16
PROJECT	CA.MON.1803
SHEET	Y-5



LEGEND

- ELECTRODE (QTY. 21)
- TEMPERATURE MONITORING POINT (QTY. 12)
- RTD FBx — RTD FIELD BOX (QTY. 4)
- ETHERNET CABLE
- 12/3 SOOW CABLE
- SDTX-# — STEP DOWN TRANSFORMER

0 15 30
SCALE IN FEET

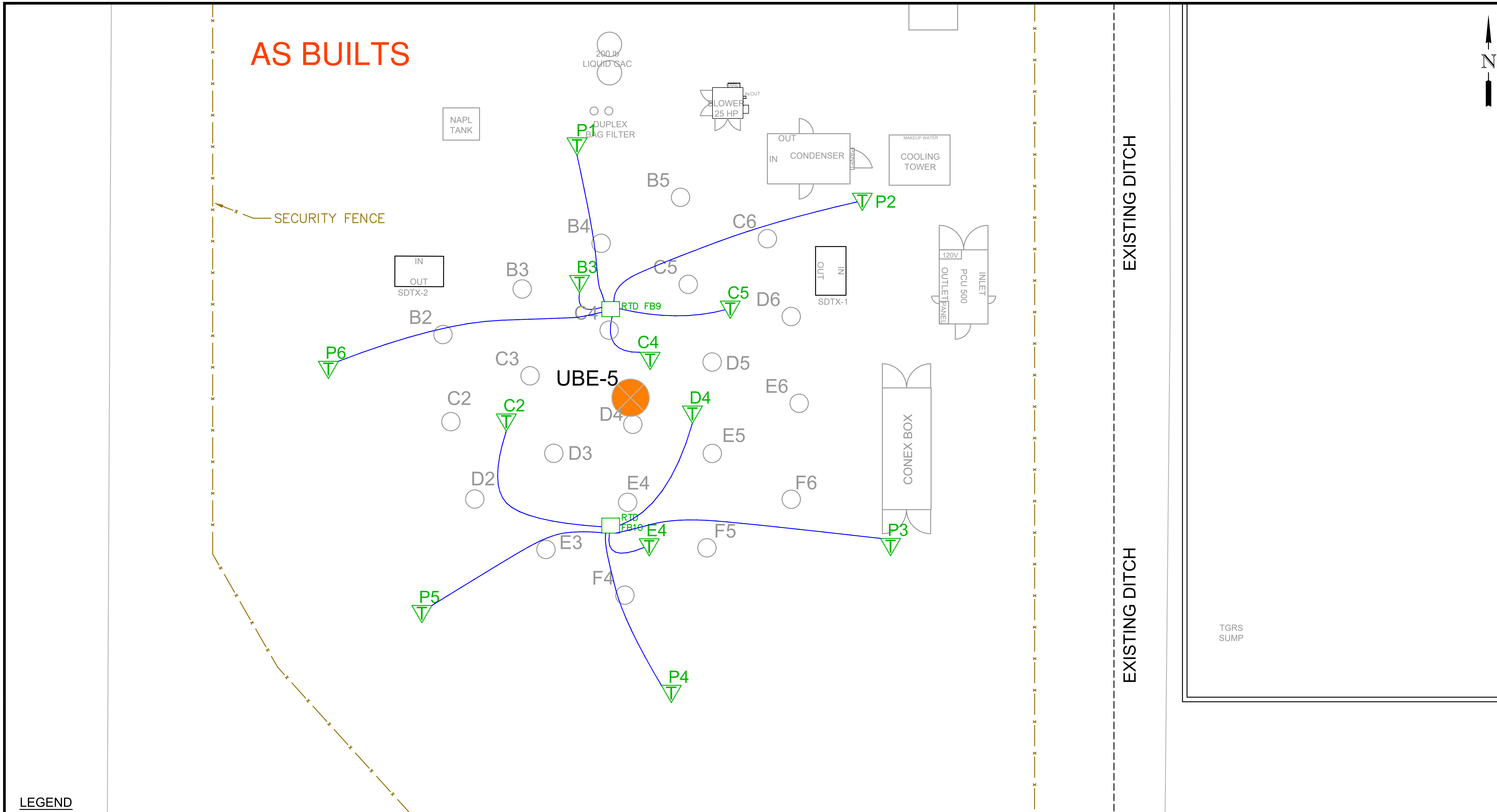
TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

FIELD BOX PLACEMENT AND WIRING PLAN

APPROVED FOR CONSTRUCTION	
BY	
DATE	
DATE	2019.JUL.16
PROJECT	CA.MON.1803
SHEET	Y-6



LEGEND

- ELECTRODE (QTY. 21)
- TEMPERATURE MONITORING POINT (QTY. 12)
- RTD FBx — RTD FIELD BOX (QTY. 4)
- RTD WIRING
- SDTX-# — STEP DOWN TRANSFORMER

0 15 30
SCALE IN FEET

TRS
Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx

SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

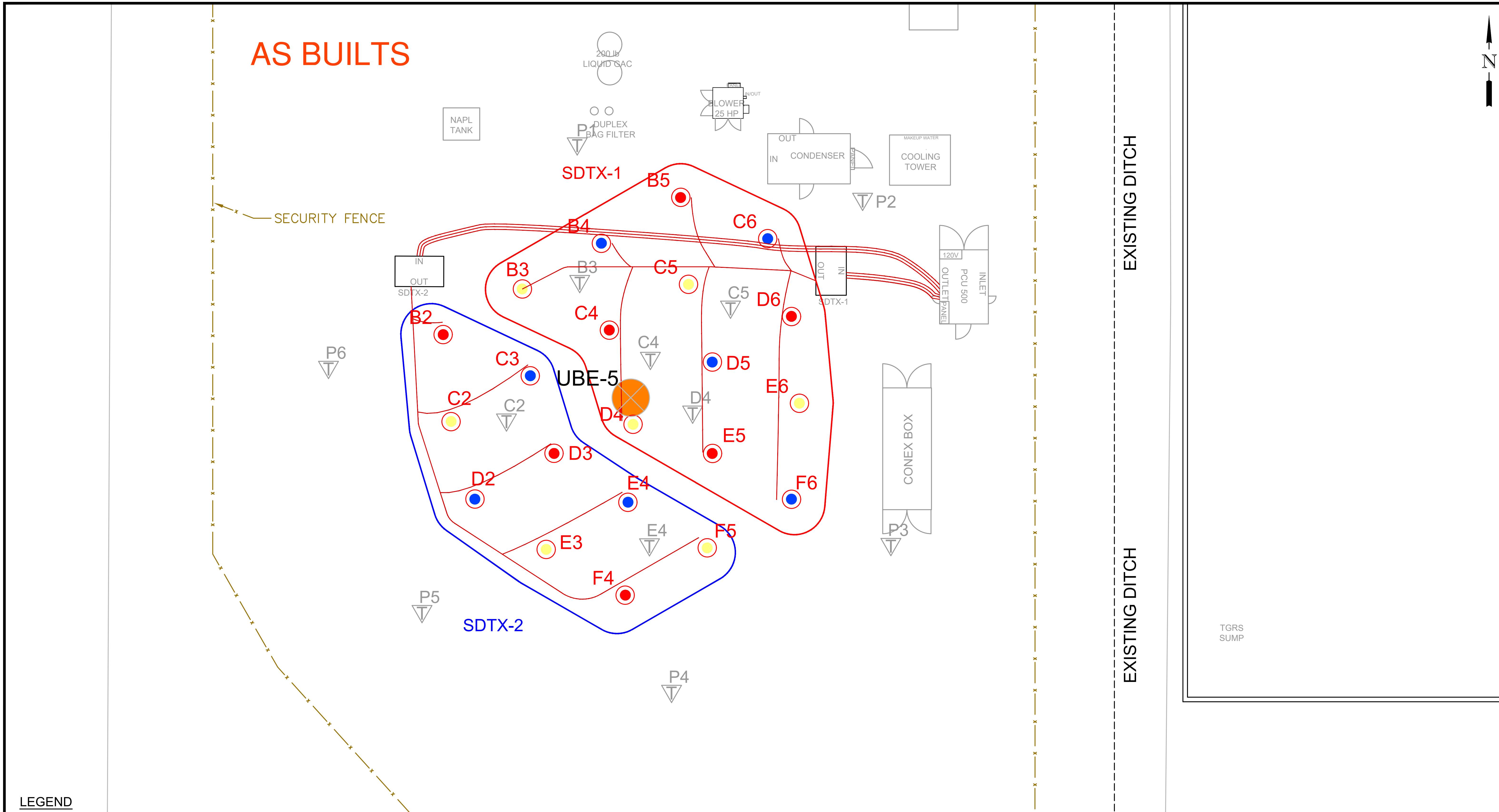
RESISTANCE TEMPERATURE DETECTOR WIRING PLAN

APPROVED FOR CONSTRUCTION

BY ____________

DATE ____________

DATE	2019.JUL.16
PROJECT	CA.MON.1803
SHEET	Y-7



LEGEND

ELECTRODE (QTY. 21)

TEMPERATURE MONITORING POINT (QTY. 12)

CABLE ROUTING

(7) (7) (7) ELECTRODE PHASING

STEP DOWN TRANSFORMER

SDTX-#

0 15 30

SCALE IN FEET

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx

SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

CABLE AND PHASING PLAN

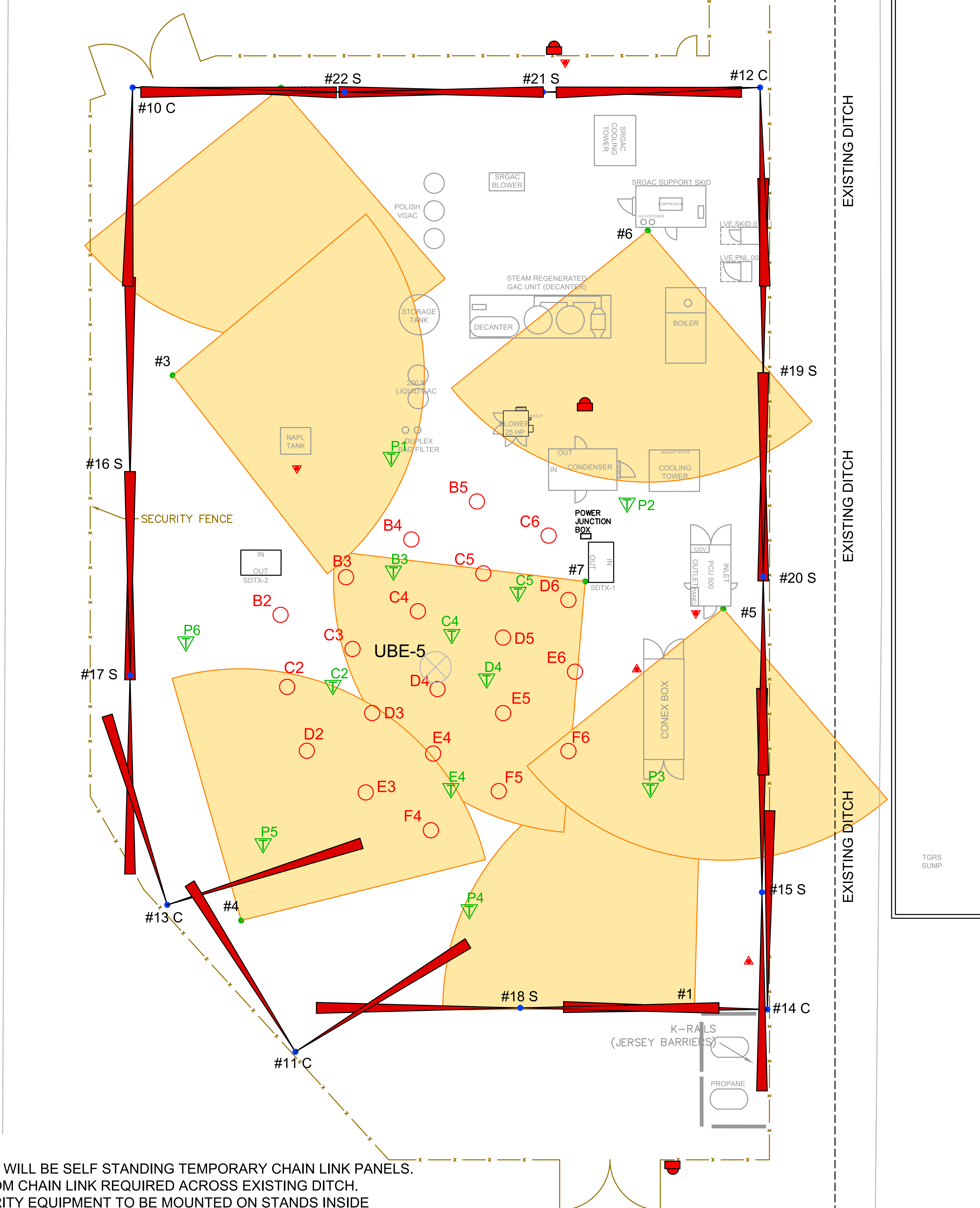
APPROVED FOR CONSTRUCTION	DATE 2019.JUL.16	PROJECT CA.MON.1803	
BY ____	SHEET	Y-8	
DATE ____			

AS BUILTS

LEGEND

- ELECTRODE (QTY. 21)
- TEMPERATURE MONITORING POINT (QTY. 12)
- SECURITY MOTION SENSOR (QTY. 8)
- SECURITY MOTION SENSOR CORNER MOUNT (QTY.6)
- VIDEOFIED SECURITY CAMERA (QTY. 7)
- FIRE EXTINGUISHER (QTY. 5)
- E-STOP (QTY. 3)
- SDTX-# STEP DOWN TRANSFORMER

N



NOTES

1. FENCE WILL BE SELF STANDING TEMPORARY CHAIN LINK PANELS.
2. CUSTOM CHAIN LINK REQUIRED ACROSS EXISTING DITCH.
3. SECURITY EQUIPMENT TO BE MOUNTED ON STANDS INSIDE TEMPORARY FENCE.

TRS *Accelerating Value*

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

0 10 20 40

SCALE IN FEET

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx

SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

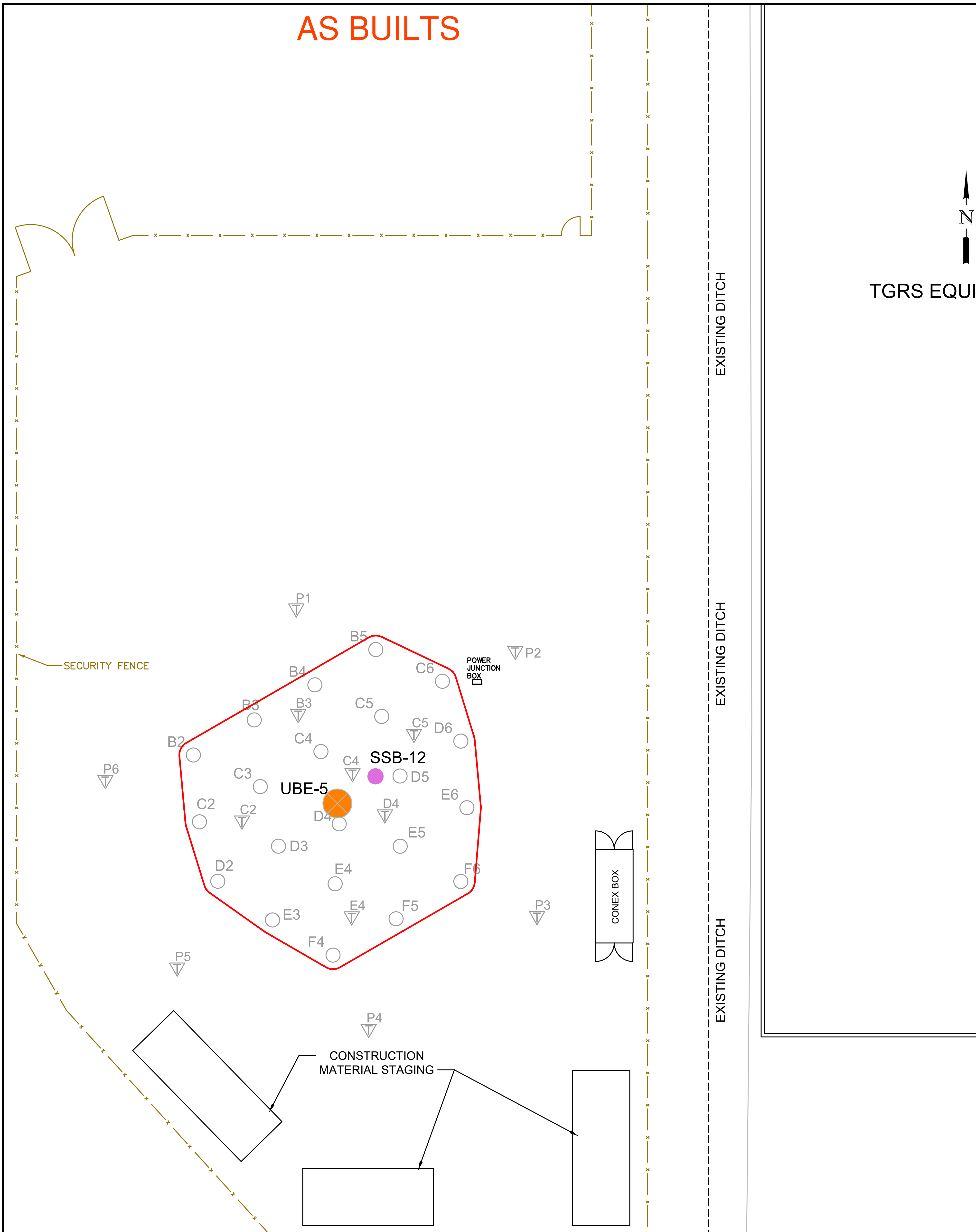
SECURITY PLAN

APPROVED FOR CONSTRUCTION

BY ____________

DATE ____________

DATE	2019.JUL.16
PROJECT	CA.MON.1803
SHEET	Y-9



LEGEND

PILOT STUDYTREATMENT AREA

HISTORICAL SOIL BORINGS CONTAINING MOBILE DNAPL

ELECTRODE WITH CO-LOCATED VAPOR RECOVERY (QTY.21)

TEMPERATURE MONITORING POINT WITH CO-LOCATED VAPOR PIEZOMETER (QTY.12)

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

0 10 20 40

SCALE IN FEET

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

CONSTRUCTION MATERIAL STAGING PLAN

APPROVED FOR CONSTRUCTION

BY ____________________

DATE ____________________

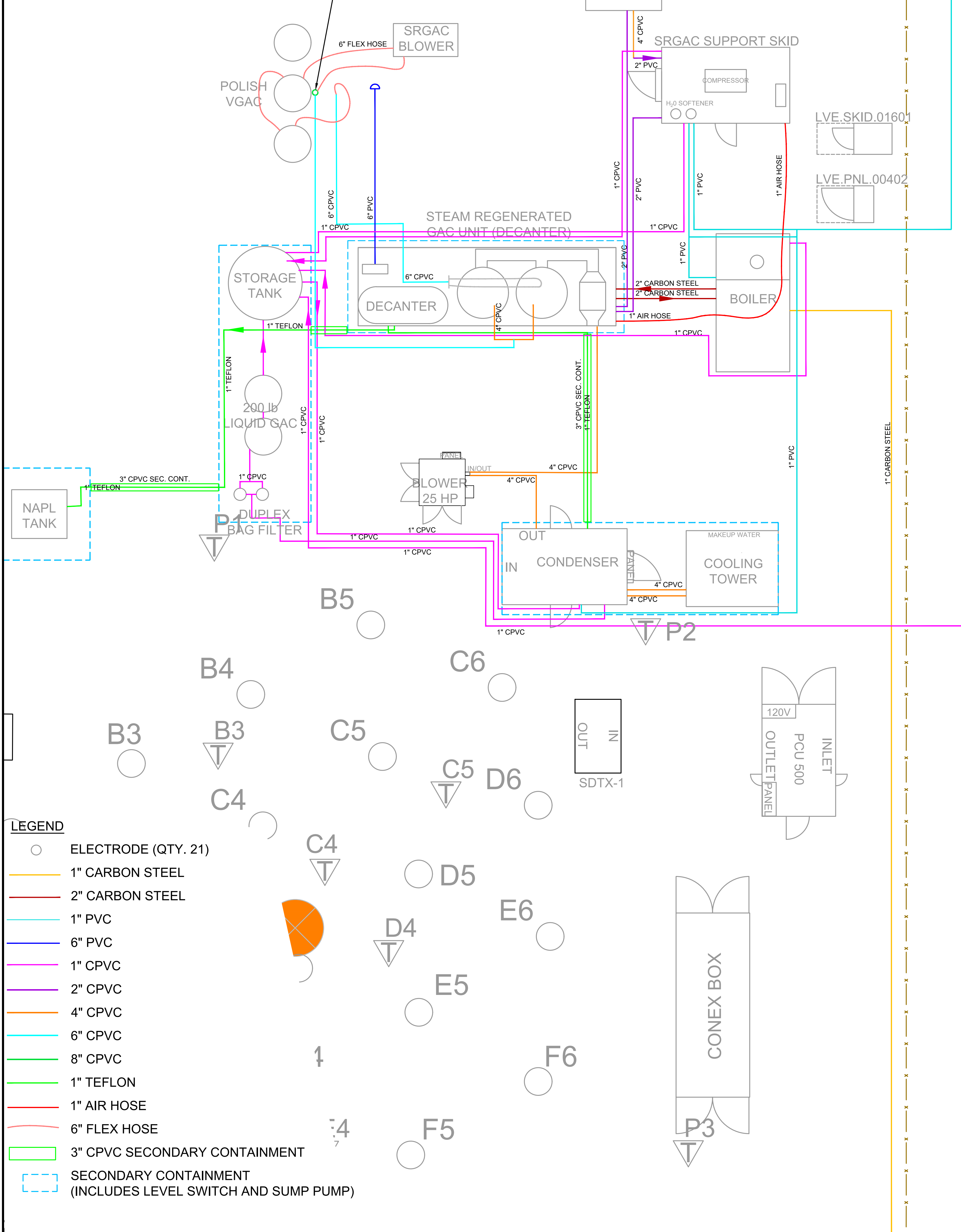
DATE	2019.JUL.16
PROJECT	CA.MON.1803
SHEET	Y-10

NOTES

AS BUILTS

1. WATER SOURCE AND WATER DISCHARGE ARE LOCATED IN EXISTING TGRS.

2. IF CHANGE OF LGAC OR VGAC VESSELS IS REQUIRED, PRIMARY VESSEL WILL BE REPLACED AND SECONDARY VESSEL WILL BE BECOME PRIMARY.



LEGEND

- ELECTRODE (QTY. 21)
- 1" CARBON STEEL
- 2" CARBON STEEL
- 1" PVC
- 6" PVC
- 1" CPVC
- 2" CPVC
- 4" CPVC
- 6" CPVC
- 8" CPVC
- 1" TEFLON
- 1" AIR HOSE
- 6" FLEX HOSE
- 3" CPVC SECONDARY CONTAINMENT
- SECONDARY CONTAINMENT (INCLUDES LEVEL SWITCH AND SUMP PUMP)

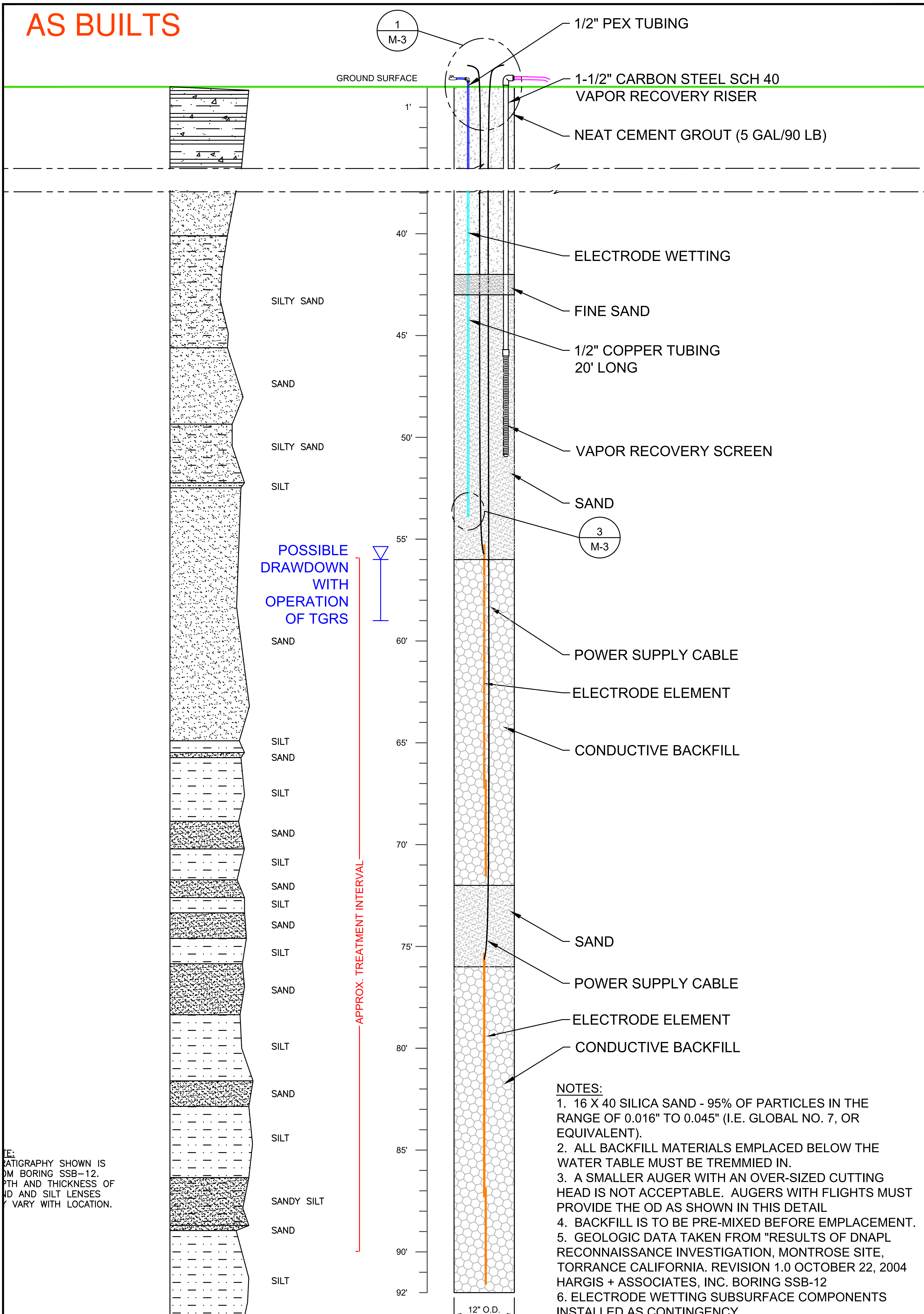
TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

0 5 10 20
SCALE IN FEET

DESIGNED BY D. SEILER	SITE	MONTROSE CHEMICAL	
DRAWN BY A. PEABODY	LOCATION	CALIFORNIA	
CHECKED BY D. OBERLE	CLIENT	CONFIDENTIAL CLIENT	
PROJECT MANAGER L. STAUCH	EQUIPMENT PIPING PLAN		
QSAT REVIEW xx/xx/xx	APPROVED FOR CONSTRUCTION BY ______ DATE ______	DATE 2019.JUL.16	PROJECT CA.MON.1803
		SHEET	Y-11

AS BUILTS



NOTES:
1. 16 X 40 SILICA SAND - 95% OF PARTICLES IN THE RANGE OF 0.016" TO 0.045" (I.E. GLOBAL NO. 7, OR EQUIVALENT).
2. ALL BACKFILL MATERIALS EMPLACED BELOW THE WATER TABLE MUST BE TREMMIED IN.
3. A SMALLER AUGER WITH AN OVER-SIZED CUTTING HEAD IS NOT ACCEPTABLE. AUGERS WITH FLIGHTS MUST PROVIDE THE OD AS SHOWN IN THIS DETAIL
4. BACKFILL IS TO BE PRE-MIXED BEFORE EMPLACEMENT.
5. GEOLOGIC DATA TAKEN FROM "RESULTS OF DNAPL RECONNAISSANCE INVESTIGATION, MONTROSE SITE, TORRANCE CALIFORNIA. REVISION 1.0 OCTOBER 22, 2004 HARGIS + ASSOCIATES, INC. BORING SSB-12
6. ELECTRODE WETTING SUBSURFACE COMPONENTS INSTALLED AS CONTINGENCY.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

ELECTRODE DETAIL

APPROVED FOR CONSTRUCTION

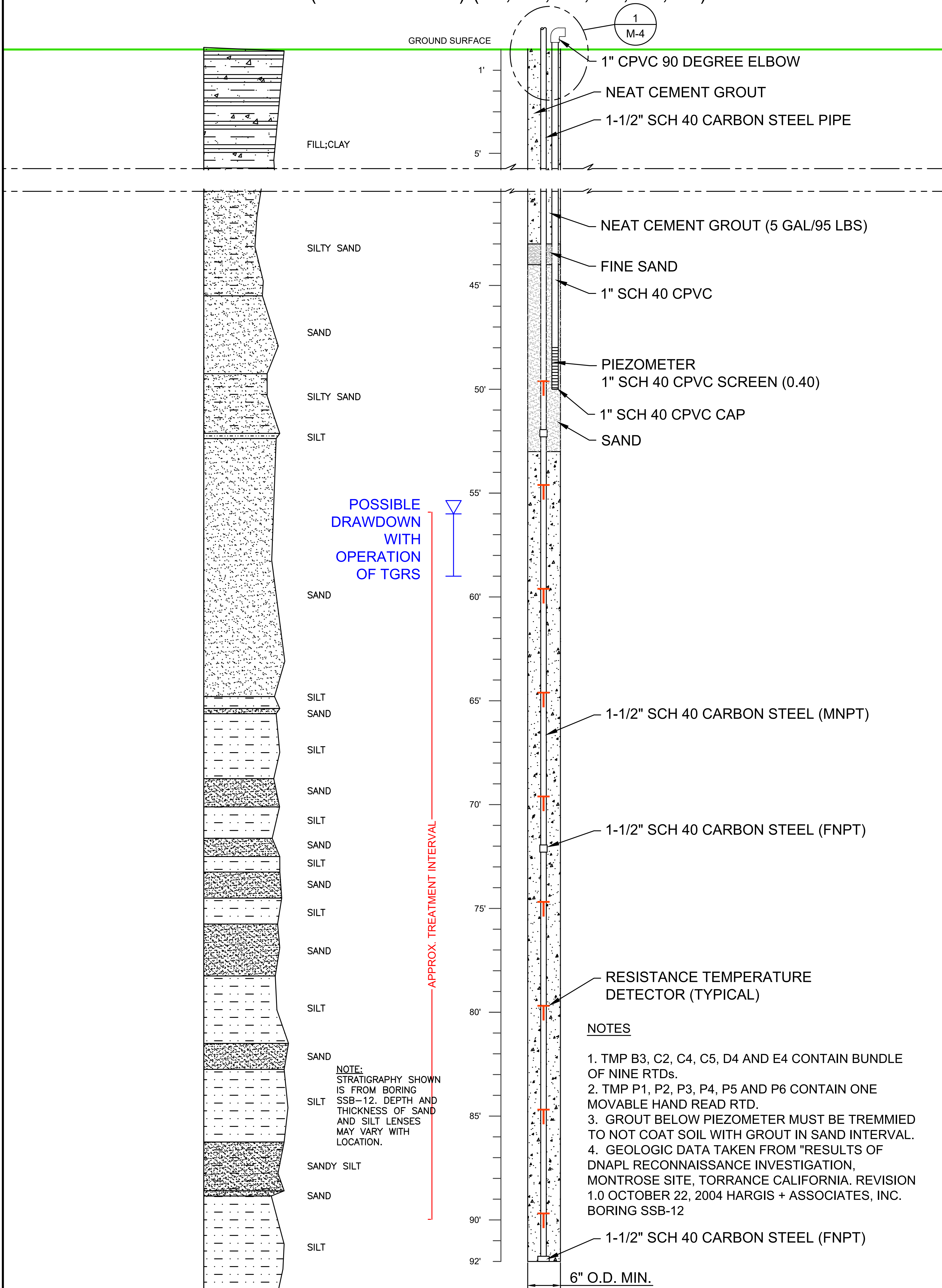
BY ____________

DATE ____________

DATE	2018.OCT.31
PROJECT	CA.MON.1803
SHEET	M-1

AS BUILTS

TEMPERATURE MONITORING POINT
(TYPICAL OF 6) (B3, C2, C4, C5, D4, E4)



NOTES

1. TMP B3, C2, C4, C5, D4 AND E4 CONTAIN BUNDLE OF NINE RTDs.
2. TMP P1, P2, P3, P4, P5 AND P6 CONTAIN ONE MOVABLE HAND READ RTD.
3. GROUT BELOW PIEZOMETER MUST BE TREMMIED TO NOT COAT SOIL WITH GROUT IN SAND INTERVAL.
4. GEOLOGIC DATA TAKEN FROM "RESULTS OF DNAPL RECONNAISSANCE INVESTIGATION, MONTROSE SITE, TORRANCE CALIFORNIA. REVISION 1.0 OCTOBER 22, 2004 HARGIS + ASSOCIATES, INC. BORING SSB-12

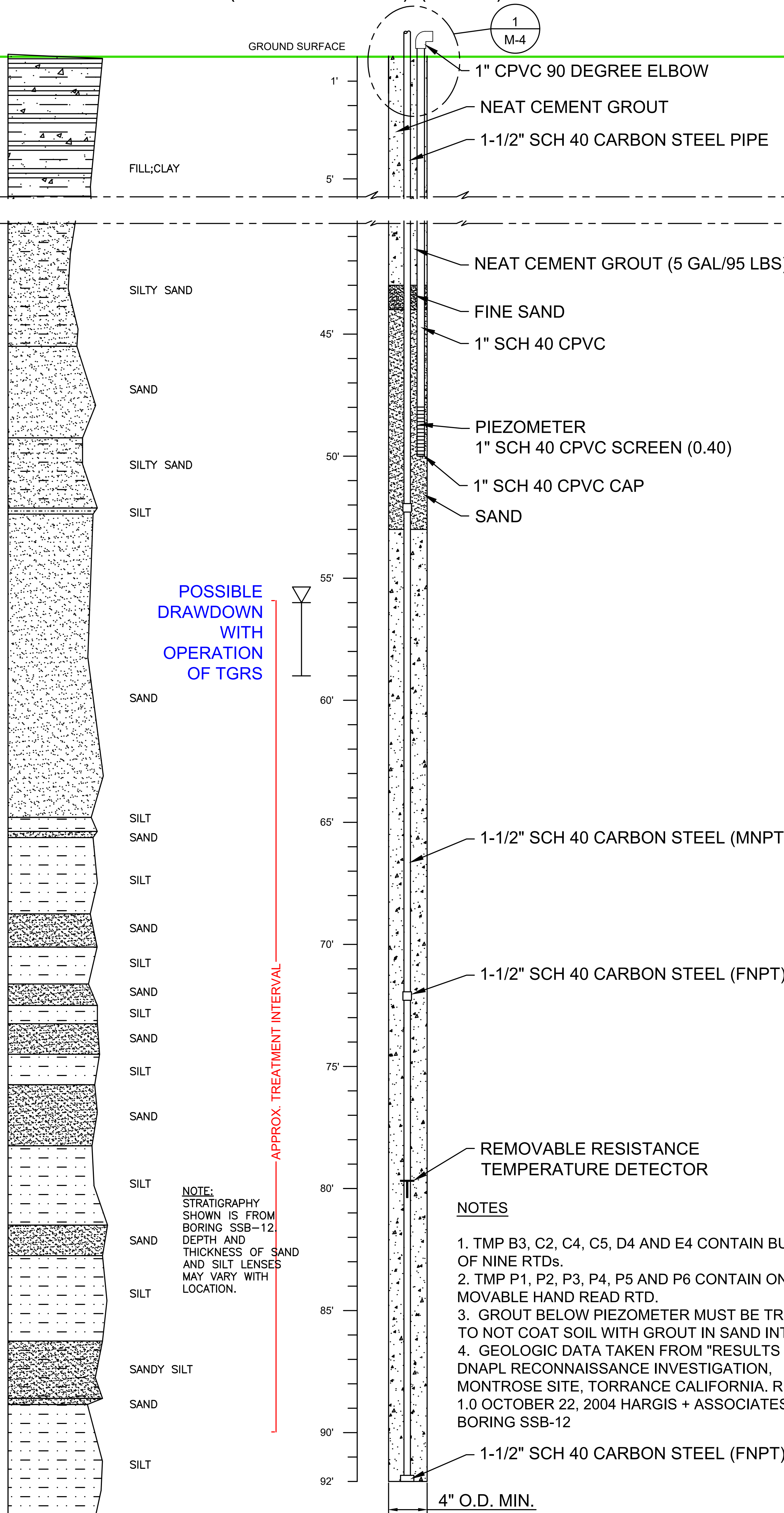
TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY: D. SEILER	SITE	MONTROSE CHEMICAL
	LOCATION	CALIFORNIA
	CLIENT	CONFIDENTIAL CLIENT
DRAWN BY: A. PEABODY	INTERNAL TEMPERATURE MONITORING POINT DETAIL	
CHECKED BY: D. OBERLE		
PROJECT MANAGER: L. STAUCH	APPROVED FOR CONSTRUCTION	DATE 2018.OCT.31 / PROJECT CA.MON.1803
QSAT REVIEW: xx/xx/xx	BY ______ DATE ______	SHEET M-2a

AS BUILTS

TEMPERATURE MONITORING POINT (TYPICAL OF 6) (P1-P6)



NOTES

1. TMP B3, C2, C4, C5, D4 AND E4 CONTAIN BUNDLE OF NINE RTDs.
2. TMP P1, P2, P3, P4, P5 AND P6 CONTAIN ONE MOVABLE HAND READ RTD.
3. GROUT BELOW PIEZOMETER MUST BE TREMMIED TO NOT COAT SOIL WITH GROUT IN SAND INTERVAL.
4. GEOLOGIC DATA TAKEN FROM "RESULTS OF DNAPL RECONNAISSANCE INVESTIGATION, MONTROSE SITE, TORRANCE CALIFORNIA. REVISION 1.0 OCTOBER 22, 2004 HARGIS + ASSOCIATES, INC. BORING SSB-12

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

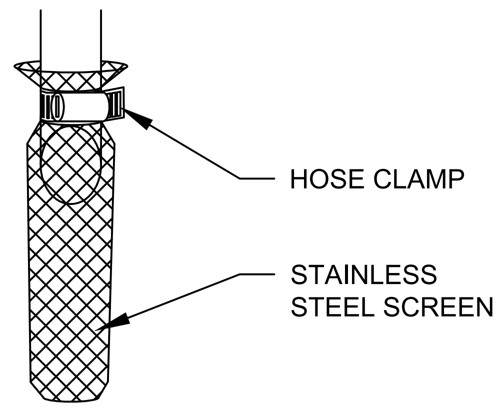
DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

EXTERNAL
TEMPERATURE MONITORING POINT DETAIL

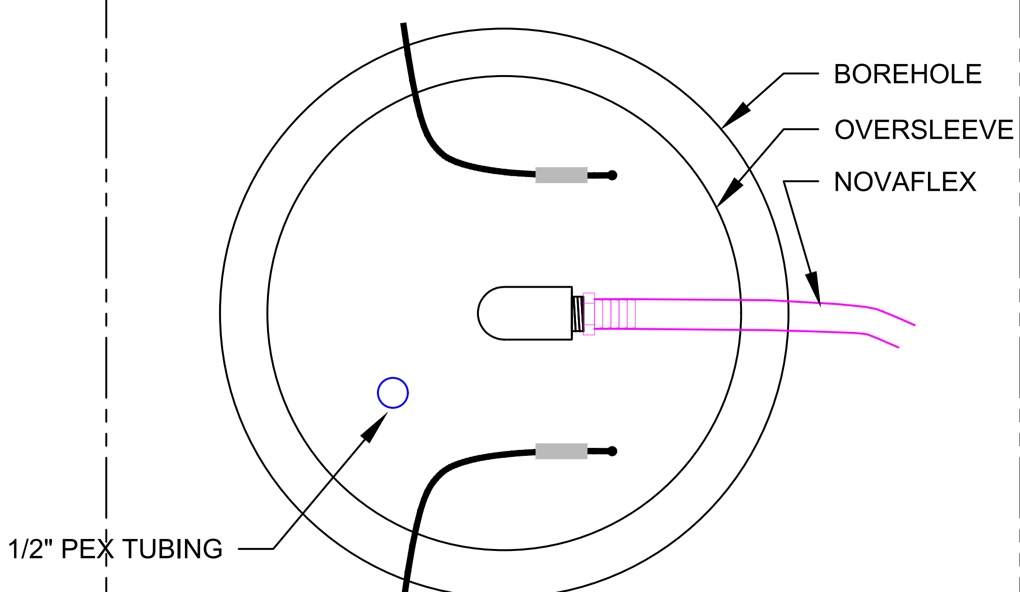
APPROVED FOR CONSTRUCTION
BY ____________
DATE ____________

DATE	2018.OCT.31
PROJECT	CA.MON.1803
SHEET	M-2b

AS BUILTS

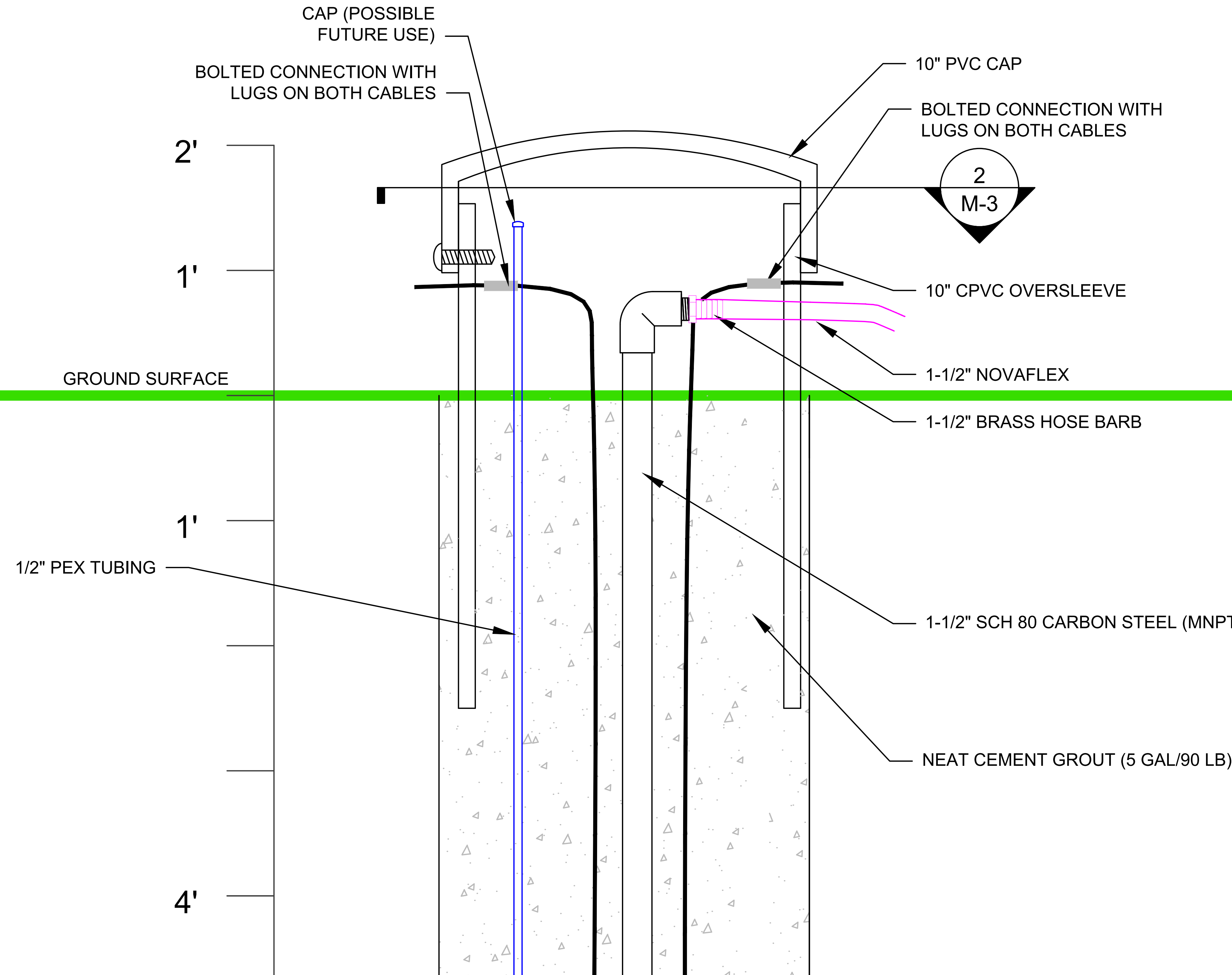


3 ELECTRODE WETTING DETAIL
N.T.S.



2 PLAN VIEW
N.T.S.

1 SURFACE COMPLETION DETAIL
N.T.S.



TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

ELECTRODE HEAD DETAIL

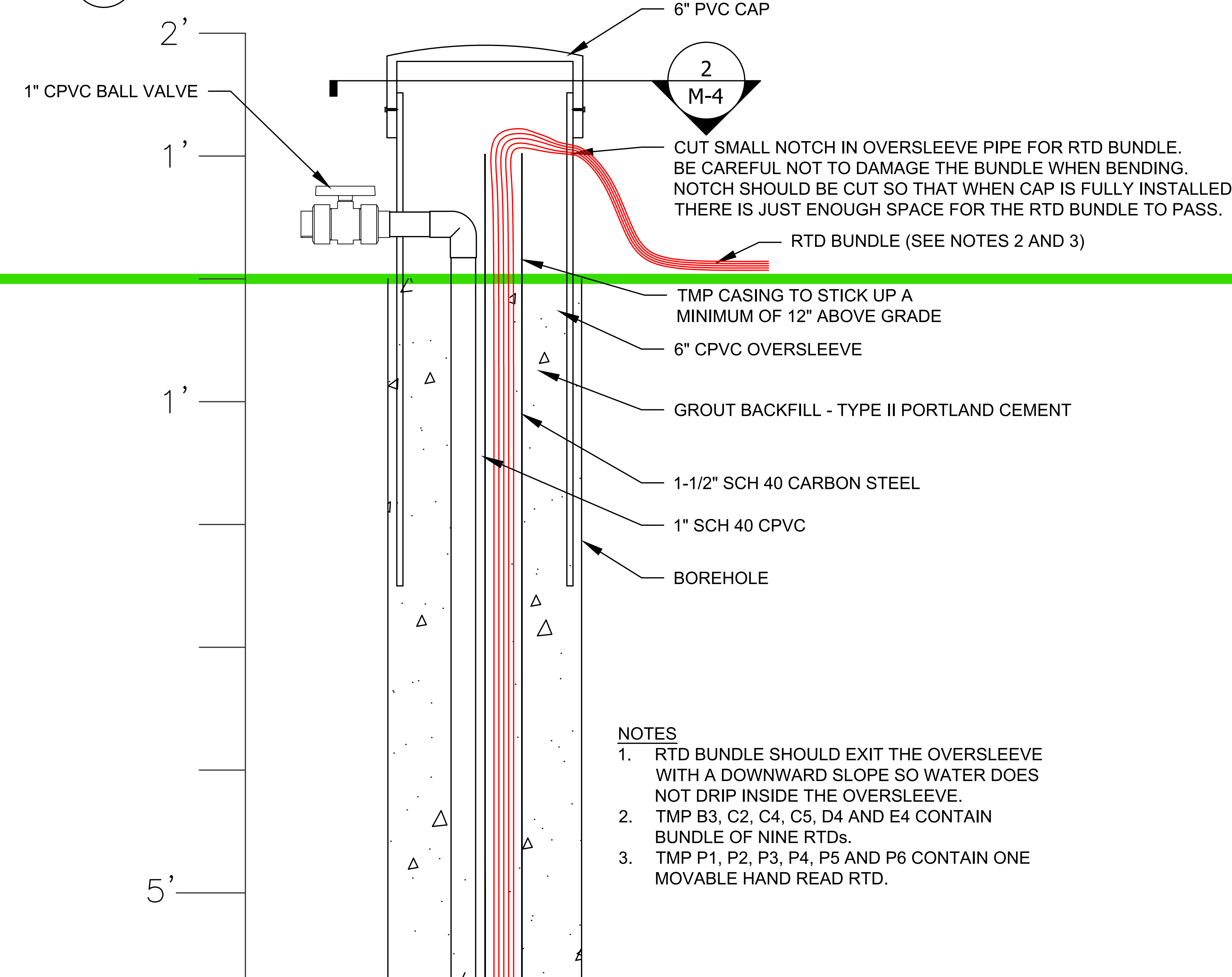
APPROVED FOR CONSTRUCTION
BY ____________
DATE ____________

DATE	2018.OCT.31
PROJECT	CA.MON.1803
SHEET	M-3

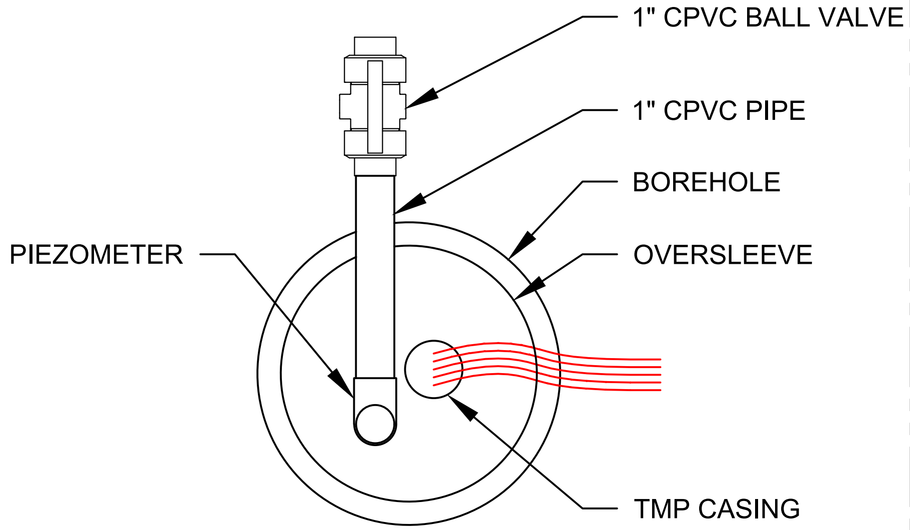
AS BUILTS

TEMPERATURE MONITORING POINT SURFACE COMPLETION DETAIL

1



NOTES
1. RTD BUNDLE SHOULD EXIT THE OVERSLEEVE WITH A DOWNWARD SLOPE SO WATER DOES NOT DRIP INSIDE THE OVERSLEEVE.
2. TMP B3, C2, C4, C5, D4 AND E4 CONTAIN BUNDLE OF NINE RTDs.
3. TMP P1, P2, P3, P4, P5 AND P6 CONTAIN ONE MOVABLE HAND READ RTD.



2 PLAN VIEW
N.T.S.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

TEMPERATURE MONITORING POINT HEAD DETAIL

APPROVED FOR CONSTRUCTION	
BY	
DATE	
DATE	2018.OCT.31
PROJECT	CA.MON.1803
SHEET	M-4

AS BUILTS

LEGEND

- ELECTRONIC SIGNAL
- ELECTRONIC SIGNAL
- BAG FILTER
- PROCESS LINE LABELING
  SEE SHEET P-2 FOR DESCRIPTION
- SOLENOID
- BALL VALVE
- BUTTERFLY VALVE
- ANTI-SIPHON VALVE
- GATE VALVE
- PVC TRUE UNION BALL VALVE
- SAMPLE PORT
- CHECK VALVE
- SELF-CONTAINED
  PRESSURE REGULATOR
- SPIGOT
- BACKFLOW PREVENTER
- FLANGE
- VACUUM RELEASE VALVE
- XX — XX PIPING SPEC. # CHANGE
- PUMP
- BLOWER
- ROTARY LOBE BLOWER
- DIAPHRAGM PUMP
- COMPRESSED AIR FILTER
- HEATER COIL
- HEAT EXCHANGER

YC 1	COMPUTER OPERATED MONITORING, DATA COLLECTION AND CONTROLS
YC 1	HARDWIRE CONTROLS
PI	PRESSURE INDICATOR
PCV	PRESSURE CONTROL VALVE
PSL	PRESSURE SWITCH LOW
FE	FLOW ELEMENT
FI	FLOW INDICATOR
FQI	FLOW QUANTITY INDICATOR
FT	FLOW TRANSMITTER
FQI	FLOW QUANTITY INDICATOR
LI	LEVEL INDICATOR
LSH	LEVEL SWITCH HIGH
LSHH	LEVEL SWITCH HIGH-HIGH
LSL	LEVEL SWITCH LOW
LSLL	LEVEL SWITCH LOW-LOW
TAH	TEMPERATURE ALARM HIGH
TE	TEMPERATURE ELEMENT
TSL	TEMPERATURE SWITCH LOW
TI	TEMPERATURE INDICATOR
TSH	TEMPERATURE SWITCH HIGH
TT	TEMPERATURE TRANSMITTER
YC	CONTROLLER
T	TEMPERATURE SENSOR
CS	CARBON STEEL
CPVC	SCH 40. CPVC PIPE
PEX	PEX TUBING
FCV	FLOW CONTROL VALVE
PSA	PRESSURE SWITCH ACTIVATOR

P&ID LINE COLORS

- SOFTENED/POTABLE/CLEAN WATER
- PROCESS WATER
- AIR
- STEAM
- AIR/STEAM MIX
- SOLVENT/CHEMICALS
- BLOWDOWN
- FUEL
- COMPUTER OPERATED CONTROLS
- HARDWIRE CONTROLS
- POWER SUPPLY CABLE

NOTES

1. THIS IS AN ALL INCLUSIVE LEGEND SHEET. NOT ALL SYMBOLS WILL APPEAR ON EACH SHEET.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

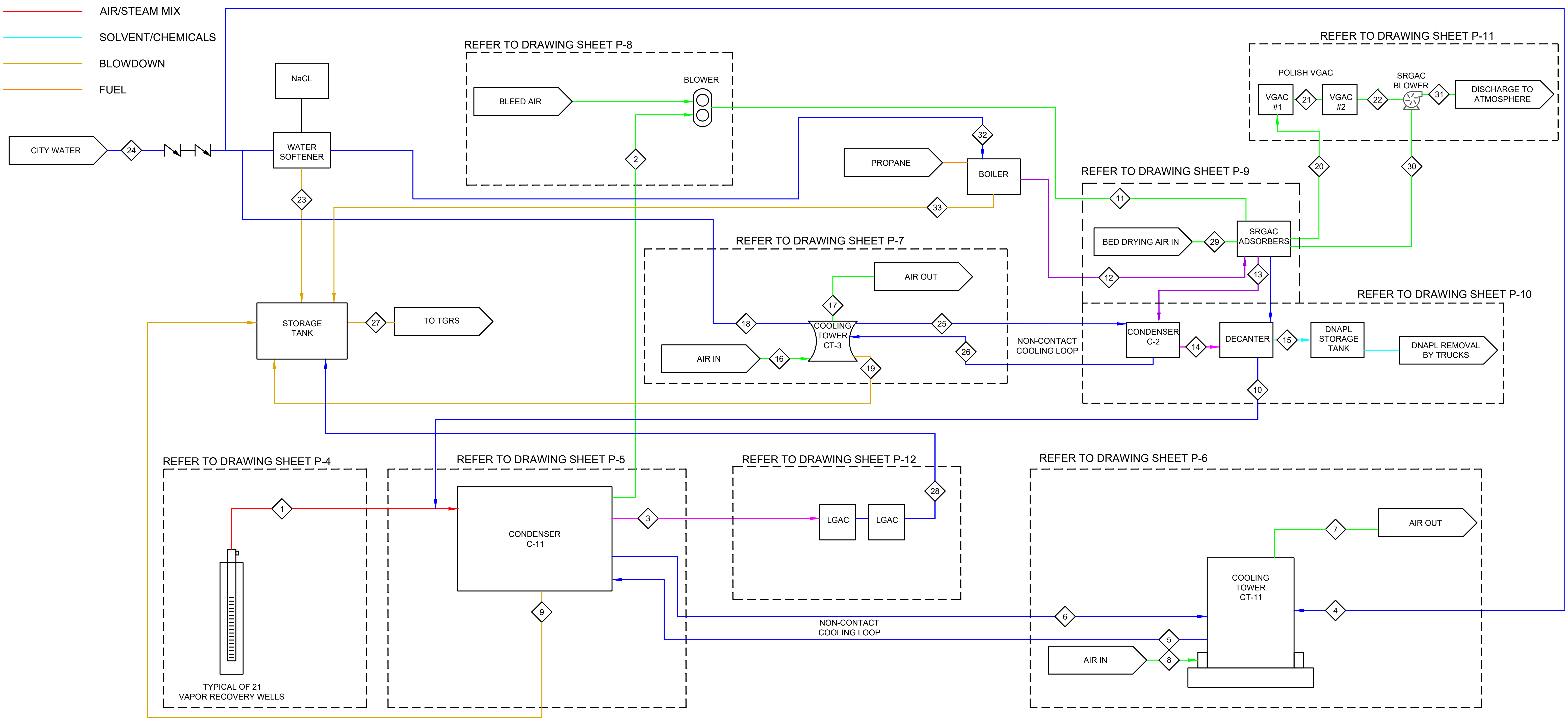
LEGEND
PROCESS AND INSTRUMENTATION DIAGRAMS

APPROVED FOR CONSTRUCTION	
BY	
DATE	
DATE	2018.NOV.01
PROJECT	CA.MON.1803
SHEET	P-1

P&ID LINE COLORS

- SOFTENED/POTABLE/CLEAN WATER
- PROCESS WATER
- AIR
- STEAM
- AIR/STEAM MIX
- SOLVENT/CHEMICALS
- BLOWDOWN
- FUEL

AS BUILTS



NOTES

SEE SHEET P-3 FOR PROCESS STREAM INFORMATION.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

PROCESS FLOW DIAGRAM

APPROVED FOR CONSTRUCTION	
BY	
DATE	
DATE	2018.NOV.01
PROJECT	CA.MON.1803
SHEET	P-2

Process Stream	Location	Air		Water Vapor		Water		CVOCs		Temperature		Pressure
Description	#	(lb/min)	(scfm)	(lb/min)	(scfm)	(lb/min)	(gpm)	(lb/min)	(ppm)	°C	°F	(Δ from barometric)
Extracted air and steam from vapor recovery wells	1	20	260	6.6	140	0	0	1.48E-01	1268	73	164	2" Hg Vac
Discharge air from condenser after steam removal	2	20	260	0.4	8	0	0	1.57E-01	2008	25	77	4" Hg Vac
Condensate discharge from condenser to LGAC	3	0	0	0	0	15.6	1.9	9.65E-04	62	40	104	10 psig
Make-up water to condenser cooling tower	4	0	0	0	0	2.3	0.3	0	0	20	68	25 psig
Cooling water to condenser	5	0	0	0	0	2499	300	0	0	18	64	10 psig
Cooling water return to cooling tower	6	0	0	0	0	2499	300	0	0	25	77	10 psig
Air exhaust from cooling tower	7	563	7,500	7.3	155	0	0	0	0	18	64	0 psig
Air inlet to cooling tower	8	563	7,500	6.0	127	0	0	0	0	21	69	0 psig
Blowdown from condenser	9	0	0	0	0	1.0	0.1	0	0	18	64	0.5 psig
Water from decanter to condenser	10	0	0	0	0	9.4	1.1	9.87E-03	1050	25	77	0 psig
Discharge air from rotary lobe blower	11	20	260	0.4	8	0	0	1.57E-01	2008	45	113	0 psig
Steam from boiler to SRGAC	12	0	0	9.4	200	0	0	0	0	100	212	25 psig
Regeneration steam & CVOCs from SRGAC to condenser C-2	13	0	0	9.4	200	0	0	1.49E-01	2535	100	212	0.5 psig
Condensed water & NAPL from SRGAC condenser to decanter	14	0	0	0	0	9.4	1.1	1.49E-01	Saturated	25	77	1 psig
DNAPL to storage tank	15	0	0	0	0	0.01	0.0	1.40E-01	DNAPL&Water	25	77	0.5 psig
Air inlet to SRGAC cooling tower	16	600	8000	6.4	136	0	0	0	0	21	69	1 psig
Air exhaust from SRGAC cooling tower	17	600	8000	7.8	165	0	0	0	0	18	64	0 psig
Make-up water to SRGAC cooling tower	18	0	0	0	0	2.4	0.3	0	0	20	68	25 psig
Blowdown from SRGAC cooling tower	19	0	0	0	0	1	0.1	0	0	35	95	0.5 psig
Discharge air from SRGAC	20	20	260	0.4	8	0	0	7.86E-03	100.7	35	95	-1.0 psig
Discharge air from polish VGAC #1	21	20	260	0.4	8	0	0	7.86E-04	10.1	30	86	-1.5 psig
Discharge air from polish VGAC #2	22	20	260	0.4	8	0	0	7.86E-05	1.0	27	80	-2.0 psig
Regeneration water from softener	23	0	0	0	0	1.4	0.2	0	0	20	68	25 psig
City water demand	24	0	0	0	0	15.5	1.9	0	0	20	68	25 psig
Cooling water to SRGAC shell and tube condenser	25	0	0	0	0	416.5	50.0	0	0	18	64	25 psig
Cooling water return to SRGAC cooling tower	26	0	0	0	0	416.5	50.0	0	0	22	72	2 psig
Discharge water to TGRS	27	0	0	0	0	19.1	2.3	9.65E-06	0.5	32	90	10 psig
Condensate after LGAC treatment	28	0	0	0	0	15.6	1.9	9.65E-06	0.6	40	104	8 psig
Air inlet for bed drying air	29	59.475	793	0.6	13	0.0	0.0	0	0.0	21	69	0.7 psig
Air exhaust for bed drying air	30	59.475	793	9.1	193	0.0	0.0	8E-04	2.7	60	140	0 psig
Combined discharge air	31	78.975	1053	9.4	201	0.0	0.0	9E-04	2.4	38	100	0 psig
Softened water to boiler	32	0	0	0	0	9.4	1.1	0	0	20	68	25 psig
Boiler Blowdown	33	0	0	0	0	0.1	0.01	0	0	82	180	25 psig

AS BUILTS

TRS
Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY D. SEILER
DRAWN BY J. ERARIO
CHECKED BY D. OBERLE
PROJECT MANAGER L. STAUCH
QSAT REVIEW xx/xx/xx

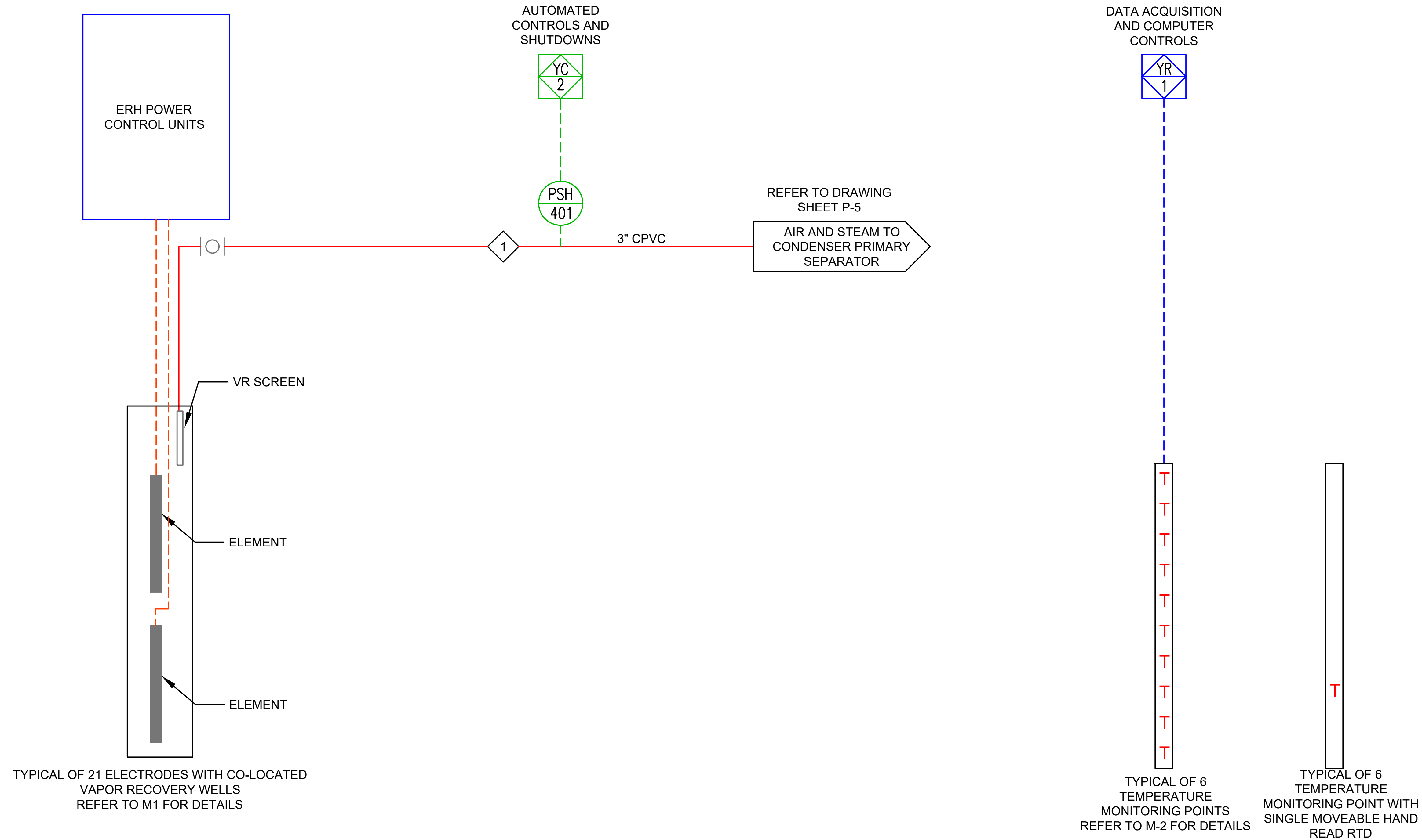
SITE MONTROSE CHEMICAL
LOCATION CALIFORNIA
CLIENT CONFIDENTIAL CLIENT

PROCESS FLOW MASS BALANCE

APPROVED FOR CONSTRUCTION
BY ______
DATE ______

DATE 2018.NOV.01
PROJECT CA.MON.1803
SHEET P-3

AS BUILTS



NOTES

1. SEE THE ELECTRODE AND TEMPERATURE MONITORING POINT DETAILS FOR MORE INFORMATION ON THEIR CONSTRUCTION.
2. PSH-401 WILL SHUT DOWN THE PCU IN THE EVENT OF A LOW FIELD VACUUM (LESS THAN 2" H_20).

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx

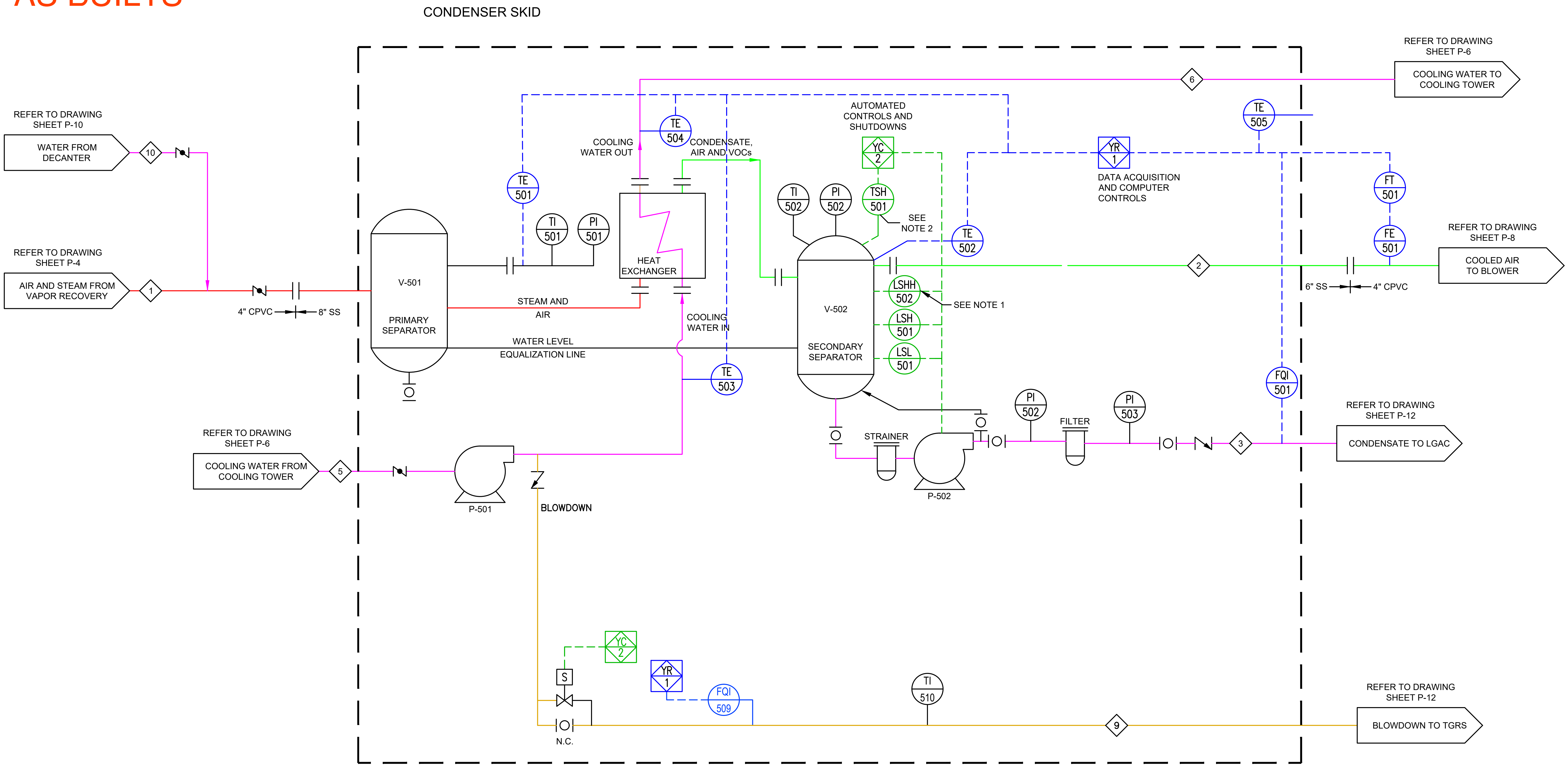
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

FIELD
PROCESS AND INSTRUMENTATION DIAGRAM

APPROVED FOR CONSTRUCTION
BY ____________
DATE ____________

DATE	2018.NOV.01
PROJECT	CA.MON.1803
SHEET	P-4

AS BUILTS



NOTES:

1. LSHH-501 WILL SHUT DOWN THE VAPOR RECOVERY BLOWER (B-801) AND THE ELECTRODES.
2. TSH-501 WILL SHUT DOWN THE VAPOR RECOVERY BLOWER (B-801). TEMPERATURE SET POINT IS 140°F
3. THE HEAT EXCHANGER IS ASME 2 RATED.
4. PIPE, VESSELS AND HEAT EXCHANGER PLATES ARE STAINLESS STEEL.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx

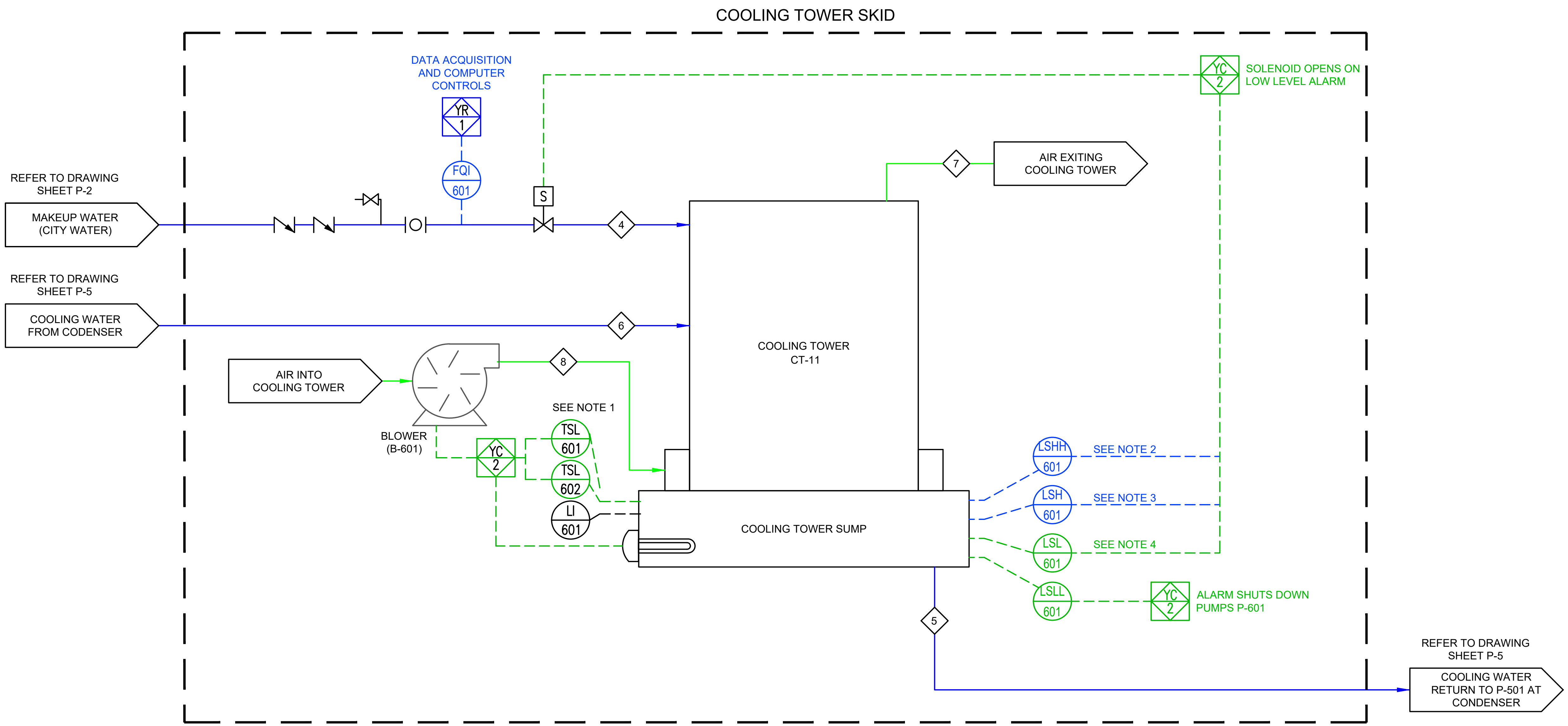
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

CONDENSER
PROCESS AND INSTRUMENTATION DIAGRAM

APPROVED FOR CONSTRUCTION
BY ____________
DATE ____________

DATE	2018.NOV.01
PROJECT	CA.MON.1803
SHEET	P-5

AS BUILTS



NOTES

1. TSL-601 AUTOMATICALLY SHUTS DOWN THE COOLING TOWER FAN AT 45° F. TSL-602 TURNS ON AN IMMERSION HEATER IN THE COOLING TOWER SUMP.
2. LSHH SHUTS DOWN SYSTEM.
3. LSH OPENS BLOWDOWN SOLENOID AT CONDENSER.
4. LSL-601 MUST BE AT LEAST 2 FEET ABOVE PUMP INTAKE.
5. POTABLE MAKEUP WATER IS SUPPLIED TO THE COOLING WATER SUMP TANK AT AN AVERAGE RATE OF 3-5 GPM IN 30 SECOND INCREMENTS.

TRS
Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY D. SEILER
DRAWN BY J. ERARIO
CHECKED BY D. OBERLE
PROJECT MANAGER L. STAUCH
QSAT REVIEW xx/xx/xx

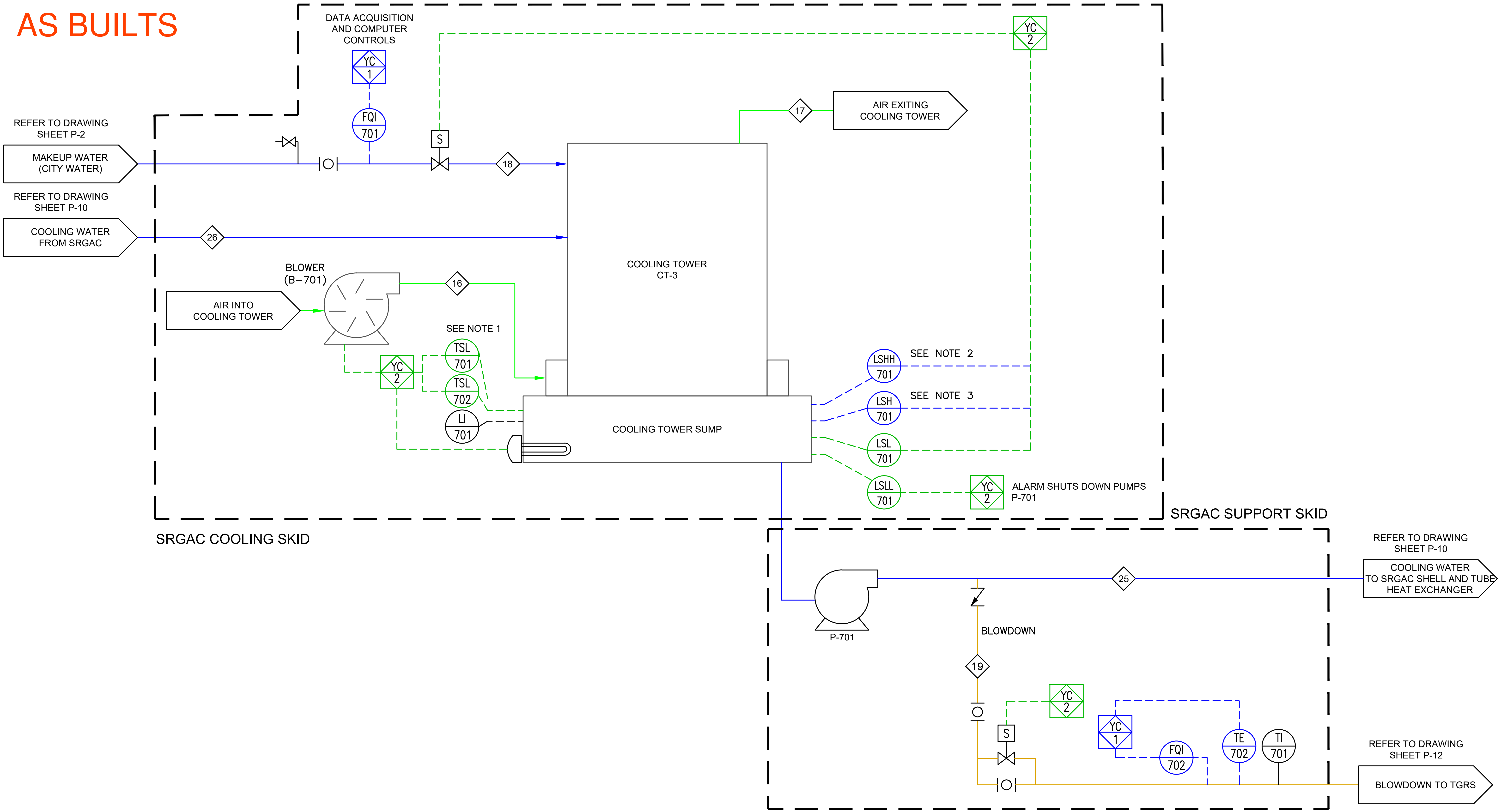
SITE MONTROSE CHEMICAL
LOCATION CALIFORNIA
CLIENT CONFIDENTIAL CLIENT

COOLING TOWER
PROCESS AND INSTRUMENTATION DIAGRAM

APPROVED FOR CONSTRUCTION
BY
DATE

DATE 2018.NOV.01
PROJECT CA.MON.1803
SHEET P-6

AS BUILTS



NOTES:

1. TSL-701 AUTOMATICALLY SHUTS DOWN THE COOLING TOWER FAN AT 45° F. TSL-702 TURNS ON AN IMMERSION HEATER IN THE COOLING TOWER SUMP.
2. LSHH SHUTS DOWN SYSTEM.
3. LSH OPENS BLOWDOWN SOLENOID AT CONDENSER.
4. LSL-701 MUST BE AT LEAST 2 FEET ABOVE PUMP INTAKE.
5. POTABLE MAKEUP WATER IS SUPPLIED TO THE COOLING TOWER AT AN AVERAGE RATE OF 3-5 GPM IN 30 SECOND INCREMENTS.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY D. SEILER
DRAWN BY J. ERARIO
CHECKED BY D. OBERLE
PROJECT MANAGER L. STAUCH
QSAT REVIEW xx/xx/xx

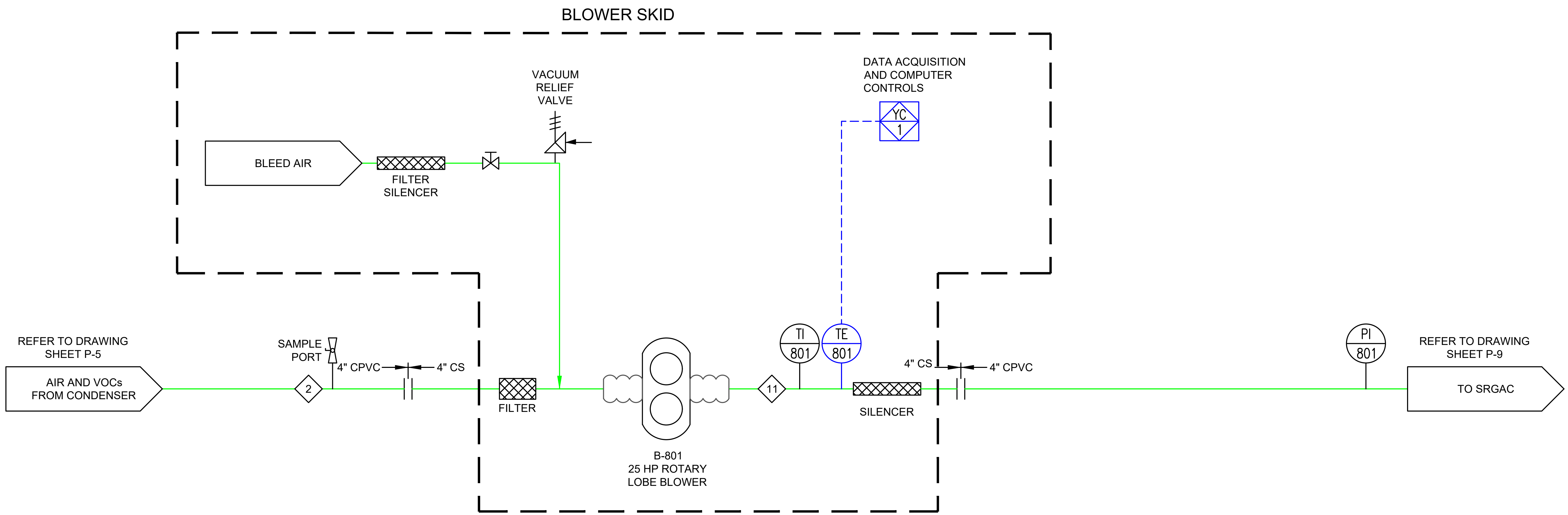
SITE MONTROSE CHEMICAL
LOCATION CALIFORNIA
CLIENT CONFIDENTIAL CLIENT

SRGAC COOLING TOWER
PROCESS AND INSTRUMENTATION DIAGRAM

APPROVED FOR CONSTRUCTION
BY ____________
DATE ____________

DATE 2018.NOV.01
PROJECT CA.MON.1803
SHEET P-7

AS BUILTS



NOTES

1. PSH-801 AND PSL-801 WILL SHUT DOWN THE BLOWER IN THE EVENT OF A HIGH OR LOW BLOWER DISCHARGE PRESSURE. PSL-801 WILL HAVE A SET POINT OF 1" WC AND PSH-801 WILL HAVE A SET POINT OF 2 PSIG.
2. THE KUNKLE VALVE WILL BE SET AT 11" HG.
3. BLEED AIR NOT ANTICIPATED DURING THIS PROJECT.

TRS Accelerating Value

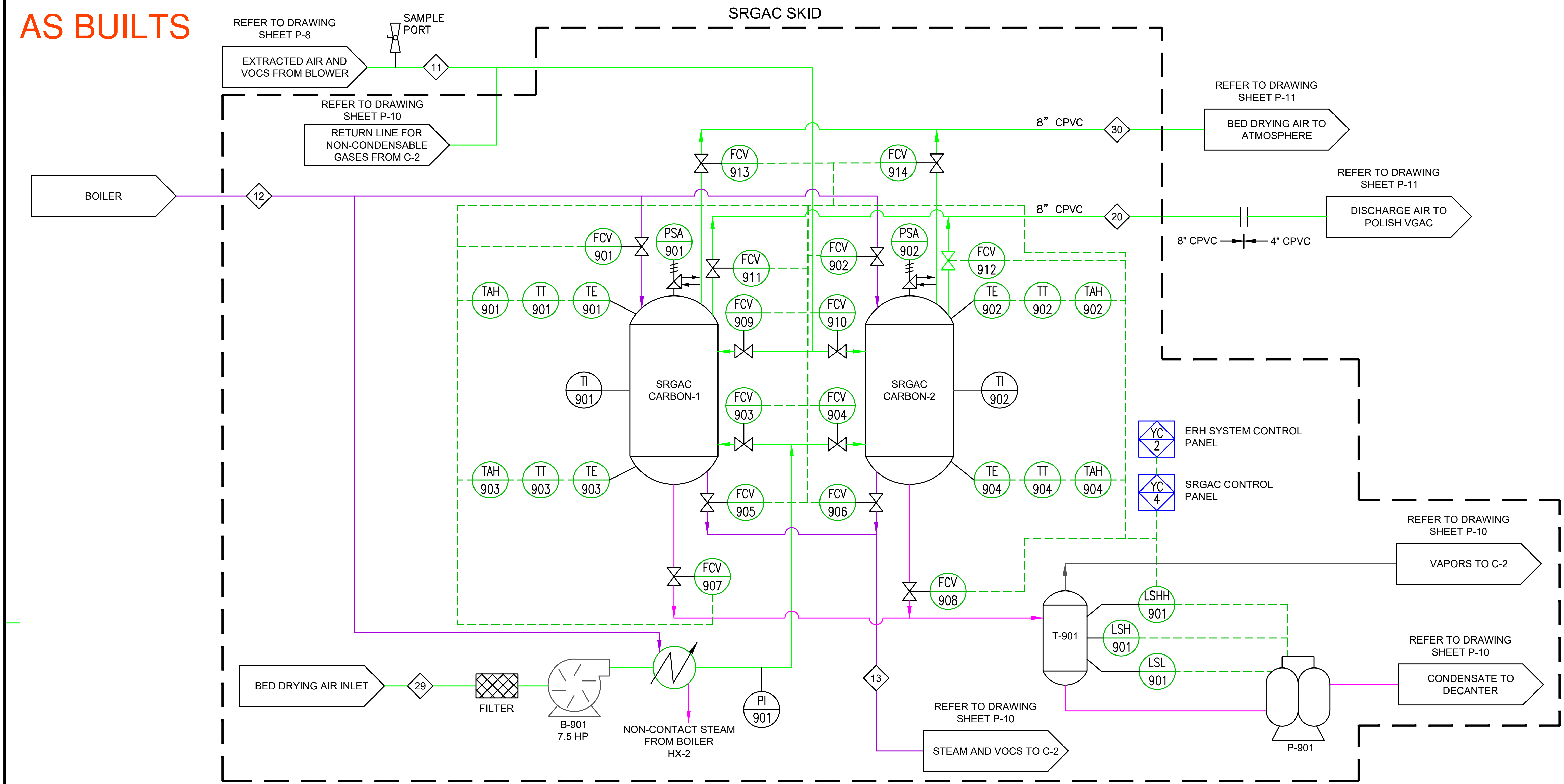
TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

BLOWER
PROCESS AND INSTRUMENTATION DIAGRAM

APPROVED FOR CONSTRUCTION		DATE 2018.NOV.01	PROJECT CA.MON.1803
BY		SHEET	P-8
DATE			

AS BUILTS



NOTES

1. ALL FLOW CONTROL VALVES FOR THE SRGAC FAIL CLOSED.
2. TAH-901 AND TAH-902 HAVE VARIABLE SETPOINTS DEPENDING ON THE PROCESS STAGE. DURING ADSORPTION THE ALARM POINT IS 125°F, THE SHUT DOWN IS 140°F. DURING STEAMING AND DRYING THE ALARM IS 250°F, THE SHUT DOWN IS 275°F. DURING COOLING THE ALARM IS 200°F, THE SHUT DOWN IS 220°F.
3. PSA-901 AND PSA-902 HAVE SETPOINTS OF 2" PSI. THIS WILL SHUT DOWN THE SRGAC SYSTEM.
4. LSHH-901 WILL SHUT DOWN THE SRGAC SYSTEM.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

SRGAC
PROCESS AND INSTRUMENTATION DIAGRAM

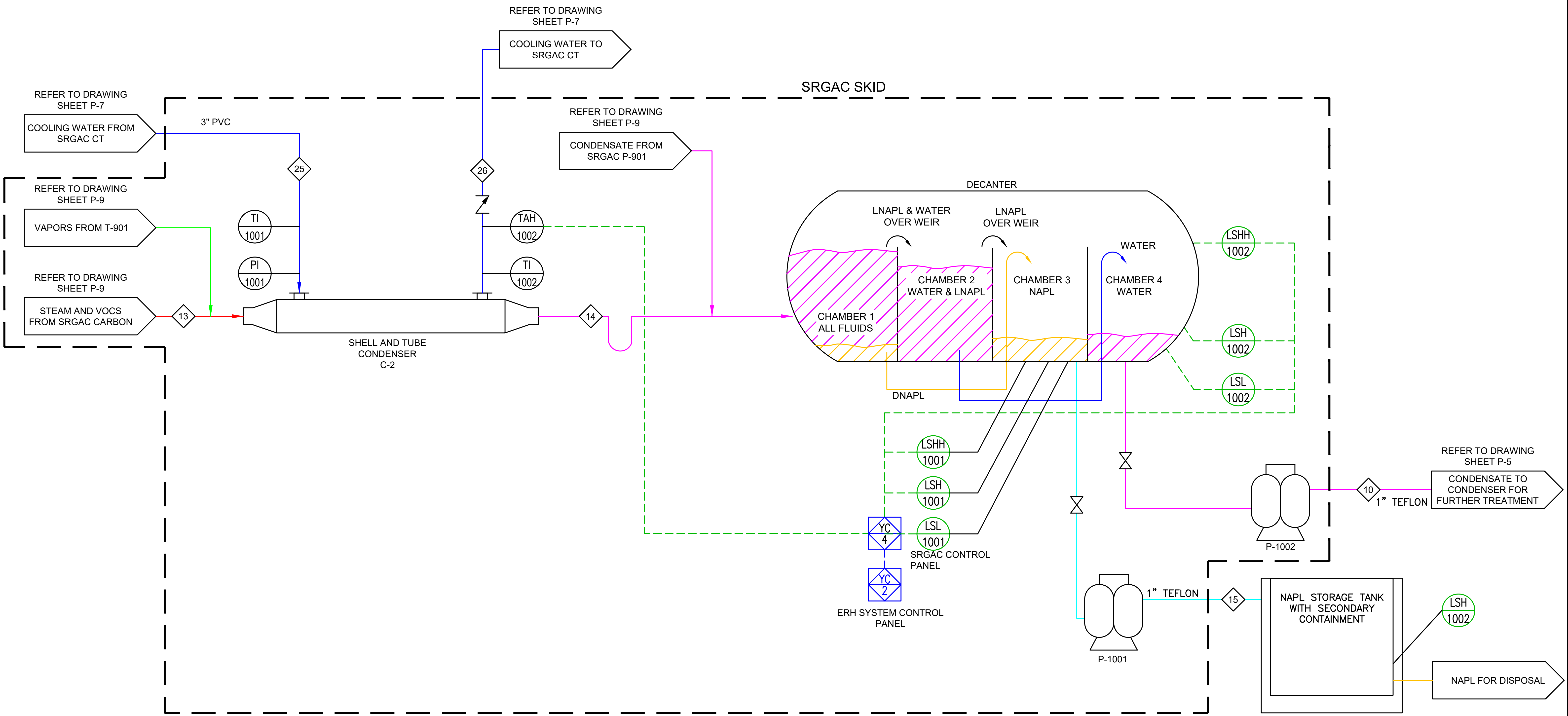
APPROVED FOR CONSTRUCTION

BY

DATE

DATE	2018.NOV.01
PROJECT	CA.MON.1803
SHEET	P-9

AS BUILTS



NOTES

1. THE NAPL PIPING FROM THE DECANTER TO THE DNAPL STORAGE TANK WILL BE DOUBLE CONTAINED.
2. THE CONDENSATE PIPING FROM THE DECANTER TO THE CONDENSER INLET WILL BE DOUBLE CONTAINED.
3. LSHH-1002 WILL SHUT DOWN THE SRGAC SYSTEM AND TERMINATE POWER TO THE ELECTRODES.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

SRGAC CONDENSER AND DECANTER
PROCESS AND INSTRUMENTATION DIAGRAM

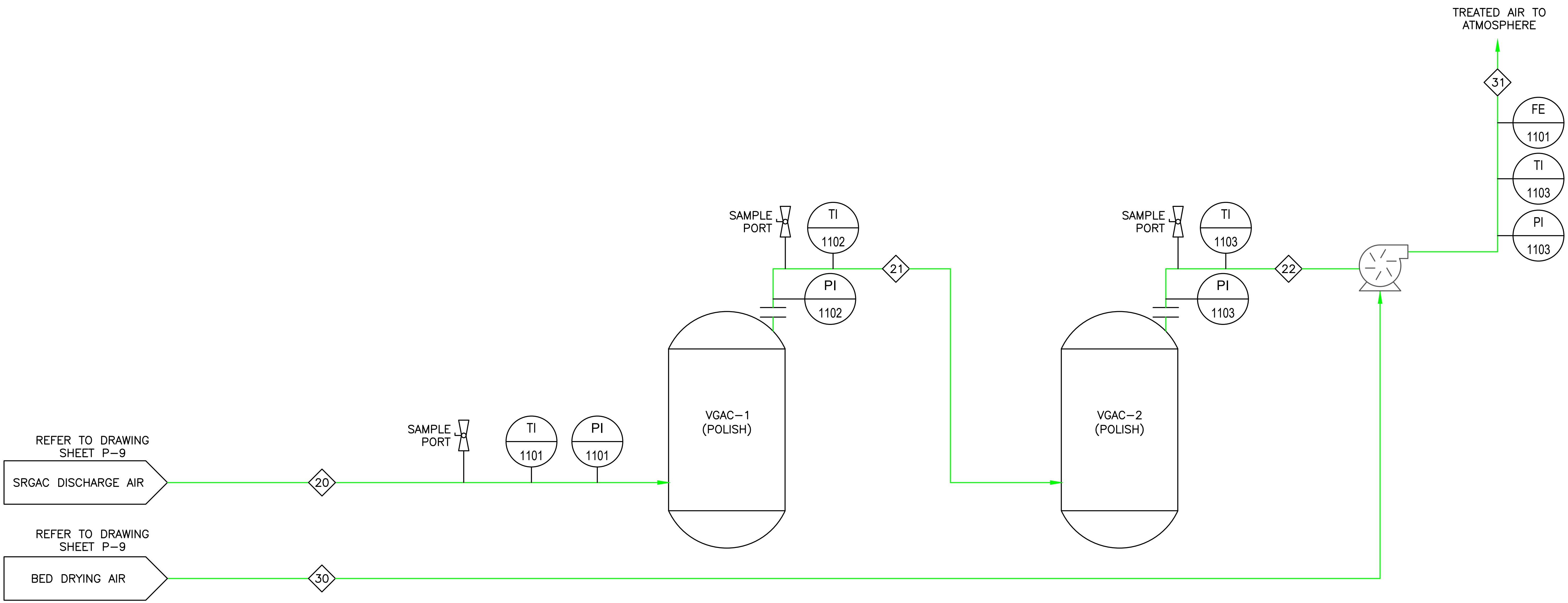
APPROVED FOR CONSTRUCTION

BY ______

DATE ______

DATE	2018.NOV.01
PROJECT	CA.MON.1803
SHEET	P-10

AS BUILTS



NOTE:
IF VGAC CHANGEOUT IS REQUIRED, PRIMARY VESSEL WILL BE REPLACED AND SECONDARY VESSEL WILL BECOME PRIMARY VESSEL.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

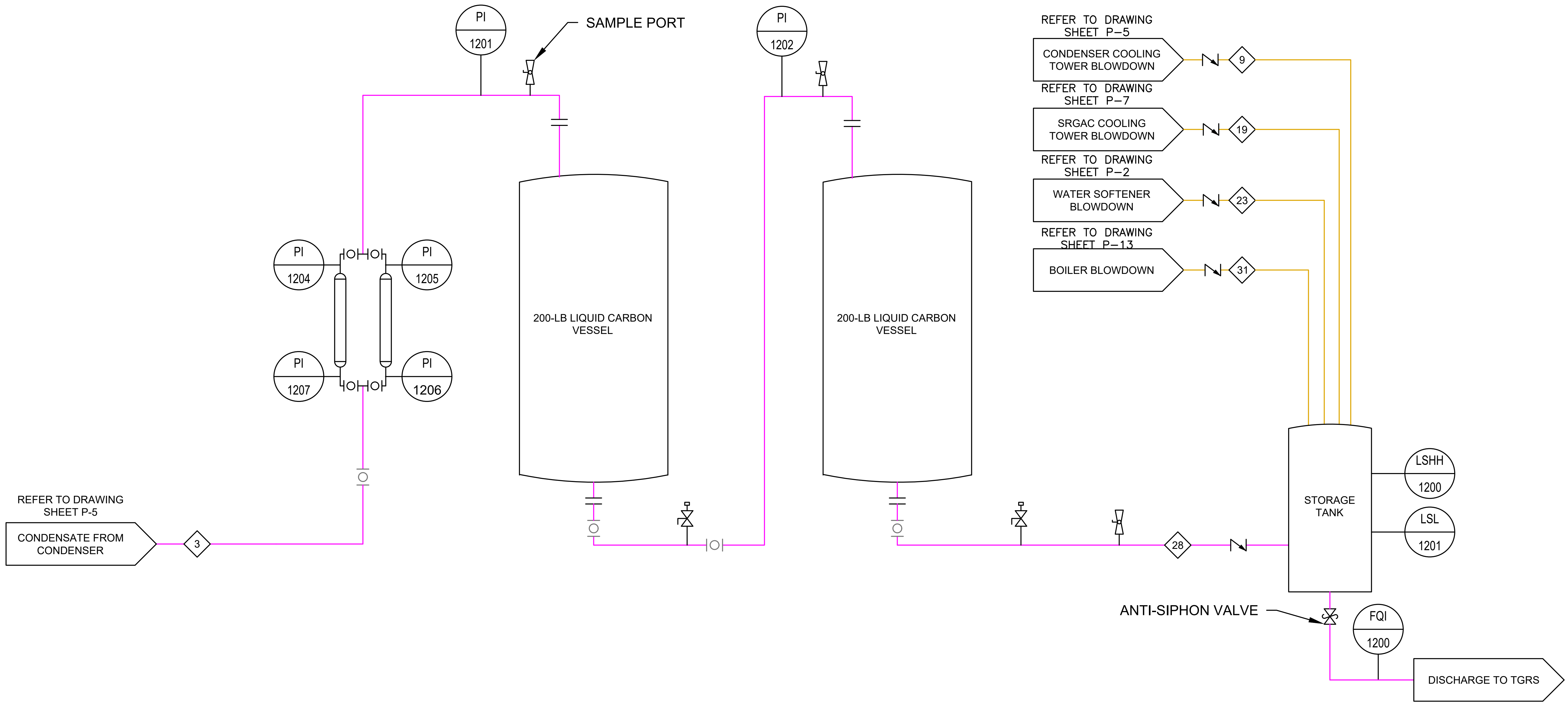
DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx

SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

POLISH VGAC
PROCESS AND INSTRUMENTATION DIAGRAM

APPROVED FOR CONSTRUCTION		DATE 2018.NOV.01	PROJECT CA.MON.1803
BY ______	DATE ______	SHEET	P-11

AS BUILTS



NOTES:

1. VESSEL CONNECTIONS MAY VARY.
2. ALL PIPING FOR THE WATER TREATMENT SYSTEM SHOULD BE SCH40 CPVC.
3. ALL VALVES TO BE TRUE UNION BALL VALVES.
4. VESSELS TO BE FIBERGLASS, EVOQUA PG-200.
5. TRUE UNIONS SHOULD BE ADDED TO VESSEL INLETS AND OUTLETS OF EACH VESSEL TO AID IN GAC CHANGE-OUT AND SILT REMOVAL.
6 CARTRIDGE FILTERS SHOULD BE INSTALLED ON SITES WHERE SILT IS EXPECTED.
7. IF VGAC CHANGEOUT IS REQUIRED, PRIMARY VESSEL WILL BE REPLACED AND SECONDARY VESSEL WILL BECOME PRIMARY VESSEL.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

WATER TREATMENT AND DISCHARGE
PROCESS AND INSTRUMENTATION DIAGRAM

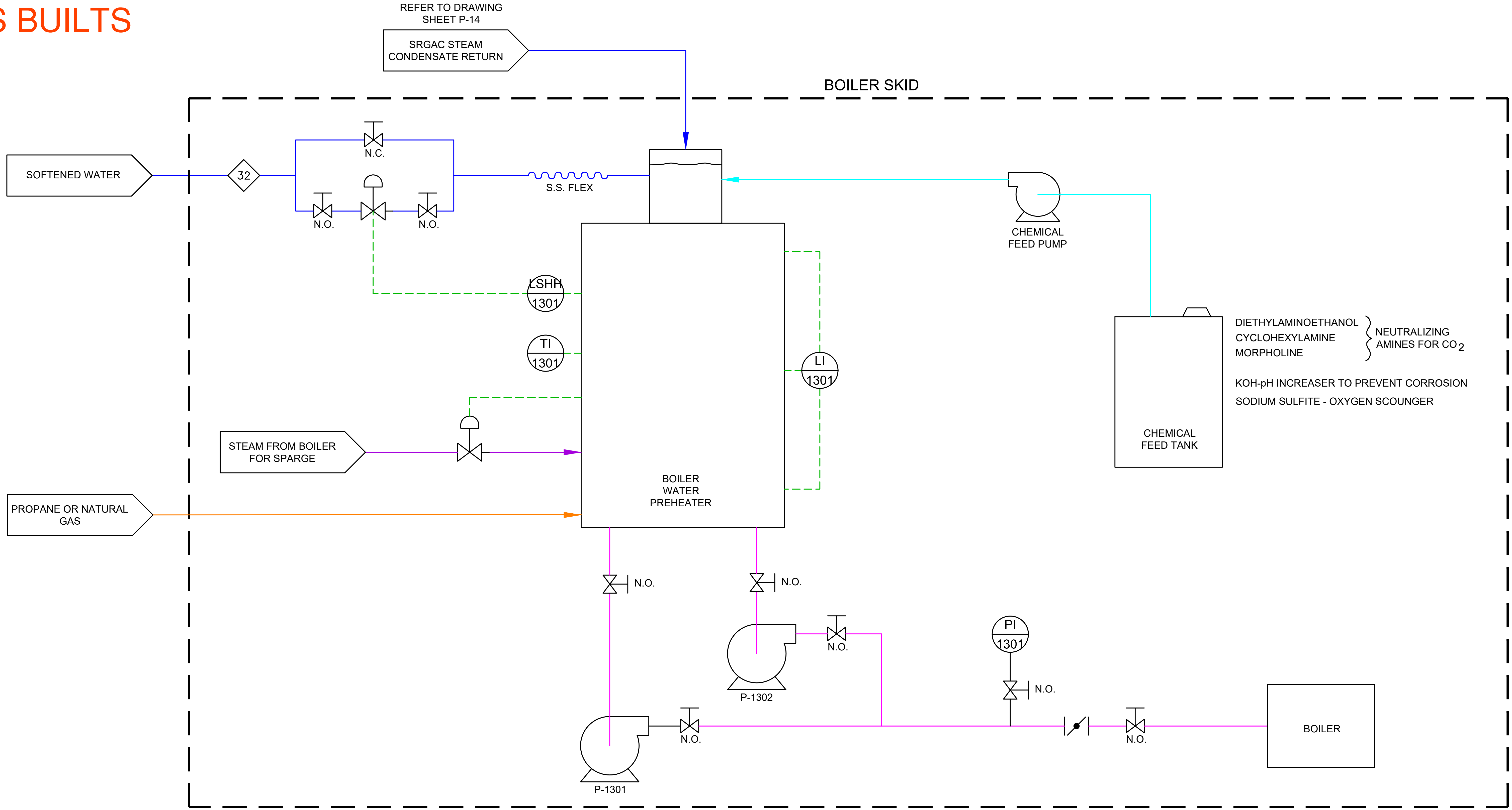
APPROVED FOR CONSTRUCTION

BY __________

DATE __________

DATE	2018.NOV.01
PROJECT	CA.MON.1803
SHEET	P-12

AS BUILTS



NOTES

1. ALL COMPONENTS SHOWN ARE PART OF A VENDOR-SUPPLIED BOILER SYSTEM.
2. P-1301 AND P-1302 ARE PART OF A DUPLEX PUMP SYSTEM CONTROLLED BY LEVEL SWITCHES IN THE BOILER.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	J. ERARIO
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx

SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

BOILER WATER PRECONDITIONING
PROCESS AND INSTRUMENTATION DIAGRAM

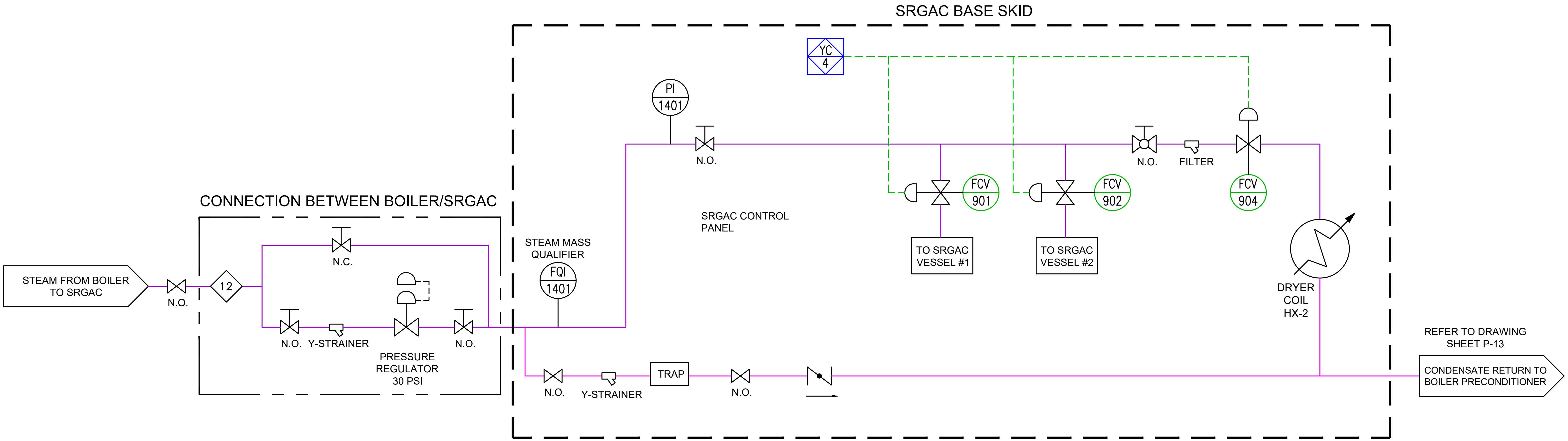
APPROVED FOR CONSTRUCTION

BY ____________________

DATE ____________________

DATE	2018.NOV.01
PROJECT	CA.MON.1803
SHEET	P-13

AS BUILTS



NOTES

1. THE MAXIMUM STEAM PRESSURE FROM THE BOILER IS 150 PSIG.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY D. SEILER
DRAWN BY J. ERARIO
CHECKED BY D. OBERLE
PROJECT MANAGER L. STAUCH
QSAT REVIEW xx/xx/xx

SITE MONTROSE CHEMICAL
LOCATION CALIFORNIA
CLIENT CONFIDENTIAL CLIENT

STEAM DELIVERY SYSTEM TO SRGAC
PROCESS AND INSTRUMENTATION DIAGRAM

APPROVED FOR CONSTRUCTION
BY ____________
DATE ____________

DATE 2018.NOV.01
PROJECT CA.MON.1803
SHEET P-14

AS BUILTS

SYMBOLS

	UTILITY METERING
	MEDIUM VOLTAGE DRAW OUT CIRCUIT BREAKER
	FUSE
	DISCONNECT SWITCH
	FUSED DISCONNECT SWITCH
	CIRCUIT BREAKER
	N.O. CONTACT A NORMALLY OPEN (N.O.) CONTACT IS OPEN WHEN IT, OR THE DEVICE OPERATING IT, IS IN A DE-ENERGIZED
	N.C. CONTACT A NORMALLY CLOSED (N.C.) CONTACT IS CLOSED WHEN IT, OR THE DEVICE OPERATING IT, IS IN A DE-ENERGIZED STATE OR RELAXED STATE.
	THERMAL OVERLOAD
	ANTI-SIPHON VALVE
15 HP	PUMP/MOTOR
H1 H3 H2 H4 X4 X2 X3 X1	TRANSFORMER
	VARIABLE OUTPUT 3 PHASE TRANSFORMER
	GENERATOR
	AUTOMATIC TRANSFER SWITCH

ABBREVIATIONS

A	AMPERES
ATS	AUTOMATIC TRANSFER SWITCH
FLA	FULL LOAD AMPS
HP	HORSEPOWER
KW	KILOWATT
KVA	KILOVOLT-AMPERES
KV	KILO-VOLTS
N.O.	NORMALLY OPEN
OL	OVERLOAD
P	POLE
PH, Ø	PHASE
SRGAC	STEAM REGENERATED GAS ACTIVATED CARBON
VAC	VOLTAGE ALTERNATING CURRENT
VFD	VARIABLE FREQUENCY DRIVE
V	VOLT
W	WATTS, WIRE

NOTE: THIS IS AN ALL INCLUSIVE LEGEND SHEET. NOT ALL SYMBOLS/ABBREVIATIONS WILL APPEAR ON EACH SHEET.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

ELECTRICAL ONE-LINE DIAGRAM LEGEND

APPROVED FOR CONSTRUCTION	
BY	
DATE	
DATE	2018.NOV.20
PROJECT	CA.MON.1803
SHEET	E-1

AS BUILTS

GENERAL NOTES

1. PERFORM INSTALLATION IN ACCORDANCE WITH THE CURRENT EDITION OF THE NATIONAL ELECTRICAL CODE (NEC) AND THE OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA). EQUIPMENT SHALL BE LISTED BY A NATIONALLY RECOGNIZED TESTING LABORATORY (NRTL).
2. PROVIDE AND MAINTAIN A CLEAR WORKING SPACE ABOUT ELECTRIC EQUIPMENT IN ACCORDANCE WITH NEC ARTICLES 110.26 AND 110.34.
3. PROVIDE CIRCUIT BREAKERS WITH UL LISTED INTERRUPTING RATING (RMS SYMMETRICAL AMPERES) GREATER THAN THE AVAILABLE FAULT CURRENT SHOWN IN THE SHORT CIRCUIT REPORT.
4. PROVIDE PADLOCKING PROVISIONS FOR EACH TWO AND THREE POLE CIRCUIT BREAKERS.
5. USE #12AWG OR LARGER CONDUCTORS FOR POWER WIRING.
6. USE #14AWG OR LARGER CONDUCTORS FOR CONTROL WIRING UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS.
7. LIMIT USE OF ELECTRICAL METALLIC TUBING (EMT) AND SCHEDULE 40 PVC CONDUIT TO AREAS WHERE IT WILL NOT BE SUBJECT TO PHYSICAL DAMAGE.
8. USE LIQUID TIGHT FLEXIBLE METAL CONDUIT FOR FLEXIBLE CONNECTIONS TO EQUIPMENT OUTDOORS.
9. USE INTERMEDIATE METALLIC CONDUIT (IMT) OR RIGID GALVANIZED STEEL CONDUIT (RGS) OR SCHEDULE 80 PVC CONDUIT FOR WORK EMBEDDED IN CONCRETE OR EXPOSED TO PHYSICAL DAMAGE. THESE CONDUIT TYPES MAY BE USED IN ALL APPLICATIONS WHERE SCHEDULE 40 PVC OR EMT WOULD BE APPROPRIATE, AT THE DISCRETION OF THE DESIGN ENGINEER.
10. USE THE FOLLOWING CONDUCTOR COLOR CODES.

	240/120V	208Y/120V	480Y/277V	MED VOLTAGE	ELECTRODE CABLES
PHASE A	BLACK	BLACK	BROWN	RED	RED W/ELECTRODE MARKER
PHASE B	RED	RED	ORANGE	YELLOW	YELLOW W/ELECTRODE MARKER
PHASE C		BLUE	YELLOW	BLUE	BLUE W/ELECTRODE MARKER
NEUTRAL	WHITE	WHITE	GRAY		
EQUIP, GND	GREEN/BARE	GREEN/BARE	GREEN/BARE	GREEN/BARE	

ISOLATED GROUND SHALL BE GREEN WITH YELLOW TRACER.

11. USE ONLY COPPER CONDUCTORS.
12. POWER CONDUCTORS 10AWG AND SMALLER SHALL BE SOLID . POWER CONDUCTORS 8AWG AND LARGER SHALL BE STRANDED
13. FOR NON-ELECTRODE CIRCUITS, PROVIDE TYPE THHN/THWN WIRE INSULATION. XHHW INSULATION MAY BE USED FOR 1AWG AND LARGER. TYPE W AND DLO CABLE MAY BE USED FOR CIRCUITS WHICH REQUIRE FLEXIBILITY. CONDUCTORS THAT REQUIRE FLEXIBILITY ARE PERMITTED TO BE STRANDED REGARDLESS OF CONDUCTOR SIZE. USE OF WIRE FERRULES ON UN-LUGGED FLEXIBLE CABLE IS REQUIRED. SOW CABLE IS PERMITTED FOR SKID POWER FEEDERS.
14 . ARRANGE CONNECTIONS FOR SINGLE PHASE CIRCUITS TO ACHIEVE THREE PHASE LOAD BALANCE WITHIN 10% OF THE AVERAGE PHASE LOAD CURRENT FOR SCR POWERED LOADS.
15. ARRANGE CONNECTIONS FOR SINGLE PHASE CIRCUITS TO ACHIEVE THREE PHASE LOAD BALANCE WITHIN 20% OF THE AVERAGE PHASE LOAD CURRENT FOR NON-SCR POWERED LOADS.
16. INSTALL OUTDOOR EQUIPMENT TO BE WEATHERPROOF AND TO EXCLUDE BIRDS AND RODENTS WITH A MAXIMUM ½" DIAMETER UNPROTECTED OPENINGS IN ENCLOSURES.
17. TEST CONDUCTORS FOR CONTINUITY AND FREEDOM FROM SHORTS AND UNINTENTIONAL GROUNDS.
18. ELECTRICAL MATERIALS AND CONSTRUCTION SHALL CONFORM TO TRS GROUP INC STANDARD CONSTRUCTION SPECIFICATIONS WHERE APPLICABLE.
19. IF A CONFLICT ARISES BETWEEN THE FIELD CONDITIONS AND THESE GENERAL ELECTRICAL REQUIREMENTS, STOP WORK AND CONTACT THE PROJECT ENGINEER.
20. TIE-INS TO EXISTING POWER SYSTEMS WILL BE PERFORMED BY OTHERS, WORKING UNDER THE DIRECTION OF A LOCALLY LICENSED ENGINEER OR UTILITY AUTHORITY. SEE TRS ELECTRICAL CONTRACTING SPECIFICATION FOR ADDITIONAL REQUIREMENTS IF PERFORMED BY TRS SUBCONTRACTOR.

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

ELECTRICAL ONE-LINE REQUIREMENTS

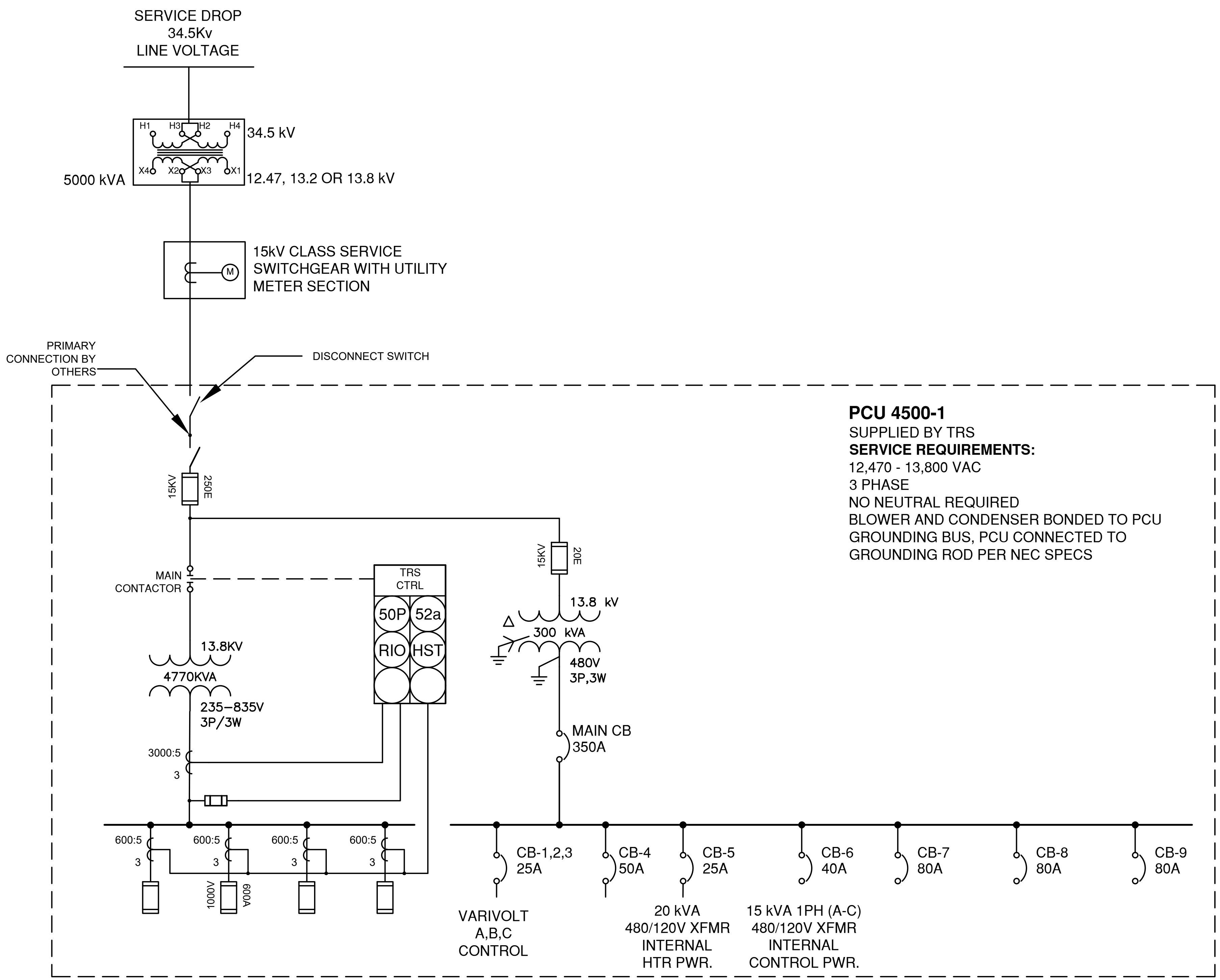
APPROVED FOR CONSTRUCTION

BY

DATE

DATE	2018.NOV.20
PROJECT	CA.MON.1803
SHEET	E-2

AS BUILTS



ELECTRICAL LOAD SUMMARY

LOAD	NUMBER		CONNECTED LOAD		LOAD FACTOR		DESIGN LOAD
		X		X		=	
		X		X		=	
		X		X		=	
		X		X		=	
		X		X		=	
		X		X		=	
		X		X		=	

TOTAL PEAK ELECTRODE LOAD =

TOTAL DESIGN LOAD =

TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY D. SEILER

DRAWN BY A. PEABODY

CHECKED BY D. OBERLE

PROJECT MANAGER L. STAUCH

QSAT REVIEW xx/xx/xx

SITE MONTROSE CHEMICAL

LOCATION CALIFORNIA

CLIENT CONFIDENTIAL CLIENT

ELECTRICAL ONE-LINE DIAGRAM

APPROVED FOR CONSTRUCTION

BY ______

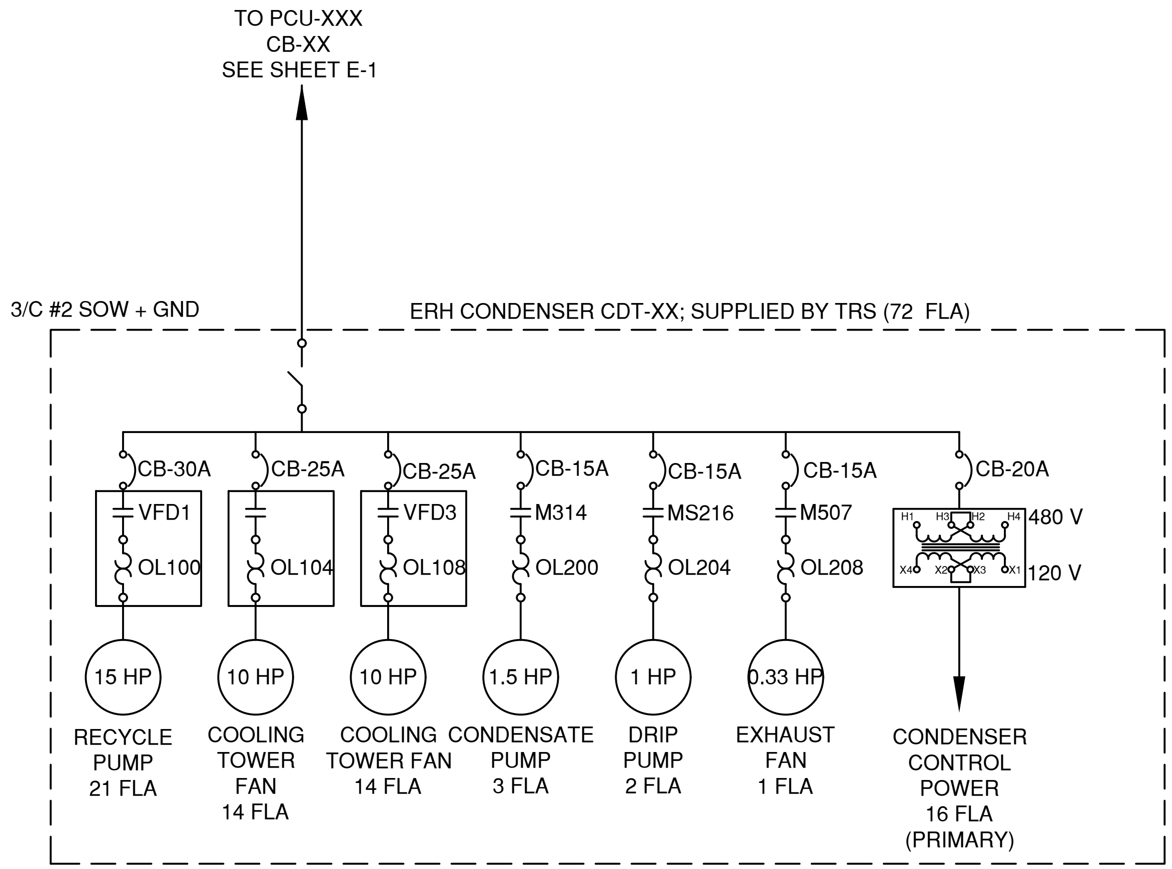
DATE ______

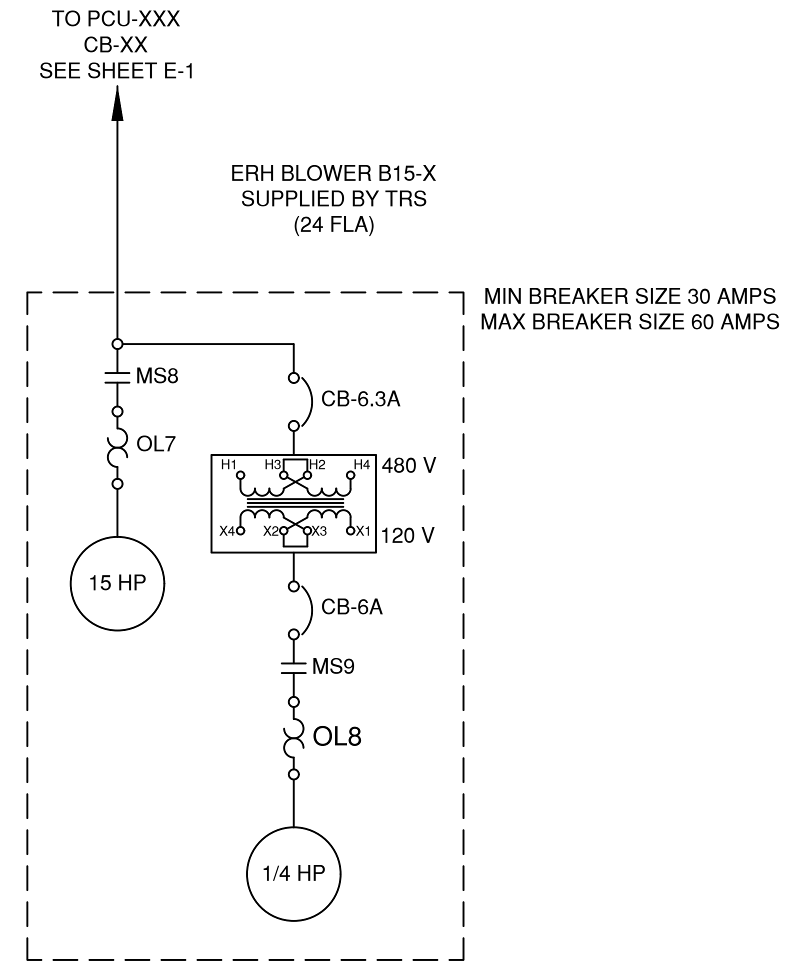
DATE 2018.DEC.07

PROJECT CA.MON.1803

SHEET E-3

AS BUILTS





TRS Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

DESIGNED BY	D. SEILER
DRAWN BY	A. PEABODY
CHECKED BY	D. OBERLE
PROJECT MANAGER	L. STAUCH
QSAT REVIEW	xx/xx/xx
SITE	MONTROSE CHEMICAL
LOCATION	CALIFORNIA
CLIENT	CONFIDENTIAL CLIENT

ELECTRICAL ONE-LINE DIAGRAM

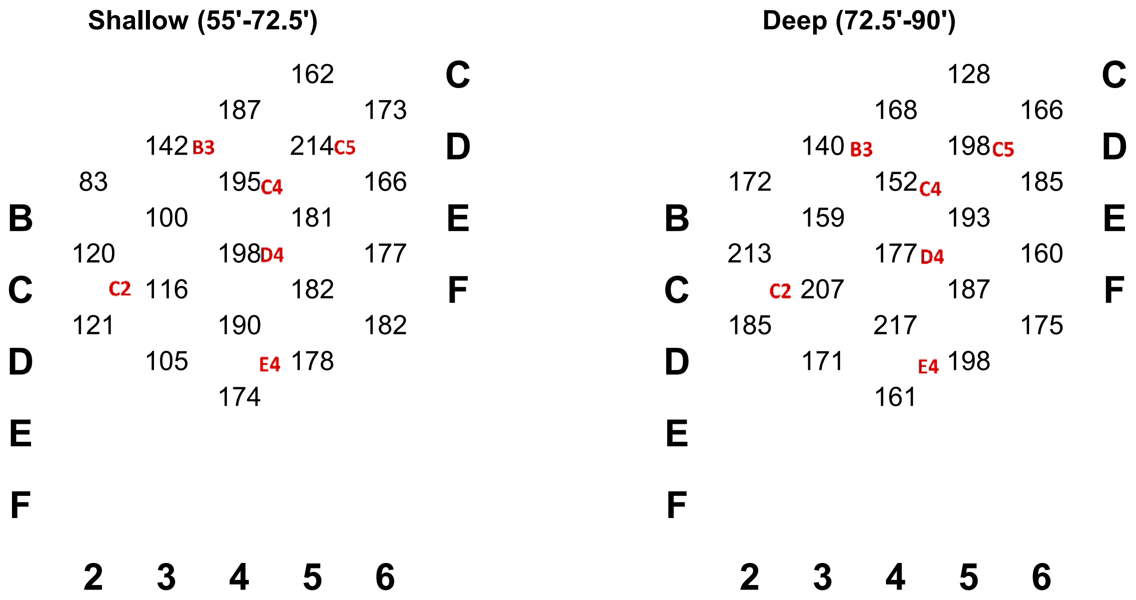
APPROVED FOR CONSTRUCTION

BY

DATE

DATE	2018.NOV.20
PROJECT	CA.MON.1803
SHEET	E-4

Figure 1 - Electrode Energy Density (kWh/yd^3)



XX Indicates TMP name and location

Energy Density data from: 4/30/19

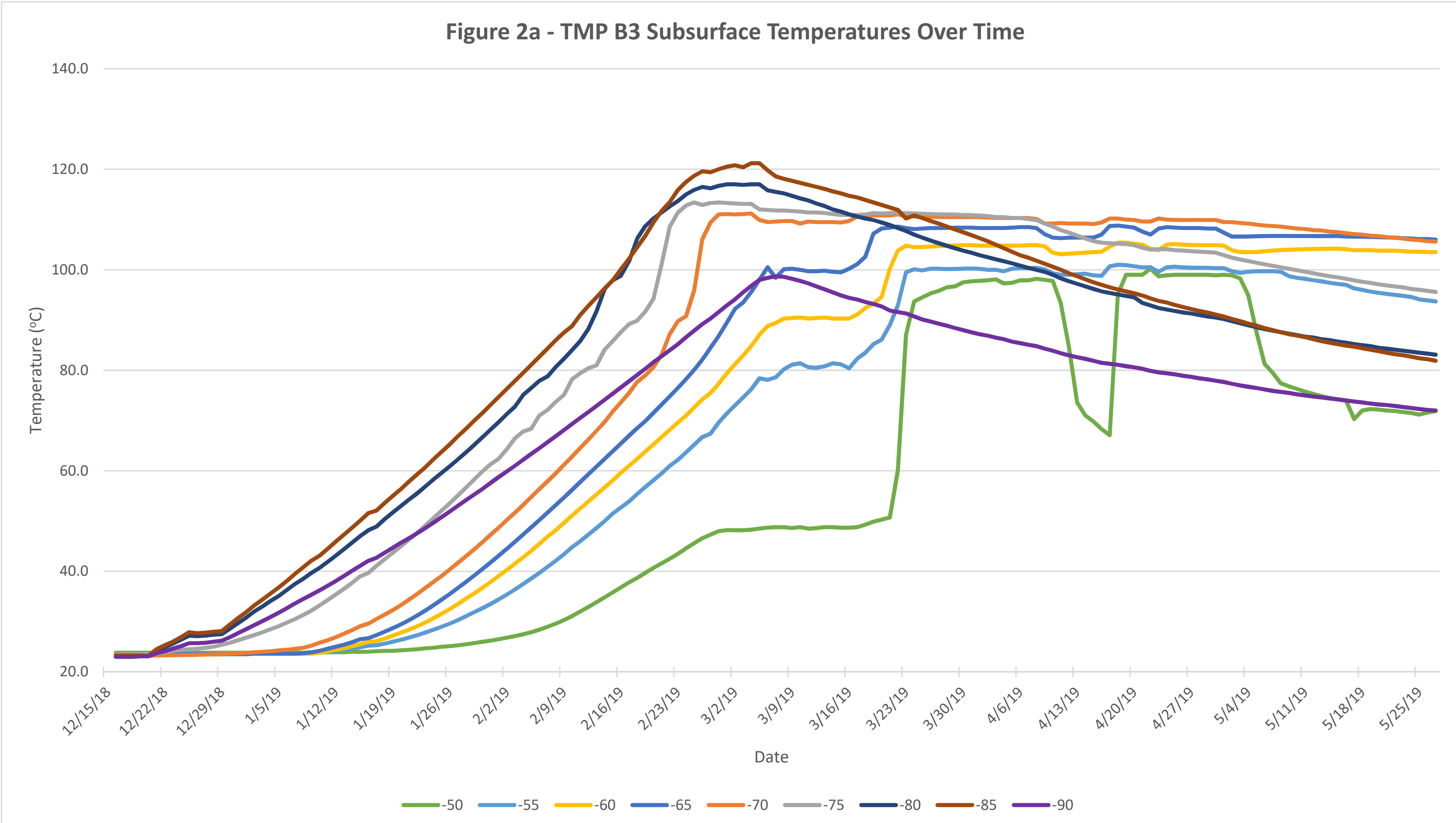


Figure 2a - TMP B3 Subsurface Temperatures Over Time
140.0
120.0
100.0
80.0
60.0
40.0
20.0
Temperature (ºC)
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
5/4/19
5/11/19
5/18/19
5/25/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90

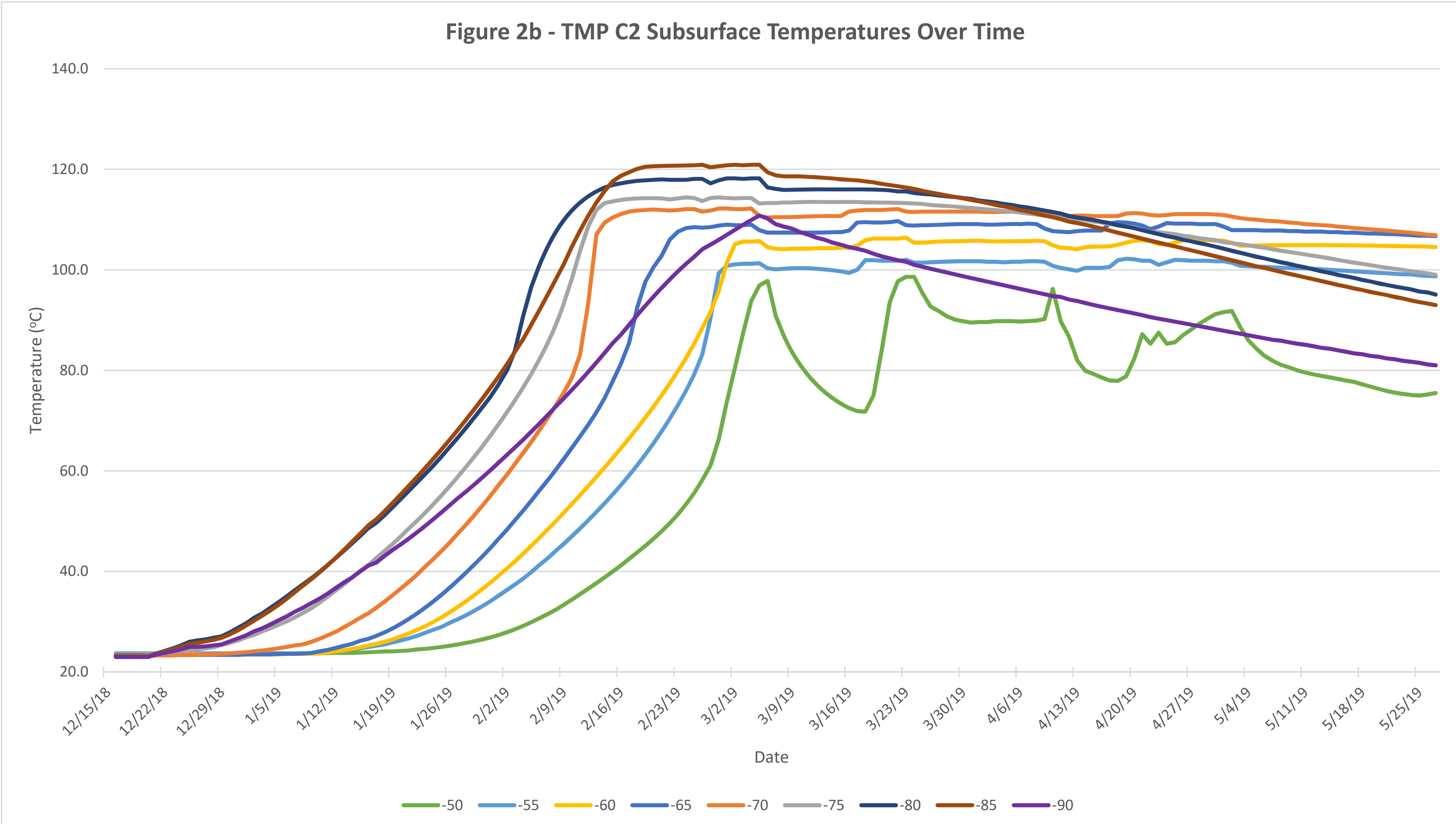


Figure 2b - TMP C2 Subsurface Temperatures Over Time
Temperature (ºC)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
5/4/19
5/11/19
5/18/19
5/25/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90

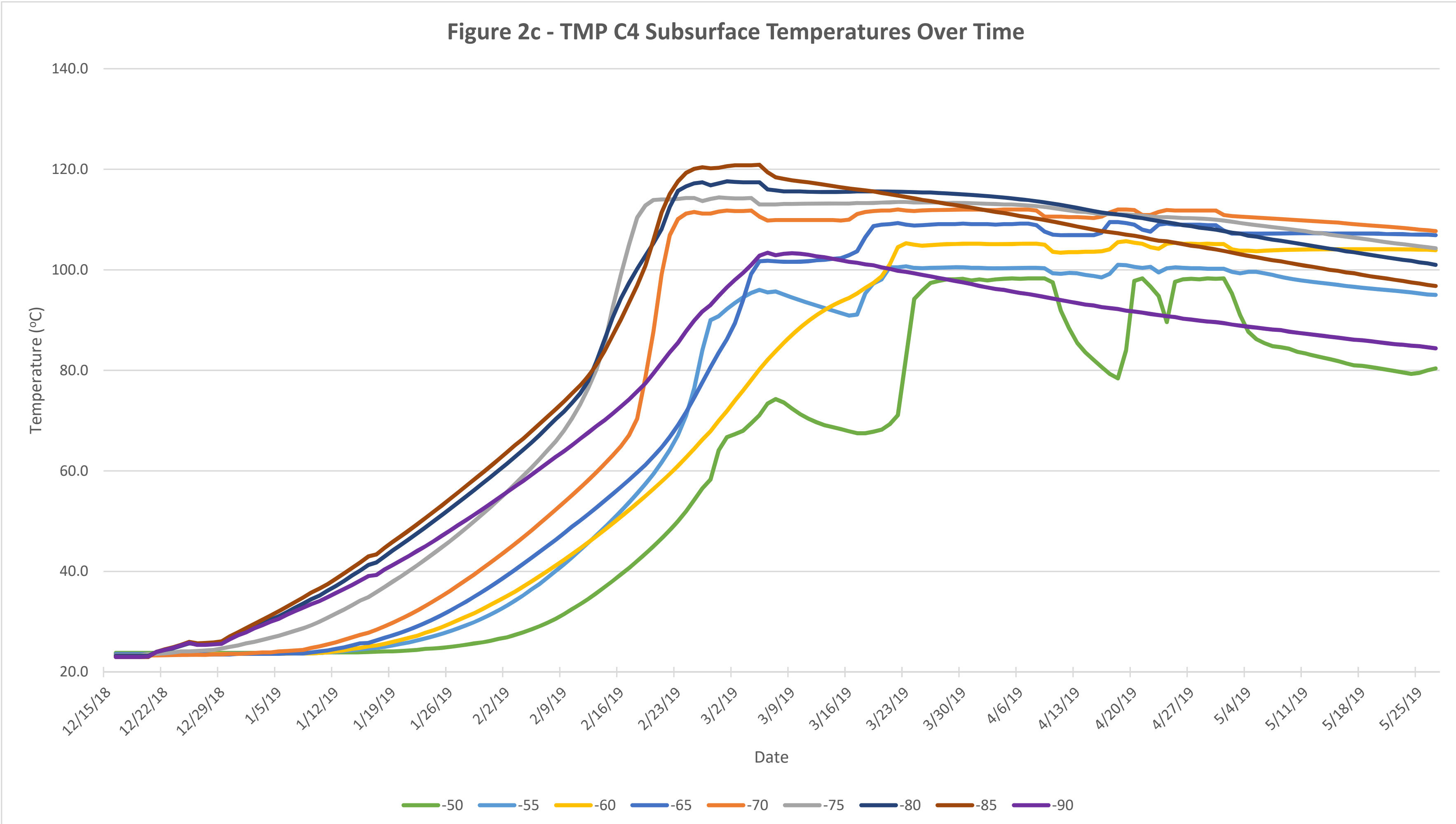


Figure 2c - TMP C4 Subsurface Temperatures Over Time
140.0
120.0
100.0
80.0
60.0
40.0
20.0
Temperature (ºC)
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
5/4/19
5/11/19
5/18/19
5/25/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90

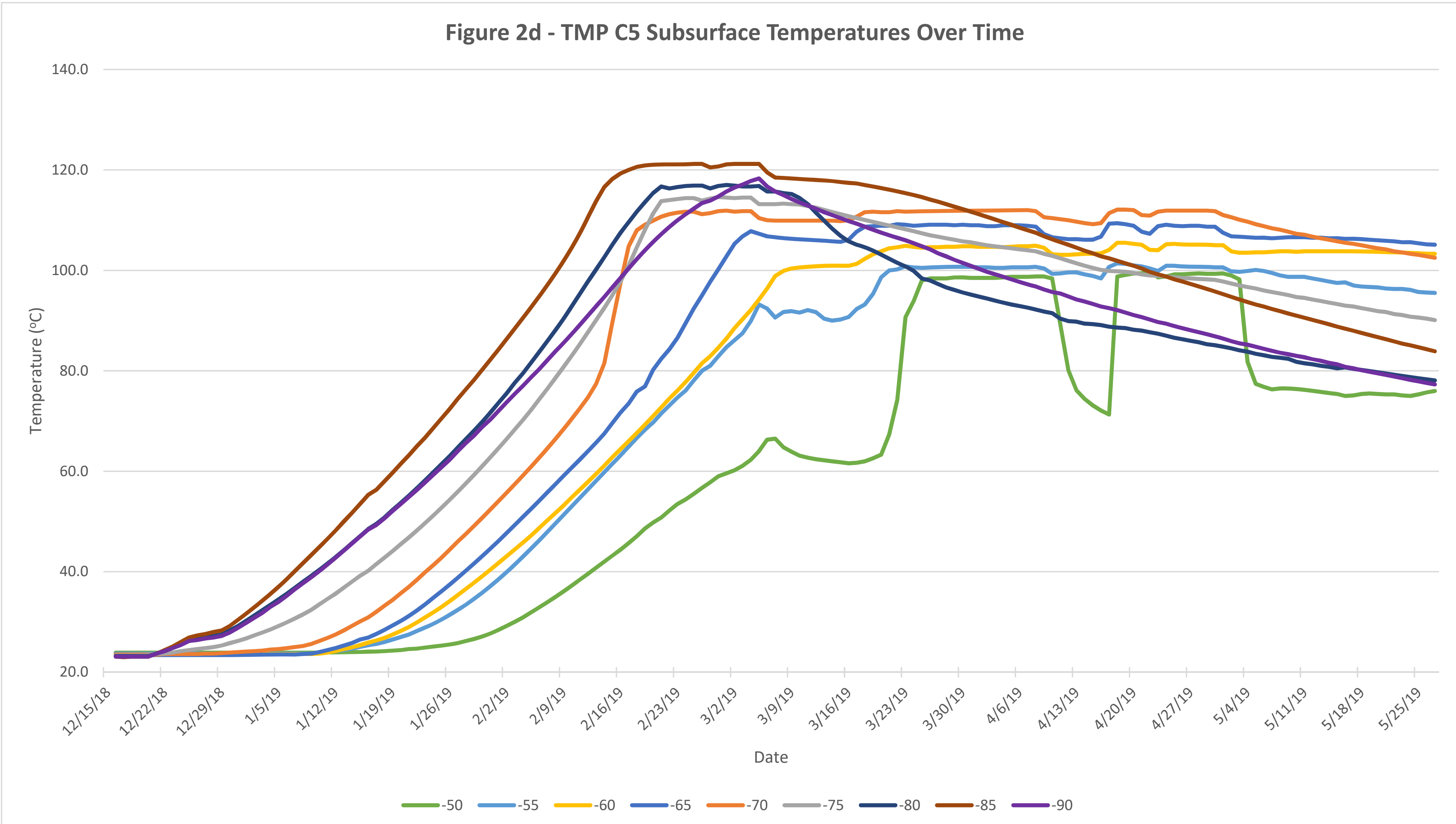


Figure 2d - TMP C5 Subsurface Temperatures Over Time
Temperature (ºC)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
5/4/19
5/11/19
5/18/19
5/25/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90

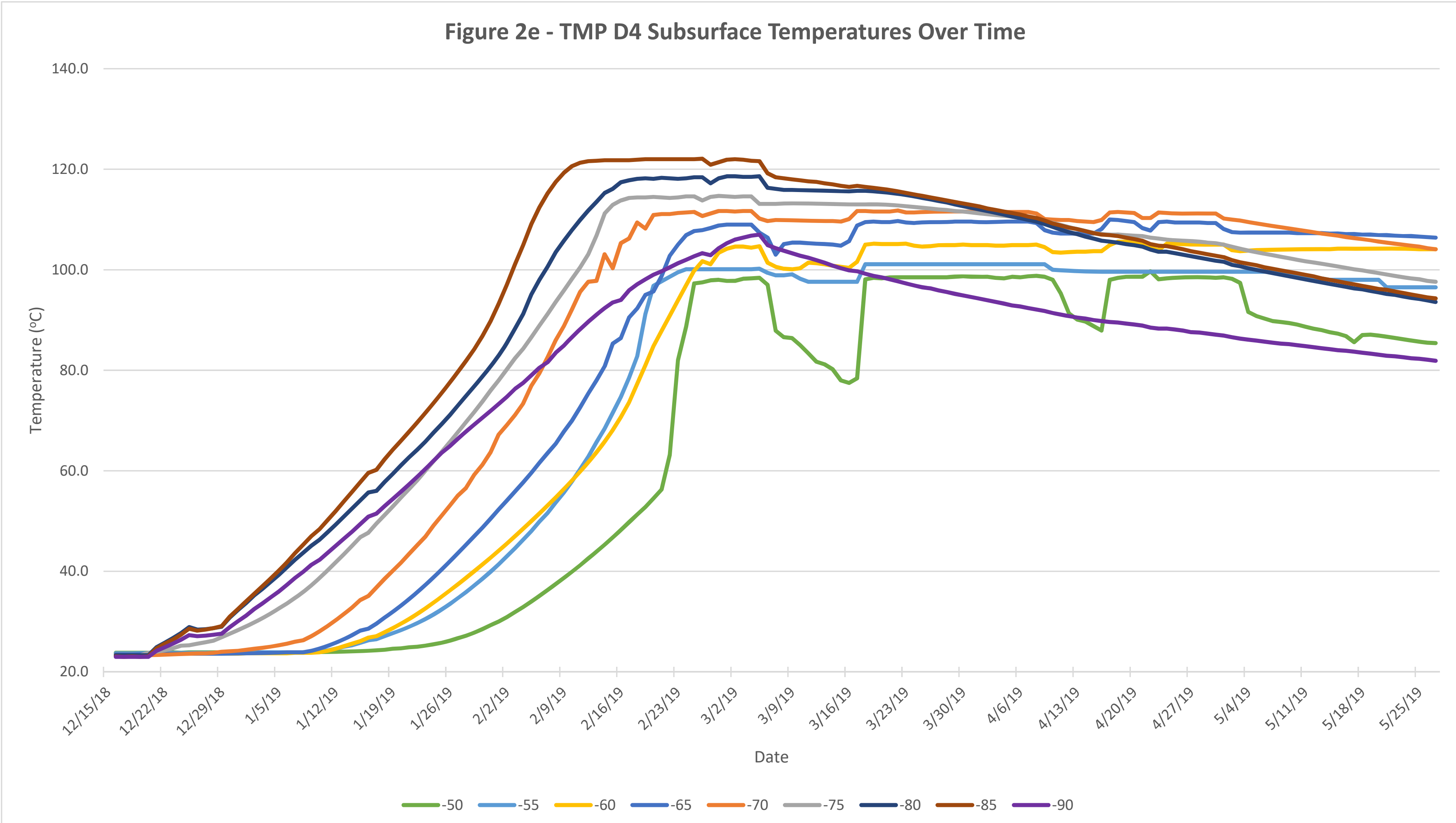


Figure 2e - TMP D4 Subsurface Temperatures Over Time
Temperature (ºC)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
5/4/19
5/11/19
5/18/19
5/25/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90

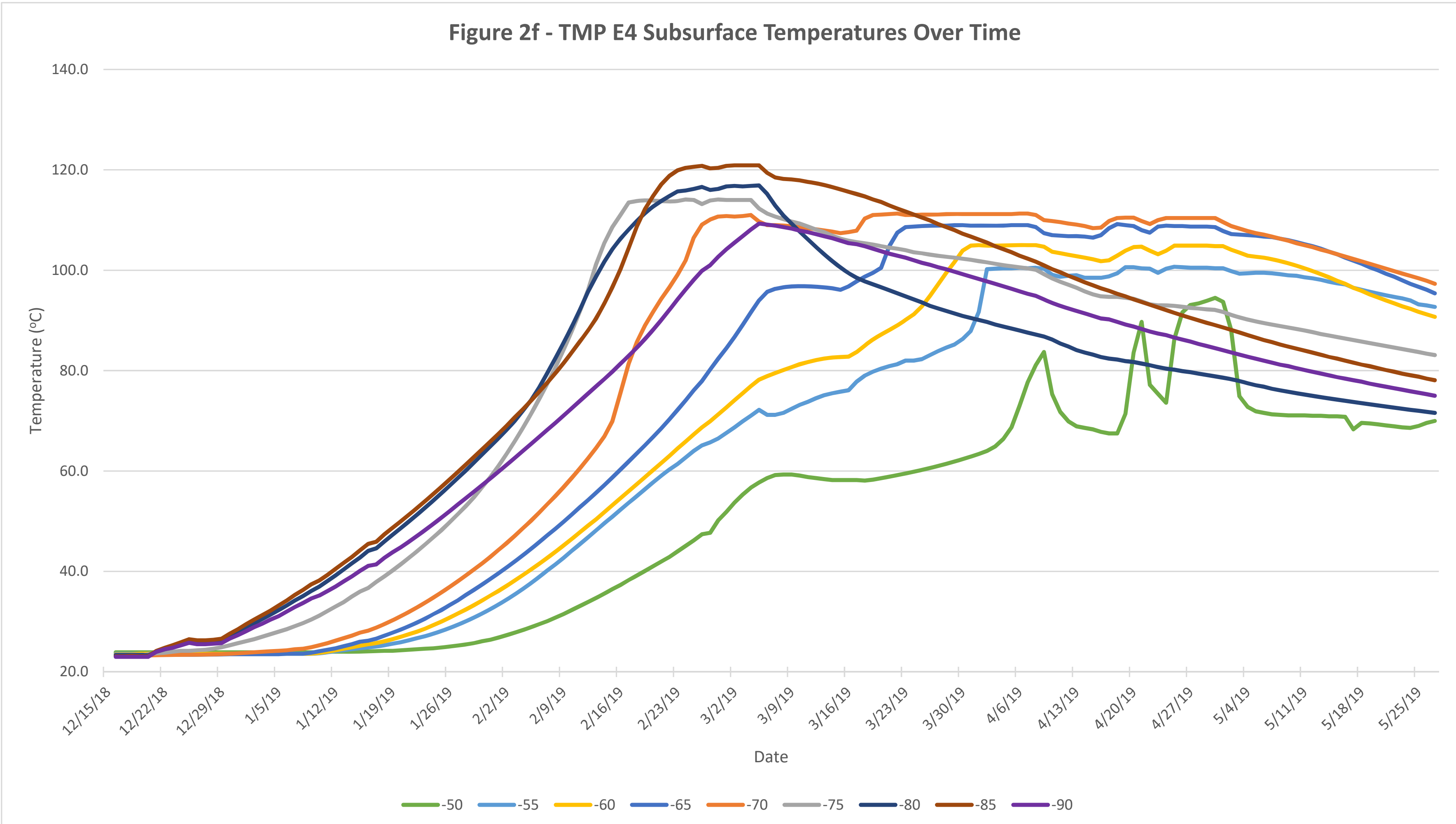


Figure 2f - TMP E4 Subsurface Temperatures Over Time
140.0
120.0
100.0
80.0
60.0
40.0
20.0
Temperature (ºC)
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
5/4/19
5/11/19
5/18/19
5/25/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90

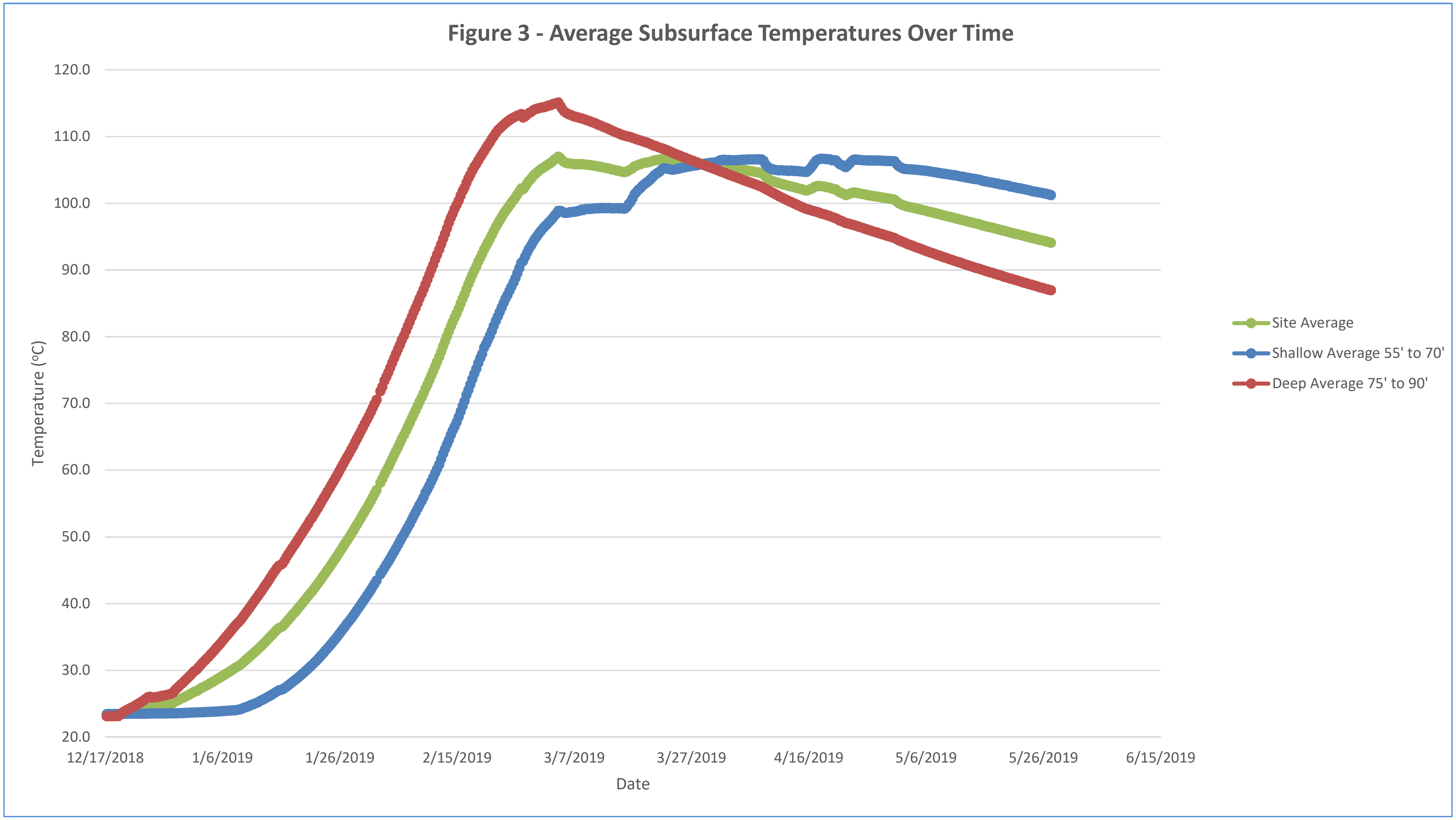
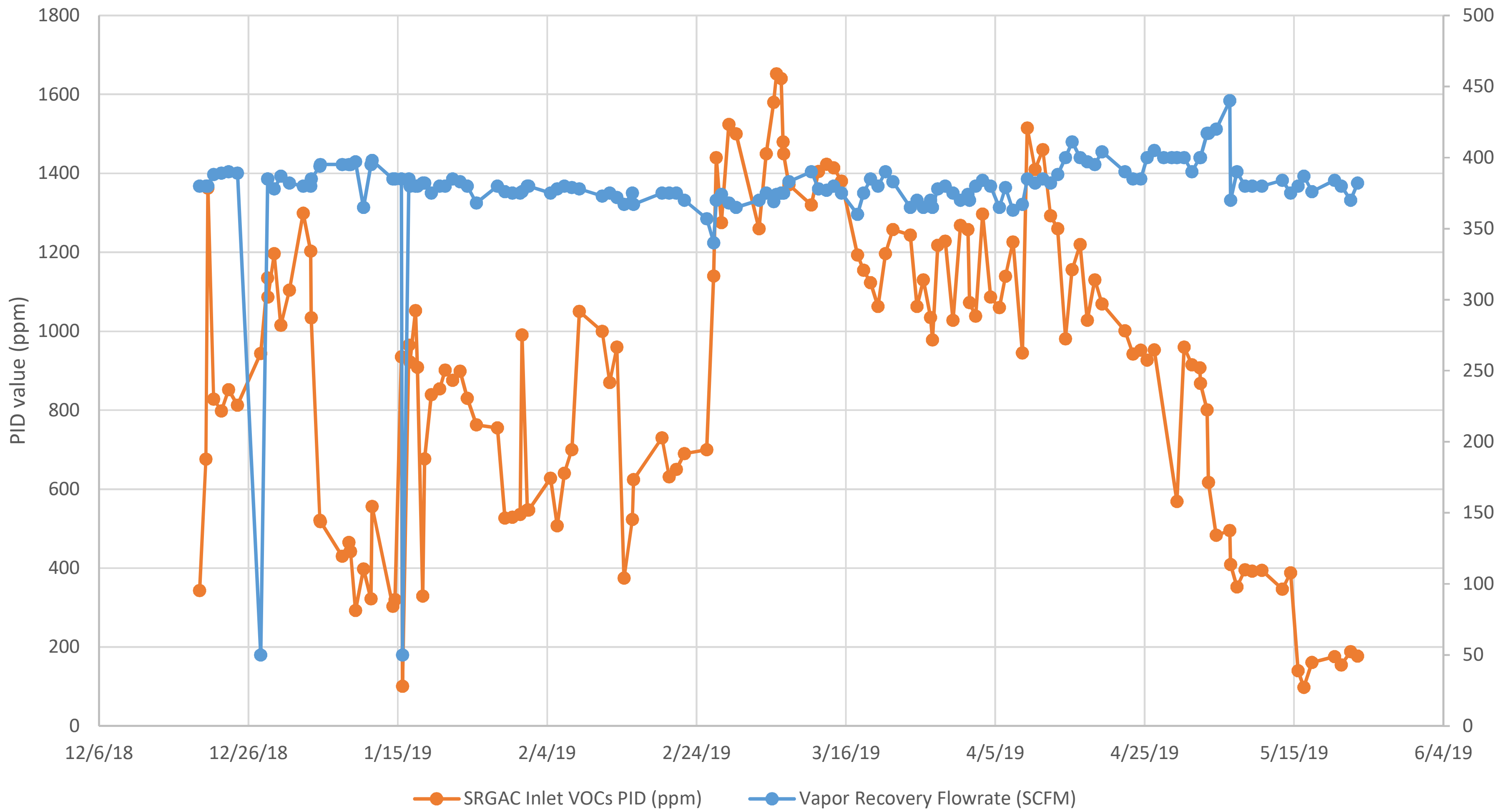


Figure 3 - Average Subsurface Temperatures Over Time
Temperature (ºC)
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
12/17/2018
1/6/2019
1/26/2019
2/15/2019
3/7/2019
3/27/2019
4/16/2019
5/6/2019
5/26/2019
6/15/2019
Date
Site Average
Shallow Average 55' to 70'
Deep Average 75' to 90'

Figure 4 - SRGAC Inlet PID Readings and Vapor Recovery Flowrate



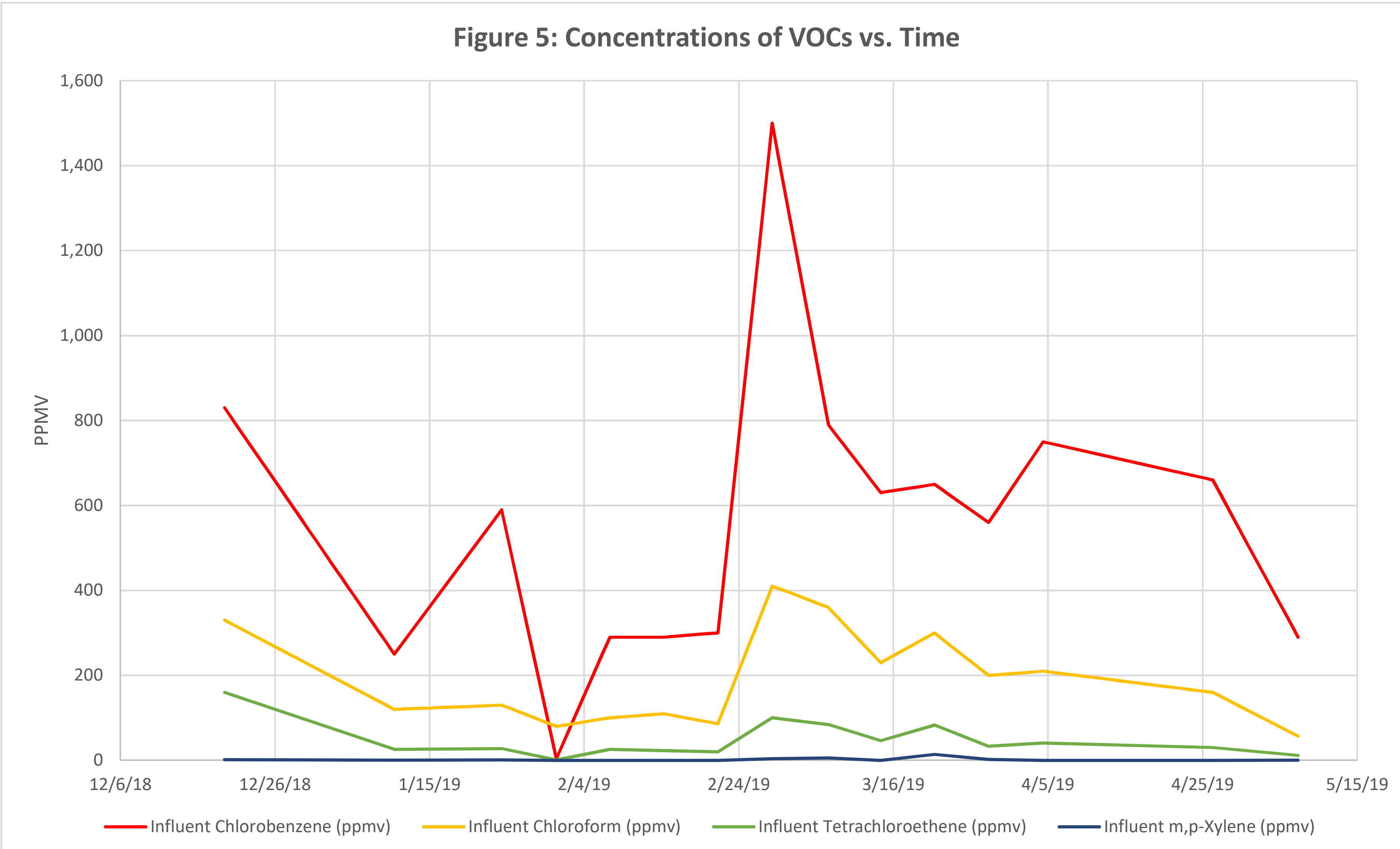


Figure 5: Concentrations of VOCs vs. Time
PPMV
1,600
1,400
1,200
1,000
800
600
400
200
0
12/6/18
12/26/18
1/15/19
2/4/19
2/24/19
3/16/19
4/5/19
4/25/19
5/15/19
Influent Chlorobenzene (ppmv)
Influent Chloroform (ppmv)
Influent Tetrachloroethene (ppmv)
Influent m,p-Xylene (ppmv)

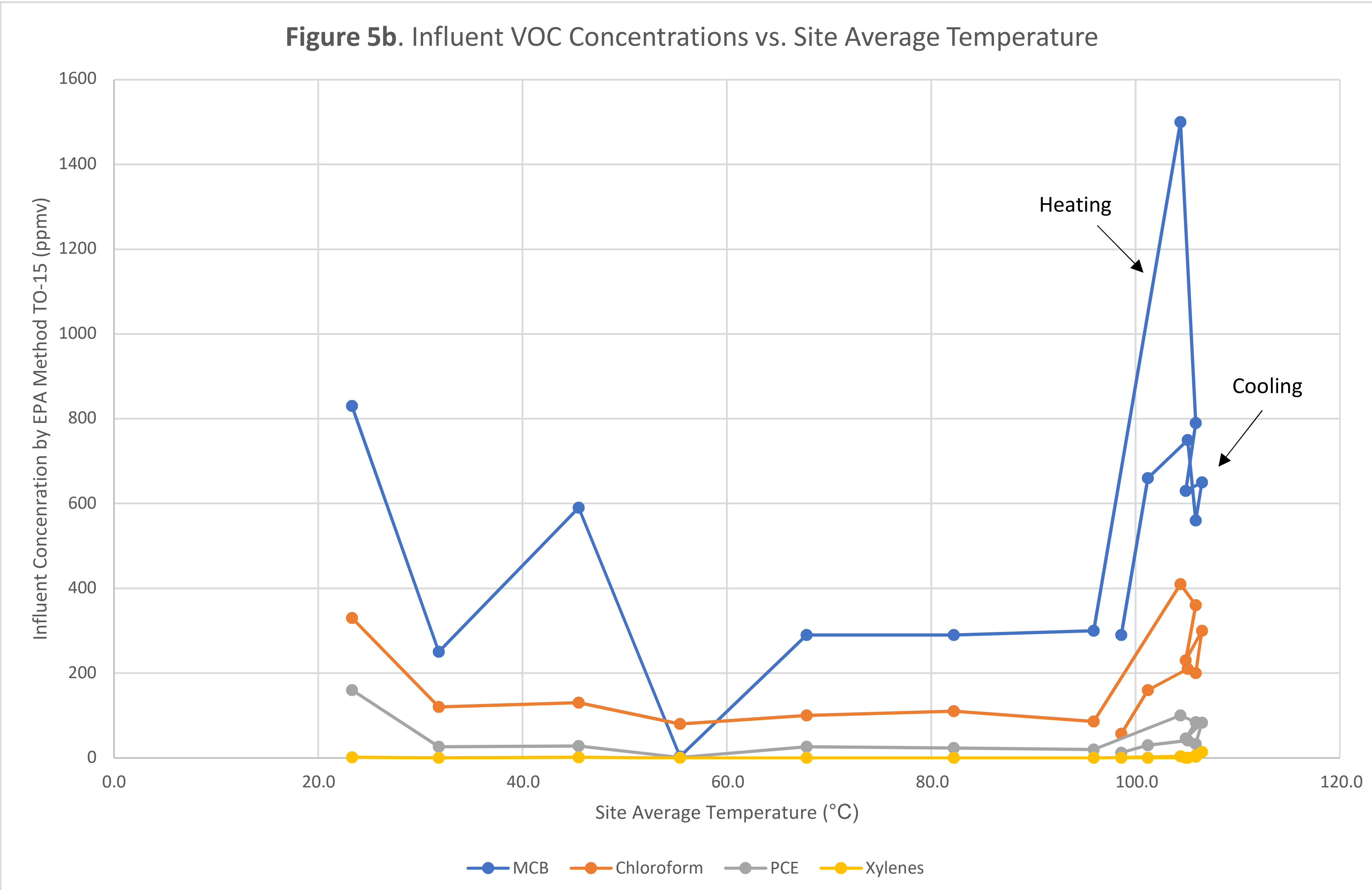


Figure 5b. Influent VOC Concentrations vs. Site Average Temperature
1600
1400
1200
1000
800
600
400
200
0
Influent Concenration by EPA Method TO-15 (ppmv)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
Site Average Temperature (°C)
Heating
Cooling
MCB
Chloroform
PCE
Xylenes

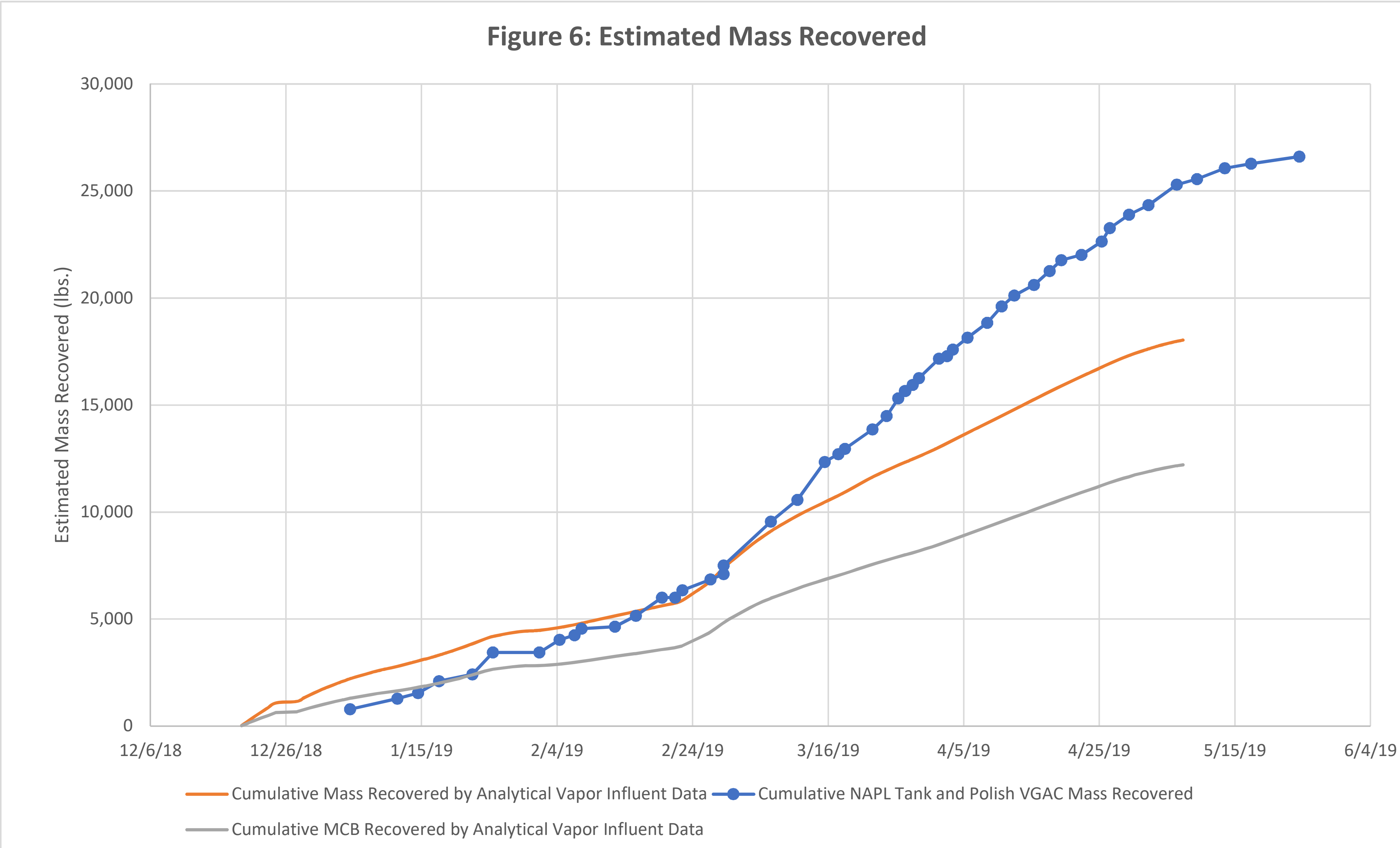
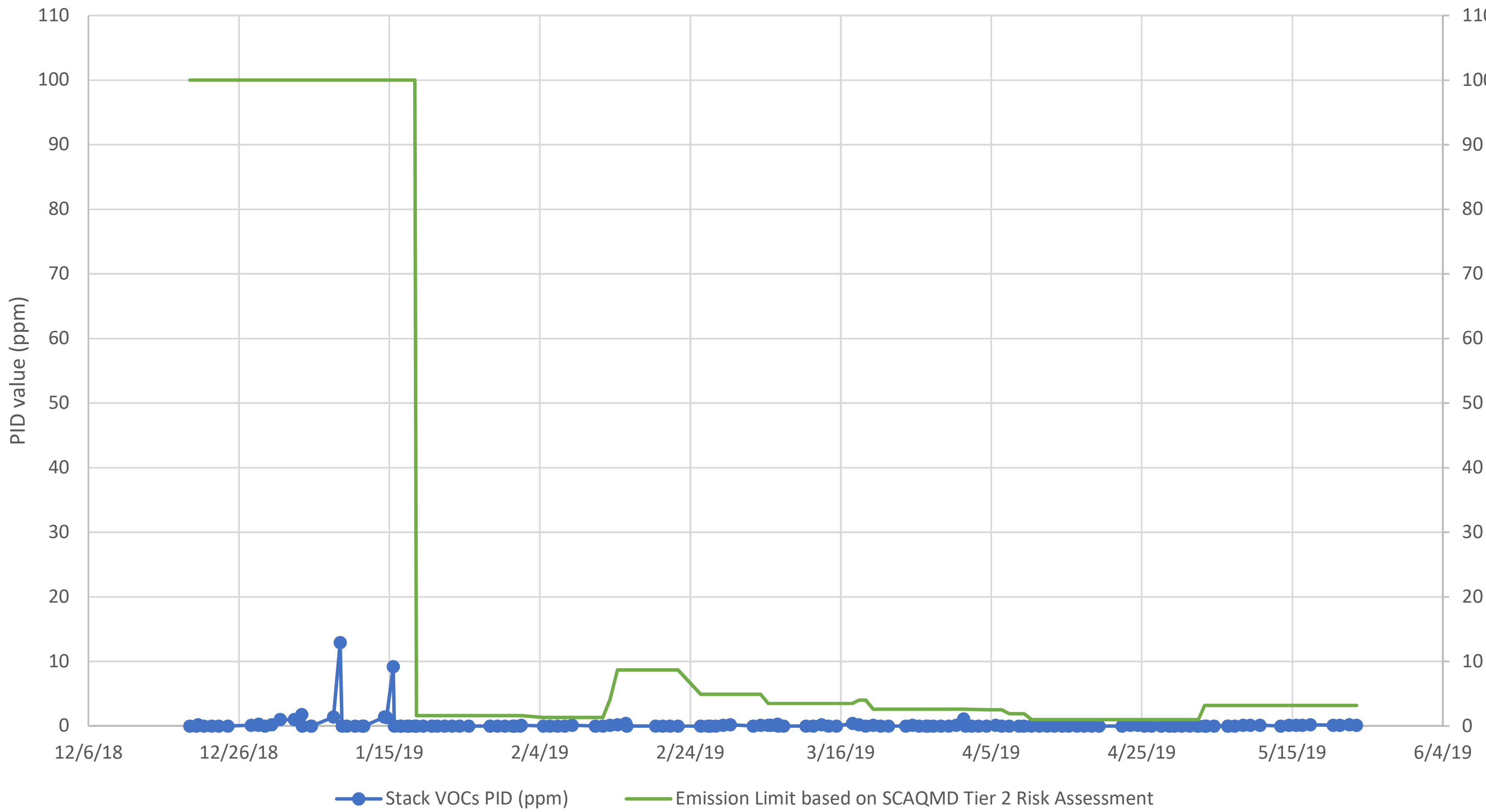


Figure 6: Estimated Mass Recovered
Estimated Mass Recovered (lbs.)
30,000
25,000
20,000
15,000
10,000
5,000
0
12/6/18
12/26/18
1/15/19
2/4/19
2/24/19
3/16/19
4/5/19
4/25/19
5/15/19
6/4/19
Cumulative Mass Recovered by Analytical Vapor Influent Data
Cumulative NAPL Tank and Polish VGAC Mass Recovered
Cumulative MCB Recovered by Analytical Vapor Influent Data

Figure 7 - Stack PID readings



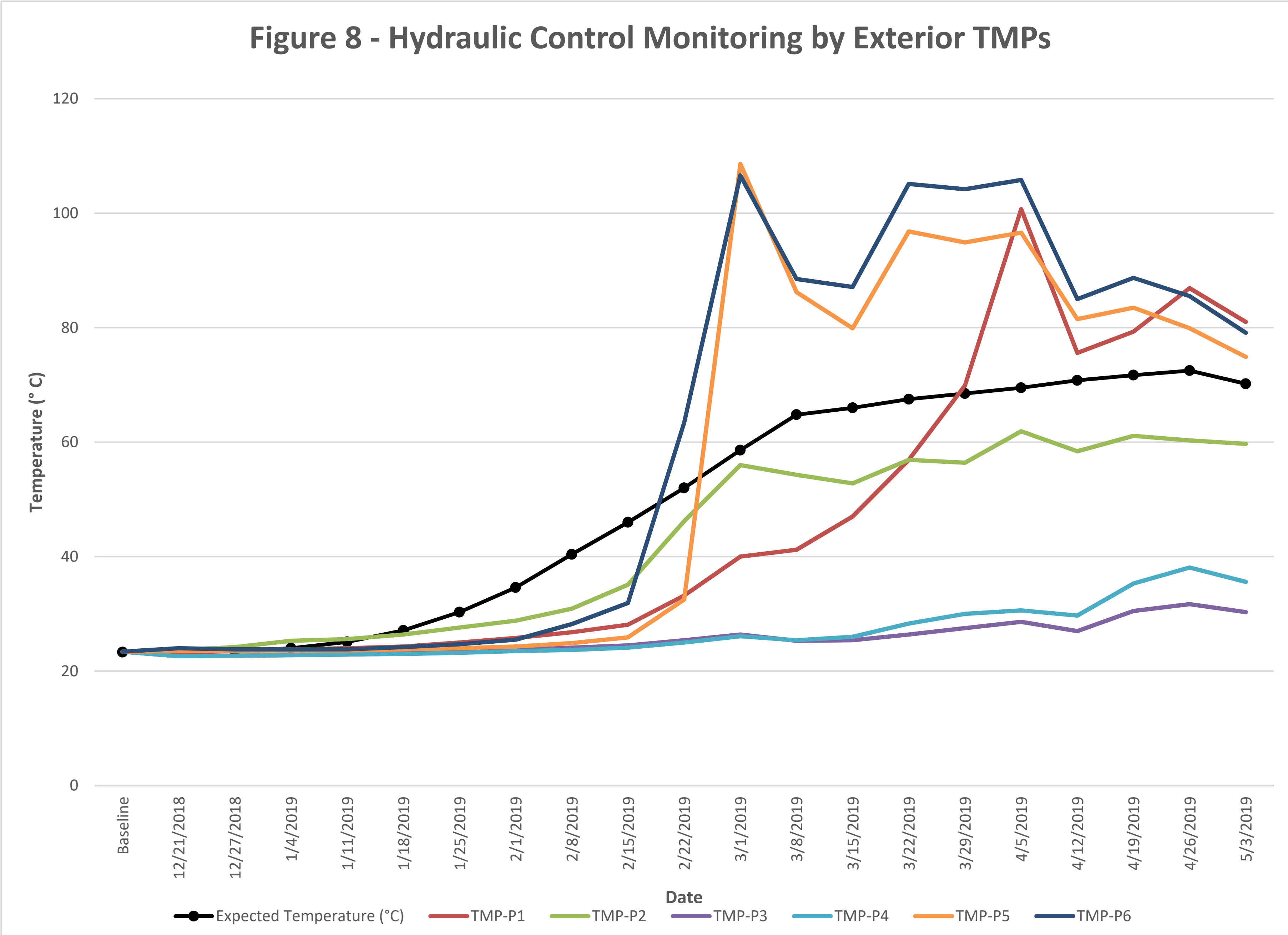


Figure 8 - Hydraulic Control Monitoring by Exterior TMPs
Temperature (° C)
120
100
80
60
40
20
0
Baseline
12/21/2018
12/27/2018
1/4/2019
1/11/2019
1/18/2019
1/25/2019
2/1/2019
2/8/2019
2/15/2019
2/22/2019
3/1/2019
3/8/2019
3/15/2019
3/22/2019
3/29/2019
4/5/2019
4/12/2019
4/19/2019
4/26/2019
5/3/2019
Date
Expected Temperature (°C)
TMP-P1
TMP-P2
TMP-P3
TMP-P4
TMP-P5
TMP-P6

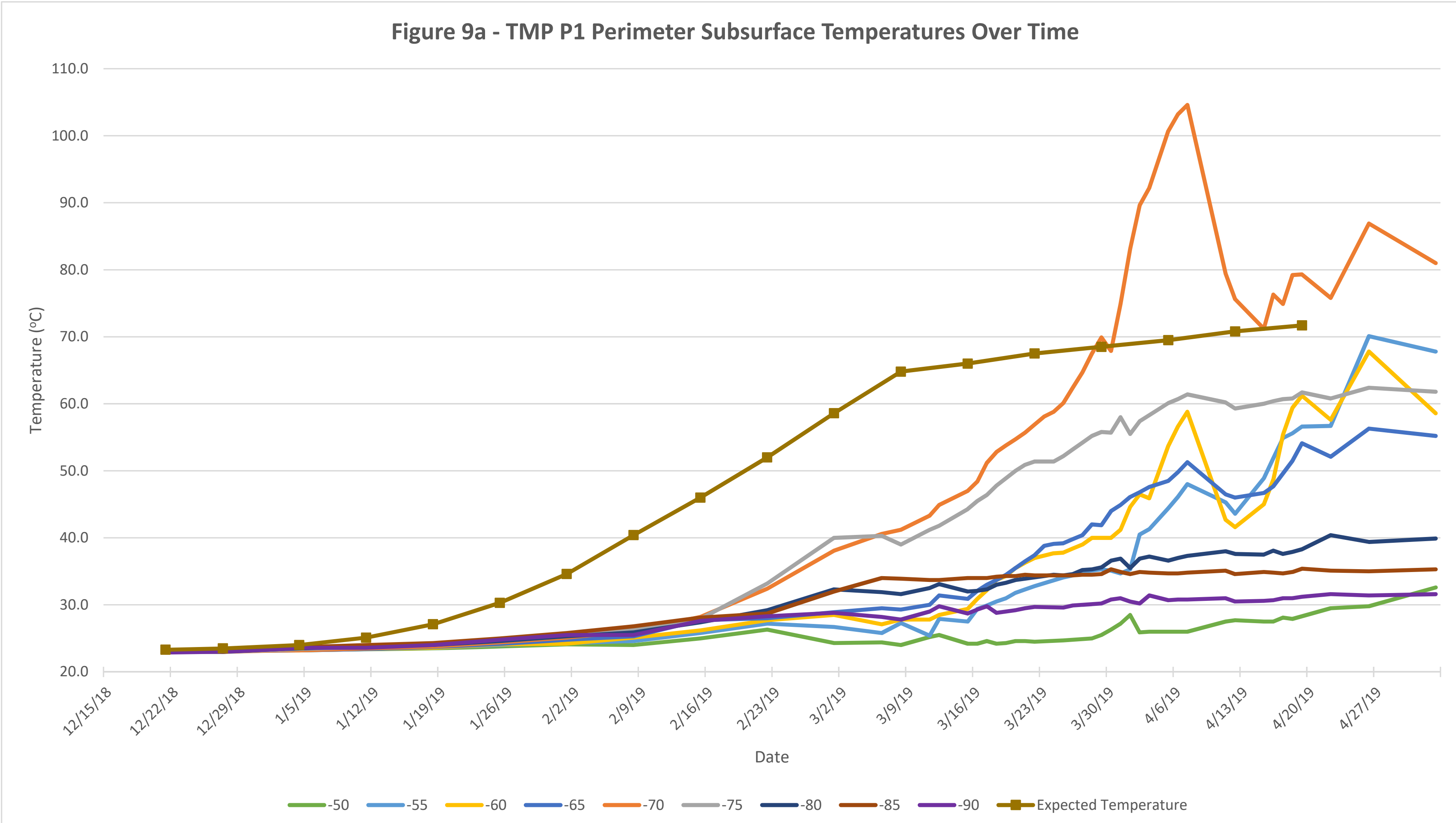


Figure 9a - TMP P1 Perimeter Subsurface Temperatures Over Time
Temperature (ºC)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90
Expected Temperature

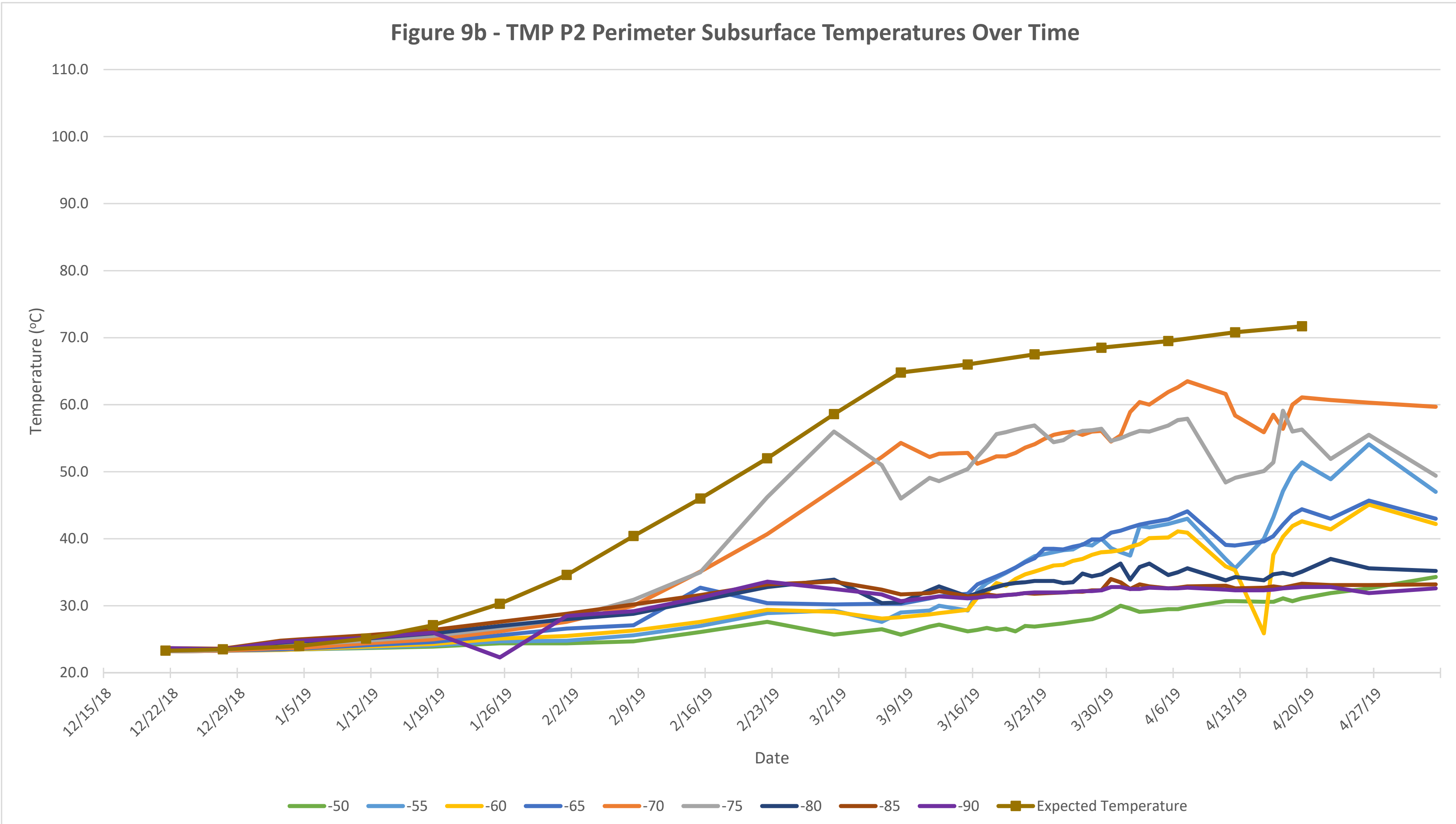


Figure 9b - TMP P2 Perimeter Subsurface Temperatures Over Time
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
Temperature (ºC)
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90
Expected Temperature

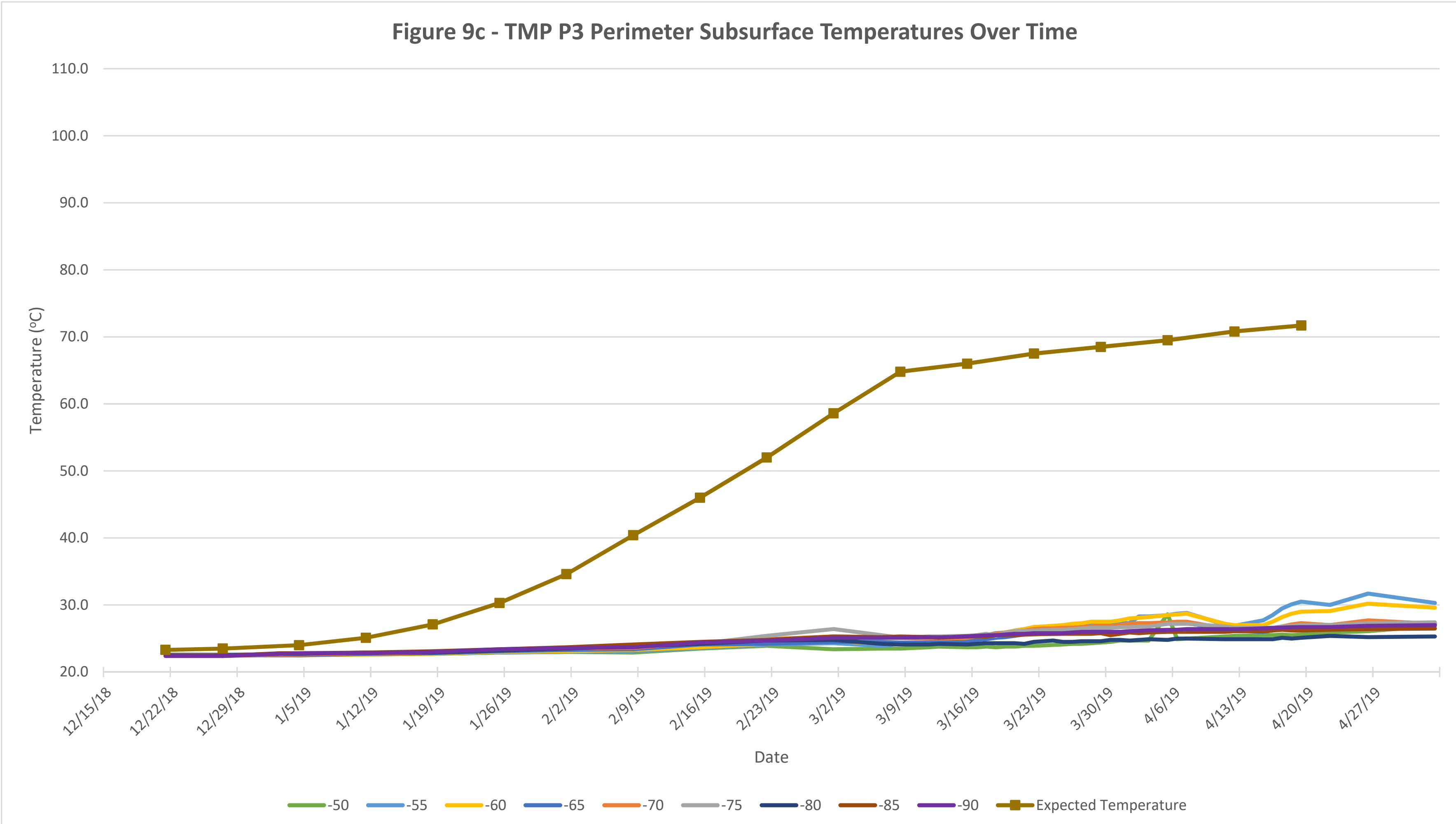


Figure 9c - TMP P3 Perimeter Subsurface Temperatures Over Time
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
Temperature (ºC)
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90
Expected Temperature

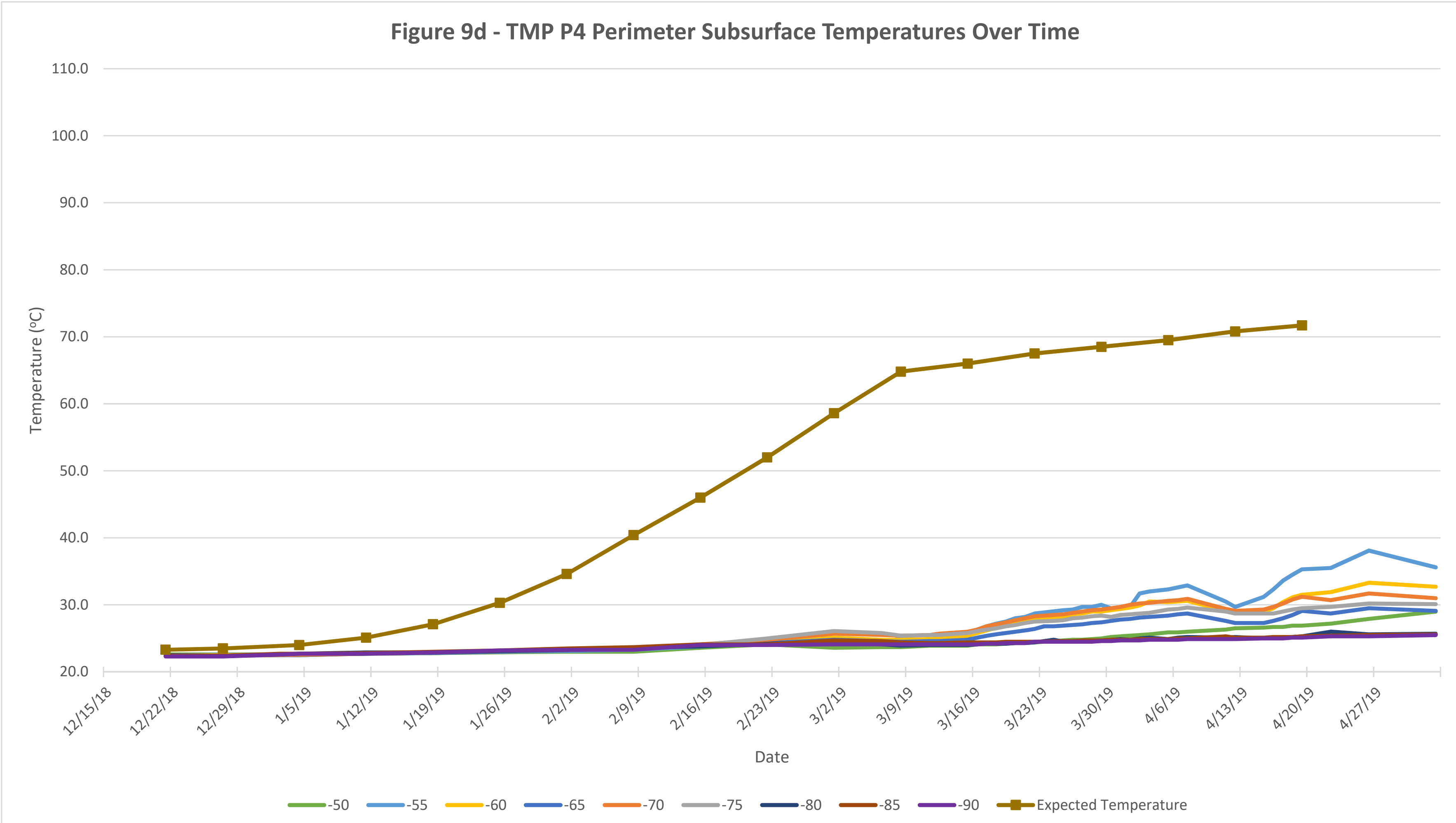


Figure 9d - TMP P4 Perimeter Subsurface Temperatures Over Time
Temperature (ºC)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90
Expected Temperature

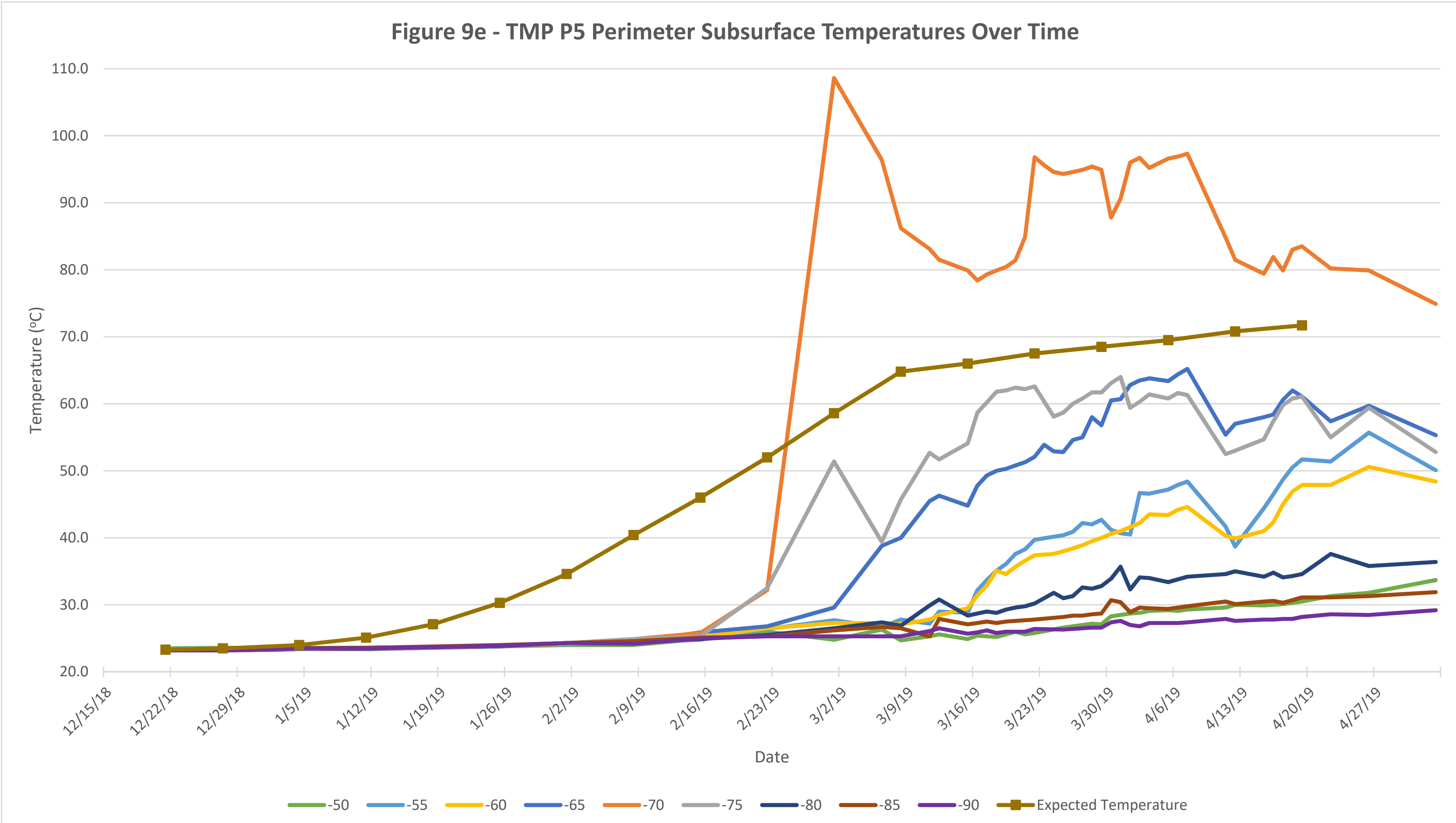


Figure 9e - TMP P5 Perimeter Subsurface Temperatures Over Time
Temperature (ºC)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90
Expected Temperature

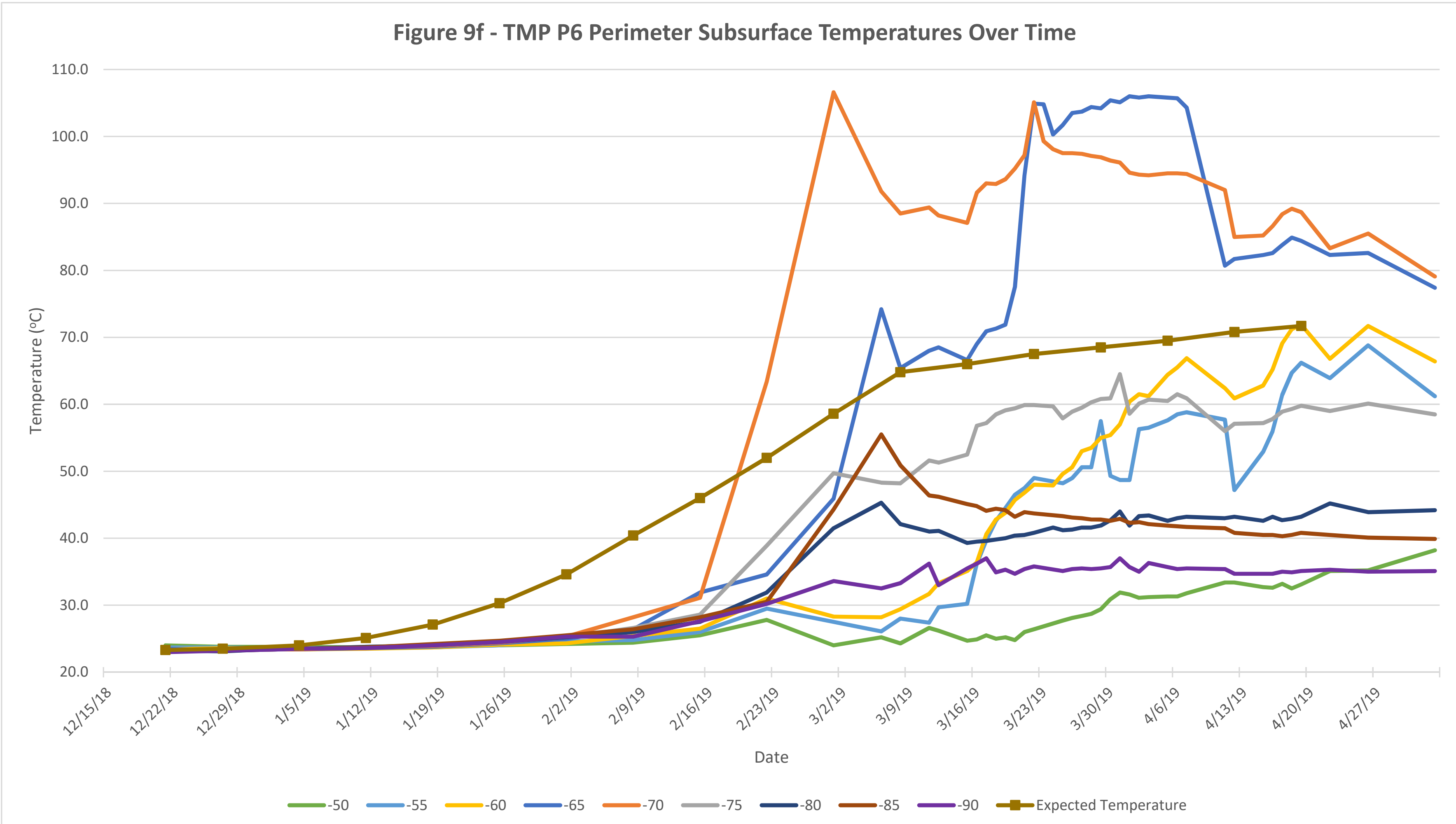


Figure 9f - TMP P6 Perimeter Subsurface Temperatures Over Time
Temperature (ºC)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
12/15/18
12/22/18
12/29/18
1/5/19
1/12/19
1/19/19
1/26/19
2/2/19
2/9/19
2/16/19
2/23/19
3/2/19
3/9/19
3/16/19
3/23/19
3/30/19
4/6/19
4/13/19
4/20/19
4/27/19
Date
-50
-55
-60
-65
-70
-75
-80
-85
-90
Expected Temperature

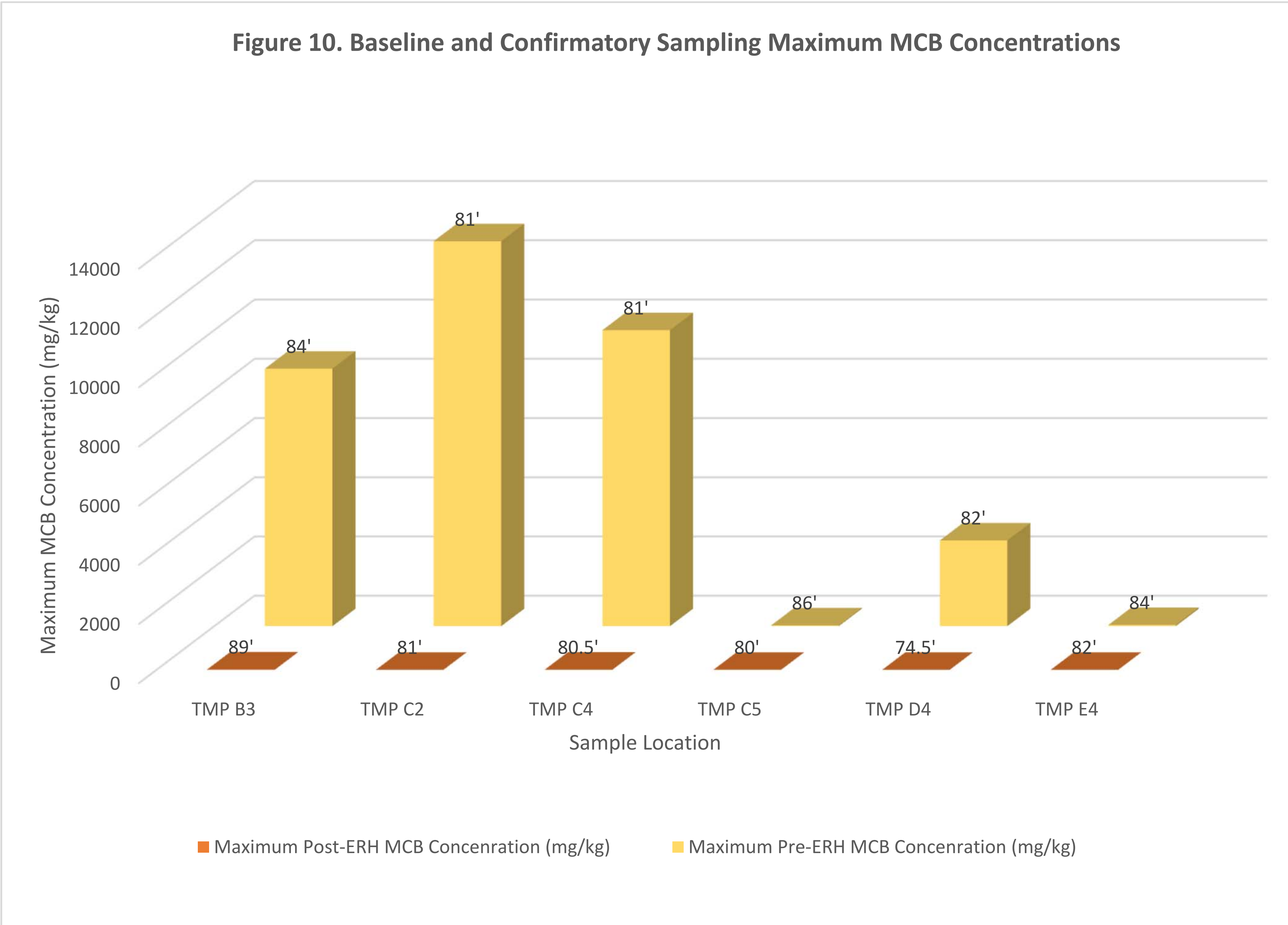


Figure 10. Baseline and Confirmatory Sampling Maximum MCB Concentrations
Maximum MCB Concentration (mg/kg)
0
2000
4000
6000
8000
10000
12000
14000
84'
81'
81'
86'
82'
84'
89'
81'
80.5'
80'
74.5'
82'
TMP B3
TMP C2
TMP C4
TMP C5
TMP D4
TMP E4
Sample Location
Maximum Post-ERH MCB Concenration (mg/kg)
Maximum Pre-ERH MCB Concenration (mg/kg)