OPERATION AND MAINTENANCE MANUAL

Waukegan Harbor Groundwater Treatment System, Remedial Construction Activities, Waukegan, Illinois

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ch2m

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Acronyms and Abbreviations

Arrowhead	Arrowhead Contracting, Inc.
CF	consolidation facility
CH2M	CH2M HILL, Inc.
DAT	Diffused Aeration Tank
EPA	U.S. Environmental Protection Agency
GAC	granular activated carbon
gpm	gallons per minute
HDPE	high-density polyethylene
HELP	hydrologic evaluation of landfill performance
HMI	human machine interface
HOA	Hand-Off-Automatic
hp	horsepower
IEPA	Illinois Environmental Protection Agency
mADC	milliamps direct current
NSWRD	North Shore Waste Reclamation District
NPT	national pipe thread
O&M	operations and maintenance
ODC	Old Die Cast
OIT	Operator Interface Terminal
OOR	On-Off-Remote
OU	operable unit
PCB	polychlorinated biphenyl
PLC	programmable logic controller
PPE	personal protective equipment
psi	pounds per square inch
PVC	polyvinyl chloride
RA	remedial action
TDH	total dynamic head
UPS	uninterruptible power supply
VAC	volts alternating current
VOC	volatile organic compound
WA	Work Assignment
WTS	water treatment system

SECTION 1

Introduction

CH2M HILL, Inc. (CH2M) was tasked by the U.S. Environmental Protection Agency (EPA) to complete the remedial action (RA) at the Outboard Marine Corporation (OMC) Waukegan Harbor Site under Work Assignment (WA) No. 137-RARA-0528 with continued operation of the plant under WA No. 228-RARA-0528. This document constitutes the Operations and Maintenance (O&M) Manual for the water treatment system (WTS) at the former OMC Plant located in Waukegan, Illinois. CH2M and Arrowhead Contracting, Inc. (Arrowhead) prepared this document for EPA. The O&M manual is organized as follows:

- Introduction, including background and summary of design
- Construction Activities
- Infiltration Wetland
- O&M Activities
- Record drawings depicting the as-builts
- System Startup and Calibration summary
- WTS
- Consolidation facility (CF) facility sump pump
- Diffused Aeration Tank (DAT), Static Mixer, and Metering Pump O&M
- Old Die Cast (ODC) O&M
- Infiltration Treatment Wetland

1.1 Site Description and Background

Waukegan Harbor is located on the western shore of Lake Michigan, about 40 miles north of Chicago, Illinois, in the City of Waukegan, Illinois. Waukegan Harbor is part of the OMC Superfund site that includes four operable units (OUs): the Waukegan Harbor site (OU1), the Waukegan Manufactured Gas and Coke Plant site (OU2) on the eastern edge of the harbor, the polychlorinated biphenyl (PCB) containment cells (OU3) on the northern portion of the OMC Plant 2 and in former Slip 3, in which thermally treated, PCB-impacted sediment and untreated PCB-contaminated soil are managed, and the OMC Plant 2 site (OU4) north of the harbor. OMC Plant 2 is the source of the PCB contamination in Waukegan Harbor sediments. Figure 1-1 shows the general site layout.

Consistent with the Record of Decision Amendment issued by EPA in October 2009, dredging, dewatering the dredged sediment, and treatment of the water prior to its discharge back into the harbor was completed in 2014. The PCB-contaminated sediments were hydraulically dredged and conveyed to geotextile tubes located in the CF, constructed on the northern portion of the OMC Plant 2 property. After dredging was completed in 2014, the processing system was decommissioned and the geotextile tubes within the CF were isolated from the environment using a clay/soil cover. The CF was connected to a new 50-gallon-per-minute (gpm) WTS constructed to handle the combined flow from the existing West PCB Containment Cell, the infiltration through the CF cover, and the groundwater extracted from the newly constructed cell that was built to contain PCB-contaminated soils beneath the western portion of the OMC Plant 2 building, referred to hereinafter as the ODC PCB Containment Cell.

Additional RA activities were implemented by SulTRAC in 2014 to address high levels of PCB-contaminated subsurface soils beneath the western portion of the former Plant 2 building that was the ODC area and in the utility corridors along the western and northern property boundaries. The construction activities included installation of a soil-bentonite slurry wall to provide containment of the PCB-contaminated subsurface soil in the ODC area and paving the utility corridors.

1.2 Summary of Design

The WTS was designed to remove total suspended solids, PCBs, and volatile organic compounds (VOCs) from the three influent streams (CF, ODC PCB Containment Cell, and West PCB Containment Cell) before it is discharged to a constructed infiltration wetland. The WTS design drawings, specifications, construction, and O&M components were presented in the Scope of Work document dated February 2014 (CH2M 2014a). The WTS is designed to operate at an average flow rate of 15 to 20 gpm and at a maximum flow rate of 50 gpm. The main objectives of the treatment system are to:

- Lower the water table to the extent practicable to maintain inward gradients within the West PCB Containment Cell and ODC PCB Containment Cell, and minimize the water level within the CF.
- Treat PCB and VOCs in the influent streams (CF, West PCB Containment Cell, and ODC) and discharge the treated water that meets the discharge criteria agreed upon by the Illinois Environmental Protection Agency (IEPA) and EPA.
- Reduce ammonia concentrations in the infiltration wetland via natural nitrification processes before it infiltrates to the underlying groundwater.

1.2.1 Summary of the Water Treatment System Influents

The WTS is designed to treat the following influent streams: West PCB Containment Cell, ODC PCB Containment Cell, and CF. Table 1-1 (located at the end of Section 1) summarizes the anticipated influent concentrations from each source.

1.2.1.1 West PCB Containment Cell

The water is extracted from the West PCB Containment Cell from April to November to maintain an inward hydraulic gradient and reduce the potential for contaminated groundwater to migrate out of the cell. The water extracted by two wells is pumped to the new WTS, through existing influent pipe from the two extraction wells. Based on the historical operating data provided by the current operator, the anticipated influent flow is up to 10 gpm per extraction well.

1.2.1.2 ODC PCB Containment Cell

The new containment cell constructed in the ODC area by SulTRAC includes a dewatering and conveyance system to maintain an inward hydraulic gradient to minimize the migration of contaminated groundwater and consists of two extraction wells, the associated extraction well pumps, control and power wires, and conduit.

Per the ODC PCB Containment Cell design documents (Appendix A), the extraction well pumps and pipelines are capable of flow rates up to 22 gpm, if required. However, based on initial operations, the capable flowrates are anticipated only up to 5 gpm from each of the extraction well. The use of variable-frequency drives for the pump motors allowed operation of the extraction wells over a wide range of flow rates to maintain the inward gradients under different site conditions.

1.2.1.3 Consolidation Facility

In general, precipitation on the CF flows from the top of the soil cover in all directions into grass-lined perimeter drainage swales; however, a limited amount of water infiltrates through the clay/soil cover. The hydrologic evaluation of landfill performance (HELP) computer model, Version 3.07, was used to evaluate infiltration through the CF soil cover. The HELP model estimated an average annual volume of infiltration through the soil cover and into the collection sump of 5,200 gallons per day, or about 4 gpm. Due to the storage capacity of the CF, water in the CF sump does not require continuous pumping to the WTS. The water from the CF is pumped into the WTS at a rate equal to the available system capacity.

1.2.2 WTS Design Deviations

Changes to the design that were accepted by both the design team and EPA are presented in the construction completion reports submitted to EPA in 2014 and 2015 (CH2M 2014b and 2015a).

The record drawings in Appendix B present these changes. The major design changes that were implemented in the construction included the following:

- **Installation of termination vault:** Due to the construction schedule for the ODC Containment Cell, the termination vault, which serves as the connection point for the WTS and the ODC Containment Cell, required installation by Arrowhead. Upon completion of the ODC Containment Cell and connection of the piping and electrical to the termination vault, the connection of the ODC Containment Cell was completed.
- **Concrete pad:** The original design included the installation of a new concrete pad for the placement of the WTS. During the pre-bid site walk, it was observed that the existing treatment system was placed directly on the asphalt paving, and the scope was modified to include repairs of the asphalt paving prior to placement of the new WTS. Once the existing treatment system was removed, it was determined that the asphalt beneath the building was not suitable for placement of the new WTS and the concrete pad, as originally design, was installed.
- **Piping depth:** Because of the elevated groundwater level conditions, the target installation depth of the pipe to achieve frost depth was not achievable. Insulation board (2-inch-thick, R-11-rated) was installed around the portion of the pipes adjacent to the WTS building that were above the target installation depth. A 0.75-inch polyvinyl chloride pipe was also installed adjacent to the pipes for future installation of heat trace wire, if needed.
- **Fence:** A 6-foot-tall fence was installed around the wellhead on the berm of the CF to provide security against tampering while also allowing sufficient space for pump removal in the future. Portions of the existing perimeter fence that limited sitewide access were removed and will not be replaced.
- **Backwashing:** The carbon vessels were backwashed because monitoring of the treatment system noted an increase in pressure differential across the carbon vessels and reduced flow. Backwashing the system prior to the carbon changeout was not originally included in the design.
- **Discharge criteria and change in discharge location:** The original design, construction, and initial operations included discharging the WTS effluent to the North Ditch. The design effluent criteria were based on numerical limits in the Illinois Effluent Standards (Title 35 Part 304) and Illinois Water Quality Standards (Title 35 Part 302e) and included in the *Water Treatment System (WTS) Compliance and Performance Monitoring* memorandum (CH2M 2014c). In February 2015, IEPA recommended discharge criteria to the North Ditch that were lower than the CH2M proposed limits and included limits on additional parameters. A comparison of the effluent concentrations from the WTS and IEPA's recommended discharge criteria indicated potential exceedances of the daily maximum criteria for ammonia, arsenic, and iron; the 30-day average discharge criteria for ammonia; and the annual limits for total PCBs, mercury, and vinyl chloride. The operation of the WTS was halted, and other options for the discharge location were evaluated. Because the dewatering systems of the two PCB Containment Cells needed to be operated to establish and maintain inward gradients, a short-term solution was needed until the discharge criteria and discharge location could be finalized. Various options for temporary storage of the discharge were evaluated, and the most cost-effective option of diverting the effluent into the CF sump for temporary storage was approved as a short-term solution.

- **Temporary discharge to onsite pond:** The continued use of the CF as the option for the discharge was re-evaluated as the water levels approached the maximum storage capacity. Options for the discharge from the WTS, including discharge to the North Shore Waste Reclamation District (NSWRD) or to the onsite ponds, were evaluated and discussed with EPA. In September 2015, EPA, in consultation with IEPA, approved the installation of a temporary discharge line from the WTS to the large pond south of the CF.
- **System modification:** The system modification consisted of a precipitation/clarification system using two existing poly tanks outside of the building with an air sparging system in one tank and the other tank functioning as a settling tank. Treated water from the settling tank would be pumped to the existing influent tank in the building and through the existing treatment system to the North Ditch. The new equipment (blower, air sparge assembly, transfer pump, and controls) would sit outside the existing building and would not be operated during the winter months. The iron precipitate in the sparge and settling tanks would be collected and disposed of offsite as a Toxic Substances Control Act waste. At the time of construction, the discharge location changed from the North Ditch to the NSWRD; therefore, the design was modified to use the diffuser and sequestering agent to control iron that was determined to be a more cost-effective solution for long-term operation.
- **Power upgrade:** The main power supply of the operating WTS system was evaluated to verify that sufficient power was available to operate the modified system. The team identified that power should be upgraded from 150 amps to a 300-amp service, and ComEd was contracted to install a new transformer on an existing pole along the north boundary of the site. New power lines and poles were installed to transmit the new service from the ComEd transformer to the WTS location.

1.2.3 Infiltration Treatment Wetland

Because the treatment system is not designed to remove ammonia and ammonia levels are above IEPA criteria for discharge, EPA and IEPA selected to use of an infiltration system to manage the effluent as the preferred discharge option. The Basis of Design Report (CH2M 2020) presents the design details for the permanent infiltration facility constructed in the form of a treatment wetland to polish ammonia and infiltrate water to the underlying surficial aquifer.

The constructed infiltration wetland consists of a constructed impoundment that includes earthen berms and vegetation to contain, treat, and infiltrate the applied water from the WTS. The berms were constructed from onsite material excavated to create deep and marsh zones throughout the wetland footprint. The designed wetted area of the infiltration wetland is 0.77 acre. Accounting for berms, the total wetland area is 1.56 acres. The wetland is sized and is operated to achieve shallow water levels that can support native wetland vegetation communities. The wetland was planted with native species adapted to different water depths within the deep zones and the marsh zones. The water that enters the new treatment wetland system is conveyed through a new pipe from the existing WTS.

Table 1-1. Summary of Influent Concentrations

Water Treatment System, Waukegan, Illinois

	West PCB Containment Cell (WCC)			Consolidation Facility (CF)			Old Die Cast Cell (ODC)		
Chemical Name	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
Total PCBs, µg/L	955.0000	2.0300	40.5281	12.1000	0.0534	0.1090	588.0000	4.5500	65.5225
Ammonia, mg/L	4.9500	2.8900	4.2521	3.9500	2.1400	3.1882	3.3100	0.3400	1.2292
TSS, mg/L	16.9000	8.1300	14.3153	7.5900	0.3160	1.2704	64.3000	5.7300	19.0490
Metals (mg/L)									
Aluminum	0.3120	0.0265	0.1693	0.0604	0.0265	0.0604	0.4190	0.0265	0.1817
Antimony	0.0312	0.0006	0.0081	0.0264	0.0007	0.0081	0.0024	0.0006	0.0015
Arsenic	0.1150	0.0179	0.1007	0.0971	0.0021	0.0031	0.0031	0.0004	0.0016
Barium	0.1660	0.1320	0.1514	0.1710	0.0556	0.1048	0.2330	0.1320	0.1846
Beryllium	0.0003	0.0002	0.0003	0.0005	0.0002	0.0004	0.0004	0.0003	0.0003
Cadmium	0.0003	0.0002	0.0003	0.0009	0.0002	0.0007	0.0004	0.0003	0.0004
Chromium	0.0065	0.0009	0.0029	0.0015	0.0008	0.0010	0.0069	0.0008	0.0013
Cobalt	0.0047	0.0003	0.0017	0.0052	0.0002	0.0015	0.0040	0.0003	0.0014
Copper	0.0080	0.0031	0.0032	0.0065	0.0031	0.0051	0.0350	0.0032	0.0038
Iron	7.8600	0.8530	6.7856	7.4800	0.1010	0.1899	4.5900	1.5200	3.1467
Lead	0.0007	0.0003	0.0004	0.0044	0.0003	0.0013	0.0138	0.0003	0.0011
Manganese	1.0400	0.2280	0.2408	42.6000	0.1330	3.6224	0.2530	0.0977	0.1682
Nickel	0.0391	0.0014	0.0073	0.0169	0.0014	0.0123	0.1370	0.0016	0.0074
Selenium	0.0008	0.0003	0.0007	19.1000	0.0003	0.0005	13.5000	0.0004	0.0005
Silver	0.0010	0.0004	0.0004	0.0028	0.0005	0.0016	0.0005	0.0004	0.0004
Thallium	0.0004	0.0003	0.0003	0.0004	0.0004	0.0004	0.0040	0.0003	0.0003

Table 1-1. Summary of Influent Concentrations

Water Treatment System, Waukegan, Illinois

	West PCB Containment Cell (WCC)			Consolidation Facility (CF)			Old Die Cast Cell (ODC)		
Chemical Name	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
Vanadium	0.0042	0.0002	0.0007	0.0004	0.0002	0.0003	0.0098	0.0009	0.0023
Zinc	0.0280	0.0039	0.0069	0.0413	0.0033	0.0115	0.1100	0.0041	0.0139
Mercury	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0003
Calcium	346.0000	144.0000	167.5000	382.0000	80.9000	164.1357	136.0000	90.4000	110.8583
Magnesium	82.2000	34.7000	40.5938	115.0000	21.7000	43.2071	36.0000	24.6000	30.1000
Potassium	15.5000	0.0008	10.7738	19.1000	2.3100	5.1400	20.4000	9.4400	12.8783
Sodium	248.0000	105.0000	135.5000	392.0000	18.8000	38.2071	246.0000	133.0000	187.0000
VOCs (µg/L)									
1,1,1-Trichloroethane	3.7500	1.8700	3.7500	0.3750	0.3750	0.3750	0.3750	0.3750	0.3750
1,1,2,2-Tetrachloroethane	4.6200	2.3100	4.6200	0.4620	0.4620	0.4620	0.4620	0.4620	0.4620
1,1,2-Trichloroethane	3.9000	1.9500	3.9000	0.3900	0.3900	0.3900	0.3900	0.3900	0.3900
1,1-Dichloroethane	23.5000	2.3600	11.5500	0.4720	0.4720	0.4720	2.1600	0.7500	1.4045
1,1-Dichloroethene	16.3000	4.3000	12.7154	0.4790	0.4790	0.4790	0.4790	0.4790	0.4790
1,2-Dibromo-3-chloropropane	9.7000	4.8500	9.7000	1.0200	1.0200	1.0200	1.0200	0.9700	0.9950
1,2-Dibromoethane	4.6300	2.3200	4.6300	0.4630	0.4630	0.4630	0.4630	0.4630	0.4630
1,2-Dichloroethane	3.2600	1.6300	3.2600	0.3260	0.3260	0.3260	0.3260	0.3260	0.3260
1,2-Dichloropropane	3.1000	1.5500	3.1000	0.3100	0.3100	0.3100	0.3100	0.3100	0.3100
1-Butanol	223.0000	111.0000	223.0000	22.3000	22.3000	22.3000	22.3000	22.3000	22.3000
2-Butanone	13.0000	6.5100	13.0000	1.3000	1.3000	1.3000	1.3000	1.3000	1.3000
2-Hexanone	11.0000	5.5200	11.0000	1.1000	1.1000	1.1000	1.1000	1.1000	1.1000

Table 1-1. Summary of Influent Concentrations

Water Treatment System, Waukegan, Illinois

	West PCB Containment Cell (WCC)			Consolidation Facility (CF)			Old Die Cast Cell (ODC)		
Chemical Name	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
4-Methyl-2-pentanone	11.4000	5.7200	11.4000	1.1400	1.1400	1.1400	1.1400	1.1400	1.1400
Acetone	96.9000	48.5000	96.9000	9.6900	9.6900	9.6900	9.6900	9.6900	9.6900
Acrolein	37.4000	18.7000	37.4000	3.7400	3.7400	3.7400	3.7400	3.7400	3.7400
Acrylonitrile	6.5000	3.2500	6.5000	0.6500	0.6500	0.6500	0.6500	0.6500	0.6500
Benzene	4.2300	2.1100	4.2300	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230
Bromodichloromethane	4.2400	2.1200	4.2400	0.4240	0.4240	0.4240	0.4240	0.4240	0.4240
Bromoform	4.9300	2.4600	4.9300	0.4930	0.4930	0.4930	0.4930	0.4930	0.4930
Bromomethane	6.8800	3.4400	6.8800	0.6880	0.6880	0.6880	0.6880	0.6880	0.6880
Carbon disulfide	4.8200	2.4100	4.8200	0.4820	0.4820	0.4820	0.4820	0.4820	0.4820
Carbon tetrachloride	5.4500	2.7200	5.4500	0.5450	0.5450	0.5450	0.5450	0.5450	0.5450
Chlorobenzene	4.7400	2.3700	4.7400	0.4740	0.4740	0.4740	0.4740	0.4740	0.4740
Chloroethane	10.9000	5.4300	10.9000	1.0900	1.0900	1.0900	1.0900	1.0900	1.0900
Chloroform	3.5500	1.7800	3.5500	0.3550	0.3550	0.3550	0.3550	0.3550	0.3550
Chloromethane	6.6900	3.3500	6.6900	0.9500	0.9500	0.9500	1.2800	0.6690	0.9097
cis-1,2-Dichloroethene	1940.0000	180.0000	1329.0000	2.2500	2.2500	2.2500	2.2500	2.2500	2.2500
cis-1,3-Dichloropropene	2.2700	1.1300	2.2700	0.2270	0.2270	0.2270	0.2270	0.2270	0.2270
Dibromochloromethane	4.1600	2.0800	4.1600	0.4160	0.4160	0.4160	0.4160	0.4160	0.4160
Ethylbenzene	4.5700	2.2800	4.5700	0.4570	0.4570	0.4570	0.4570	0.4570	0.4570
m,p-Xylene	9.0000	4.5000	9.0000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000
Methyl tert-butyl ether	2.5000	1.2500	2.5000	0.4000	0.3300	0.3650	0.2500	0.2500	0.2500

Table 1-1. Summary of Influent Concentrations

Water Treatment System, Waukegan, Illinois

	West PCB Containment Cell (WCC)			Consolidation Facility (CF)			Old Die Cast Cell (ODC)		
Chemical Name	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
Methylene chloride	13.0000	1.9200	3.0200	0.4500	0.3840	0.4113	0.6300	0.3840	0.4545
o-Xylene	4.4900	2.2400	4.4900	0.4490	0.4490	0.4490	0.4490	0.4490	0.4490
Styrene	3.1000	1.5500	3.1000	0.3100	0.3100	0.3100	0.3100	0.3100	0.3100
Tetrachloroethene	6.1200	3.0600	6.1200	0.6120	0.6120	0.6120	0.6120	0.6120	0.6120
Toluene	7.0000	1.9700	5.7800	0.3940	0.3940	0.3940	0.4800	0.3940	0.4227
trans-1,2-Dichloroethene	8.0000	4.0000	23.4000	2.3400	2.3400	2.3400	2.3400	2.3400	2.3400
trans-1,3-Dichloropropene	2.5000	1.2500	2.5000	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500
Trichloroethene	81.8000	2.5000	56.1786	0.4790	0.4790	0.4790	2.6200	0.4790	1.2549
Vinyl acetate	5.5500	2.7800	5.5500	0.5550	0.5550	0.5550	0.5550	0.5550	0.5550
Vinyl chloride	636.0000	245.0000	500.1875	0.4260	0.4260	0.4260	13.6000	0.4260	1.1620
Xylenes, Total	13.5000	6.7400	13.5000	1.3500	1.3500	1.3500	1.3500	1.3500	1.3500
1,3-Dichloropropene, Total	4.7700	2.3800	4.7700	0.4770	0.4770	0.4770	0.4770	0.4770	0.4770
SVOCs (µg/L)									
1,4-Dioxane	62.5000	62.5000	62.5000	12.6000	12.6000	12.6000	12.6000	12.6000	12.6000
2,4,5-Trichlorophenol	0.0000	0.0000	0.0000	0.2460	0.2460	0.2460	0.2470	0.1060	0.1997
2,4,6-Trichlorophenol	0.0000	0.0000	0.0000	0.3290	0.3290	0.3290	0.3300	0.3290	0.3295
2,4-Dichlorophenol	0.0000	0.0000	0.0000	0.3920	0.3920	0.3920	0.3930	0.3920	0.3925
2,4-Dimethylphenol	0.7170	0.3170	0.5224	0.3500	0.3500	0.3500	10.1000	0.3990	4.0708
2,4-Dinitrophenol	0.0000	0.0000	0.0000	2.4400	2.4400	2.4400	2.4500	2.4400	2.4450
2,4-Dinitrotoluene	0.1800	0.1800	0.1800	0.4510	0.4510	0.4510	0.4520	0.1800	0.3610

Table 1-1. Summary of Influent Concentrations

Water Treatment System, Waukegan, Illinois

	West PCB Containment Cell (WCC)			Consolidation Facility (CF)			Old Die Cast Cell (ODC)		
Chemical Name	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
2,6-Dinitrotoluene	0.0490	0.0490	0.0490	0.1230	0.1230	0.1230	0.1230	0.1230	0.1230
2-Chloronaphthalene	0.0000	0.0000	0.0000	0.2020	0.2020	0.2020	0.2020	0.2020	0.2020
2-Chlorophenol	0.1500	0.1500	0.1500	0.3780	0.3780	0.3780	0.3790	0.3780	0.3785
2-Methylnaphthalene	0.1390	0.1390	0.1390	0.0724	0.0724	0.0724	0.1970	0.0724	0.1270
2-Methylphenol	0.0000	0.0000	0.0000	1.6800	1.6800	1.6800	1.6800	0.8800	1.4133
3,3-Dichlorobenzidine	0.0000	0.0000	0.0000	3.4000	3.4000	3.4000	3.4000	3.4000	3.4000
3-Nitroaniline	0.0000	0.0000	0.0000	0.9280	0.9280	0.9280	0.9290	0.9280	0.9285
3-,4-Methylphenol	0.6270	0.6270	0.6270	0.8760	0.8760	0.8760	118.0000	5.3900	40.6082
4-Bromophenyl-phenylether	0.0000	0.0000	0.0000	0.1260	0.1260	0.1260	0.1260	0.1260	0.1260
4-Chloroaniline	0.0000	0.0000	0.0000	0.1740	0.1740	0.1740	0.1740	0.1740	0.1740
4-Nitrophenol	0.0000	0.0000	0.0000	1.4400	1.4400	1.4400	1.4500	1.4400	1.4450
Acenaphthene	0.0000	0.0000	0.0000	0.0709	0.0709	0.0709	0.5720	0.0319	0.2432
Acenaphthylene	0.2900	0.2900	0.2900	0.7270	0.7270	0.7270	0.7280	0.7270	0.7275
Anthracene	0.0000	0.0000	0.0000	0.4210	0.4210	0.4210	0.4210	0.4210	0.4210
Benzo(a)anthracene	0.0000	0.0000	0.0000	0.1960	0.1960	0.1960	0.1970	0.1960	0.1965
Benzo(a)pyrene	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.2510	0.1000	0.2003
Benzo(b)fluoranthene	0.0000	0.0000	0.0000	0.1840	0.1840	0.1840	0.1840	0.1840	0.1840
Benzo(g,h,i)Perylene	0.0000	0.0000	0.0000	0.2090	0.2090	0.2090	0.2090	0.2090	0.2090
Benzo(k)fluoranthene	0.0000	0.0000	0.0000	0.1830	0.1830	0.1830	0.1830	0.1830	0.1830
Bis(2-Chloroethoxy)Methane	0.0000	0.0000	0.0000	0.1580	0.1580	0.1580	0.1580	0.0630	0.1263

Table 1-1. Summary of Influent Concentrations

Water Treatment System, Waukegan, Illinois

	West PCB Containment Cell (WCC)			Consolidation Facility (CF)			Old Die Cast Cell (ODC)		
Chemical Name	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
Bis(2-Chloroethyl)ether	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.2090	0.2090	0.2090
bis(2-Ethylhexyl)phthalate	2.4700	1.0900	1.7500	193.0000	0.9270	39.9854	1.6900	0.8190	1.2555
Butylbenzylphthalate	0.0000	0.0000	0.0000	1.6700	1.6700	1.6700	1.6800	0.6700	1.3400
Carbazole	0.0000	0.0000	0.0000	0.0669	0.0669	0.0669	0.2910	0.0670	0.1499
Chrysene	0.0000	0.0000	0.0000	0.1550	0.1550	0.1550	0.1550	0.0620	0.1240
Di-N-Butylphthalate	0.0000	0.0000	0.0000	0.2740	0.2740	0.2740	0.2740	0.1100	0.2193
Di-n-octylphthalate	0.0000	0.0000	0.0000	0.1620	0.1620	0.1620	0.1630	0.0650	0.1300
Dibenzo(a,h)Anthracene	0.0000	0.0000	0.0000	0.2180	0.2180	0.2180	0.2180	0.2180	0.2180
Diethylphthalate	0.0000	0.0000	0.0000	0.3960	0.3960	0.3960	0.3960	0.3960	0.3960
Dimethylphthalate	0.0000	0.0000	0.0000	1.9400	1.9400	1.9400	0.5810	0.5800	0.5805
Fluoranthene	0.0690	0.0690	0.0690	0.1730	0.1730	0.1730	0.1740	0.0702	0.1428
Fluorene	0.0000	0.0000	0.0000	0.1040	0.1040	0.1040	0.1040	0.1040	0.1040
Hexachlorobenzene	0.0280	0.0280	0.0280	0.0704	0.0704	0.0704	0.0705	0.0704	0.0705
Hexachlorobutadiene	0.0000	0.0000	0.0000	0.8670	0.8670	0.8670	0.8690	0.8670	0.8680
Hexachlorocyclopentadiene	0.0000	0.0000	0.0000	0.7420	0.7420	0.7420	0.7430	0.7420	0.7425
Hexachloroethane	0.0000	0.0000	0.0000	0.9380	0.9380	0.9380	0.9390	0.9380	0.9385
Indeno(1,2,3-cd)pyrene	0.0000	0.0000	0.0000	0.1120	0.1120	0.1120	0.1120	0.1120	0.1120
Isophorone	0.0000	0.0000	0.0000	0.1770	0.1770	0.1770	0.1770	0.1770	0.1770
n-Nitrosodiphenylamine	0.3700	0.3700	0.3700	1.1000	1.1000	1.1000	0.9310	0.9290	0.9300
Naphthalene	0.0343	0.0343	0.0343	0.0667	0.0667	0.0667	0.5450	0.0518	0.1904

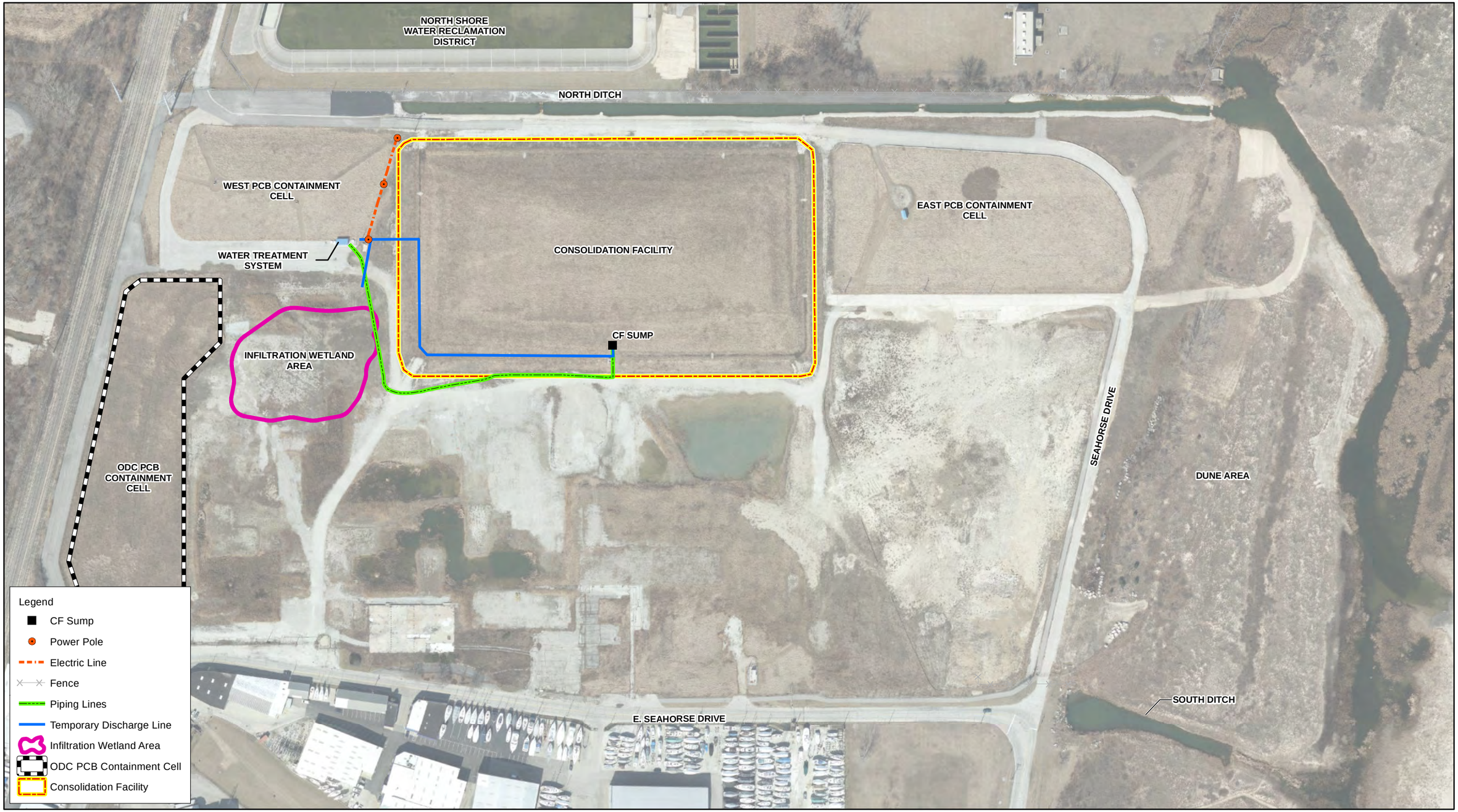
Table 1-1. Summary of Influent Concentrations

Water Treatment System, Waukegan, Illinois

Chemical Name	West PCB Containment Cell (WCC)			Consolidation Facility (CF)			Old Die Cast Cell (ODC)		
	Maximum	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
Nitrobenzene	0.0000	0.0000	0.0000	0.2780	0.2780	0.2780	0.2780	0.2780	0.2780
Pentachlorophenol	0.0000	0.0000	0.0000	6.3000	6.3000	6.3000	6.3100	6.3000	6.3050
Phenanthrene	0.0000	0.0000	0.0000	0.0736	0.0736	0.0736	0.2410	0.0727	0.1529
Phenol	1.1900	0.2960	0.6533	1.1100	0.3430	0.7265	510.0000	0.5610	137.3301
Pyrene	0.0000	0.0000	0.0000	0.0468	0.0468	0.0468	0.1010	0.0464	0.0650

Note:

Summary influent concentrations includes data collected from November 2014 through August 2016.



Note:
1. 2018 Aerial Photography provided by Esri ArcGIS Online World Imagery.

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Figure 1-1
Water Treatment System
OMC Waukegan Harbor RA
Waukegan, IL

ch2m

\\LAKEFRONT\PROJ\EPA\186305-OMC\GIS_DATA\MXDS\2020\MISC\FIGURE 1-1 - WATER TREATMENT SYSTEM.MXD JHANSEN1 8/11/2020 1:12:01 PM

SECTION 2

Construction Activities

The WTS and associated piping, power/control wiring, and pumps were installed by Arrowhead from May 28 to August 15, 2014, and consisted of the following activities:

- Demolished the previous treatment system for the West PCB Containment Cell and construction of a new 50-gpm WTS to treat water from the West PCB Containment Cell, CF, and ODC Containment Cell (constructed by SulTRAC).
- Provided a fully functional WTS with interior piping and manifold, instrumentation and controls, heating and ventilation, and electrical to meet applicable local, state, and federal building codes.
- Provided exterior underground pipe and pump electrical controls from the CF sump to the treatment system.
- Provided a pump and associated controls to convey water from the CF sump to the treatment system.
- Provided exterior underground pipe and electrical conduit from the ODC junction box to the treatment system.
- Connected the existing West PCB Containment Cell piping and control wiring to the treatment system.
- Worked with SulTRAC (TetraTech) to connect the ODC wells to the treatment system.
- Completed startup and performance testing of the treatment system.

The Construction Change Order #1 scope of work was completed July 7-9, 2015, and involved installing tanks, piping, pumps, electrical connections, and controls to temporarily convey the discharge water from the WTS to the CF sump. The system is aboveground and temporary and will be used until a permanent discharge point can be obtained. The system cannot be operated during freezing temperatures and will need to be shut down and winterized in late November. The temporary system includes the following features and involved implementing the following activities:

- Moved one of the 1,100-gallon tanks stored at the site to the east side of the building and cut holes/installed flanges to insert the influent line and discharge line into the tank.
- Installed new piping from the system to the 1,100-gallon temporary tank using a combination of hard piping and flexible piping with quick connects. Two ball valves were added so that the discharge could be run to either the North Ditch or the temporary tank.
- Installed the new sump pump into the temporary tank with hard piping to the top of the tank and flexible piping with quick connects to the temporary discharge line to the CF sump. A backflow preventer was also installed in the piping to prevent siphoning back into the temporary tank.
- Installed about 800 linear feet of 2-inch, high-density polyethylene (HDPE) piping from the pump in the temporary tank to the CF sump. Also installed flexible piping with quick connects and a ball valve between the temporary tank and the 2-inch HDPE pipe.
- Installed conduit from the breaker box and control panel inside the WTS building, through the wall of the building, and onto a unistrut structure located beside the temporary tank. Installed exterior outlets and electrical boxes for the power and control wiring on the unistrut structure. Connected power to the pump and installed a float switch to control the pump and a high-high alarm float switch in the tank. Connected power wiring to the breaker box and control wiring to the control panel.

- Programmed the programmable logic controller (PLC) to shut down the entire system if the high-high float switch is activated. The sump pump in the temporary tank is not controlled by the PLC but instead is wired directly to the breaker box and is controlled by the float switch.
- Ran the system and confirmed proper operation of the new equipment. Intentionally overfilled the temporary tank, and the high-high alarm successfully shut down the entire system.
- The scope of work for Construction Changer Order #2 was completed September 9 through 25, 2015, and involved installing a new electrical service, installing a diffuser, and installing a metering pump, plus associated piping, power, and controls. The new power service was necessary to run the additional equipment. The diffuser removes VOCs from the water prior to carbon treatment, and the metering pump injects a chemical into the water to keep the iron in suspension. Installed a new electrical service, including two power poles, one guy wire, triplex cable, riser, weather head, meter fitting, main breaker, and grounding. Coordinated with ComEd on the new service and payed the connection fee. Obtained and paid the fee for the building permit from Lake County.
- Installed underground conduit and cable from the new breaker to the building. Replaced the existing breaker and panel with a new breaker and panel and reconnected all existing wiring to the new panel. Terminated and locked out the existing electrical service.
- Installed new conduit and wiring for the power and controls to the new diffuser and metering pump. Installed new contacts in the control panel to control the new equipment.
- Installed the metal rack above the influent tank and bolted to the floor. Installed the diffuser on the metal rack and bolted to the rack. Installed the blower on the rack and bolted it to the rack. Installed new influent piping to the diffuser with two valves so that influent can go either through the diffuser or directly into the influent tank. Installed new piping from the diffuser discharge to the influent tank. Installed air intake piping from the blower to the diffuser. Installed air discharge piping from the diffuser out the west side of the building.
- Mounted the metering pump on the north wall of the WTS building and ran tubing to the influent pipe. Purchased and staged a 55-gallon drum of tetrapotassium pyrophosphate near the metering pump and inserted the suction tubing from the metering pump.
- Installed a static mixer to allow a laminar mixing of the tetrapotassium pyrophosphate with the influent streams prior to aeration process in the DAT mixing tank. The static mixer is anticipated to aid the reduction of iron precipitation.
- Connected all power and control wiring for the new diffuser and metering pump. Modified the PLC to automatically control the diffuser and metering pump, including a high-high alarm on the diffuser. Programmed the PLC to run the system only if the blower is on. To run the system without the blower, turn on the blower at the panel, and turn off the breaker for the blower in the breaker panel.
- Ran the system to test the new equipment. Intentionally overfilled the diffuser, and the high-high alarm successfully shut down the system. Set the metering pump at the recommended setting and observed no iron stain in the diffuser during the time that it was operating. Also, noted that there was no iron precipitation in the temporary tank when the system was not running. Prior to using the tetrapotassium pyrophosphate, iron would precipitate in the holding tank if it was not operated for a few hours.
- Reprogramed the ODC well survey and water level information provided by SulTRAC into the PLC.
- Installed a “T” in the temporary 2-inch HDPE discharge piping so that discharge could be sent either to the CF sump or to Pond #3/5. The piping is aboveground, except where it crossed the haul road south of the CF where it was trenched to a depth of about 2 feet bgs.

- From July to August 2020, a 1.56-acre infiltration treatment wetland was constructed to receive the WTS effluent water. The option to discharge to the CF remains in place using the existing above ground HDPE pipe. To assist in winterization of the WTS, a "T" fitting was installed inside the WTS building to allow for the introduction of compressed air into the HDPE effluent pipe to push out any water remaining water in the pipe.
- During August 2020, tasks on a final instrumentation and control checkout list generated by CH2M were completed.

2.1 Replacement Parts and Services

The parts suppliers and vendors for this project include the following:

Parts or Services	Provider
WTS parts	H2K Technologies, Inc. 7550 Commerce St. Corcoran, MN 55340 Office: 763-746-9900 Fax: 763-746-9903 www.H2Ktech.com
CF sump pump	EPG Companies, Inc. 19900 County Road 81 Maple Grove, MN 55311 Phone: 800-443-7426 www.epgco.com
Spent granular activated carbon (GAC) disposal New GAC Cartridge Filters	Evoqua 2600 South 17th Street Broadview, IL 60155 Phone: 847-226-4514 Fax: 708-345-9558 www.evoqua.com
Cartridge Filter Disposal	US Ecology P.O. Box 673974 Detroit, MI 4827 800-592-5489 www.usecology.com
DAT Blower	H2K Technologies, Inc. 7550 Commerce St. Corcoran, MN 55340 Office: 763-746-9900 Fax: 763-746-9903 www.H2Ktech.com
Watertech 5390 (tetrapotassium pyrophosphate)	Watertech of America, Inc. 5000 South 110th Street Greenfield, WI 53228 Phone: 414-425-3339 Fax: 414-425-3362 www.watertechusa.com

SECTION 3

Operation and Maintenance

Operation of the system includes treating the influent streams from the existing West PCB Containment Cell, the CF, ODC PCB Containment Cell, and water from other RA activities being conducted by CH2M and SulTRAC. The routine O&M activities include monitoring of the system operations, conducting minor maintenance activities, including changing the cartridge filters, performing carbon changeouts, and backwashing the system.

A modification to the system was implemented to improve the operations relative to the amount of solids precipitating on the cartridge filters and in the carbon units. The precipitation resulted in high-pressure differentials across the units requiring the filters to be changed weekly. In addition, the higher-than-anticipated VOC concentrations measured in the influent from the West PCB Containment Cell resulted in a significantly higher organic and contaminant loading to the carbon. The system was modified to address these issues by adding an aeration and sequestration system, including a static mixer and installing a bag filter within the aeration tank to capture solids. Substantial completion for the modification was met when the startup and shakedown activities of the modified system were completed.

The O&M activities include the following components:

- Quarterly, or as-needed, site visits to conduct routine maintenance and inspection of the WTS equipment
- Biweekly cartridge filter changeout, or as needed, based on the differential pressure measured across the unit and disposal of the spent cartridge filters
- Quarterly carbon backwashing, or as needed, based on differential pressure measured across the carbon vessel
- Quarterly changeout, or as needed, based on effluent concentrations and disposal of the spent carbon
- Winterization of west PCB cell and piping from the WTS to avoid freezing and damage to pipelines
- General O&M tasks

3.1 Operation and Maintenance Activities

As mentioned in earlier sections, CH2M has modified the system to improve efficiency and reduce operational costs. Based on the on the objectives, the O&M activities are streamlined to establish and maintain an inward gradient within the West PCB Containment Cell, ODC Cell, and CF, while treating the influent streams to meet the discharge criteria.

Upon establishment of the inward gradients needed to maintain hydraulic containment in the containment cells, the system will be shut down and operated as-needed. The water levels will be monitored remotely to identify when system operations should be resumed. At least 1 foot of inward gradient should be maintained at all times, and gradient below that will trigger the operations to resume until the desired inward gradient is established. The inward gradient requirements at each cell is presented in Table 3-1.

Table 3-1. Inward Gradient Differential Requirement
Water Treatment System, Waukegan, Illinois

Containment Cell	Gradient Differential in Depth/Elevation (feet)	
	A – System Startup	B – System Shutdown
West Containment Cell (WCC)	<1.5	> 3.5
CF *	587	586
ODC Cell	< 1	> 2.0

Note: The gradient differential levels trigger the startup and shutdown of the system during the operational year. If the gradient differential decreases below the low-level threshold (A) criteria established, the WTS would be switched on and operated until a sufficient inward gradient differential level is established (B). It is expected to achieve a substantial inward gradient prior to winterization of the system such that an inward gradient achieved is maintained throughout the winter months.

* No inward gradient trigger criteria for CF. CF sump pump will automatically shut off when the water level in the CF sump drops to 586.0 feet and will resume operation once the water level recharges to 587.0 ft.

At the onset of winter, the system will be shutdown to avoid damage to the piping. The piping from the wells and to the infiltration treatment wetland is buried but only at a depth of approximately 2 feet because of the presence of the WCC geomembrane. The piping to the CF is on the ground surface. Based on the recent operations and the operational data obtained, a tentative year-round operational schedule has been developed (subject to change) and will be followed as appropriate, and as needed. Table 3-2 presents the operational schedule of the WTS. The system startup, shut down, and winterization operations and procedures are described in Appendix C.

Table 3-2. WTS Operational Schedule (Subject to Change)
Water Treatment System, Waukegan, IL

Duration	Operations	Maintenance
January	No Operations – System Shutdown	Winterization
February	No Operations - System Shutdown	Winterization
March	No Operations - System Shutdown	Winterization
April	Treat Influent stream from WCC; If needed treat influents from CF and ODC depending on the gradient differentials.	System Startup/Post Winterization O&M check; Quarterly O&M Check; Filter Changeout
May	Operate only if necessary, depending on the Gradient Differentials	None
June	Treat Influent stream from WCC; If needed treat influents from CF and ODC depending on the gradient differentials. Treat influent from ODC for two weeks, prior to carbon changeout.	Carbon Changeout; Filter Changeouts
July	Treat Influent stream from WCC; If needed treat influents from CF and ODC depending on the gradient differentials.	Filter Changeouts and Quarterly O&M Check
August	Operate only if necessary, depending on the Gradient Differentials	None
September	Treat Influent stream from WCC; If needed treat influents from CF and ODC depending on the gradient differentials. Treat influent from ODC for two weeks, prior to carbon changeout.	Carbon Changeout; Filter Changeouts
October	Treat Influent stream from WCC; If needed treat influents from CF and ODC depending on the gradient differentials.	Filter Changeouts and Quarterly O&M Check
November	Treat Influent stream from WCC, CF, and ODC to achieve the additional inward gradient differential required to last through the winter months.	Filter Changeouts
December	No Operations - System Shutdown	Winterization

Note: This draft operational schedule is subject to change depending on weather conditions and effluent discharge location.

3.1.1 Waste Management

Based on the historical waste characterization results and the waste profiles developed in 2015 through 2020, the spent cartridge filters will likely be disposed as hazardous waste, and the spent carbon from the carbon vessels may be disposed as either nonhazardous or hazardous waste depending on waste characterization results. The characterization partly depends on which cell(s) have been pumped from and how much. It is recommended to have the spent carbon tested prior to disposal to verify the correct classification.

Personal protection equipment, including gloves, paper towels, wrappers, etc., should be disposed as regular trash. Until disposal, the spent cartridge filters must be contained in 55-gallon, Department of Transportation-approved, leak-tight drums with closed lids, secured within the treatment building. The storage drums must be stored within secondary containment at all times until disposal.

SECTION 4

Record Drawings

The design drawings are included in Appendix D. Record drawings, including redline edits, have been added to the WTS plans to show the location and description of changes made to the plans and are included in Appendix B. The changes are as follows:

- The final surveyed location of the water line and electrical lines from the CF sump to the WTS building are shown in Drawing C-2 in Appendix B. A list of the survey points (northing, easting, elevation, and designation) and a figure showing a plot of the survey points shot by McClure Engineering are included in Appendix B.
- Changes to the piping penetration through the WCC as shown in Drawing C-4 in Appendix B.
- Changes in the grounding at the WTS, including grounding the four corners of the building and the rebar in slab to two grounding rods located outside the containment wall, and grounding from the secondary switch of the 25-kilovolt-amp transformer to the panelboard in the WTS building. A letter from Pier Electric, Inc. detailing these changes is included in Appendix B.
- Adding a pump control box to the pump located in the CF sump shown in Drawing C-2 in Appendix B.
- The location of the new electrical service to the WTS is shown in Drawing C-1 in Appendix B.
- In August 2020, final updates to the piping and instrumentation diagram (Drawing N-1) were added to Appendix B.
- In August 2020, final updates to the PLC drawings were added to Appendix C.
- In August 2020, design drawings and record drawings for the infiltration treatment wetland were added to Appendixes B and D.

SECTION 5

System Startup and Calibration

H2K Technologies, Inc. provided a table with details of the equipment and controls of the systems included in the WTS. The following systems are included in the table:

- Containment Cells
- Influent Pump Tank
- Liquid Cartridge Filter System
- Liquid GAC Adsorption System
- System Discharge
- Leak Detection
- Miscellaneous Non-Process Functions (Loss of Power, uninterruptible power supply [UPS] Alarms, Entry Door Alarm)
- Miscellaneous Control Systems (Heaters, Exhaust Fans, Sump Pump)

For each system, details are provided for the following, as appropriate:

- General Description of the System
- Equipment and Instruments
- Functional Requirements
- Manual Control Functions
- Auto Control Functions
- Interlocks
- Alarms

H2K Technologies completed Instrument Calibration Sheets for each of the monitoring and control instruments in the systems listed above. ODC extraction wells and piezometers were provided and installed by TetraTech, so H2K Technologies did not complete Instrument Calibration Sheets for the ODC wells and piezometers.

The equipment and controls of the systems table and Instrument Calibration Sheets are included in Appendix E.

SECTION 6

Water Treatment System

H2K Technologies originally provided a detailed O&M manual (Appendix C) for operation of the WTS equipment, which includes the following, all of which can be found in Appendix C-1:

- Systems/Equipment Description
- Mechanical Drawings
- Control Panel Schematic and Description
- Installation, Startup, and Shut Down Procedures
- Maintenance Schedule Troubleshooting Guide

Additional information on controls equipment (Appendix C-2) and mechanical equipment (Appendix C-3) are also included in Appendix C. The WTS controls description has been updated within this section and reflects the current state of the control system. A printout of the PLC program is included in Appendix C-4.

6.1 System/Equipment Description

This manual contains important information about the equipment supplied by H2K Technologies for this project (Appendix C). Specific O&M information for individual components or systems can be found in the numbered sections of the manual in Appendix C. If additional information is required, please call H2K Technologies at 763-746-9900.

6.2 Equipment Description:

Below is a list of equipment supplied by H2K Technologies and others for this project. More specific information on most of these items can be found in the numbered sections of the manual in Appendix C or the appendixes.

West Containment Cell, P-1-1-1, P-1-1-2, LS-1-1-1, and LS-1-1-2:

- By City of Waukegan

West Containment Cell, LE/LT-1-3-3 through LE/LT-1-3-6:

- (4) Level transmitters, 4-20 milliamps direct current (mADC) out, aneroid bellows, strain-relief, junction box, surge suppressor, model KPSI 720 Series

Containment Facility, P-1-2, LE/LT-1-2:

- (1) submersible pump, EPG WSDPT 12-3
  - Stainless-steel wheeled sump drainer, size 5
  - 2 horsepower (hp), 230 volt (v), 10 motor
  - 60 feet of jacketed 14-4 CP motor lead
  - 0- to 11-foot level sensor with built-in lightning arrestor
  - 60-foot Hytrel lead
  - 60-foot of 3/16-inch stainless-steel suspension cable and clamps

Old Die Cast (ODC) Containment Cell, P-1-3-1, P-1-3-2, LE/LT-1-3-1 through LE/LT-1-3-6:

- By SulTrac

Influent Flow Manifold, FIT-1-1, FIT-1-2, FCV-1-2, FIT-1-3-1, and FIT-1-3-2:

- 2-inch header with (3) 2-inch takeoffs, schedule 80 polyvinyl chloride (PVC) piping and fittings
- (6) 1.5-inch PVC or brass gate valve
- (4) 1.5-inch magnetic flow meter with indicator/transmitter, Endress Hauser promag 50P mag meter, 4-20 mADC out, model 50P40-EL0A1AA0BBAA
- (1) 1.5-inch flow control valve, electric modulating actuator, ball valve, 120 volts alternating current (VAC) power

Chemical Feed Pump, P-8-1:

- (1) Metering Pump, Grundfos DDA
  - 120 VAC power
  - Adjustable flow control
  - Self-priming
  - Graphic liquid crystal display

Diffused Aeration Tank, T-9-1 and LSHH-9-1:

- (1) H2K DTA1
  - Diffused aerator chamber 304 SS welded construction with removable bolted cover
  - (3) 24-inch stainless-steel coarse bubble diffusers
  - (1) 6-inch demister pad with nozzle outlet
  - 2-inch national pipe thread (NPT) influent and effluent connections
  - 0.75-inch drain valve
  - 2-inch PVC sump level sight glass
- (1) Welded steel stand for above to mount over 60-inch-diameter by 69-inch-high vertical HDPE tank
- (1) High-high level switch, H2K Technologies

Aeration Blower, M-9-1 and PDSH-9-1:

- (1) Rotron DR 513R58
  - Cast aluminum housing
  - Inline filter
  - 1.5 hp
  - 220 VAC single phase
- (1) Dwyer differential pressure switch, Model 1950 Series

Influent Tank, T-2-1, LIT-2-1, LSHH-2-1, and LSLL-2-1:

- (1) 550-gallon HDPE free-standing vertical tank, Norwesco model 40023
  - 67-inch-diameter by 44-inch-high, 16-inch manway
  - Inlet and outlet threaded bungs
  - Vented to outside of building
- (1) Siemens Multi-Ranger ultrasonic level transmitter, 4-20 mADC output, Model 100 with XPS-10F element
- (2) Conery level switches, float type with weight, NC/NO contacts, Model 2900 Series B8 Non-Mercury

Influent Tank Pump, P-2-1:

- (1) Paco model 15951F
  - Centrifugal pump, 50 gpm at 50-foot total dynamic head (TDH)
  - Cast iron with ductile iron impeller
  - 2 hp, 230 VAC, 1Ø, totally enclosed, fan-cooled motor
- Isolation ball valve on inlet
- Check valve on pump discharge
- Sample port on pump discharge
- Pressure gage on pump discharge, stainless steel, liquid filled

Cartridge Filter, M-3-1:

- (1) Siemens model ZHGOF0620 multi-cartridge filter housings
  - 316 stainless-steel construction, 150 pounds per square inch (psi), swing bolt closure lid
  - Unit houses (6) 20-inch cartridges
  - 2-inch NPT inlet and outlet connections
  - (6) 5-micron polypropylene filter cartridges
- (1) DP transmitter across filter housing, Rosemount 3051 CD3A22A1AS5B4M4D4

Liquid GAC Filters, M-4-1 and M-4-2:

- (2) Siemens model PV-1000 Liquid-Phase carbon vessels
  - Carbon steel construction, 90 psi design pressure
  - Epoxy resin lining, epoxy/urethane exterior finish
  - Fork tubes, lifting lugs
  - 1,000 lbs 8x30 mesh reactivated carbon in each vessel
  - 3-inch influent and effluent NPT connections
  - PVC hub and lateral internals
  - 0.25-inch and 0.75-inch air bleed valve with galvanized piping on top of vessel
  - (2) 11-inch by 16-inch manways

  - 1-inch drain valve with galvanized piping
  - 4-70 gpm flow range
  - Isolation valve on inlet and outlet of each vessel
  - Pressure gage and sample port on inlet and outlet of each vessel
- (1) Header for series lead/lag and backwash operation of two vessels
  - PVC schedule 80 PVC pipe and fittings
  - (10) 2-inch PVC true union ball valves
  - Pressure gage on inlet/outlet of each vessel
  - Stand as required
  - (2) DP transmitters, (1) across each LGAC vessel, Rosemount 3051 CD3A22A1AS5B4M4D4

Effluent Flow, FIT-5-1:

- (1) 1.5-inch effluent magnetic flow meter with indicator/transmitter, Endress Hauser promag 50P mag meter, 4-20 mADC out, model 50P40-EL0A1AA0BBAA

Storage Tank, T-6-1, P-6-1, and LSHH-6-1:

- (1) 1,100-gallon HDPE free-standing vertical tank
  - 67-inch-diameter by 44-inch-high, 16-inch manway
  - Inlet and outlet threaded bungs
- (1) Liberty model FL152A-2
  - Submersible sump pump, 85 gpm at 50-foot TDH
  - Cast iron case and volute, and impeller
  - 1.5 HP, 240 VAC, 1Ø, sealed motor with local float switch for pump control
- (1) Level switch, float type with weight
- Check valve, isolation ball valve on pump discharge

Building Sump Pump, P-7-1, LSHH-7-1:

- (1) Goulds model WE0511HH
  - Submersible sump pump, 10 gpm at 50-foot TDH
  - Cast iron case and volute, and impeller
  - 0.5 HP, 120 VAC, 1Ø, sealed motor with local float switch for pump control
- (1) Level switch, float type with weight
- Check valve, isolation ball valve on pump discharge

Treatment Building:

- (1) H2K Technologies welded steel building, 11-foot-wide by 25-foot-long y 10-foot, 6-inch-high (outside dimensions)
  - Fully insulated steel building (noncombustible design)

- 14-gage sheet steel exterior with epoxy/urethane exterior finish
- Painted steel sheets on inside of building
- Steel skid with industrial enamel coated, 3/16-inch sheet steel floor
- 6-inch structural I-beam floor supports 24-inch on center, to allow large loading
- 6-inch structural I-beam skid framing members, Anchor lugs and lifting eyes
- 9-inch-high internal floor spill containment or as required
- Floor boxes and wall sleeves for incoming and outgoing lines as needed
- Anchor lugs and lifting eyes
- Floor sump with high-level switch
- 550-gallon floor containment with galvanized steel grating
- 25-gallon sump
- (2) Incandescent light with vapor globe and wall switch
- (1) Exterior light with photocell
- (1) Interior emergency battery light – Lithonia model ELM2LED
- (1) Vent fan with inlet and outlet insulated gravity louvers and thermostat, insect screens, and filter on inlet louver
- (3) GFI outlet (2 on inside, 1 on outside)
- (2) 3-kilowatt electric fan-driven wall-mounted heaters with thermostat
- (1) Single 36-inch by 6-foot, 8-inch access door insulated steel with key lock
- (2) Double 36-inch by 6-foot, 8-inch access doors, insulated steel with key lock
- (1) Door intrusion alarm Edwards signaling model 151-6Z-06K
- (1) 2-foot by 3-foot by 6-foot-high extra-heavy-duty steel shelving with (4) adjustable shelves
- (1) 10-lb ABC dry chemical fire extinguisher, wall-mounted, with heavy-duty bracket
- (1) First-aid kit, 223-U/FAO
- (1) Bloodborne pathogen kit Safeware model CER200-906
- Groundwater treatment system and control panel is mounted, piped, and wired inside building. Piping is Schedule 80 PVC. Wiring is per NEC for a non-classified environment inside and outside of the enclosure.

6.3 Overview

6.3.1 Controls Operation Description

6.3.1.1 Scope

The controls were provided by H2K Technologies for the CH2M HILL-Waukegan, IL/#4221 site. This section on controls is provided as a descriptive summary of the process and instrumentation diagrams (Appendix B). This section can be used to determine the conditions that must be met for each item to operate.

6.3.1.2 General Operational Conditions

- Any switch in the “ON” position will operate the corresponding circuit under any alarm condition, except for a motor temperature fault or a circuit overload. The “ON” position is for diagnostics or to clear alarms. The system should never be left unattended while any switch is in the “ON” position.
- Any switch in the “REMOTE” position and the associated human machine interface (HMI) “AUTO/MANUAL” pushbutton in the “MANUAL” position will operate the corresponding circuit under any alarm condition once the HMI “START” pushbutton is depressed, except for a motor temperature fault or a circuit overload. This position is for diagnostics or to clear alarms. The system should never be left unattended while any switch is in this mode of operation.
- When the ODC wells and CF Control Valve are in the “REMOTE” and the HMI “MANUAL” position, the ODC wells will run via a manual-speed setpoint entered on the HMI (0-100%) and the valve will move to the position entered on the HMI (0-100%)
- To reset an alarm, switch all switches to the “OFF” position. Clear the cause of the alarm condition. Then the press the “RESET” button on the Operator Interface. If the panel will not reset, then an alarm condition still exists.
- Building Sump Pump will run via its own integral floats.
- Pressing any “EMERGENCY STOP” will shut down all motors immediately, including the Building Sump Pump. This occurs both in the “ON” and “REMOTE” position.
- All alarms indicated on the operator interface that DO NOT shut down equipment will initiate a remote notification via the cellular modem.
- All Dwell Timers allow the associated pump to continue to run past its off setpoint for the time period entered on the HMI. The Delay Timers entered on the HMI will not allow the associated pump to restart until its time period has expired. These timers are designed to minimize the number of starts for the pump.
- The CF Sump Pump P-1-2 also has a three-position switch located at the pump on the berm at the CF pond. To operate the CF Sump Pump from the control panel, this switch must be in the “REMOTE” position. If in the “OFF” position, the pump is disabled and will not run via the main control panel. Placing the switch in the “ON” position will bypass all control functions from the main control panel except for a motor overtemperature fault, circuit overload, or if the “EMERGENCY STOP” is depressed.
- To operate the Diffused Aeration Tank (DAT), open the valve from the influent header to the DAT and close the valve to the influent tank. Turn the DAT switch on the control panel to the “REMOTE” position. To run the system without the DAT, adjust the valves to from the header to bypass the DAT and move water directly to the influent tank. Turn off the breaker for the DAT in the breaker panel. Turn the switch for the DAT to the “REMOTE” position on control panel. NOTE THAT THE SYSTEM WILL NOT RUN UNLESS THE DAT SWITCH IS IN THE “REMOTE” POSITION.
- To operate the metering pump, make sure that the influent end of the tubing is in the drum, and turn the metering pump switch on the control panel to the “REMOTE” position.

6.3.1.3 Normal Startup

1. Place Influent Pump P-2-1 into the “REMOTE” position via the three-position switch on panel door.
   a. On the “TREATMENT BUILDING SCREEN”:
      i. Ensure the HMI “AUTO/MANUAL” pushbutton is in the “AUTO” mode.
      ii. Observe the “PUMP START” and “PUMP OFF” setpoint. Adjust if required.

2. Place WCC EW-1 into the “REMOTE” position via the three-position switch on panel door.
   a. On the “WCC EXTRACTION WELL SCREEN”:
      i. Ensure the HMI “AUTO/MANUAL” pushbutton is in the “AUTO” mode.
3. Place WCC EW-2 into the “REMOTE” position via the three-position switch on panel door.
   a. On the “WCC EXTRACTION WELL SCREEN”:
      i. Ensure the HMI “AUTO/MANUAL” pushbutton is in the “AUTO” mode.
4. Place ODC EW-1 into the “REMOTE” position via the three-position switch on panel door.
   a. On the “ODC EXTRACTION WELL SCREEN”:
      i. Ensure the HMI “AUTO/MANUAL” pushbutton is in the “AUTO” mode.
      ii. Select “CONTROL MODE” operation. If “LEVEL” is selected, enter the desired level setpoint on the “ENTER LEVEL SP” button.
      iii. Select “CONTROL MODE” operation. If “DIFFERENTIAL” is selected, enter the desired level setpoint on the “ENTER DIF SP” button.
5. Place ODC EW-2 into the “REMOTE” position via the three-position switch on panel door.
   a. On the “ODC EXTRACTION WELL SCREEN”:
      i. Ensure the HMI “AUTO/MANUAL” pushbutton is in the “AUTO” mode.
      ii. Select “CONTROL MODE” operation. If “LEVEL” is selected, enter the desired level setpoint on the “ENTER LEVEL SP” button.
      iii. Select “CONTROL MODE” operation. If “DIFFERENTIAL” is selected, enter the desired level setpoint on the “ENTER DIF SP” button.
6. Place INFLUENT VALVE FCV 2-1 into the “REMOTE” position via the three-position switch on panel door.
   a. On the “CONSOLIDATION FACILITY SUMP SCREEN”:
      i. Ensure the HMI “AUTO/MANUAL” pushbutton is in the “AUTO” mode.
      ii. On the “TREATMENT BUILDING SCREEN”, Enter the desired treatment system maximum flow. The valve will attempt to maintain a flow rate determined by subtracting the WCC Wells and ODC Wells flows from the maximum flow rate entered on the “TREATMENT BUILDING SCREEN”.
7. Place Consolidated Facility Sump Pump P-1-2 into the “REMOTE” position via the three-position switch on panel door.
   a. On the “TREATMENT BUILDING SCREEN”:
      i. Ensure the HMI “AUTO/MANUAL” pushbutton is in the “AUTO” mode.
      ii. Observe the “PUMP START” and “PUMP OFF” setpoint. Adjust if required.

6.3.1.4 Normal Shutdown

1. Place Influent Pump P-2-1 into the “OFF” position.
2. Place WCC EW-1 into the “OFF” position.
3. Place WCC EW-2 into the “OFF” position.
4. Place ODC EW-1 into the “OFF” position.
5. Place ODC EW-2 into the “OFF” position.
6. Place INFLUENT VALVE FCV 2-1 into the “OFF” position.
7. Place Consolidated Facility Sump Pump P-1-2 into the “OFF” position.

6.3.2 Operation Description Interlocks

In the “REMOTE” position and with the HMI “AUTO/MANUAL” pushbutton in the “AUTO” position.

6.3.2.1 West Containment Cell, EW-1 Pump P-1-1-1

To manually run the pump from the control panel, the “WCC EW-1 P-1-1-1” selector switch at the control panel CP-1 should be set to the “ON” position. The pump will run continuously unless an

interlock is not satisfied. To stop the pump and disable operation, “WCC EW-1 P-1-1-1” selector switch at the control panel CP-1 should be set to the “OFF” position.

Local Mode On Interlocks

- Pump Motor High Temperature Switch is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Local Mode Off Interlocks

- None.

Remote Mode Common Start Interlocks

- Restart Delay is NOT active.
- Pump is NOT out -of-service.
- Pump Run Fail (or Motor High Temperature Switch) Alarm is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Influent Tank Level Transmitter LIT-2-1 is NOT out-of-service, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 Failure Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 High-High Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level (Mech. Float) Switch LSHH-2-1 high-high level is NOT active.
- Storage Tank Level (Mech. Float) Switch LSHH-6-1 High-High Alarm is NOT active.
- Building Sump Level (Mech. Float) Switch LSHH-7-1 High-High Alarm is NOT active.
- Building Loss of Power JSL-10-1 Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Remote Mode Common Stop Interlocks

- Minimum Runtime Dwell is NOT active.

To manually run the pump from the Operator Interface Terminal (OIT), the “WCC EW-1 P-1-1-1” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then from the menu bar on the OIT, press the “WCC Wells” button. Press the “Auto/Manual” button to switch the pump to “Manual”. Press the “Start” button to start the pump. The pump will run continuously unless an interlock is not satisfied. To turn, stop the pump and disable operation, press the “Stop” Button.

Remote Mode Manual Interlocks

- None.

To automatically run the pump from the OIT, the “WCC EW-1 P-1-1-1” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then from the menu bar on the OIT press the “WCC Wells” button. Press the “Auto/Manual” button to switch the pump to “Auto”. The pump will run intermittently based on receiving the Run (Request) from the Level Controller unless an interlock is not satisfied. The level controller determines when to run based the status of the pump on level probe and the pump off level probe in the well.

Remote Mode Auto Interlocks

- Well Recovery Delay is NOT active.
- WCC Containment Cell Flow Transmitter FIT 1-1 Low Flow Delay is NOT active, or the WCC Flow Transmitter FIT-1-1 is NOT in service.
- WCC Containment Cell Flow Transmitter FIT 1-1 Failure Alarm is NOT active, or the WCC Flow Transmitter FIT-1-1 is NOT in service.
- WCC Containment Cell Flow Transmitter FIT 1-1 Low-Low Alarm is NOT active, or the WCC Flow Transmitter FIT-1-1 is NOT in service.
- Diffused Aeration Tank Level (Mech. Float) Switch LSHH-9-1 high-high level is NOT active, or the Aeration Blower is NOT in service.
- Aeration Blower is running, or the Aeration Blower is NOT in service.

6.3.2.2 West Containment Cell, EW-2 Pump P-1-1-2

To manually run the pump from the control panel, the “WCC EW-2 P-1-1-2” selector switch at the control panel CP-1 should be set to the “ON” position. The pump will run continuously unless an interlock is not satisfied. To stop the pump and disable operation, “WCC EW-2 P-1-1-2” selector switch at the control panel CP-1 should be set to the “OFF” position.

Local Mode On Interlocks

- Pump Motor High Temperature Switch is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Local Mode Off Interlocks

- None.

Remote Mode Common Start Interlocks

- Restart Delay is NOT active.
- Pump is NOT out -of-service.
- Pump Run Fail (or Motor High Temperature Switch) Alarm is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Influent Tank Level Transmitter LIT-2-1 is NOT out-of-service, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 Failure Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 High-High Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level (Mech. Float) Switch LSHH-2-1 high-high level is NOT active.
- Storage Tank Level (Mech. Float) Switch LSHH-6-1 High-High Alarm is NOT active.
- Building Sump Level (Mech. Float) Switch LSHH-7-1 High-High Alarm is NOT active.
- Building Loss of Power JSL-10-1 Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Remote Mode Common Stop Interlocks

- Minimum Runtime Dwell is NOT active.

To manually run the pump from the OIT, the “WCC EW-2 P-1-1-2” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then from the menu bar on the OIT, press the “WCC Wells” button. Press the “Auto/Manual” button to switch the pump to “Manual”. Press the “Start” button to start the pump. The pump will run continuously unless an interlock is not satisfied. To turn stop the pump and disable operation, press the “Stop” Button.

Remote Mode Manual Interlocks

- None.

To automatically run the pump from the OIT, the “WCC EW-2 P-1-1-2” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then from the menu bar on the OIT, press the “WCC Wells” button. Press the “Auto/Manual” button to switch the pump to “Auto”. The pump will run intermittently based on receiving the Run (Request) from the Level Controller unless an interlock is not satisfied. The level controller determines when to run based the status of the pump on level probe and the pump off level probe in the well.

Remote Mode Auto Interlocks

- Well Recovery Delay is NOT active.
- WCC Containment Cell Flow Transmitter FIT-1-1 Low Flow Delay is NOT active, or the WCC Flow Transmitter FIT-1-1 is NOT in service.
- WCC Containment Cell Flow Transmitter FIT-1-1 Failure Alarm is NOT active, or the WCC Flow Transmitter FIT-1-1 is NOT in service.
- WCC Containment Cell Flow Transmitter FIT-1-1 Low-Low Alarm is NOT active, or the WCC Flow Transmitter FIT-1-1 is NOT in service.
- Diffused Aeration Tank Level (Mech. Float) Switch LSHH-9-1 high-high level is NOT active, or the Aeration Blower is NOT in service.
- Aeration Blower is running, or the Aeration Blower is NOT in service.

6.3.2.3 Consolidation Facility, Sump Pump P-1-2

To manually run the pump from the control panel, the “CF Sump Pump P-1-2” selector switch at the control panel CP-1 should be set to the “ON” position, and the “On/Off/Remote” selector switch at the Consolidation Facility should be set to the “REMOTE” position. The pump will run continuously unless an interlock is not satisfied. To stop the pump and disable operation, “CF Sump Pump P-1-2” selector switch at the control panel CP-1 should be set to the “OFF” position.

To manually run the pump from the CF, the “On/Off/Remote” selector switch at the CF should be set to the “ON” position. The position of the “CF Sump Pump P-1-2” selector switch does not matter.
The pump will run continuously unless an interlock is not satisfied. To stop the pump and disable operation, “On/Off/Remote” selector switch at the CF should be set to the “OFF” position.

Local Mode On Interlocks

- Pump Motor High Temperature Switch is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Local Mode Off Interlocks

- None.

Remote Mode Common Start Interlocks

- Restart Delay is NOT active.
- Pump is NOT out -of-service.
- Pump Run Fail (or Motor High Temperature Switch) Alarm is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Influent Tank Level Transmitter LIT-2-1 is NOT out-of-service, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 Failure Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 High-High Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level (Mech. Float) Switch LSHH-2-1 high-high level is NOT active.
- Storage Tank Level (Mech. Float) Switch LSHH-6-1 High-High Alarm is NOT active.
- Building Sump Level (Mech. Float) Switch LSHH-7-1 High-High Alarm is NOT active.
- Building Loss of Power JSL-10-1 Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Remote Mode Common Stop Interlocks

- Minimum Runtime Dwell is NOT active.

To manually run the pump from the OIT, the “CF Sump Pump P-1-2” selector switch at the control panel CP-1 should be set to the “REMOTE” position, and the “On/Off/Remote” selector switch at the CF should be set to the “REMOTE” position. The “CF Valve FCV-1-2” selector switch at the control panel should be set to the “ON” or “REMOTE” position. Then from the menu bar on the OIT press the “Cons. Facility” button. Press the “Auto/Manual” button to switch the pump to “Manual”. Press the “Start” button to start the pump. The pump will run continuously unless an interlock is not satisfied. To turn stop the pump and disable operation, press the “Stop” Button.

Remote Mode Manual Interlocks

- None.

To automatically run the pump from the OIT, the “CF Sump Pump P-1-2” selector switch at the control panel CP-1 should be set to the “REMOTE” position, and the “On/Off/Remote” selector switch at the CF should be set to the “REMOTE” position. The “CF Valve FCV-1-2” selector switch at the control panel should be set to the “ON” or “REMOTE” position. Then, from the menu bar on the OIT, press the “Cons. Facility” button. Press the “Auto/Manual” button to switch the pump to “Auto”. The pump will run intermittently based on level logic unless an interlock is not satisfied. The level logic will start the pump at the CF sump start level and stop the pump at the stop level. The available flow is calculated based on the maximum effluent flow setpoint for continuous operation minus the flow of the other influent pumps.

Remote Mode Auto Interlocks

- Available Flow is NOT less than the minimum flow setpoint.
- CF Level Transmitter LIT-1-1 is NOT out-of-service.

- CF Level Transmitter LIT-1-2 Failure Alarm is NOT active.
- CF Level Transmitter LIT-1-2 Low-Low Alarm is NOT active.
- CF Flow Transmitter FIT-1-1 is NOT out-of-service.
- CF Flow Transmitter FIT-1-2 Failure Alarm is NOT active.
- CF Flow Transmitter FIT-1-2 Low-Low Alarm is NOT active.
- Diffused Aeration Tank Level (Mech. Float) Switch LSHH-9-1 high-high level is NOT active, or the Aeration Blower is NOT in service.
- Aeration Blower is running, or the Aeration Blower is NOT in service.

6.3.2.4 Consolidation Facility, Flow Control Valve FCV-1-2

To manually operate the flow control valve from the control panel, the “CF Valve FCV-1-2” selector switch at the control panel CP-1 should be set to the “ON” position. The flow control valve will be enabled and travel to set position unless an interlock is not satisfied. To disable the flow control valve operation, “CF Valve FCV-1-2” selector switch at the control panel CP-1 should be set to the “OFF” position.

Local Mode On Interlocks

- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Local Mode Off Interlocks

- None.

Remote Mode Common Interlocks

- Treatment System Stop Pushbutton HS-10-1 is NOT active.

To manually operate the flow control valve from the OIT, the “CF Valve FCV-1-2” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then, from the menu bar on the OIT, press the “Cons. Facility” button. Press the “Auto/Manual” button to switch the pump to “Manual”. Press the “Start” button to enable the flow control valve. The flow control valve will travel to set position unless an interlock is not satisfied. To disable the flow control valve operation, press the “Stop” Button. The valve will maintain its current position.

Remote Mode Manual Interlocks

- None.

To automatically operate the flow control valve from the OIT, the “CF Valve FCV-1-2” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then, from the menu bar on the OIT, press the “Cons. Facility” button. Press the “Auto/Manual” button to switch the pump to “Auto”. The flow control valve will operate intermittently based on flow logic unless an interlock is not satisfied.

Remote Mode Auto Interlocks

- None.

6.3.2.5 ODC Containment Cell, EW-1 Pump P-1-3-1

To manually run the pump from the control panel, the “ODC EW-1 P-1-3-1” selector switch at the control panel CP-1 should be set to the “ON” position. The pump will run continuously at the manual-speed command setting unless an interlock is not satisfied. To stop the pump and disable operation, “ODC EW-1 P-1-3-1” selector switch at the control panel CP-1 should be set to the “OFF” position.

Local Mode On Interlocks

- Pump Motor High Temperature Switch is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Local Mode Off Interlocks

- None.

Remote Mode Common Start Interlocks

- Restart Delay is NOT active.
- Pump is NOT out -of-service.
- Pump Run Fail (or Motor High Temperature Switch) Alarm is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Influent Tank Level Transmitter LIT-2-1 is NOT out-of-service, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 Failure Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 High-High Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level (Mech. Float) Switch LSHH-2-1 high-high level is NOT active.
- Storage Tank Level (Mech. Float) Switch LSHH-6-1 High-High Alarm is NOT active.
- Building Sump Level (Mech. Float) Switch LSHH-7-1 High-High Alarm is NOT active.
- Building Loss of Power JSL-10-1 Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Remote Mode Common Stop Interlocks

- Minimum Runtime Dwell is NOT active.

To manually run the pump from the OIT, the “ODC EW-1 P-1-3-1” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then, from the menu bar on the OIT, press the “WCC Wells” button. Press the “Auto/Manual” button to switch the pump to “Manual”. Press the “Start” button to start the pump. The pump will run continuously at the manual-speed command setting unless an interlock is not satisfied. To turn stop the pump and disable operation, press the “Stop” Button.

Remote Mode Manual Interlocks

- None.

To automatically run the pump from the OIT, the “ODC EW-1 P-1-3-1” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then, from the menu bar on the OIT, press the “WCC Wells” button. Press the “Auto/Manual” button to switch the pump to “Auto”. The pump will run intermittently based on receiving the Run (Request) from the level logic unless an interlock is not satisfied. The pump will run intermittently based on level logic unless an interlock is not satisfied.

Remote Mode Auto Interlocks

- Well Recovery Delay is NOT active.
- ODC Containment Cell EW-1 Level Transmitter LIT-1-3-1 is NOT out-of-service.

- ODC Containment Cell EW-1 Level Transmitter LIT-1-3-1 Failure Alarm is NOT active.
- ODC Containment Cell EW-1 Level Transmitter LIT-1-3-1 Low-Low Alarm is NOT active.
- ODC Containment Cell EW-1 Flow Transmitter FIT-1-3-1 Low Flow Delay is NOT active, or the ODC Containment Cell EW-1 Flow Transmitter FIT-1-3-1 is NOT in service.
- ODC Containment Cell EW-1 Flow Transmitter FIT-1-3-1 Failure Alarm is NOT active, or the ODC Containment Cell EW-1 Flow Transmitter FIT-1-3-1 is NOT in service.
- ODC Containment Cell EW-1 Flow Transmitter FIT-1-3-1 Low-Low Alarm is NOT active, or the ODC Containment Cell EW-1 Flow Transmitter FIT-1-3-1 is NOT in service.
- Diffused Aeration Tank Level (Mech. Float) Switch LSHH-9-1 high-high level is NOT active, or the Aeration Blower is NOT in service.
- Aeration Blower is running, or the Aeration Blower is NOT in service.

6.3.2.6 ODC Containment Cell, EW-2 Pump P-1-3-2

To manually run the pump from the control panel, the “ODC EW-2 P-1-3-2” selector switch at the control panel CP-1 should be set to the “ON” position. The pump will run continuously at the manual-speed command setting unless an interlock is not satisfied. To stop the pump and disable operation, “ODC EW-2 P-1-3-2” selector switch at the control panel CP-1 should be set to the “OFF” position.

Local Mode On Interlocks

- Pump Motor High Temperature Switch is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Local Mode Off Interlocks

- None.

Remote Mode Common Start Interlocks

- Restart Delay is NOT active.
- Pump is NOT out-of-service.
- Pump Run Fail (or Motor High Temperature Switch) Alarm is NOT active.
- Pump Fail (Motor Overload) Alarm is NOT active.
- Influent Tank Level Transmitter LIT-2-1 is NOT out-of-service, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 Failure Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 High-High Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level (Mech. Float) Switch LSHH-2-1 high-high level is NOT active.
- Storage Tank Level (Mech. Float) Switch LSHH-6-1 High-High Alarm is NOT active.
- Building Sump Level (Mech. Float) Switch LSHH-7-1 High-High Alarm is NOT active.
- Building Loss of Power JSL-10-1 Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Remote Mode Common Stop Interlocks

- Minimum Runtime Dwell is NOT active.

To manually run the pump from the OIT, the “ODC EW-2 P-1-3-2” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then, from the menu bar on the OIT, press the “WCC Wells” button. Press the “Auto/Manual” button to switch the pump to “Manual”. Press the “Start” button to start the pump. The pump will run continuously at the manual-speed command setting unless an interlock is not satisfied. To turn stop the pump and disable operation, press the “Stop” Button.

Remote Mode Manual Interlocks

- None.

To automatically run the pump from the OIT, the “ODC EW-2 P-1-3-2” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then, from the menu bar on the OIT, press the “WCC Wells” button. Press the “Auto/Manual” button to switch the pump to “Auto”. The pump will run intermittently based on receiving the Run (Request) from the level logic unless an interlock is not satisfied. The pump will run intermittently based on level logic unless an interlock is not satisfied.

Remote Mode Auto Interlocks

- Well Recovery Delay is NOT active.
- ODC Containment Cell EW-2 Level Transmitter LIT-1-3-2 is NOT out-of-service.
- ODC Containment Cell EW-1 Level Transmitter LIT-1-3-2 Failure Alarm is NOT active.
- ODC Containment Cell EW-2 Level Transmitter LIT-1-3-2 Low-Low Alarm is NOT active.
- ODC Containment Cell EW-2 Flow Transmitter FIT-1-3-2 Low Flow Delay is NOT active, or the ODC Containment Cell EW-2 Flow Transmitter FIT-1-3-2 is NOT in service.
- ODC Containment Cell EW-2 Flow Transmitter FIT-1-3-2 Failure Alarm is NOT active, or the ODC Containment Cell EW-2 Flow Transmitter FIT-1-3-2 is NOT in service.
- ODC Containment Cell EW-2 Flow Transmitter FIT-1-3-2 Low-Low Alarm is NOT active, or the ODC Containment Cell EW-2 Flow Transmitter FIT-1-3-2 is NOT in service.
- Diffused Aeration Tank Level (Mech. Float) Switch LSHH-9-1 high-high level is NOT active, or the Aeration Blower is NOT in service.
- Aeration Blower is running, or the Aeration Blower is NOT in service.

6.3.2.7 Chemical Feed Pump P-8-1

To manually run the pump from the control panel, the “CHEM FEED SYSTEM” selector switch at the control panel CP-1 should be set to the “ON” position. The pump will run continuously at the manual flow rate setting unless an interlock is not satisfied. To stop the pump and disable operation, “CHEM FEED SYSTEM” selector switch at the control panel CP-1 should be set to the “OFF” position.

Local Mode On Interlocks

- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Local Mode Off Interlocks

- None.

Remote Mode Common Start Interlocks

- Restart Delay is NOT active.
- Pump is NOT out-of-service.
- Influent Tank Level Transmitter LIT-2-1 is NOT out-of-service, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 Failure Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level Transmitter LIT-2-1 High-High Alarm is NOT active, or the Backup Float Mode is active.
- Influent Tank Level (Mech. Float) Switch LSHH-2-1 high-high level is NOT active.
- Storage Tank Level (Mech. Float) Switch LSHH-6-1 High-High Alarm is NOT active.
- Building Sump Level (Mech. Float) Switch LSHH-7-1 High-High Alarm is NOT active.
- Building Loss of Power JSL-10-1 Alarm is NOT active.
- Treatment System Stop Pushbutton HS-10-1 is NOT active.

Remote Mode Common Stop Interlocks

- Minimum Runtime Dwell is NOT active.

To manually run the pump from the OIT, the “CHEM FEED SYSTEM” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then, from the menu bar on the OIT, press the “Treatment Inf. Tank” button. Press the “Auto/Manual” button to switch the pump to “Manual”. Press the “Start” button to start the pump. The pump will run continuously at the manual flow rate setting unless an interlock is not satisfied. To turn stop the pump and disable operation, press the “Stop” Button.

Remote Mode Manual Interlocks

- None.

To automatically run the pump from the OIT, the “CHEM FEED SYSTEM” selector switch at the control panel CP-1 should be set to the “REMOTE” position. Then from the menu bar on the OIT press the “Treatment Inf. Tank” button. Press the “Auto/Manual” button to switch the pump to “Auto”. The pump will operate intermittently based on flow logic pacing to influent flow unless an interlock is not satisfied.

Remote Mode Auto Interlocks

- WCC Containment Cell Flow Transmitter FIT-1-1 Failure Alarm is NOT active.
- CF Flow Transmitter FIT-1-2 Failure Alarm is NOT active.
- ODC Containment Cell EW-1 Flow Transmitter FIT-1-3-1 Failure Alarm is NOT active.
- ODC Containment Cell EW-2 Flow Transmitter FIT-1-3-2 Failure Alarm is NOT active.

6.4 Operation

6.4.1 Interface Layout

The OIT screen layout is divided into four major components: a title bar, a building intrusion monitoring bar, a menu bar, and an alarm message bar, which are present on every screen for consistency.

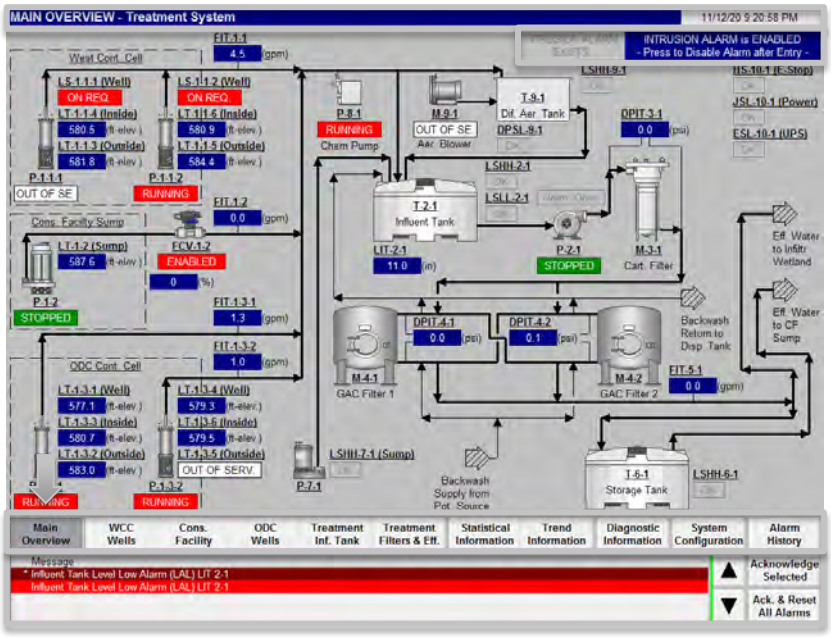


Figure 6-1. Main Overview, Treatment System Screen

The title bar is located at the top of the screen. It displays the screen title and current time. The time displayed is pulled from the PLC and is set by the PLC. The PLC synchronizes its time using a NTP server. In this case, the NTP server is the Remote Access Gateway, which acts as an NTP relay.

The building intrusion monitoring bar is located at the top of the screen below the title bar. It displays the status of the intrusion system and allows for enabling and disabling of the system (see Section 10.10 in Appendix C for more information).

The menu bar is located at the bottom of the screen above the alarm message bar. Table 6-1 contains a functional description for each of the screens accessed via the menu bar.

Table 6-1. OIT Screen Navigation

OIT Screen	Description
Main Overview	The Main Overview of the Treatment System screen displays an overview of the current system operation. It provides no control. Status consists of equipment status, levels, flows, and pressures. For control, navigate to either the “WCC Wells”, “Cons. Facility”, “ODC Wells”, “Treatment Inf. Tank”, or “Treatment Filters & Eff.” screens.
WCC Wells	The West Containment Cell Extraction Wells 1 and 2 screen displays status and control information for the well pumps.
Cons. Facility	The Containment Facility Sump screen displays status and control information for the sump pump.
ODC Wells	The ODC Containment Cell Extraction Wells 1 and 2 screen displays status and control information for the well pumps.

Table 6-1. OIT Screen Navigation

OIT Screen	Description
Treatment Inf. Tank	The Treatment Building Influent Tank and Pump screen displays status and control information for the Chemical Feed Pump, aeration blower, diffused aeration tank, influent tank, and influent tank pump.
Treatment Filters & Eff.	The Treatment Building Influent Filters and Effluent screen displays status and control information for the cartridge filter, liquid GAC filters, storage tank, and storage tank pump.
Statistical Information	The Statistical Information screen displays the daily minimum and maximum values and daily, weekly, monthly, and yearly totals for various analog signals.
Trend Information	The Trend Information screens display the status of various levels, flows, and pressures on trends over time.
Diagnostic Information	The Diagnostic Information screens display the status of the PLC discrete and analog I/O.
System Configuration	The System Configuration screens display the analog input configuration settings, building intrusion monitoring system configuration settings, and allows access to OIT settings.
Alarm History	The Alarm History screen displays the alarm history recorded by the OIT.

The alarm message bar is located at the bottom. It displays the current status of active alarms. The up and down selection buttons allow a specific alarm to be selected and acknowledged by pressing the “Acknowledge Selected” button. All active alarms are highlighted in red, and active alarms that are unacknowledged will blink. All inactive alarms are not displayed.

6.4.2 Equipment Operation

Equipment can be controlled directly from the Control Panel CP-1 using the On-Off-Remote selector switches or through the OIT. An On-Off-Remote selector switch is located at the CF for local operation. Local operation overrides any control from the OIT; to control any equipment from the OIT, the associated selector switch must be in “Remote”.

6.4.2.1 Off Mode

When the On-Off-Remote selector switch is in the “Off” position, the OIT will indicate “Off” for the given equipment. The “In Service/Out of Service” button will have no effect in this mode because the selector switch is not in “Remote”.

Figure 6-2. Off Mode

6.4.2.2 On Mode

When the On-Off-Remote selector switch is in the “On” position, the OIT will indicate “On” for the given equipment. The “In Service/Out of Service” button will have no effect in this mode because the selector switch is not in “Remote”.

Figure 6-3. On Mode

6.4.2.3 Remote Mode, Manual Control

When the On-Off-Remote selector switch is in the “Remote” position, the OIT will indicate “Remote” for the given equipment. Pressing the “Manual” button will toggle between manual and automatic control. When in “Manual” control, the equipment can be started and stopped using the “Start/Stop” button.

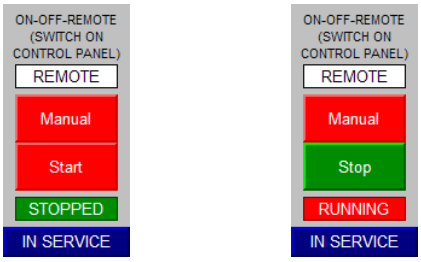


Figure 6-4. Remote Mode, Manual Control

6.4.2.4 Remote Mode, Auto Control

When the On-Off-Remote selector switch is in the “Remote” position, the OIT will indicate “Remote” for the given equipment. Pressing the “Auto” button will toggle between manual and automatic control. When in “Auto” control, the equipment will start and stop automatically based on logic in the PLC.

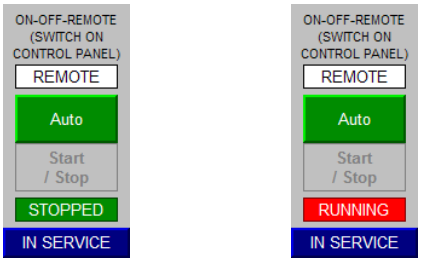


Figure 6-5. Remote Mode, Manual Control

6.4.2.5 Remote Mode, In Service / Out of Service

When the On-Off-Remote selector switch is in the “Remote” position, the OIT will indicate “Remote” for the given equipment. Pressing the “In Service/Out of Service” button will toggle between in service and out of service. When “Out of Service”, manual and automatic control will be disabled.

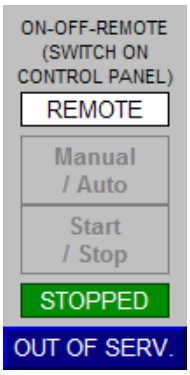


Figure 6-6. Remote Mode, In Service/Out of Service

6.4.3 West Containment Cell

The West Containment Cell screen provides status and control for the West Containment Cell Extraction Wells.

6.4.3.1 General

The “On Req./Off Req.” status indicator provides status of the level controller for each extraction well.

The level transducers status shows the inward gradient for the cell.

A “Restart Delay Active” indicator will illuminate if the restart delay timer is active and will not allow the equipment to restart.

A “Min. Runtime Dwell Active” indicator will illuminate if the minimum runtime dwell timer is active and will keep the equipment from turning off until the timer is expired.

A “Well Recovery Delay Active” indicator will illuminate if a low flow condition is detected for more than a minute. The pump will be disabled for 30 minutes to allow the well to recover.

Equipment runtimes for the West Containment Cell Extraction Well pumps are displayed on and can be reset from this screen. To reset West Containment Cell EW-1 pump, press the “Reset Hour Meter” button located below the pump and enter the reset code “P-1-1-1”. To reset West Containment Cell EW-2 pump, press the “Reset Hour Meter” button located below the pump and enter the reset code “P-1-1-2”.

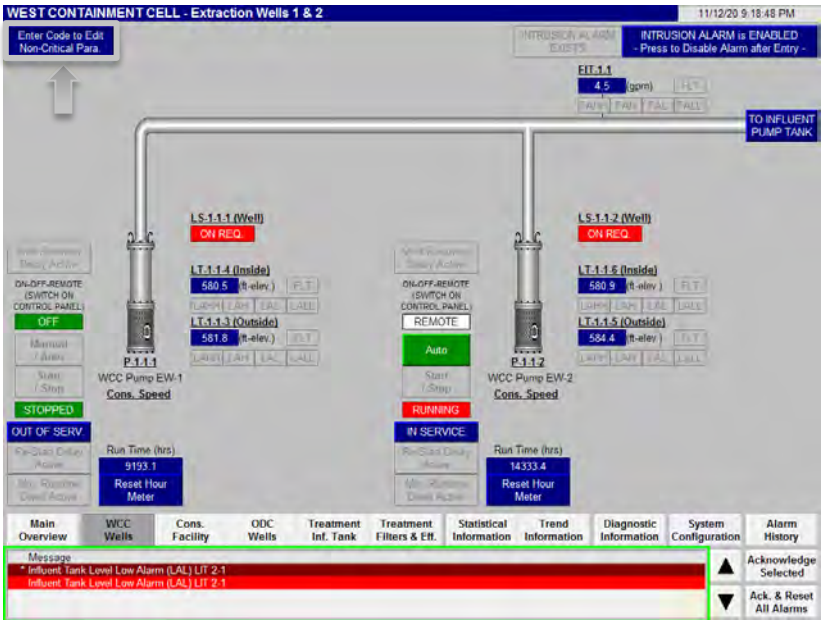


Figure 6-7. West Containment Cell Screen

6.4.3.2 Advanced Setup

Pressing the “Enter Code to Edit Non-Critical Para.” button in the upper left-hand corner will provide access to the advanced setup. Entering the code “Info” will enable the advanced setup. The code will be automatically cleared after 30 minutes after which the advanced setup will be disabled. Pressing the “Exit Non-Critical Para. Edit” button in the upper left-hand corner will also disable access to the advanced setup.

The advanced setup will allow for configuration pump restart delay on time and pump minimum dwell on time. For the West Containment Cell, the default delay on time is 864 seconds, and the default dwell time is 60 seconds.

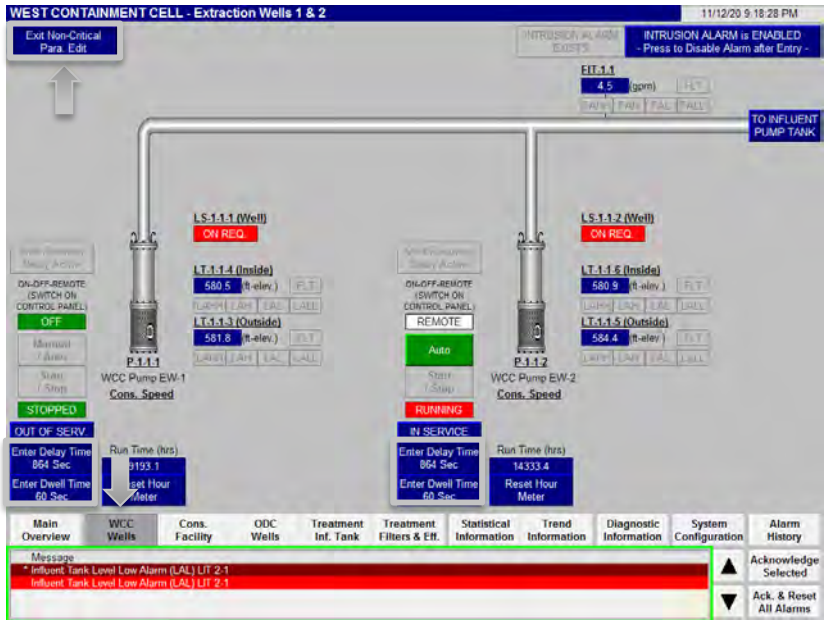


Figure 6-8. West Containment Cell Advanced Setup

6.4.4 Consolidation Facility Sump

The CF sump screen provides status and control for the CF sump.

6.4.4.1 General

The level transducer status shows the sump level.

A “Pump Start” and “Pump Stop” level setpoint is provided for automatic operation of the pump.

A “Valve Manual Position” setpoint is provided for the setting the manual position when the flow control valve is in “Manual” control.

Photoionization detector tuning setpoints are provided for tuning the flow control loop when the flow control valve is in “Auto” control.

The “Available Flow” status shows the maximum flow allowed for the CF sump; the flow control valve will modulate flow to stay below this calculated flow.

A “Restart Delay Active” indicator will illuminate if the restart delay timer is active and will not allow the equipment to restart.

A “Min. Runtime Dwell Active” indicator will illuminate if the minimum runtime dwell timer is active and will keep the equipment from turning off until the timer is expired.

Equipment runtimes for the CF sump are displayed on and can be reset from this screen. To reset CF Sump pump, press the “Reset Hour Meter” button located below the pump and enter the reset code “P-1-2”. To reset CF sump flow control valve, press the “Reset Hour Meter” button located below the flow control valve and enter the reset code “FCV-1-2”.

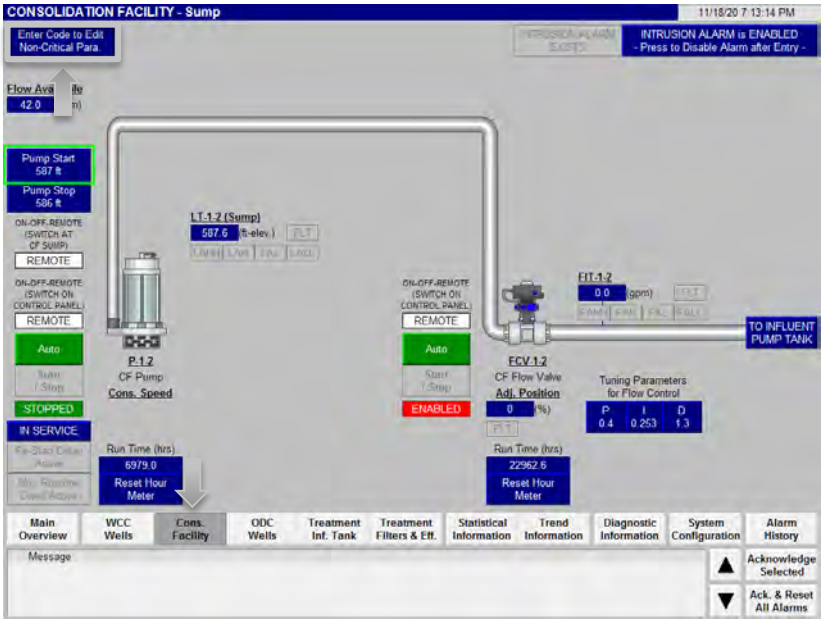


Figure 6-9. Consolidation Facility Sump Screen

6.4.4.2 Advanced Setup

Pressing the “Enter Code to Edit Non-Critical Para.” button in the upper left-hand corner will provide access to the advanced setup. Entering the code “Info” will enable the advanced setup. The code will be automatically cleared after 30 minutes, after which the advanced setup will be disabled. Pressing the

"Exit Non-Critical Para. Edit" button in the upper left-hand corner will also disable access to the advanced setup.

The advanced setup will allow for configuration pump minimum flow, pump restart delay on time, and pump minimum dwell on time. For the CF, the default delay on time is 864 seconds, and the default dwell time is 60 seconds.

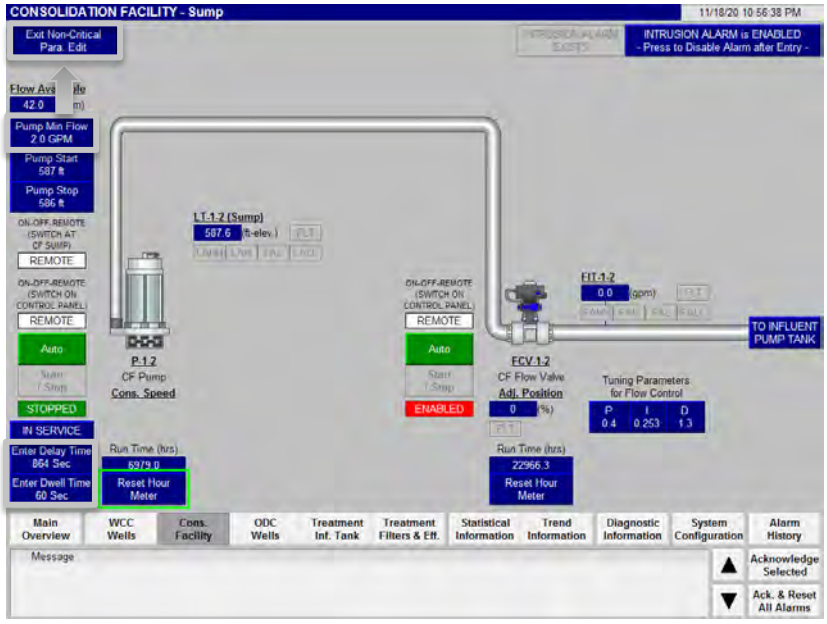


Figure 6-10. Consolidation Facility Advanced Setup

6.4.5 ODC Containment Cell

The ODC Containment Cell screen provides status and control for the ODC Containment Cell Extraction Wells.

6.4.5.1 General

The level transducers status shows the individual well levels and the inward gradient for the cell.

A "Pump Manual Speed" setpoint is provided for the setting the manual speed when the pump is in "Manual" control.

Photoionization detector tuning setpoints are provided for tuning the flow control loop when the pump is in "Auto" control.

Pressing the "Control Mode Level/Differential" button will toggle between "Level" and "Differential" control mode. In "Level" control mode, the pump will module its speed to maintain a level in the well. A "Level SP" is provided for setting the level setting in the well. In "Differential" control mode, the pump will modulate its speed to maintain a set differential across the cell wall. A "Diff. SP" is provided for setting the differential setting across the cell wall.

A "Restart Delay Active" indicator will illuminate if the restart delay timer is active and will not allow the equipment to restart.

A "Min. Runtime Dwell Active" indicator will illuminate if the minimum runtime dwell timer is active and will keep the equipment from turning off until the timer is expired.

A "Well Recovery Delay Active" indicator will illuminate if a low flow condition is detected for more than a minute. The pump will be disabled for 30 minutes to allow the well to recover.

Equipment runtimes for the ODC Containment Cell Extraction Well pumps are displayed on and can be reset from this screen. To reset ODC Containment Cell EW-1 pump, press the “Reset Hour Meter” button located below the pump and enter the reset code “P-1-3-1”. To reset ODC Containment Cell EW-2 pump, press the “Reset Hour Meter” button located below the pump and enter the reset code “P-1-3-2”.

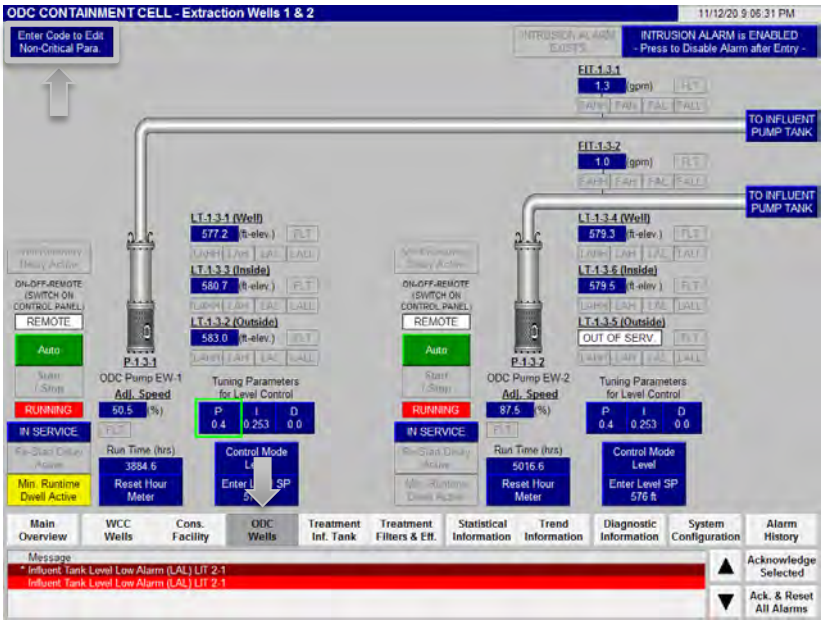


Figure 6-11. ODC Containment Cell Screen

6.4.5.2 Advanced Setup

Pressing the “Enter Code to Edit Non-Critical Para.” button in the upper left-hand corner will provide access to the advanced setup. Entering the code “Info” will enable the advanced setup. The code will be automatically cleared after 30 minutes, after which the advanced setup will be disabled. Pressing the “Exit Non-Critical Para. Edit” button in the upper left-hand corner will also disable access to the advanced setup.

The advanced setup will allow for configuration pump maximum speed, pump minimum speed, pump restart delay on time and pump minimum dwell on time. For the ODC Containment Cell, the default delay on time is 288 seconds, and the default dwell time is 60 seconds.

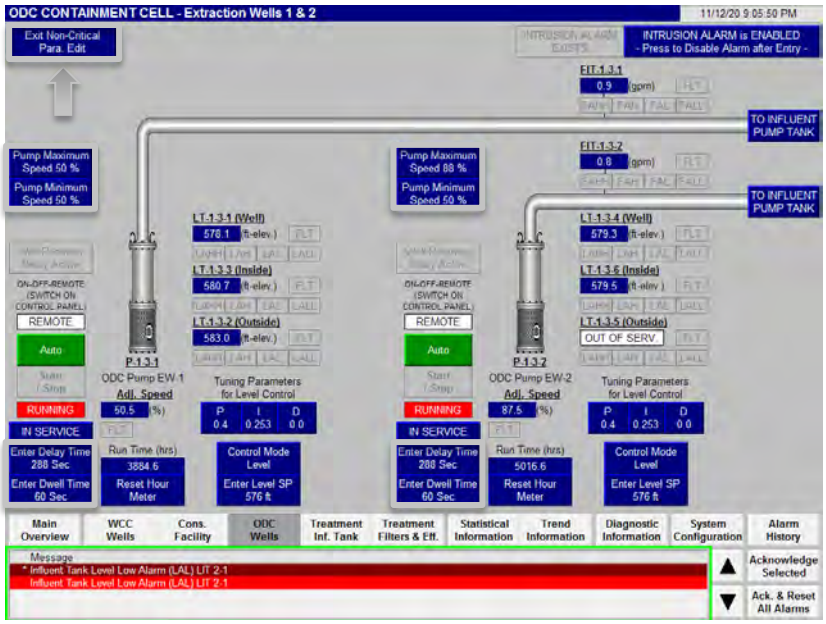


Figure 6-12. ODC Containment Cell Screen

6.4.6 Treatment Building – Influent Tank and Pump

The Treatment Building screen provides status and control for the Treatment Building equipment.

6.4.6.1 General

The level transducer status shows the influent tank level. A backup float system will take over in the event of a level transducer failure. Pressing the “Ack. & Reset All Alarms” button will clear the backup float mode provided the conditions are right and return the system to normal operation. A “Backup Oper.” Indicator will illuminate indicating the system is in backup float mode. In backup float mode the system will operation between the high-high level (mech. float) switch and the low-low level (mech. float) switch turning the Influent Tank Pump on and off.

A “Pump Start” and “Pump Stop” level setpoint is provided for automatic operation of the Influent Tank Pump.

A “Pump Manual Rate” setpoint is provided for the setting the manual flow rate when the Chemical Feed Pump is in “Manual” control.

A “Pacing Rate” setpoint is provided for the setting the pacing rate when the Chemical Feed Pump is in “Auto” control. The Chemical Feed Pump command is set by multiplying the pacing rate times the total influent flow.

A “Restart Delay Active” indicator will illuminate if the restart delay timer is active and will not allow the equipment to restart.

A “Min. Runtime Dwell Active” indicator will illuminate if the minimum runtime dwell timer is active and will keep the equipment from turning off until the timer is expired.

Equipment runtimes for the Treatment Building Aeration Blower and Influent Tank Pump are displayed on and can be reset from this screen. To reset Aeration Blower, press the “Reset Hour Meter” button located below the pump and enter the reset code “M-9-1”. To reset Influent Tank Pump, press the “Reset Hour Meter” button located below the flow control valve and enter the reset code “P-2-1”.

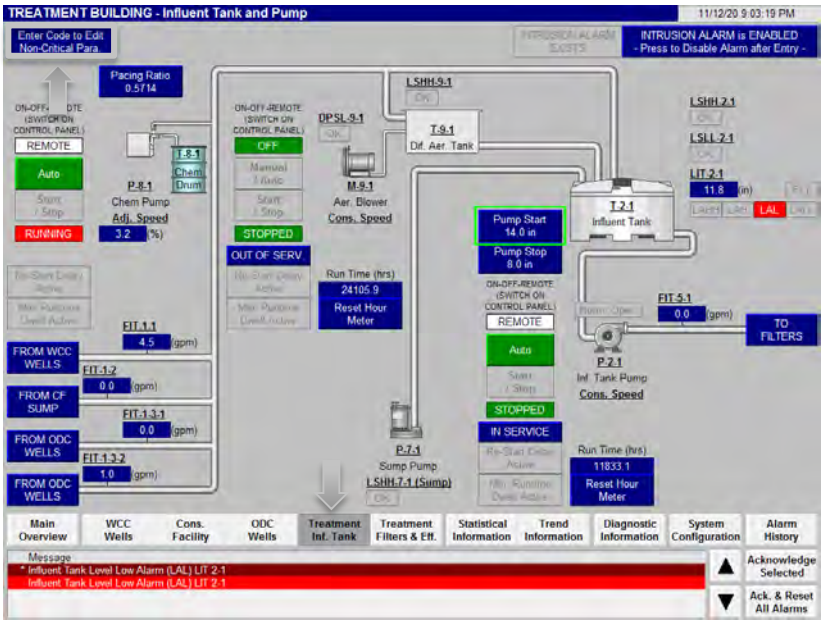


Figure 6-13. Treatment Building Influent Tank and Pump Screen

6.4.6.2 Advanced Setup

Pressing the “Enter Code to Edit Non-Critical Para.” button in the upper left-hand corner will provide access to the advanced setup. Entering the code “Info” will enable the advanced setup. The code will be automatically cleared after 30 minutes after which the advanced setup will be disabled. Pressing the “Exit Non-Critical Para. Edit” button in the upper left-hand corner will also disable access to the advanced setup.

The advanced setup will allow for configuration pump maximum speed, pump minimum speed, pump restart delay on time, and pump minimum dwell on time. For the treatment building Chemical Feed Pump, the default delay on time is 10 seconds and the default dwell time is 0 seconds. For the treatment building aeration blower, the default delay on time is 360 seconds, and the default dwell time is 0 seconds. For the treatment building influent tank pump, the default delay on time is 156 seconds, and the default dwell time is 20 seconds.

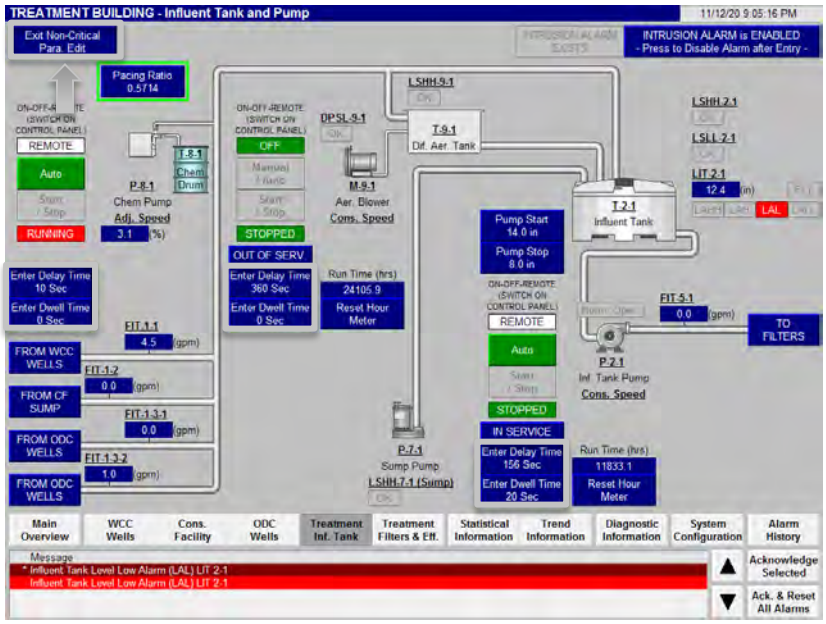


Figure 6-14. Treatment Building, Influent Tank and Pump Screen

6.4.7 Treatment Building – Filters and Effluent

The Treatment Building screen provides status and control for the Treatment Building filters and storage tank equipment.

The pressure differential transducer status for the cartridge filter and each of the liquid GAC filters is displayed on this screen.

The flow transducer status is displayed for the effluent flow from the Treatment Building. Flow can be routed to either to the Infiltration Wetland or CF sump.

A “Max. Flow Rate” and “Min. Flow Rate” setting is provided for adjusting the desired influent flow range. Ideally, the flow settings would match the effluent flow to minimize cycling of the effluent pump.

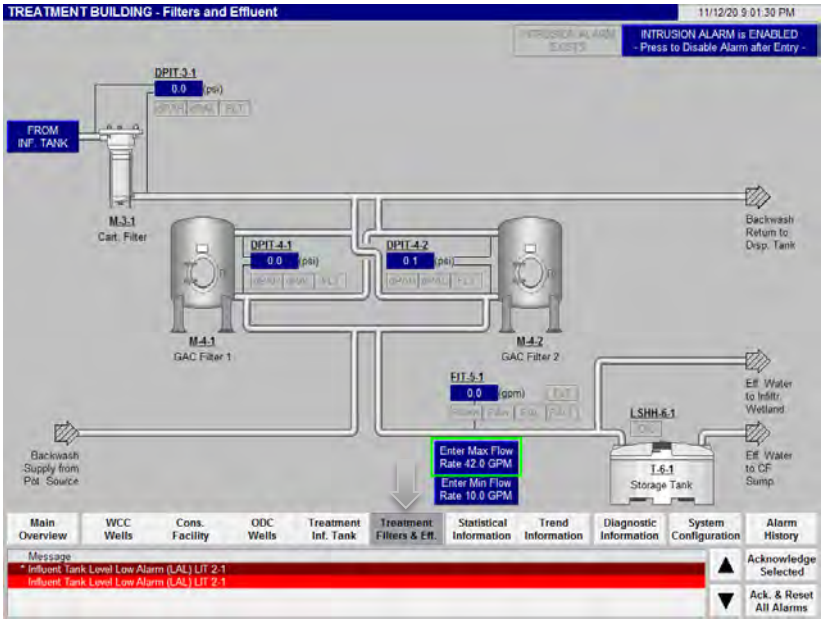


Figure 6-15. Treatment Building, Filters and Effluent Screen

6.5 Statistical Information

The Statistical Information screen shows the status of various process variables. It is accessed from the menu bar by pressing the “Statistical Information” button.

For level instruments, the current daily minimum and maximum levels are displayed. For pressure instruments, the current daily minimum and maximum pressures are displayed. For flow instruments, the current daily minimum and maximum flows are displayed. Additionally, for flow instruments, the current daily, weekly, monthly, and yearly total flows are displayed.

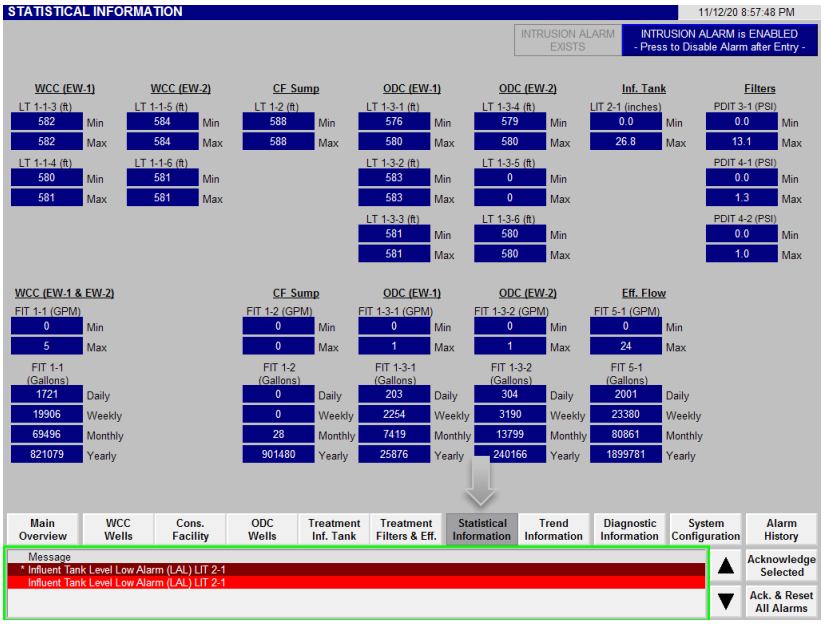


Figure 6-16. Statistical Information Screen

6.6 Trends

The Trend Information screens show the trends of various process variables. They are accessed from the menu bar by pressing the “Trend Information” button. To navigate between the diagnostic information submenus, click on the desired submenu bar “Flows”, “WCC Levels”, “CF Levels”, “ODC Levels”, “Influent Tank Level”, or “Pressures” button.

The trends show the status of various process variables. Each process variable is highlighted by its own color, which depends on the trend displayed. Pressing the “Toggle” button will highlight a specific process variable by bringing its trend to the foreground. Pressing the “Day” or “Month” button will change the current trend time display range from day to month.

The Trend Information screen for flows displays the influent and effluent flows over time.

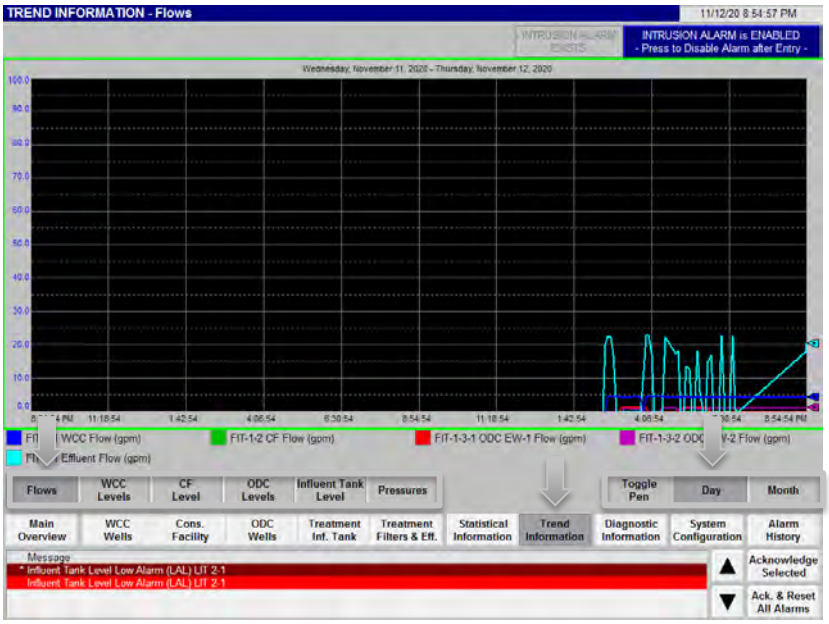


Figure 6-17. Trend Information Flows Screen

The Trend Information screen for the West Containment Cell displays the inside and outside levels over time. The actual extraction well levels are not monitored at this time.

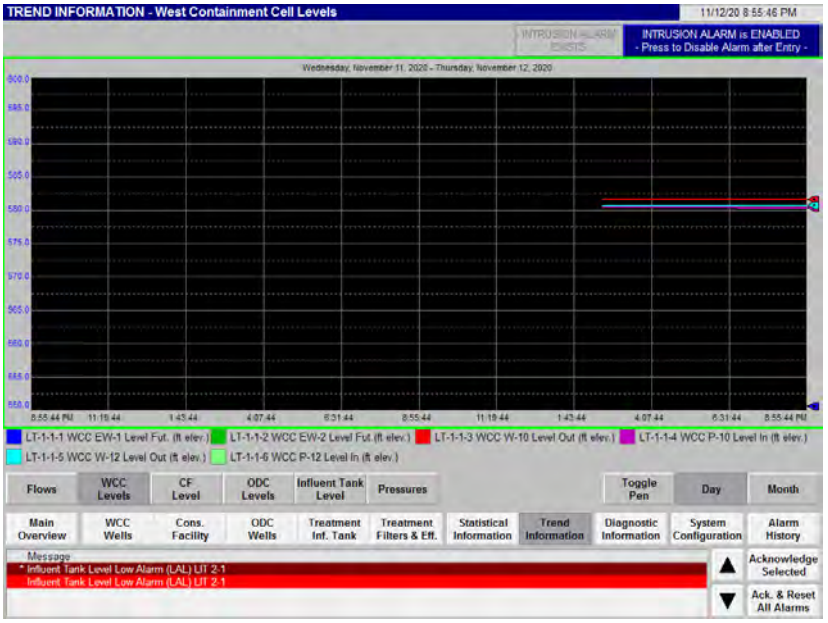


Figure 6-18. Trend Information West Containment Cell Levels Screen

The Trend Information screen for the CF displays the sump level over time.

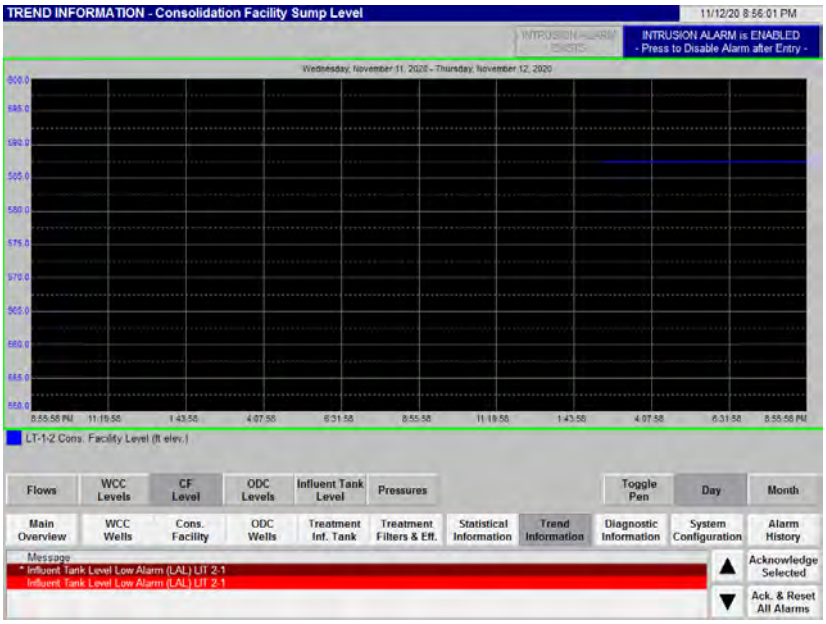


Figure 6-19. Trend Information Consolidation Facility Sump Level Screen

The Trend Information screen for the ODC Containment Cell displays the extraction well inside and outside levels over time.

Figure 6-20. Trend Information ODC Containment Cell Levels Screen

The Trend Information screen for the Influent Tank displays the tank level over time.

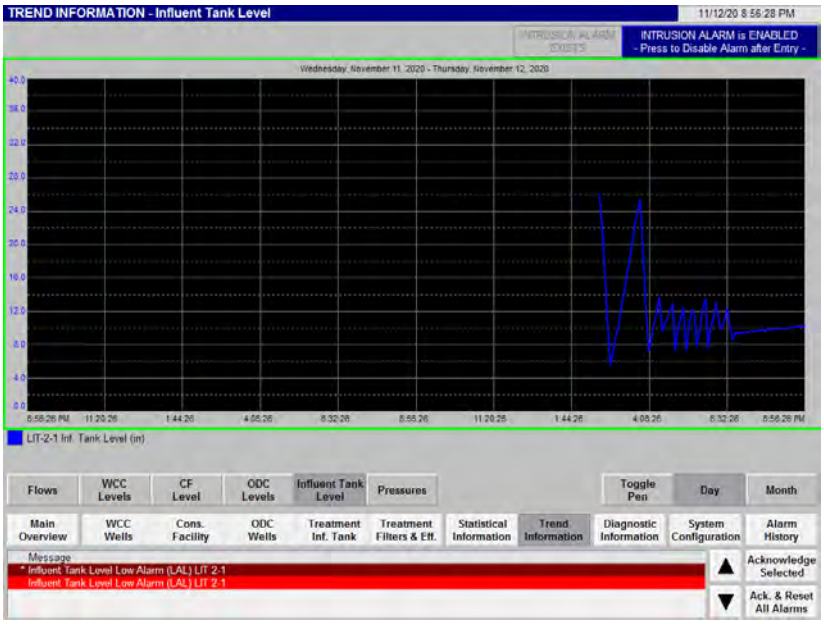


Figure 6-21. Trend Information Influent Tank Level Screen

The Trend Information screen for the pressures displays the cartridge filter and liquid GAC filter pressures over time.

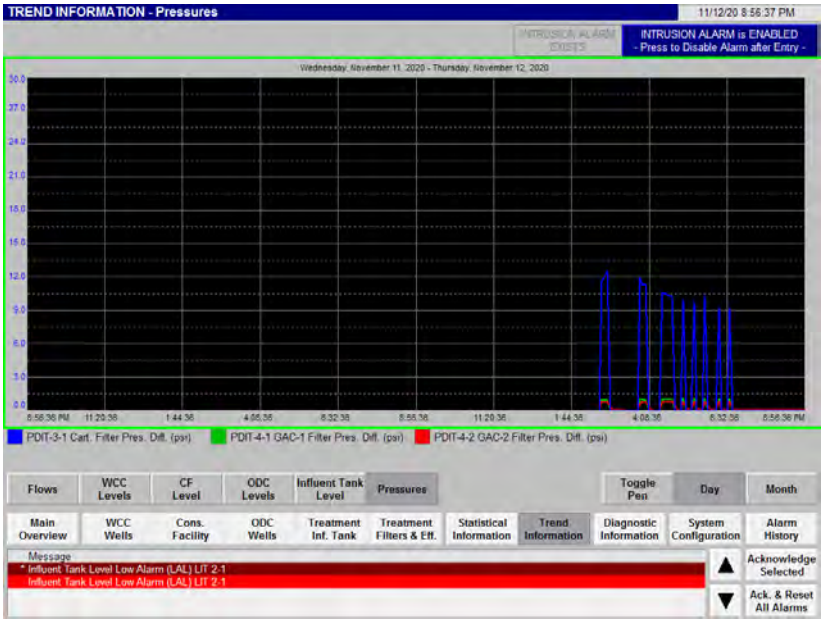


Figure 6-22. Trend Information Pressures Screen

6.7 Diagnostic Information

The Diagnostic Information screens show the status of the various PLC input and output modules. They are accessed from the menu bar by pressing the “Diagnostic Information” button. To navigate between the diagnostic information submenus, click on the desired submenu bar “PLC Slot” button.

The discrete input and output modules show the status of various points. A green indicator means the input or output is energized or on. A black indicator means the input or output is de-energized or off.

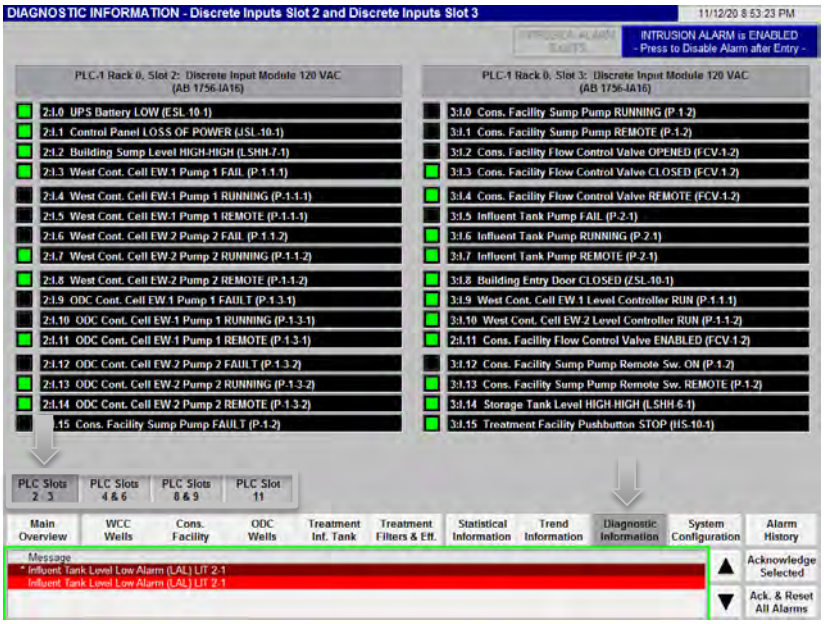


Figure 6-23. Diagnostic Information Screen for Slots 2 and 3

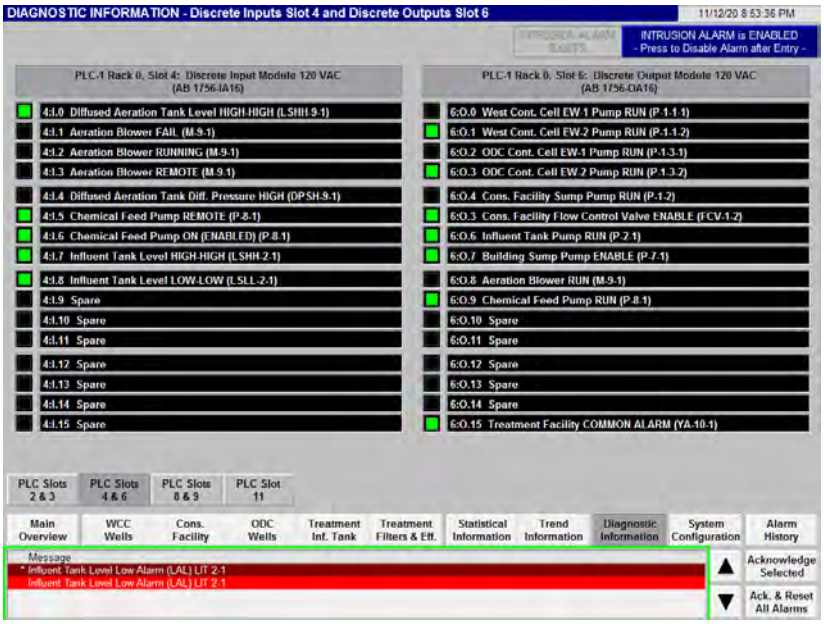


Figure 6-24. Diagnostic Information Screen for Slots 4 and 6

The analog input and output modules show the status of various points. A red fault indicator means the input or output is faulted (refer to the input or output module user manual for more information). A current mA value is also displayed to aid in troubleshooting the input or output.

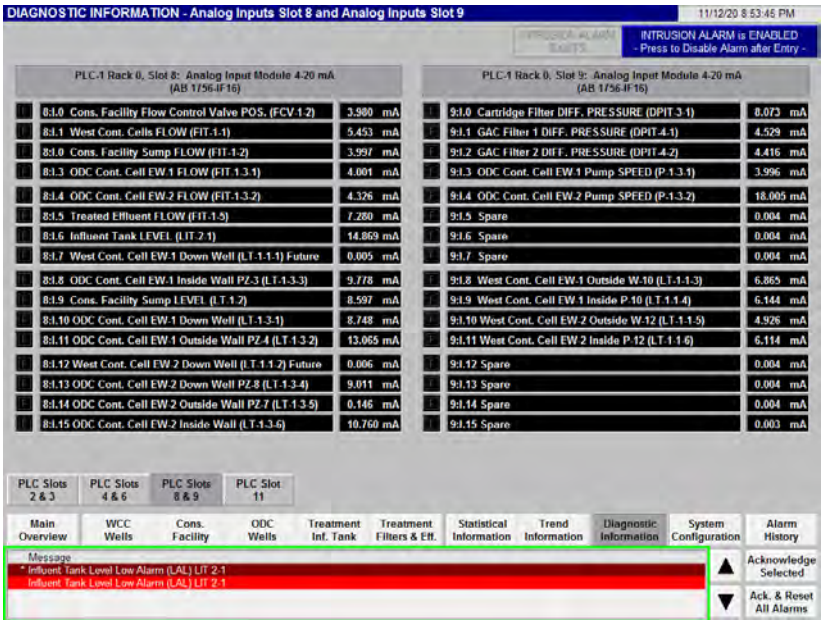


Figure 6-25. Diagnostic Information Screen for Slots 8 and 9

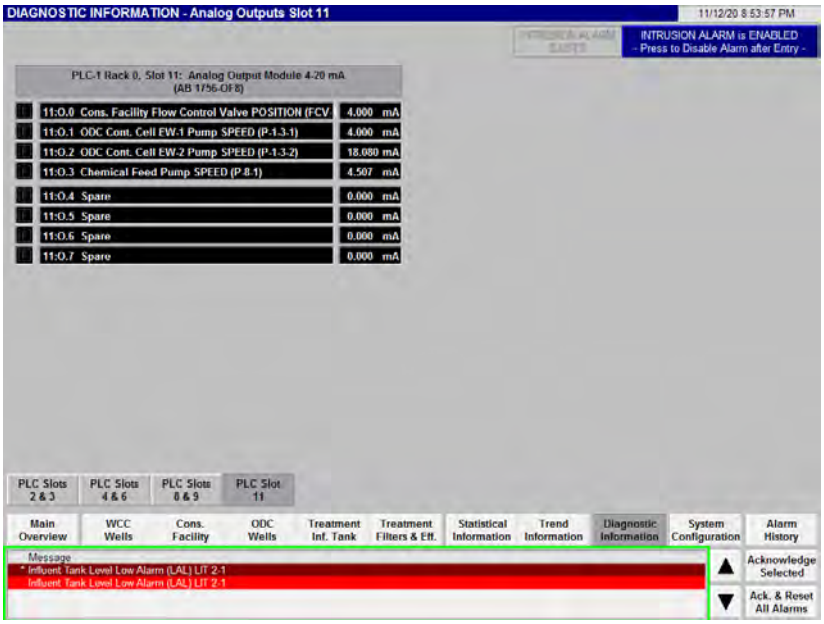


Figure 6-26. Diagnostic Information Screen for Slot 11

6.8 System Configuration

The System Configuration screens show the configuration of the analog inputs and building intrusion monitoring. They are accessed from the menu bar by pressing the “System Configuration” button. To navigate between the system configuration submenus, click on the desired submenu bar “Analog Setup” button. Refer to Section 6.10 for more information on the building intrusion monitoring.

6.8.1 General

The System Configuration screens the analog scaling and allows for configuring of the low-low, low, high, and high-high alarms. To disable any of alarms simply set the value to the maximum or total organic carbon for a given instrument or equipment.

Analog channels can be put in and out of service for maintenance or if the instrument or equipment is not present. Putting an analog channel out of service disables all the alarms associated with the instrument or equipment. It will also affect the operation of associated equipment. For example, disabling the level transmitter associated with ODC EW-2 will disable the automated level control for the pump.

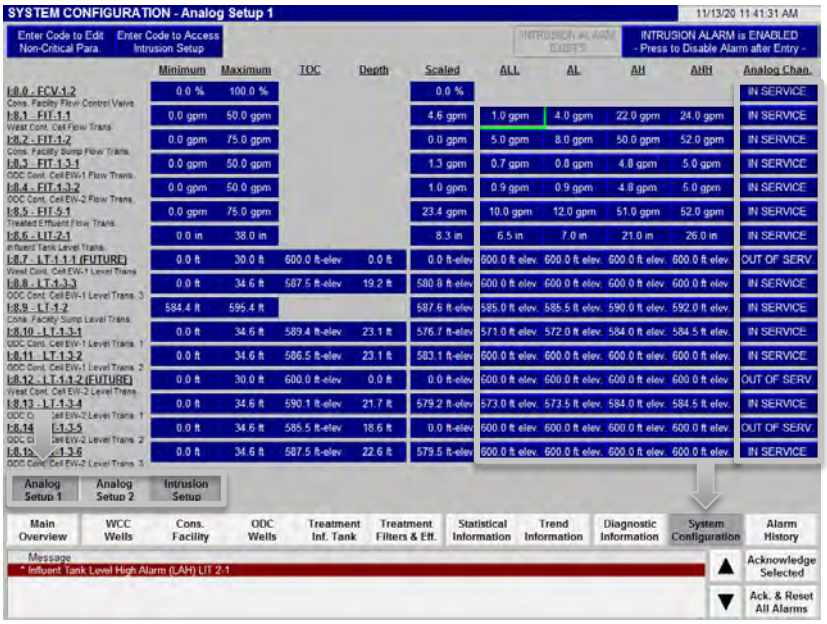


Figure 6-27. System Configuration Analog Setup 1

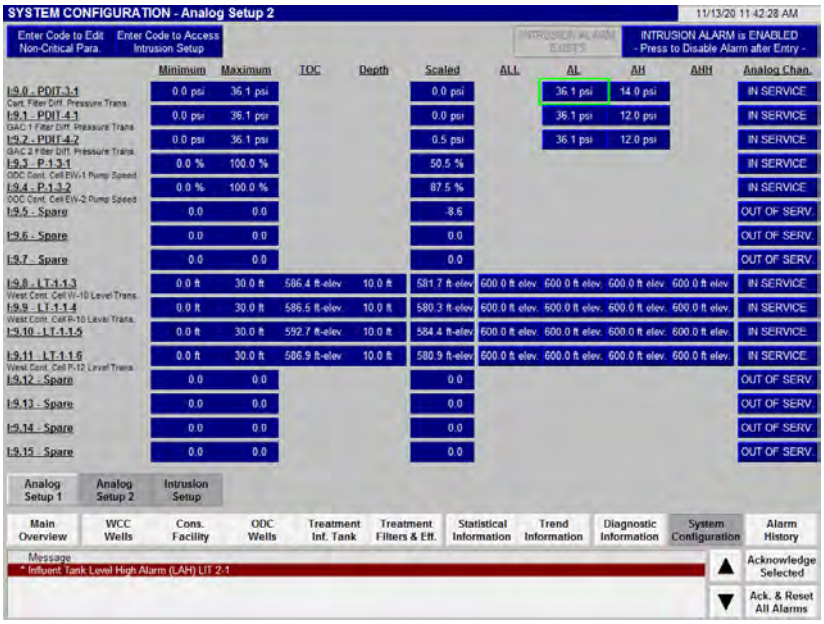


Figure 6-28. System Configuration Analog Setup 2

6.8.2 Advanced Setup

Pressing the “Enter Code to Edit Non-Critical Para.” button in the upper left-hand corner will provide access to the advanced setup. Entering the code “Info” will enable the advanced setup. The code will be automatically cleared after 30 minutes after which the advanced setup will be disabled.

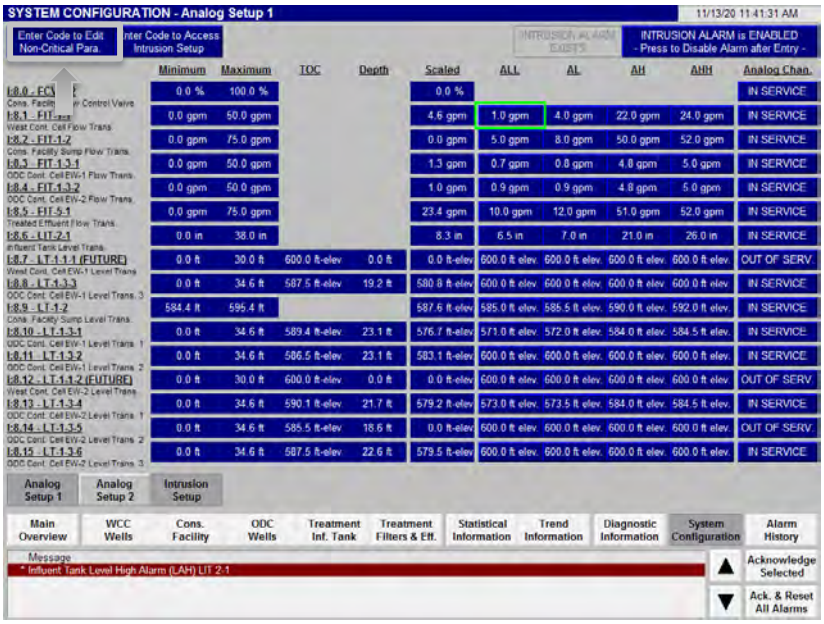


Figure 6-29. System Configuration Advanced Settings Access

The advanced settings will allow the minimum and maximum values to be changed for an analog input. Typically, this would only happen if the instrument scaling was re-ranged or changed. For submersible level instrument located in a well, a total organic carbon and depth adjustment is provided to correct the instrument for the its mounting location.

Pressing the hidden “Shutdown” button on the submenu will stop the FactoryTalk ME application program from running and allow access to the OIT configuration menus. Refer the OIT user manual for more information. This button should only be pressed if the internal settings of the OIT need to be changed, a new application program needs to be loaded, or the historical data log files need to be copied off the OIT.

Pressing the “Exit Non-Critical Para. Edit” button in the upper left-hand corner will also disable access to the advanced setup.

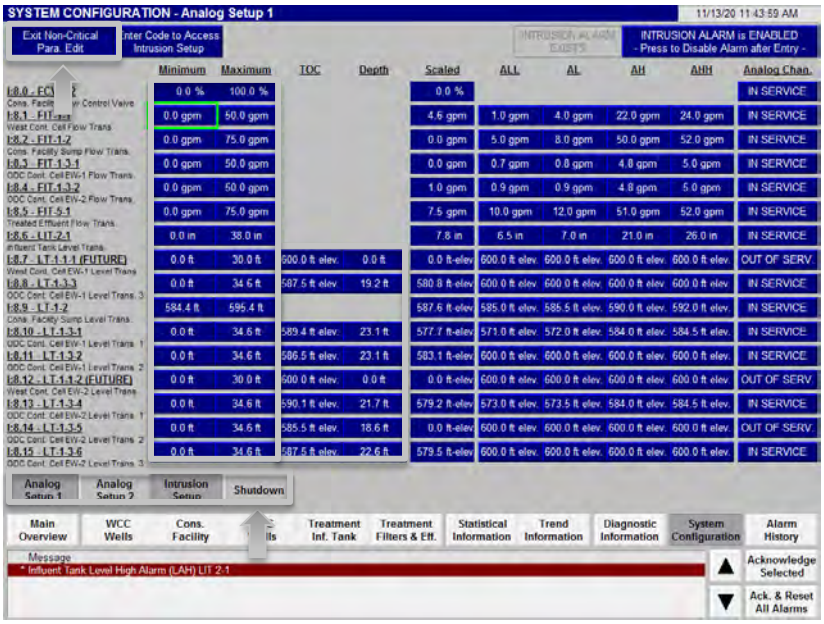


Figure 6-30. System Configuration Advanced Settings

6.9 Alarm History

The Alarm History screen shows the stored alarm history for current and past alarms. It is accessed from the menu bar by pressing the “Alarm History” button.

The selected alarm is highlighted in blue; using the up and down arrow keys will select a different alarm. All active alarms are highlighted in red, and active alarms that are unacknowledged will blink. All inactive alarms are highlighted in grey, and inactive alarms that are unacknowledged will blink. The alarm time and time the alarm was acknowledged is recorded. Pressing the “Sort Alarm” button will sort the alarms alphabetically by the message description. Pressing the “Clear History” button will clear the history; once pressed, the alarm history cannot be recovered.

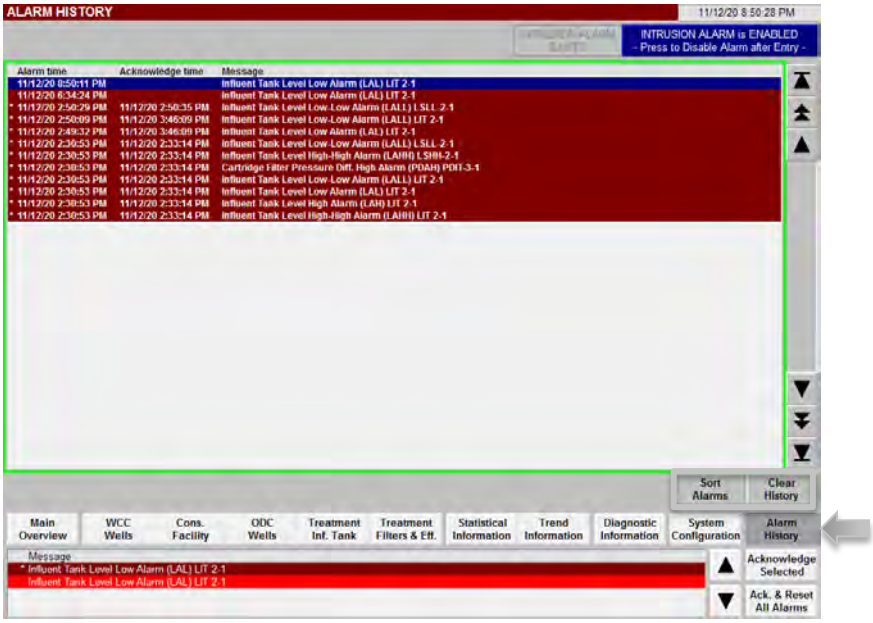


Figure 6-31. Alarm History

6.10 Building Intrusion Monitoring

6.10.1 General

The Treatment Building is equipped with an intrusion alarm that will send remote notification that building has been entered. The remote notification is sent via an email and/or a SMS text message. The status of the building intrusion is shown in the upper right-hand corner of each screen on the local OIT. The first indicator indicates whether an intrusion alarm exists. The second indicator indicates whether the intrusion alarm is enabled or disabled.

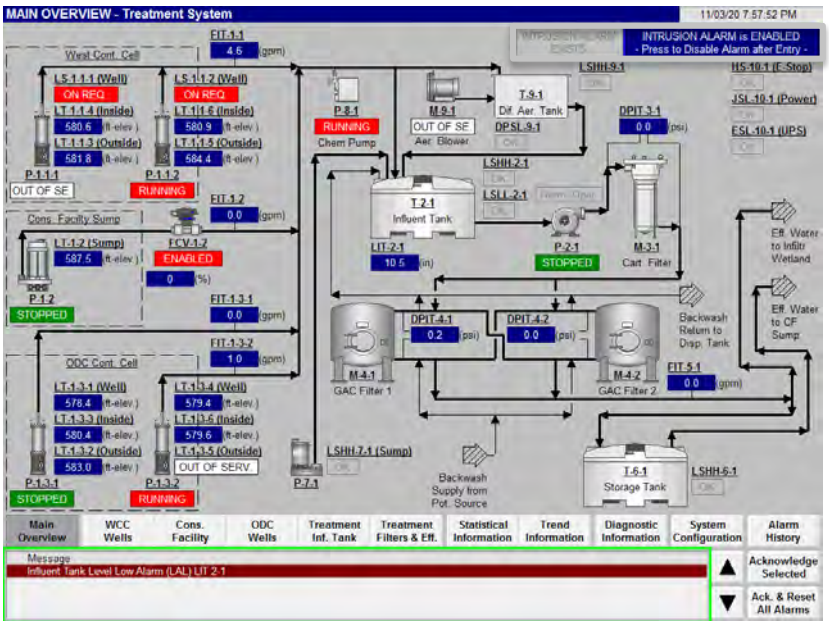


Figure 6-32. Building Intrusion Alarm System Status

6.10.2 Enabling Intrusion Alarm

If the intrusion alarm is disabled, before exiting the building you will have to enable the intrusion alarm after which you will have a set number seconds (default is 60) to exit the building. Press the “INTRUSION ALARM is DISABLED” button to enable the alarm.

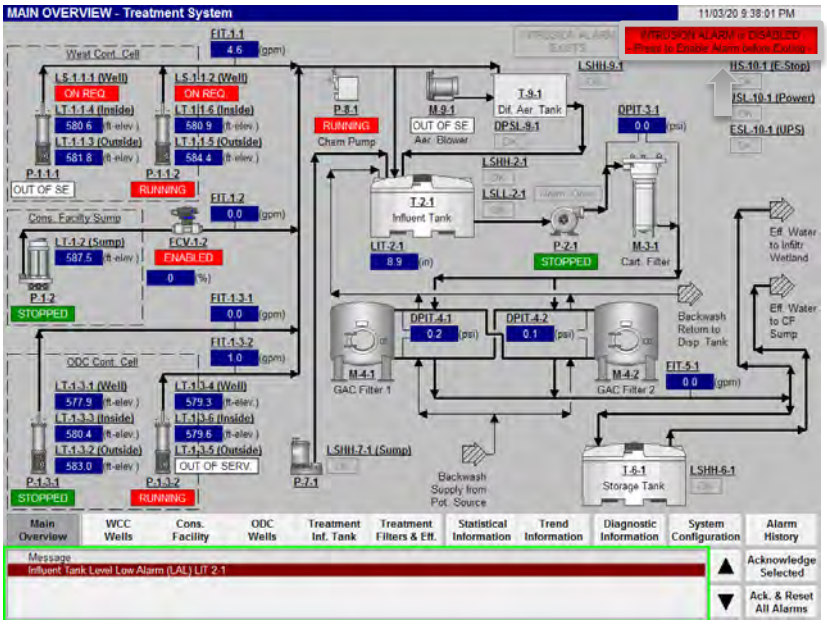


Figure 6-33. Building Intrusion Alarm System Enable

6.10.3 Disabling Intrusion Alarm

If the intrusion alarm is enabled, upon entering the building, you will have a set number seconds (default is 60) to enter the disable code (default is “zxc”) before the alarm will activate. Press the “INTRUSION ALARM is ENABLED” button to disable the alarm. After disabling the intrusion alarm, the system will automatically re-enable after a set number minutes (default is 600).

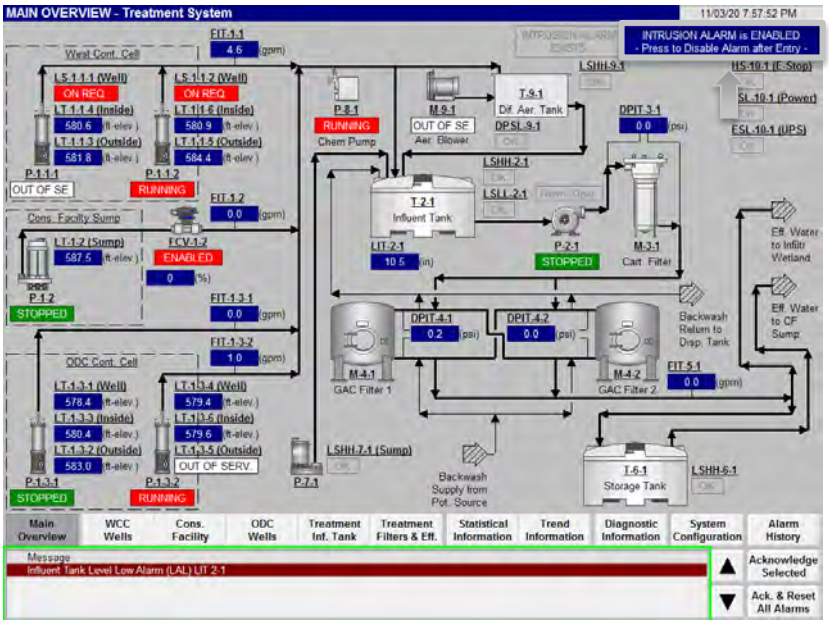


Figure 6-34. Building Intrusion Alarm System Disable

6.10.4 Configuring Intrusion Alarm

To access the intrusion alarm setup screen, press the “System Configuration” button on the menu bar. Press the “Enter Code to Access Intrusion Setup” button in the upper left-hand corner. Entering the code “abcd” will enable “Intrusion Setup” button on the submenu bar. Once that button is enabled, you may press it to enter the Intrusion Alarm Setup screen. The code will be automatically cleared after 7 seconds, after which the Intrusion Setup Button will be disabled. Access to the “Intrusion Alarm Setup” screen will remain active until the screen is exited.

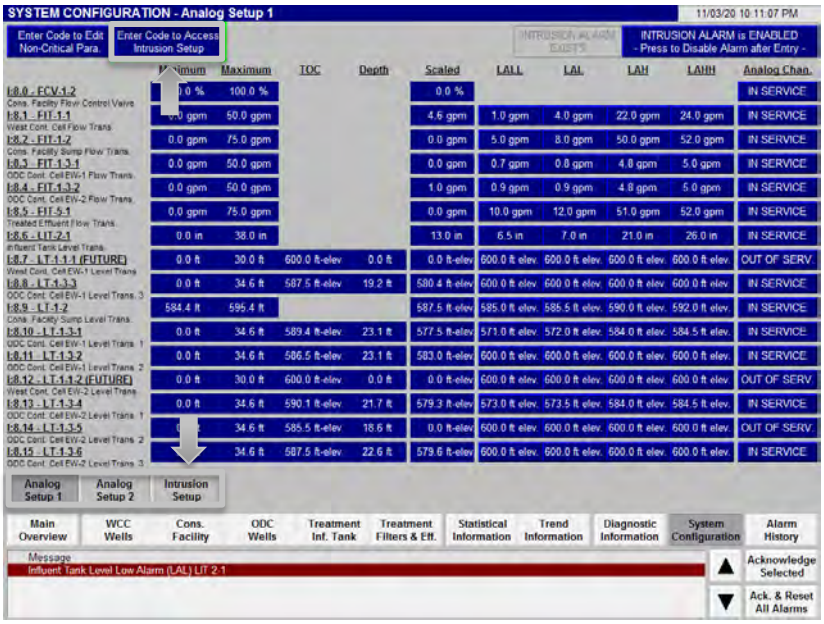


Figure 6-35. Building Intrusion Alarm System Setup Access

On the Intrusion Alarm Setup screen, the “Intrusion Alarm Disable Code, Intrusion Alarm Delay, Intrusion Re-Enable Delay, and Intrusion Alarm Auto-Re-Enable Delay” can be changed from their default settings. The default intrusion alarm disable code is “zxc”. The default intrusion alarm delay is 1 minute, which means from entering the building, one has 1 minute to disable the alarm system. The default intrusion re-enable delay is 1 minute, which means one has 1 minute to exit the building. The default auto re-enable delay is 10 hours, which means the system will automatically re-enable after 10 hours expires.

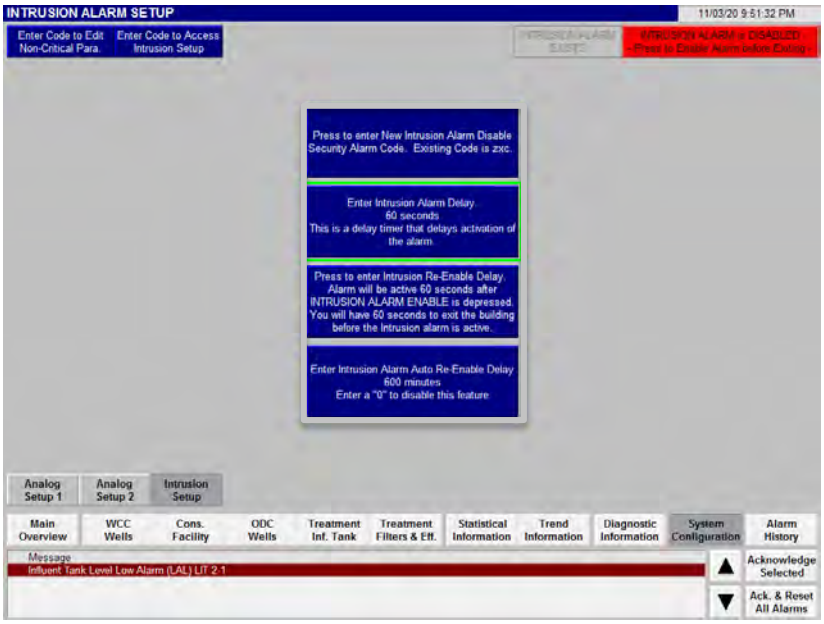


Figure 6-36. Building Intrusion Alarm System Setup

6.11 Installation

Contains general installation instructions and startup and shutdown procedures.

Before starting any system, thoroughly inspect the system for signs of damage. Use the process and instrumentation diagrams (Appendix B) to verify that the system has been connected correctly. Then, read the startup procedure before proceeding.

6.11.1 Startup Procedure

- Verify the system is properly secure.
- Verify that all influent and effluent connections have been made, and open all valves to ensure that there are no restrictions on the blower.
- Turn on power to the control panel. If any lights come on, press the reset button, and the alarms should clear. If not, check the switches and controls to determine the problem.
- For initial startup, verify the power leads are properly wired to the motor. If the operator is not comfortable with this inspection, an electrician should perform the work. Incorrect voltage or improper wiring will ruin the motor. Motor circuit protection is installed (overloads, breakers, variable-frequency drives) that may trip if incorrect voltage is supplied, or if the motor is wired incorrectly.

6.11.2 Control Panel 1ϕ, 240V

WARNING! – Do not power the panel until this procedure is complete. Damage to the panel may result.

- Switch the disconnect to the “OFF” position and open the inner door. Verify that the inner door disconnect is in the off position.
- Switch on the main incoming power to the panel. CAUTION! - The disconnect now has power!
- Confirm that incoming power is 240V. If the incoming power has a “high leg” (four-wire delta system), measure the voltage from each leg to ground. It is critical that L1 and L2 to ground are 120V. Power for the control panel is taken from either L1 or L2.

- It is best to record the initial readings of the system for troubleshooting purposes later. Record the following operating conditions:

  L1 to ground _____ V

  L2 to ground _____ V

  L1 to L2 _____ V
- Be sure that all circuit protectors are reset.
- Close the inner door. Make sure that all of the green OORs (On-Off-Remote) are in the "OFF" position. Turn the main breaker to the "ON" position. Turn the control power breaker to the "ON" position. The panel should have power. If any alarms are present, press the "RESET" button. If the alarms will not reset, an alarm may be tripped. (See Appendix C-1 for details.)
- Rotation needs to be verified on all motors at initial startup. If the incoming power does not change, or if the motor is never disconnected, the rotation should remain correct after initial verification. To do so, bump any motor holding the Hand-Off-Automatic (HOA) in the "HAND" position for no more than a second. Rotation arrows are located on most pieces of equipment. If the operator is not comfortable completing this task, an electrician should perform the task.
- If rotation is backwards, have an electrician change rotation per the wiring diagram on the motor. Be sure to lock out and tag the main incoming power. Verify that there is no power with a multimeter.

6.11.3 Metering Pump, P-8-1

To operate the Metering Pump:

- On the control panel "Treatment Building Equipment Screen", touch the metering pump icon and set the amount of product to be injected into the influent to the desired volume, denoted as a percentage (%). Adjust the percentage up or down as necessary to vary the volume of WaterTech 5390 (tetrapotassium pyrophosphate) injected into the influent water to eliminate the iron from precipitating from the influent.
- Note that the volume of product injected into the influent is automatically adjusted based on the volume of flow through the influent header system. Thus, adding/eliminating pumps or increasing/decreasing the pumping rate of the pumps will automatically increase/decrease the injection rate of the metering pump.

6.11.4 Diffused Aeration Tank (DAT), M-9-1

To operate the DAT:

- Open the valve from the influent header to the DAT. Close the valve from the influent header to the influent tank.
- Close all drain valves at the base of the DAT tank.

To bypass the DAT:

- Reverse the valves from the influent header so that the water bypasses the DAT and flows directly to the influent tank.
- Turn the breaker for the DAT blower in the breaker panel to the off position.
- Turn the DAT switch on the control panel to the "REMOTE" position.

Note that the system will not operate unless the DAT switch on the control panel is in the "remote" position.

6.11.5 Influent Tank Pump, P-2-1

- Ensure that all valves upstream on the pump are open. Valves upstream should never be used to throttle the pump. All valves located upstream of a pump are strictly isolation valves for servicing the pump. Close all sample taps.
- For initial startup, verify the power leads are properly wired to the motor. If the operator is not comfortable with this inspection, an electrician should perform the work. Incorrect voltage or improper wiring will ruin the motor. Motor circuit protection is installed (overloads, breakers, variable-frequency drives) that may trip if incorrect voltage is supplied, or if the motor is wired incorrectly.
- Check alignment of the pump and motor coupling.
- Install gear oil into the pump housing per the manufacturer's recommendations.
- Bump the pump to verify rotation by holding the PUMP HOA in the "HAND" position for no more than a few seconds. Rotation arrows are located on the pump to signify proper rotation.
- If rotation is backwards, have an electrician change the wiring per the motor diagram for rotation change. Be sure to lock out and tag the main incoming power. Verify that there is not power at the motor with a multimeter.
- Prime the pump for initial startup. Once the pump is primed and not run dry, it should stay primed.
- If there is a suction head requirement on the pump inlet due to elevation, the pump may be primed by opening the top plug and adding water until full.
- If there is a suction head requirement due to a mechanical vacuum, the pump may be primed by turning off the source of the vacuum. Water should gravity feed into the pump.
- If there is a positive suction head, the pump should self-prime.
- Test the prime. Run the pump for a few seconds to verify that water is flowing through the pump at a constant rate and pressure. If not, repeat the above steps.
- Put the Pump HOA in the "AUTO" position. Throttle the pump to the desired flow.
- It is best to record the initial readings of the system for troubleshooting purposes later. Record the following operating conditions:

  PUMP motor amp draw _____

  PUMP pressure _____

  PUMP flow rate _____

Notes: Depending on the interlock schedule, the pump may not run until all of the appropriate alarms have been cleared and the correct pieces of equipment enabled.

6.11.6 Cartridge Filter, M-3-1

- Select and install the correct-size micron filter cartridge. Make sure the filter cartridge is "seated" to the top and bottom of the filter housing, and tightly close it.
- Note: We normally recommend a 25-micron or less filter to protect carbon adsorbers.
- Make sure all water connections are made and valves are open or closed as necessary.
- Open vent plug on lid to allow air to escape from housing.

- When housing body is full of water, liquid will escape from the vent. Close the vent.
- Open the outlet connection and fully open the inlet connection. Housing is now operating properly.

6.11.7 Removal of Spent Filter Cartridge:

- When the differential pressure (this is the difference between the inlet and outlet pressure gauges) across the housing reaches approximately 10 psi, the filter cartridge(s), need to be changed. The alarm setpoint is adjustable in the operator interface. A setting between 10 to 12 psi differential is recommended. A higher pressure will lower the water flow rate of the system.

  Note: It may take days or weeks for the differential pressure to reach 10 psi, but the differential pressure will rise very quickly when it approaches 10 psi. You may also need to change the filter before 10 psi because of reduced water flow rates.

- Turn off the water source to the filter.
- Close the inlet and outlet valves.
- Relieve pressure inside the housing by slowing opening the air bleed valve, or the drain valve.
- Drain the housing into the floor sump using the drain valve and tubing.
- Loosen the housing lid with a wrench.
- Discard the filter in accordance with all local and federal laws.
- Debris and sludge should be removed from the housing, to prolong filter efficiency.
- Install new filter in housing and follow the startup procedure.

6.11.8 Liquid GAC Filters, M-4-1 and M-4-2

Please review the below for recommend operating flow rates. The correct flow rate for your system will be determined by the contaminate levels you are treating. Make sure that all valves are open or closed as required and all connections are properly made to the vessels. Note water flow is in at the top, out the bottom. The maximum recommended flow rate through the PV1000 carbon vessel is 50 gpm.

- It is recommended that cartridge filters are used to protect the carbon bed from being fouled if there is sediment in the water to be treated. We recommend a 25-micron or smaller filter cartridge.
- The initial startup pressure drop through a clean vessel should be approximately 1 to 5 psi, depending on the flow rate.
- During operation, the differential pressure through the vessel should not be allowed to exceed 15 psi. If this happens, the vessel should be taken offline and the top of the carbon bed inspected for fouling and backwashed.

Note: If the top of the carbon bed is encrusted, the encrusted layer will have to be removed manually before a backwash is started.

- Water samples taken between the vessels will determine when the carbon needs to be changed out.
- The newly replaced carbon vessel should be installed in the lag position and the lag vessel moved into the lead position.

Backwashing:

- For optimum performance, the carbon should be backwashed to remove carbon fines and allow for better water distribution. It is VERY IMPORTANT that the backwash be done properly or the vessel can be damage and/or the carbon bed can be ruined. If backwashing is not possible, flooding the

vessels from the bottom up with clean water 24 hours before the vessels are to be used is recommended.

- The backwash water source needs to be sediment-free and contaminate free water.
- The backwash rate for the PV1000 carbon vessel is 40 to 50 gpm. Ideally, the carbon bed should be flooded and allowed to sit for 24 hours with clean water before the backwash is started. The backwash should be performed at the flow rate listed for 15 to 20 minutes per vessel. Start out with a slow flow (approximately 10 gpm) at the beginning of the backwash, slowly increasing the flow until the required backwash is met. Observe the backwash discharge to make sure carbon is not coming out of the vessel. If it is, slow down the flow and slowly increase again until the required backwash flow is met.
- Only one vessel can be done at a time, isolated from the rest of the system, with the discharge backwash water going to a holding tank.
- Backwash flow rate should be started low and brought up to the recommended flow rate. If the backwash flow rate is started too high, the carbon bed will rise and be flushed out the backwash discharge line. Monitor the backwash discharge, if carbon is present, back off on the flow rate.
- The differential pressure across the carbon bed needs to be monitored closely. It should never be allowed to exceed 20 psi, as this will cause damage to the internal piping assembly in the carbon vessel.
- The backwash should be done until the backwash discharge water is clear; this takes approximately 20 minutes at the recommend flow rate.

6.12 Maintenance

6.12.1 Shut Down Procedures

CAUTION! – When disabling any motor or piece of equipment, be certain that all sources of power and fluid have been locked out and tagged.

6.12.1.1 Influent Pumps, P-1-1-1, P-1-1-2, P-1-2, P-1-3-1, and P-1-3-2

- Turn HOA switches to off.

6.12.1.2 Consolidation Facility Flow Control Valve, FCV-1-2

- Allow sump pump to turn off.
- Turn the HOA switch to off.

6.12.1.3 Chemical Feed Pump, P-8-1

- Allow influent pumps to turn off.
- Turn the HOA switch to off.

6.12.1.4 Diffused Aeration Tank (DAT), M-9-1

- Turn DAT tank blower HOA switches to off.
- Close the influent valve from the influent header to the DAT tank.
- For short-term shutdown, water can remain in the DAT tank.

- For long-term shutdown, drain all water from the DAT tank by opening the 0.75-inch valves at the base of the tank.

6.12.1.5 Influent Tank Pump, P-2-1

- Allow pump to turn off via the pump down in the tank.
- Turn the HOA switch to off.

6.12.1.6 Cartridge Filter, M-3-1

- Turn influent tank pump HOA switches to off.
- For short-term shutdown, no other action required.
- For long-term shutdown, drain and remove filters to prevent biogrowth.

6.12.1.7 Liquid GAC Filters, M-4-1 and M-4-2

- Be sure all sources of water to the units are disabled.
- For short-term shutdown, water and carbon can remain in the vessels.
- For long-term shutdown, drain all water from the vessels. Pressurized air in the inlet may be needed to remove the water completely. Carbon can be removed if there is a chance of biogrowth developing.

6.12.2 Maintenance Intervals

These forms should be used as a guide for general maintenance items. The recommended maintenance intervals are based upon past experience with the equipment and equipment manufactures' literature. It is important to use discretion when implementing the maintenance schedule. Unforeseen operating conditions may require additional maintenance.

6.12.2.1 Influent Tank Pump, P-2-1

Table 6-2. Centrifugal Pump Maintenance Schedule

Recommended Frequency	Task	Comment
First 200 hours	Replace gear oil.	
First 2,000 hours	Replace gear oil.	
Yearly	Grease motor with NLGI #2, if applicable. Replace gear oil.	May require service more often based on the site operating conditions.

6.12.2.2 Cartridge Filter, M-3-1

Table 6-3. Cartridge Filter Vessel Maintenance Schedule

Recommended Frequency	Task	Comment
As needed	Filter change out	When differential pressure across the vessel exceeds 10 to 12 psi. • Shut off water flow to the filter. • Isolate the inlet and outlet of the filter. • Slowly open the air bleed valve to release the pressure. • Open the housing with the wrench provided and pull out the dirty filter. • Put in new filters and make sure they are seated properly. • Reinstall and tighten housing. • Close drain. • Open isolation valves. • Begin water flow. • Bleed air out of the filter and close bleed air valve.

6.12.2.3 Liquid GAC Filters, M-4-1 and M-4-2

Table 6-4. Liquid-Phase Carbon Vessel Maintenance Schedule

Recommended Frequency	Task	Comment
As needed	Backwash	When differential pressure across the vessel exceeds 15 psi.
As needed	Exchange Carbon	When carbon becomes spent or cannot be effectively backwashed, or the carbon is spent.

6.12.3 Local Access

Local access is possible through a hardwired ethernet connection to the Remote Access Gateway. Connect a PC to the panel interface connector using an Ethernet patch cable. The panel interface is located on the front of the local control panel. The PC will need a static IP address set as follows:

IP Address: 192.168.2.240

Subnet Mask: 255.255.255.0

6.12.3.1 PC Setup

To setup a PC on the same subnet as the local control network, the following instructions are provided for various operating systems:

Windows 10 Steps

1. Click on the Start Menu, and select Windows System\Control Panel.
2. Double-click on Network and Sharing Center.
3. From the side menu select Change Adapter Settings.

4. Double-click on the Ethernet for the Ethernet port being used.
5. On the Networking tab, select Internet Protocol Version 4 (TCP/IPv4), and press the Properties button.
6. On the General tab, select Use the following IP address.
7. Enter a valid IP address and subnet mask. The default gateway is not important.
8. Press the Okay button two times to accept the changes.

Windows 7 Steps

1. Click on the Start Menu, and select the Control Panel.
2. Double-click on Network and Sharing Center.
3. From the side menu, select Change Adapter Settings.
4. Double-click on the Local Area Connection for the Ethernet port being used.
5. On the General tab, press the Properties button.
6. On the Networking tab, select Internet Protocol Version 4 (TCP/IPv4), and press the Properties button.
7. On the General tab, select Use the following IP address.
8. Enter a valid IP address and subnet mask. The default gateway is not important.
9. Press the Okay button two times to accept the changes.
10. Press the Close button once.

Windows XP Steps

1. Click on the Start Menu, and select the Control Panel.
2. Double-click on Network Connections.
3. Double-click on the Local Area Connection for the Ethernet port being used.
4. On the General tab, press the Properties button.
5. On the General tab, select Internet Protocol (TCP/IP) and press the Properties button.
6. On the General tab, select Use the following IP address.
7. Enter a valid IP address and subnet mask. The default gateway is not important.
8. Press the Okay button two times to accept the changes.
9. Press the Close button once.

6.12.4 Remote Access

Remote access is possible through a remote cellular connection to the site using a Remote Access Gateway. The Remote Access Gateway employed at the site is an Ewon Flexy 205. The Ewon Flexy is a modular system that allows for the cellular modem to be changed out independent of the Remote Access Gateway. All the parameter settings are stored in the Remote Access Gateway, not the cellular modem. So, in the future, the cellular modem can be upgraded to 5G when available and 4G is no longer supported. The cellular modem installed supports either AT&T Wireless or T-Mobile. A different cellular modem is required for Verizon Wireless.

The Remote Access Gateway is accessed remotely using either a VPN Client or a web browser. The VPN Client is used for configuring the account, configuring the visibility of the connected devices, application programming of the connected devices, monitoring of the connected devices, and configuring the web visibility of the connected devices. The web browser interface only allows monitoring of the connected devices through your PC or a mobile device.

6.12.4.1 Remote Access Gateway Information

The Remote Access Gateway component data is as follows:

Gateway Model:	Flexy20500
Gateway Serial Number:	2006-0011-04
Gateway Firmware:	14.1s1
Cellular Modem Model:	FLB3205_00/S 4G NA
Cellular Modem Serial Number:	1033-2003-0087-24
Cellular Modem IMEI Number:	358148062764670

6.12.4.2 Cellular Account Information

The current cellular provider is AT&T Wireless, and the account information is as follows:

Customer Support Number:	800-331-0500
Wireless Number:	847-505-6056
SIM Card ICCID Number:	8901 4104 2718 1245 4046

6.12.4.3 VPN Client

The VPN Client used for remote access is called eCatcher. eCatcher is intended to be installed on a PC running Microsoft Windows. The software will need to be downloaded from the following website:

https://www.ewon.biz/technical-support/pages/all-downloads/

After downloading the software, it will need to be installed on a PC, preferably a PC with the programming tools also installed. During installation, accept the default settings, except uncheck the requirement for USB driver installation. The site does not have any devices connected to the USB port, so it is not needed.

Logging In

Launch the eCatcher software from the Windows Start menu. On the launch window, enter the account, username, and password information as follows:

Account Name:	Waukegan-WTS
Username:	WTS-Admin
Password:	#RemoteWTS100$

After the information is entered, press the “Log In” button to proceed.

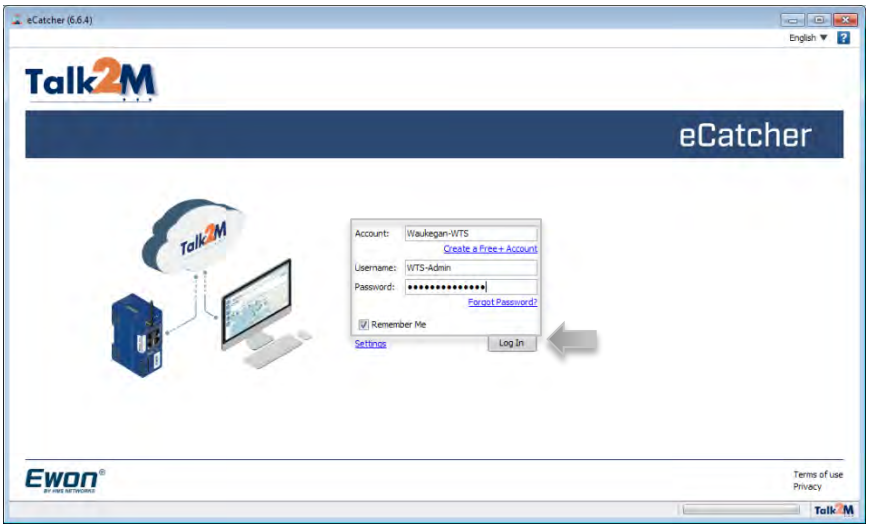


Figure 6-37. VPN Client eCatcher Login Window

The eCatcher software will connect to Talk2M cloud server and display the Remote Access Gateways configured on the account and whether they are online.

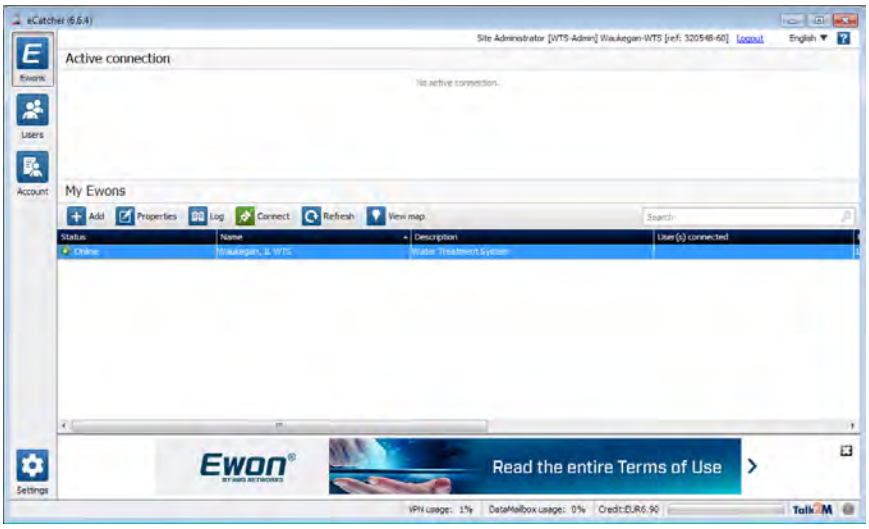


Figure 6-38. VPN Client eCatcher Remote Access Gateways

Establishing a VPN Connection

To establish a VPN connection, select the desired Remote Access Gateway, and press the Connect button.

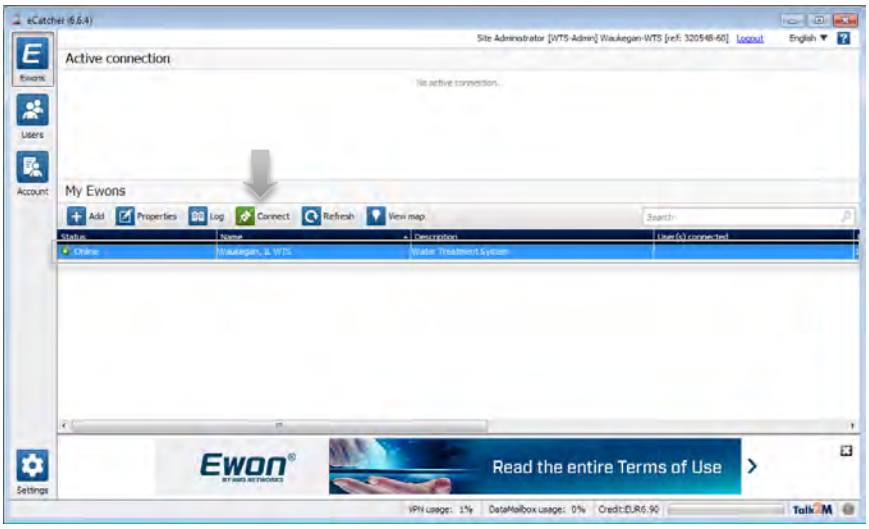


Figure 6-39. VPN Client eCatcher Remote Access Gateways

The active connection area will show the current active connection and the devices accessible through the VPN connection.

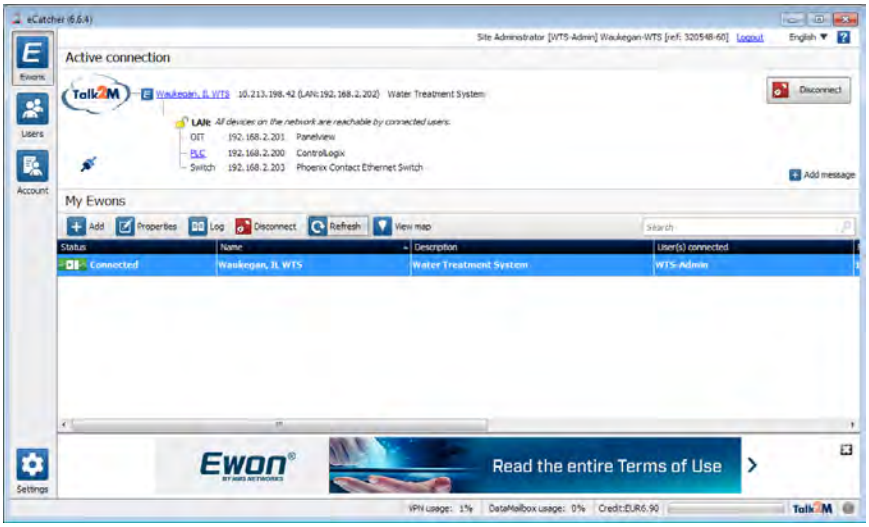


Figure 6-40. VPN Client eCatcher Active Remote Access Gateways

Remote Access Gateway

Clicking on the eWon (Waukegan, IL WTS) shortcut button will bring up the eWon embedded web page. This will allow for configuration of the eWon. Refer to Remote Access Gateway Embedded Web Server Section 10.12.5 for more information.

OIT

A separate VNC Client is required for viewing the local OIT screens when using the VPN Client. The VNC Client used for viewing is called TightVNC. TightVNC is intended to be installed on a PC running Microsoft Windows. The software will need to be downloaded from the following website:

https://www.tightvnc.com/

After downloading the software, it will need to be installed on a PC, preferably a PC with the programming tools also installed. During installation, select a custom installation, and unselect the TightVNC Server.

Launch the TightVNC Viewer software from the Windows Start menu. On the launch window, enter the IP address for the OIT as the remote host:

Remote Host: 192.168.2.201

After the information is entered, press the Connect button to proceed.

Figure 6-41. VNC Client setup

The VNC Authentication window will be displayed; enter the password below:

Password: admin

After the information is entered, press the OK button to proceed.

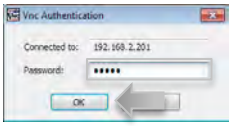


Figure 6-42. VNC Client authentication

The current screen at the local OIT will be displayed in the web browser, in which the Main Overview screen is shown.

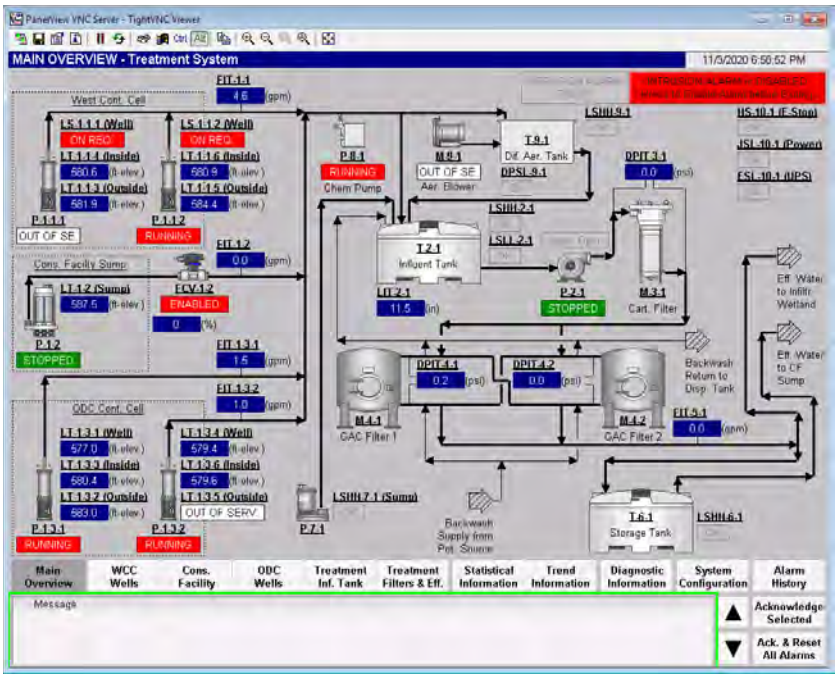


Figure 6-43. VNC Client OIT Embedded VNC Server Example Local Screen

PLC

Clicking on the PLC shortcut button will bring up the ControlLogix Ethernet Module embedded web page. This will allow checking of the issues with the communication interface.

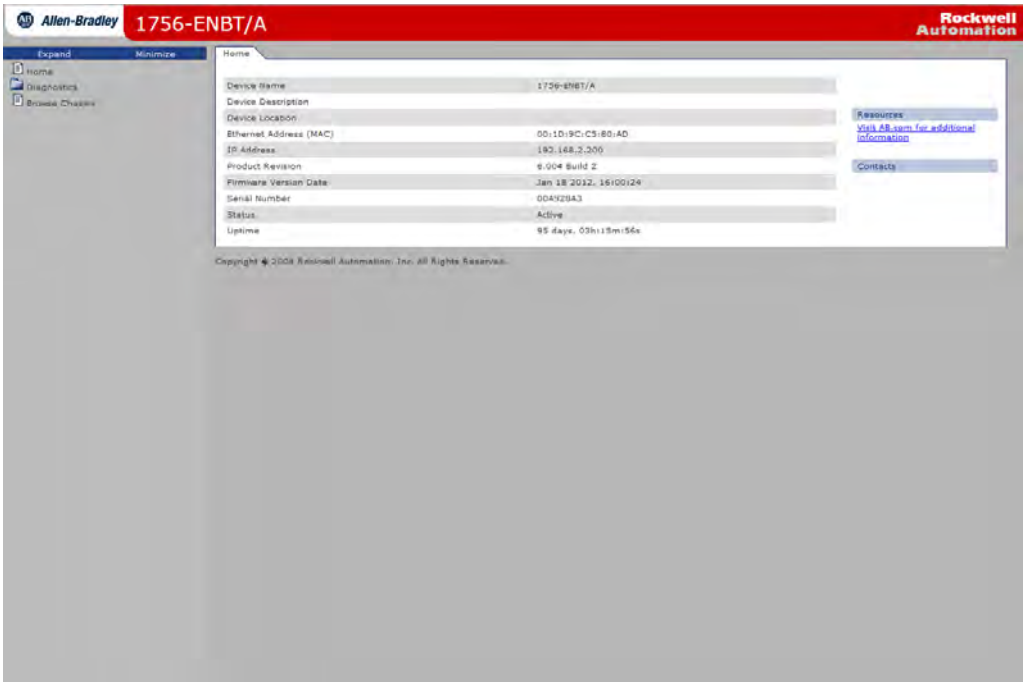


Figure 6-44. Web Browser PLC Embedded Web Server Summary Page

6.12.4.4 Web Browser

The cloud service used for remote access is called Talk2M. To access the site using a web browser, enter the following address:

https://m2web.talk2m.com/

Logging In

On the login web page, enter the account, username, and password information as follows:

Account Name:	Waukegan-WTS
Username:	WTS-Admin
Password:	#RemoteWTS100$

After the information is entered, press the “Connect” button to proceed.

Figure 6-45. Web Browser Talk2M Remote Site Login Page

On the remote site web page, the levels for the West Containment Cell, ODC Containment Cell, CF, and Influent Tank are visible. The online status indicates whether the site is online or not; since it is always connected, it should always indicate connected. There is an alternate option to turn the site online and offline intermittently; however, this incurs an additional charge to send a text message to wake up the unit, so this option is not enabled.

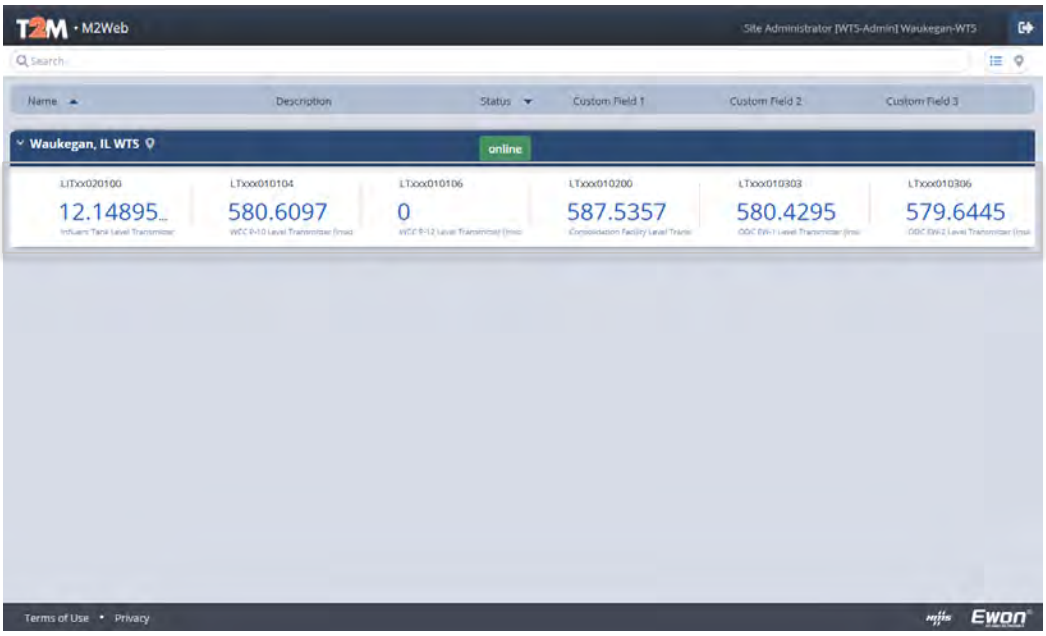


Figure 6-46. Web Browser Talk2M Remote Site Summary Page

To access the connected devices remotely, click on the arrow next to the site name “Waukegan, IL WTS”. Clicking on either the eWon, OIT, or PLC loads, their respective embedded web server.

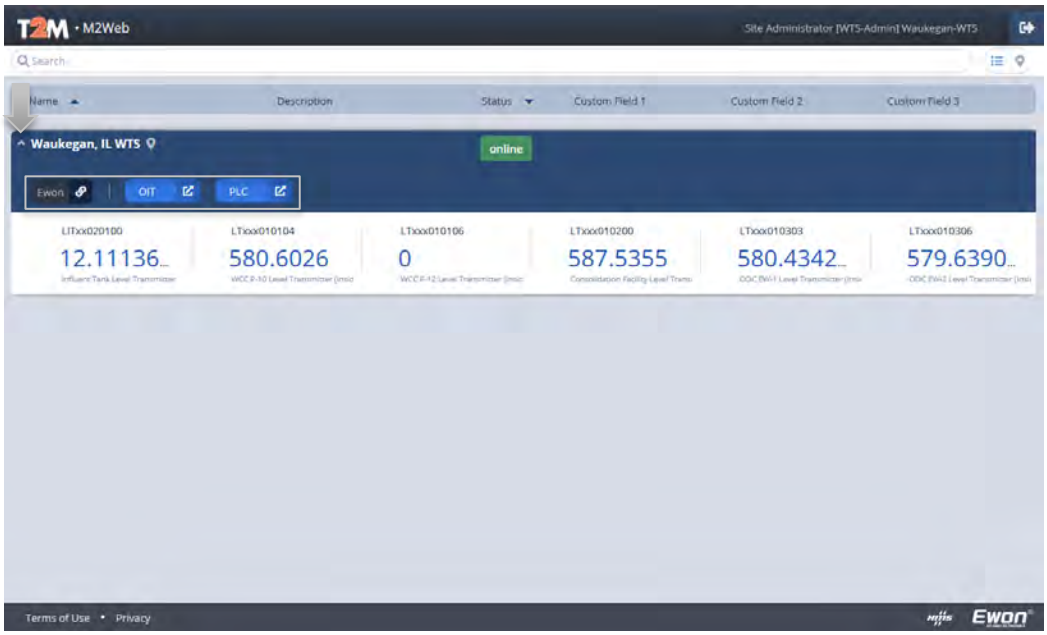


Figure 6-47. Web Browser Talk2M Remote Site Connected Devices

Remote Access Gateway

Clicking on the eWon shortcut button will bring up the eWon embedded web page. This will allow for configuration of the eWon; however, the VPN Client will be required to transfer files using FTP. Refer to Remote Access Gateway Embedded Web Server Section 6.12.5 for more information.

OIT

Clicking on the OIT shortcut button will bring up the PanelView VNC web page for remotely displaying screens. This will allow remote operation of the site through the local OIT. On the login web page, enter the VNC password information as follows:

VNC Password: admin

After the information is entered, press the OK button to proceed.

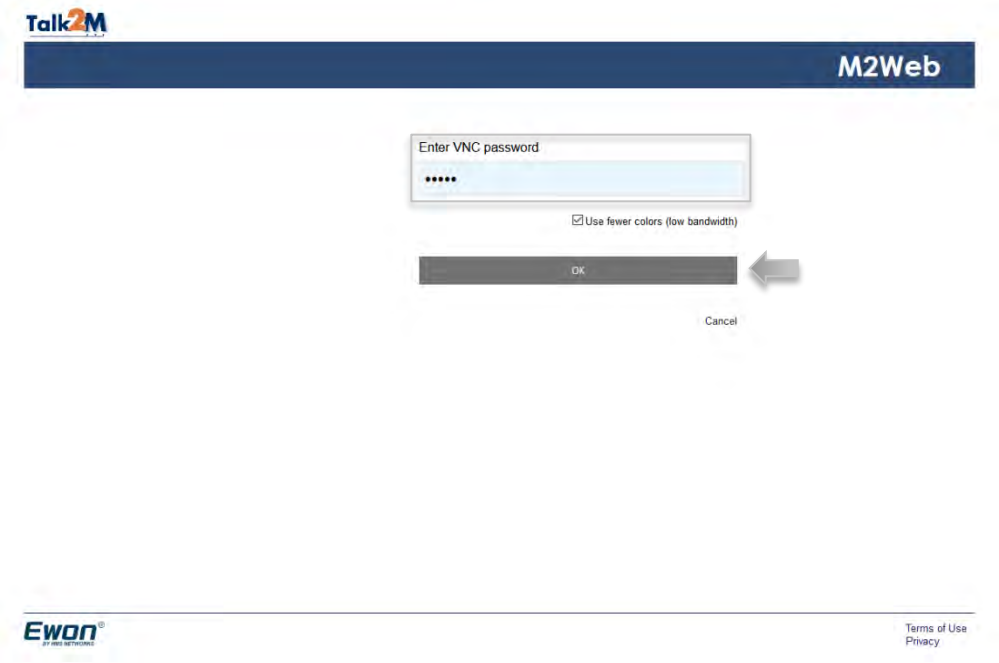


Figure 6-48. Web Browser OIT Embedded VNC Server Login Page

The current screen at the local OIT will be displayed in the web browser, in which the Main Overview screen is shown.

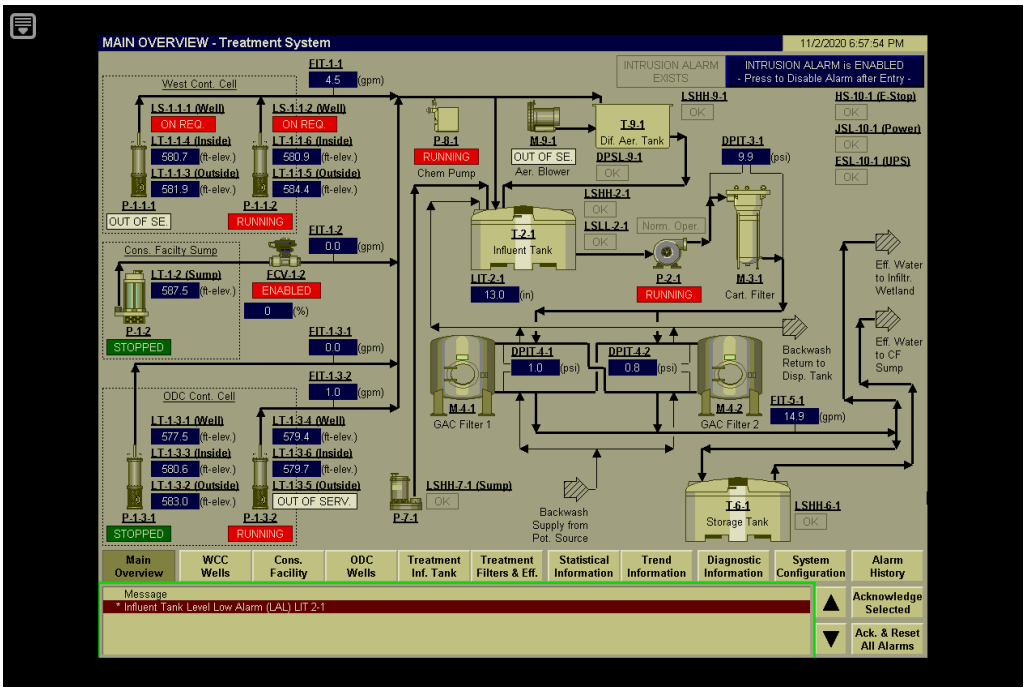


Figure 6-49. Web Browser OIT Embedded VNC Server Example Local Screen

PLC

Clicking on the PLC shortcut button will bring up the ControlLogix Ethernet Module embedded web page. This will allow checking of the issues with the communication interface.

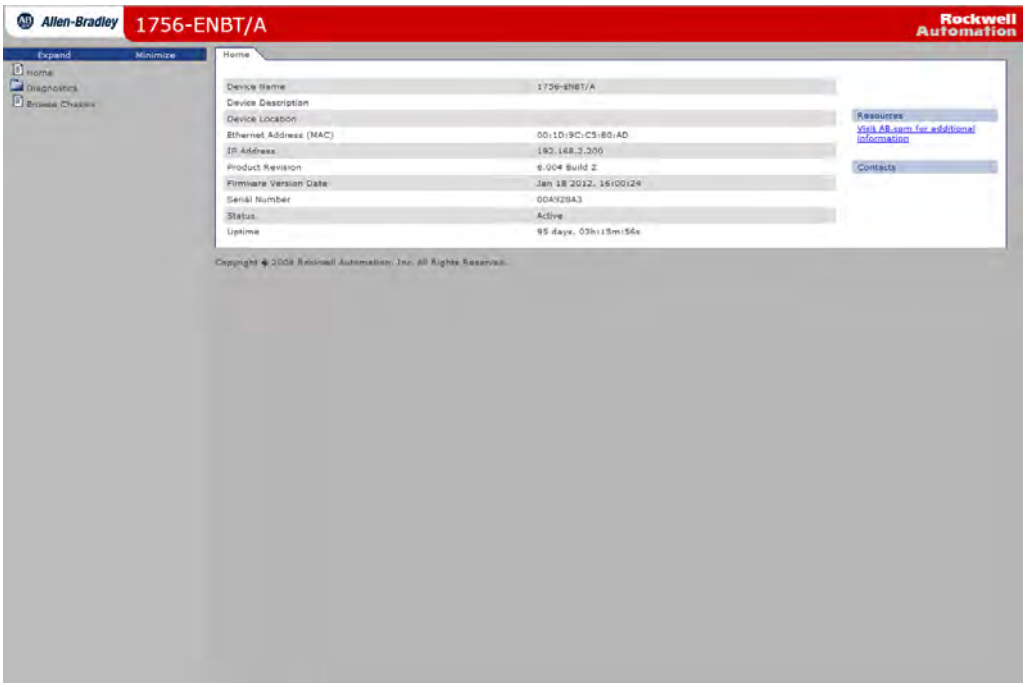


Figure 6-50. Web Browser PLC Embedded Web Server Summary Page

6.12.5 Remote Access Gateway Embedded Web Server

The Remote Access gateway can be accessed locally or remotely. For local access, refer to the Local Access Section 10.12.3. After connecting locally, enter the IP address of the remote access gateway in the address bar of a web browser:

IP Address: 192.168.2.202

After the information is entered, press the “Enter” key to proceed.

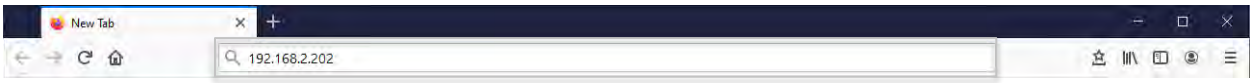


Figure 6-51. Web Browser Remote Access Gateway local access.

For remote access, refer to the Remote Access Section 6.12.4.

6.12.5.1 Logging In

On the login web page, enter the username and password information as follows:

Username: WTS-Admin

Password: #RemoteWTS100$

After the information is entered, press the OK button to proceed.

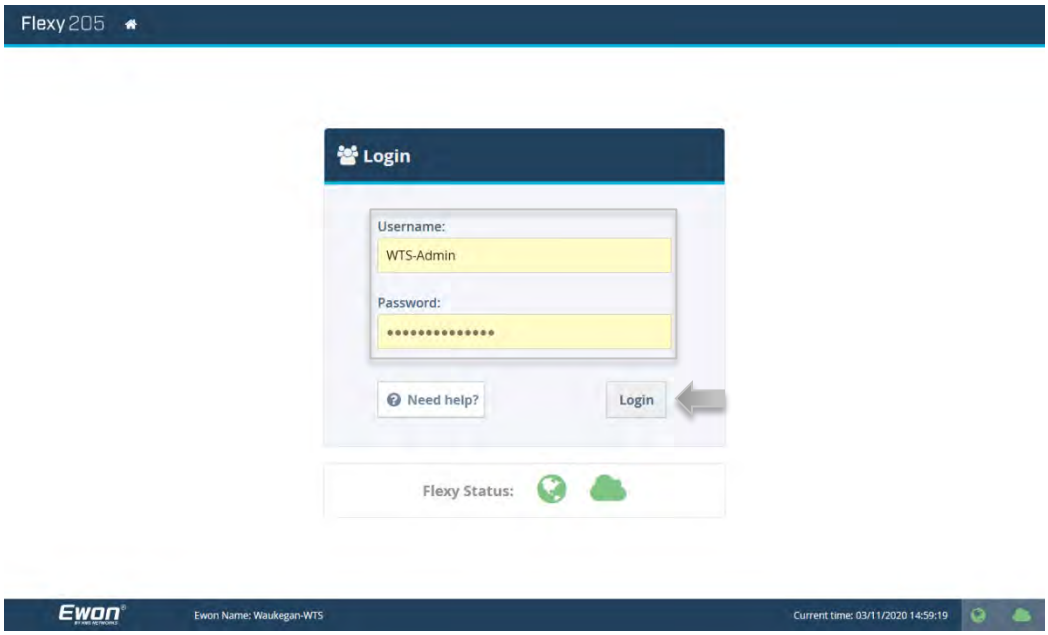


Figure 6-52. Web Browser Remote Access Gateway Embedded Web Server Login

After logging in remotely to the Remote Access Gateway, the summary display will be loaded. Remote access allows for configuration, access to trending, historical data, alarm logs, etc. However, notifications can only be adjusted manually from here. To bulk change settings, the VPN Client will be required or local access. Refer the manufacturer's user manual for further information on functionality.

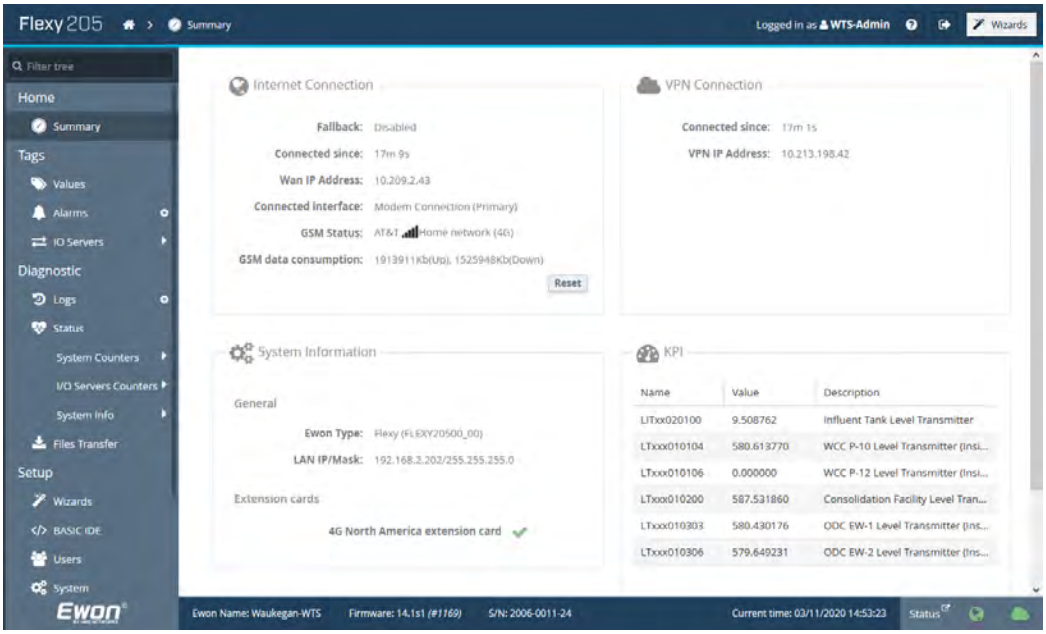


Figure 6-53. Web Browser Remote Access Gateway Embedded Web Server Summary Page

6.12.5.2 Remote Notifications

Remote notifications are sent out via an email or text message. Setup is configured on an alarm-by-alarm basis after logging into the Remote Access Gateway. To make changes to an alarm, select "Values" from the menu on the left and set the mode to "Setup". Next, select a tag to be edited and press the "Configure Alarm Actions" button. Under "Email upon", enter the email address or text message in the

"Email to:" field. Multiple email messages should be separated by a comma. For a text message, the appropriate carrier format will need to be used. Press the "Update" button to accept the changes.

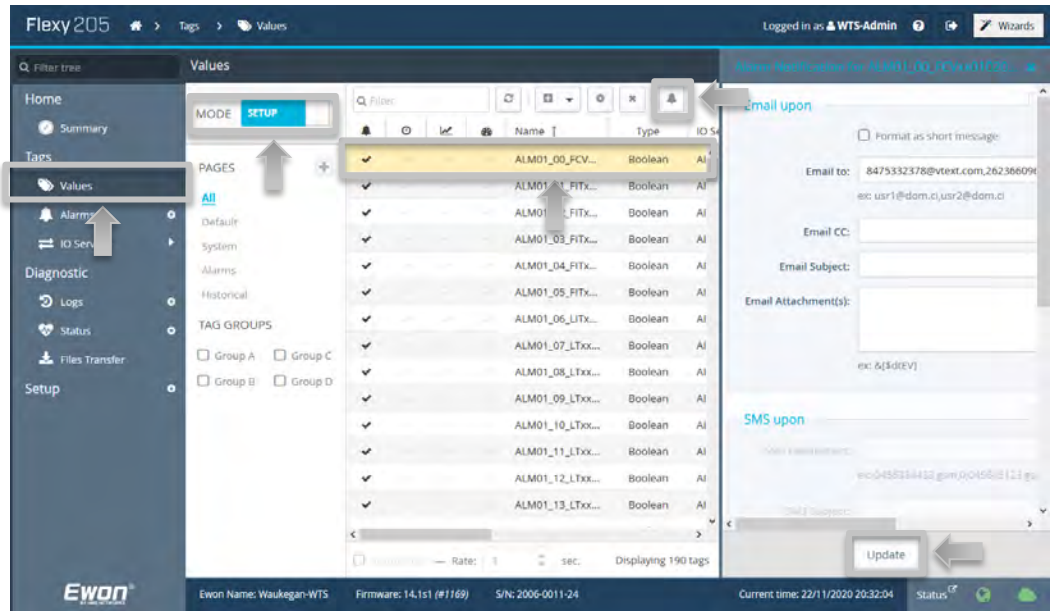


Figure 6-54. Remote Access Gateway, Notification Setup

An alternative way to edit the notifications in bulk uses a Microsoft Excel spreadsheet to update the notifications. The spreadsheet is called "Waukegan IL - Cellular Modem Setup ########.xlsm" where "########" is the modification date. On the "Config – Users Manager" tab, the notification type will need to be specified as "Email", "Text", or "Both". For email addresses, enter the email address if required. For text messages, enter the cell phone number and select the carrier.

First Name	Last Name	User ID	Role	Description	Password	Notification	Primary Email	Secondary Email	Cell Phone	Carrier	SMS to Email
System	Administrator	admin	Admin	The default system administrator account	#RemoteWTS100$				847-505-6056	None	
[redacted]	[redacted]		Admin			Text	[redacted]		[redacted]	Verizon	[redacted]
[redacted]	[redacted]		Admin			Text	[redacted]		[redacted]	AT&T	[redacted]
[redacted]	[redacted]		Admin			Text	[redacted]		[redacted]	T-Mobile	[redacted]
[redacted]	[redacted]		Admin			Both	[redacted]		[redacted]	U.S. Cellular	[redacted]
[redacted]	[redacted]		Admin			Text			[redacted]	Verizon	[redacted]
[redacted]	[redacted]		Admin			Text			[redacted]	Verizon	[redacted]
[redacted]	[redacted]		Admin			Email	[redacted]			None	[redacted]

Figure 6-55. Email and Text Message Configuration

On the "Export Config", press the "Export to CSV" button to generate the import file. The file will be in the same directory as the Excel spreadsheet and will be called "var_lst.csv". An ftp file transfer program like "FileZilla" will be needed to transfer the file to the Remote Access Gateway. The software will need to be downloaded from the following website:

https://filezilla-project.org/

The ftp transfer software will need the IP address, username, and password of the Remote Access Gateway to transfer the file. After connecting, select the file on the host computer and drag it to the root folder on the device. Accept transferring the file.

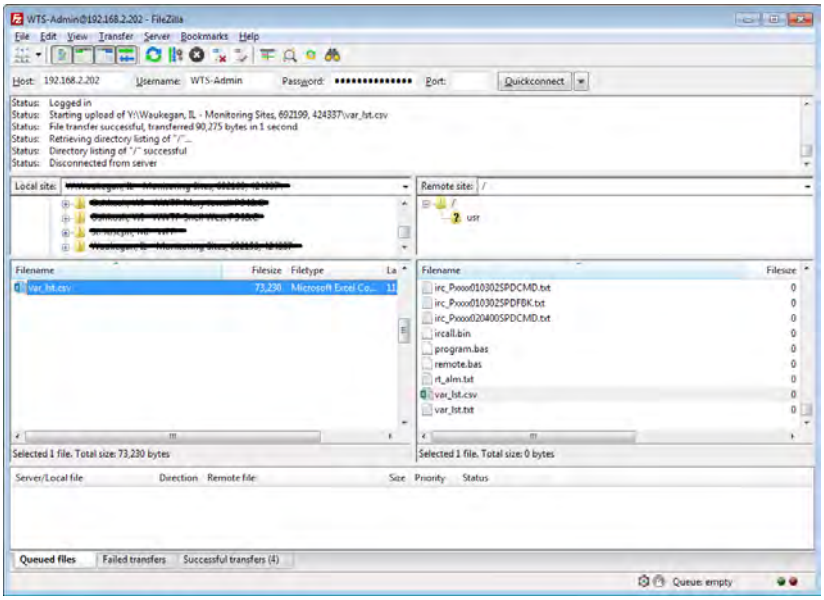


Figure 6-56. FTP File Transfer

6.12.5.3 Historical Data

Historical data is logged locally at the Allen-Bradley PanelView and on the Remote Access Gateway. There are two ways to retrieve historical data.

The Allen-Bradley PanelView first way is to use FactoryTalk View Studio File Viewer Utility, which can be obtained from Rockwell Automation. Refer to the user manual for more detailed information on downloading the data log file.

The second way is to use the Remote Access Gateway. To download the historical data, select “Values” from the menu on the left and set the mode to “View”. Select the “Historical” page, and press the “Historical Logging Table” button.

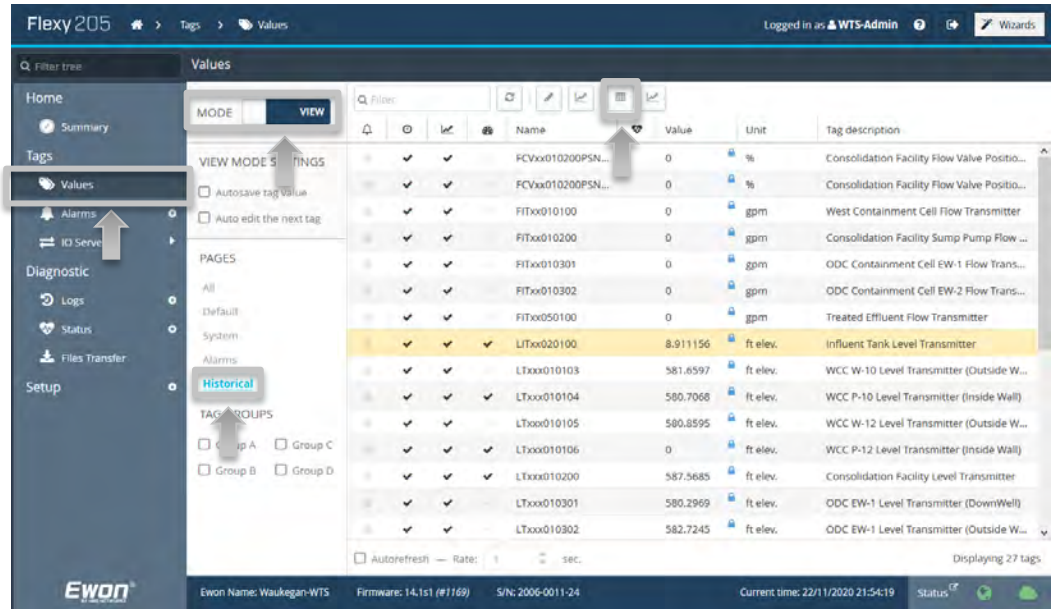


Figure 6-57. Accessing Historical Data

Select a data range, and press the “Upload” Button. Once the data loads, it can be saved as a text file by pressing the “Download as text file” button.

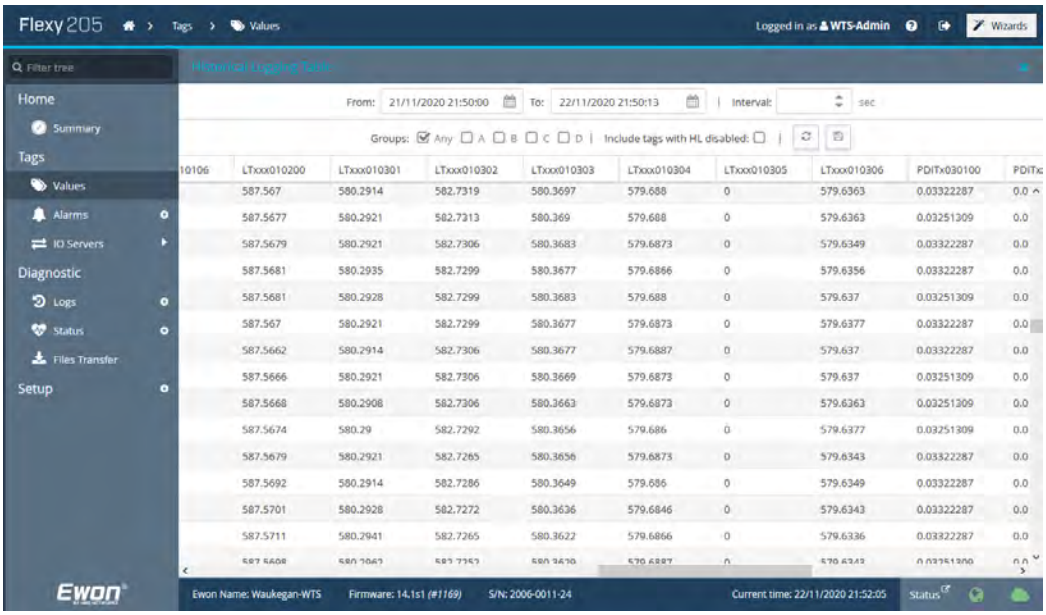


Figure 6-58. Historical Logging Table

6.13 Troubleshooting

6.13.1 General

Any time the system will not run and there is not an alarm condition present, verify the following:

1. Control Panel, CP-1
   a. All alarm lights are functioning.
   b. All circuit breakers are reset and on.
      i. Open the control panel door with appropriate personal protective equipment (PPE) and reset any circuit breakers that may have been tripped.
      ii. A tripped circuit breaker may indicate a problem with the system.
      iii. Inspect the system for abnormal conditions.
   c. All fuses are not blown.
      i. Open the control panel door with appropriate PPE and verify that none of the blown fuse indicator are lighted.
      ii. Replace blown fuses with correct replacement fuse indicated on drawings.
      iii. A blown fuse may indicate a problem with the system.
      iv. Inspect the system for abnormal conditions.
2. Control Panel, CP-2
   a. All motor overloads are reset.
      i. Open the control panel door with appropriate PPE and reset any motor overloads that may have been tripped.
      ii. A tripped motor overload may indicate a problem with the system.
      iii. Test motor for rotation. Verify motor current with clamp-on amp meter. Verify motor resistance/insulation tester.
      iv. Inspect the system for abnormal conditions.

3. CF Starter Panel, CP-3
   a. All motor heaters are reset.
      i. Open the control panel door with appropriate PPE and check for any motor heaters that may have been tripped.
      ii. A tripped motor heater may indicate a problem with the system.
      iii. Test motor for rotation. Verify motor current with clamp-on amp meter. Verify motor resistance/insulation tester.
      iv. Inspect the system for abnormal conditions.
   b. Check starter capacitors.
4. Power Distribution Panel, PP-1
   a. All circuit breakers are reset at lighting panel.
   b. Open the lighting panel door and reset any circuit breakers that may have been tripped.
   c. A tripped circuit breaker may indicate a problem with the system.
   d. Inspect the system for abnormal conditions.
5. All the upstream and downstream equipment interlocks have been properly satisfied. Check for loose wiring and equipment failures.

6.13.2 Influent Pumps, P-1-1-1, P-1-1-2, P-1-2, P-1-3-1, and P-1-3-2

Refer to the submersible pump O&M manual for troubleshooting information.

6.13.3 Metering Pump, P-8-1

Refer to the metering pump O&M manual for troubleshooting information.

6.13.4 Diffused Aeration Tank (DAT), M-9-1

Refer to the aeration blower O&M manual for troubleshooting information.

6.13.5 Influent Tank Pump, P-2-1

Refer to the centrifugal pump O&M manual for troubleshooting information.

6.13.6 Cartridge Filter, M-3-1

Table 6-5. Cartridge Filter Vessel Troubleshooting.

System Problem	Possible Cause	Solution
High differential pressure	Bag fouled	Replace filter element.
	Solids or organics fouling top of bed	Replace filter element.
	Air pocket	Bleed air from top of vessel.
Solids in the effluent	Filter element torn or damaged	Replace filter element.
	Too large of micron filter element	Use smaller micron filter element.

6.13.7 Liquid GAC Filters, M-4-1 and M-4-2

Table 6-6. Liquid-Phase Carbon Vessel Troubleshooting.

System Problem	Possible Cause	Solution
High differential pressure	Fines were not backwashed out at startup	Backwash vessel.
	Solids or organics fouling top of bed	Backwash vessel.
	Air pocket	Bleed air from top of vessel.
High differential pressure even after backwash	Solids or organics fouling top of bed	Remove the top layer or affected area of the carbon Bed.
Carbon in the effluent	Lateral broken	Empty carbon bed and replace damaged lateral.

6.13.8 Alarms

The following alarm messages are displayed on the local OIT and sent as a notification via an email or text message. Any active alarm will illuminate the Common Alarm light at the local control panel. Table 6-7 provides troubleshooting information for addressing the alarm.

Table 6-7. Water Treatment System Alarm Messages

Alarm Description	Solution
Analog Input 8.0 Fail FCV-1-2 Position Feedback	The flow control valve position feedback reading is out of range. This has no effect on the operation of the system. Verify valve setup, verify valve power, examine valve for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.1 Fail FIT-1-1 Flow Feedback	The flow transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.2 Fail FIT-1-2 Flow Feedback	The flow transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.3 Fail FIT-1-3-1 Flow Feedback	The flow transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.4 Fail FIT-1-3-2 Flow Feedback	The flow transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.5 Fail FIT-5-1 Flow Feedback	The flow transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.

Table 6-7. Water Treatment System Alarm Messages

Alarm Description	Solution
Analog Input 8.6 Fail LIT-2-1 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.11 Fail LT-1-3-2 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.8 Fail LT-1-1-2 (Future) Level Feedback	Not applicable (N/A)
Analog Input 8.9 Fail LT-1-2 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.10 Fail LT-1-3-1 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.7 Fail LT-1-1-1 (Future) Level Feedback	N/A
Analog Input 8.12 Fail LT-1-3-3 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.13 Fail LT-1-3-4 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.14 Fail LT-1-3-5 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 8.15 Fail LT-1-3-6 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 9.0 Fail PDIT-3-1 Pressure Diff. Feedback	The pressure transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 9.1 Fail PDIT-4-1 Pressure Diff. Feedback	The pressure transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 9.2 Fail PDIT-4-2 Pressure Diff. Feedback	The pressure transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.

Table 6-7. Water Treatment System Alarm Messages

Alarm Description	Solution
Analog Input 9.3 Fail P-1-3-1 ODC EW-1 Pump Speed Feedback	The AFD speed feedback reading is out of range. This has no effect on the operation of the system. Verify AFD setup, verify AFD power, examine AFD for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 9.4 Fail P-1-3-2 ODC EW-2 Pump Speed Feedback	The AFD speed feedback reading is out of range. This has no effect on the operation of the system. Verify AFD setup, verify AFD power, examine AFD for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 9.5 Fail Spare	N/A
Analog Input 9.6 Fail Spare	N/A
Analog Input 9.7 Fail Spare	N/A
Analog Input 9.8 Fail LT-1-1-3 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 9.9 Fail LT-1-1-4 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 9.10 Fail LT-1-1-5 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 9.11 Fail LT-1-1-6 Level Feedback	The level transmitter feedback reading is out of range. Verify transmitter setup, verify transmitter loop power, examine transmitter for failure, check analog input fuse, check analog input wiring for short circuits, and check analog input for open circuits.
Analog Input 9.12 Fail Spare	N/A
Analog Input 9.13 Fail Spare	N/A
Analog Input 9.14 Fail Spare	N/A
Analog Input 9.15 Fail Spare	N/A
UPS Battery Low Alarm (EAL) ESL-10-1	The UPS battery is low, bad, or there is some issue with the UPS. Verify UPS battery condition, replace every three years or as recommended by manufacturer. Verify UPS power and operation.
Loss of Power Alarm (JAL) JSL-10-1	The control panel power is off. This will inhibit operation of the Water Treatment System. Check circuit breaker to control panel and facility power.
Building Sump Alarm (LAHH) LSHH-7-1	The Treatment Building Sump has a high-high alarm. This will inhibit operation of the Water Treatment System. Check pump operation and check for leaks.
WCC EW-1 Pump Run Fail (YA) P-1-1-1	The pump failed to run after a set time. This will inhibit operation pump. Check pump power, circuit breaker, and operation. Check pump motor high temperature switch.

Table 6-7. Water Treatment System Alarm Messages

Alarm Description	Solution
WCC EW-1 Pump Fail (YA) P-1-1-1	The pump fail indicates the motor overload tripped. This will inhibit operation pump. Check pump motor overload and operation.
WCC EW-2 Pump Run Fail (YA) P-1-1-2	The pump failed to run after a set time. This will inhibit operation pump. Check pump power, circuit breaker, and operation. Check pump motor high temperature switch.
WCC EW-2 Pump Fail (YA) P-1-1-2	The pump fail indicates the motor overload tripped. This will inhibit operation pump. Check pump motor overload and operation.
ODC EW-1 Pump Run Fail (YA) P-1-3-1	The pump failed to run after a set time. This will inhibit operation pump. Check pump power, circuit breaker, and operation.
ODC EW-1 Pump Fault (YA) P-1-3-1	The pump fault indicates the AFD has detected a problem. This will inhibit operation pump. Check pump AFD fault status for cause and pump operation.
ODC EW2 Pump Run Fail (YA) P-1-3-2	The pump failed to run after a set time. This will inhibit operation pump. Check pump power, circuit breaker, and operation.
ODC EW-2 Pump Fault (YA) P-1-3-2	The pump fault indicates the AFD has detected a problem. This will inhibit operation pump. Check pump AFD fault status for cause and pump operation.
CF Sump Pump Run Fail (YA) P-1-2	The pump failed to run after a set time. This will inhibit operation pump. Check pump power, circuit breaker, and operation. Check pump motor high temperature switch.
CF Sump Pump Fail (YA) P-1-2	The pump fail indicates the motor overload tripped. This will inhibit operation pump. Check pump motor overload and operation.
Influent Tank Pump Run Fail (YA) P-2-1	The pump failed to run after a set time. This will inhibit operation pump. Check pump power, circuit breaker, and operation. Check pump motor high temperature switch.
Influent Tank Pump Fail (YA) P-2-1	The pump fail indicates the motor overload tripped. This will inhibit operation pump. Check pump motor overload and operation.
Building Intrusion Alarm (ZAL) ZSL-10-1	The Water Treatment System has detected unauthorized entry into the building. Check building for forced entry.
Treatment System Stop Active (YA) HS-10-1	The control panel Stop button has been pressed. This will inhibit operation of the Water Treatment System. Reset Stop button and clear alarm to resume operation.
WCC Flow High-High Alarm (FAHH) FIT-1-1	Indicates the flow high-high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
WCC Flow High Alarm (FAH) FIT-1-1	Indicates the flow high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
WCC Flow Low Alarm (FAL) FIT-1-1	Indicates the flow low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
WCC Flow Low-Low Alarm (FALL) FIT-1-1	Indicates the flow low-low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.

Table 6-7. Water Treatment System Alarm Messages

Alarm Description	Solution
CF Flow High-High Alarm (FAHH) FIT 1-2	Indicates the flow high-high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
CF Flow High Alarm (FAH) FIT 1-2	Indicates the flow high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
CF Flow Low Alarm (FAL) FIT 1-2	Indicates the flow low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
CF Flow Low-Low Alarm (FALL) FIT 1-2	Indicates the flow low-low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
ODC EW-1 Flow High-High Alarm (FAHH) FIT-1-3-1	Indicates the flow high-high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
ODC EW-1 Flow High Alarm (FAH) FIT-1-3-1	Indicates the flow high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
ODC EW-1 Flow Low Alarm (FAL) FIT-1-3-1	Indicates the flow low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
ODC EW-1 Flow Low-Low Alarm (FALL) FIT-1-3-1	Indicates the flow low-low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
ODC EW-2 Flow High-High Alarm (FAHH) FIT-1-3-2	Indicates the flow high-high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
ODC EW-2 Flow High Alarm (FAH) FIT-1-3-2	Indicates the flow high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
ODC EW-2 Flow Low Alarm (FAL) FIT-1-3-2	Indicates the flow low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
ODC EW-2 Flow Low-Low Alarm (FALL) FIT-1-3-2	Indicates the flow low-low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
Effluent Flow High-High (FAHH) FIT 5-1	Indicates the flow high-high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
Effluent Flow High (FAH) FIT 5-1	Indicates the flow high setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
Effluent Flow Low (FAL) FIT 5-1	Indicates the flow low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.

Table 6-7. Water Treatment System Alarm Messages

Alarm Description	Solution
Effluent Flow Low-Low (FALL) FIT 5-1	Indicates the flow low-low setpoint has been reached. The associated pump must be running before flow is monitored. This alarm will clear automatically.
Influent Tank Level High-High Alarm (LAHH) LIT 2-1	Indicates the level high-high setpoint has been reached. Backup float mode will disable this alarm. This alarm will clear automatically.
Influent Tank Level High Alarm (LAH) LIT 2-1	Indicates the level high setpoint has been reached. Backup float mode will disable this alarm. This alarm will clear automatically.
Influent Tank Level Low Alarm (LAL) LIT 2-1	Indicates the level low setpoint has been reached. Backup float mode will disable this alarm. This alarm will clear automatically.
Influent Tank Level Low-Low Alarm (LALL) LIT 2-1	Indicates the level low-low setpoint has been reached. Backup float mode will disable this alarm. This alarm will clear automatically.
WCC EW-1 Level High-High Alarm (LAHH) LT-1-1-1	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
WCC EW-1 Level High Alarm (LAH) LT-1-1-1	Indicates the level high setpoint has been reached. This alarm will clear automatically.
WCC EW-1 Level Low Alarm (LAL) LT-1-1-1	Indicates the level low setpoint has been reached. This alarm will clear automatically.
WCC EW-1 Level Low-Low Alarm (LALL) LT-1-1-1	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level High-High Alarm (LAHH) LT-1-1-2	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level High Alarm (LAH) LT-1-1-2	Indicates the level high setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level Low Alarm (LAL) LT-1-1-2	Indicates the level low setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level Low-Low Alarm (LALL) LT-1-1-2	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
CF sump Level High-High Alarm (LAHH) LT-1-2	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
CF sump Level High Alarm (LAH) LT-1-2	Indicates the level high setpoint has been reached. This alarm will clear automatically.
CF sump Level Low Alarm (LAL) LT-1-2	Indicates the level low setpoint has been reached. This alarm will clear automatically.
CF sump Level Low-Low Alarm (LALL) LT-1-2	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level High-High Alarm (LAHH) LT-1-3-1	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level High Alarm (LAH) LT-1-3-1	Indicates the level high setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level Low Alarm (LAL) LT-1-3-1	Indicates the level low setpoint has been reached. This alarm will clear automatically.

Table 6-7. Water Treatment System Alarm Messages

Alarm Description	Solution
ODC EW-1 Level Low-Low Alarm (LALL) LT-1-3-1	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level High-High Alarm (LAHH) LT-1-3-2	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level High Alarm (LAH) LT-1-3-2	Indicates the level high setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level Low Alarm (LAL) LT-1-3-2	Indicates the level low setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level Low-Low Alarm (LALL) LT-1-3-2	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level High-High Alarm (LAHH) LT-1-3-3	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level High Alarm (LAH) LT-1-3-3	Indicates the level high setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level Low Alarm (LAL) LT-1-3-3	Indicates the level low setpoint has been reached. This alarm will clear automatically.
ODC EW-1 Level Low-Low Alarm (LALL) LT-1-3-3	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level High-High Alarm (LAHH) LT-1-3-4	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level High Alarm (LAH) LT-1-3-4	Indicates the level high setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level Low Alarm (LAL) LT-1-3-4	Indicates the level low setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level Low-Low Alarm (LALL) LT-1-3-4	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level High-High Alarm (LAHH) LT-1-3-5	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level High Alarm (LAH) LT-1-3-5	Indicates the level high setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level Low Alarm (LAL) LT-1-3-5	Indicates the level low setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level Low-Low Alarm (LALL) LT-1-3-5	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level High-High Alarm (LAHH) LT-1-3-6	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level High Alarm (LAH) LT-1-3-6	Indicates the level high setpoint has been reached. This alarm will clear automatically.
ODC EW-2 Level Low Alarm (LAL) LT-1-3-6	Indicates the level low setpoint has been reached. This alarm will clear automatically.

Table 6-7. Water Treatment System Alarm Messages

Alarm Description	Solution
ODC EW-2 Level Low-Low Alarm (LALL) LT-1-3-6	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
Cartridge Filter Pressure Diff. High Alarm (PDAH) PDIT-3-1	Indicates the pressure high setpoint has been reached. The influent pump must be running before pressure is monitored. This alarm will clear automatically.
Cartridge Filter Pressure Diff. Loq Alarm (PDAL) PDIT-3-1	Indicates the pressure low setpoint has been reached. The influent pump must be running before pressure is monitored. This alarm will clear automatically.
GAC Filter 1 Pressure Diff. High Alarm (PDAH) PDIT-4-1	Indicates the pressure high setpoint has been reached. The influent pump must be running before pressure is monitored. This alarm will clear automatically.
GAC Filter 1 Pressure Diff. Low Alarm (PDAL) PDIT-4-1	Indicates the pressure low setpoint has been reached. The influent pump must be running before pressure is monitored. This alarm will clear automatically.
GAC Filter 2 Pressure Diff. High Alarm (PDAH) PDIT-4-2	Indicates the pressure high setpoint has been reached. The influent pump must be running before pressure is monitored. This alarm will clear automatically.
GAC Filter 2 Pressure Diff. Low Alarm (PDAL) PDIT-4-2	Indicates the pressure low setpoint has been reached. The influent pump must be running before pressure is monitored. This alarm will clear automatically.
Storage Tank Level High-High Alarm (LAHH) LSHH-6-1	Indicates the storage tank high-high-level float switch is active. This will inhibit operation of the Water Treatment System.
Diffused Aeration Tank Level High-High Alarm (LAHH) LSHH-9-1	Indicates the diffused aeration tank high-high level float switch is active. This will inhibit operation of the blower.
Aeration Blower Pressure Diff. Low Alarm (PDAL) PDSL-9-1	Indicates the aeration blower differential pressure low switch is active. This will inhibit operation of the blower.
Aeration Blower Fail (YA) M-9-1	The blower fail indicates the motor overload tripped. This will inhibit operation of the blower. Check blower motor overload and operation.
Aeration Blower Run Fail (YA) M-9-1	The blower failed to run after a set time. This will inhibit operation blower. Check blower power, circuit breaker, and operation.
WCC EW-1 Level High-High Alarm (LAHH) LT-1-1-3	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
WCC EW-1 Level High Alarm (LAH) LT-1-1-3	Indicates the level high setpoint has been reached. This alarm will clear automatically.
WCC EW-1 Level Low Alarm (LAL) LT-1-1-3	Indicates the level low setpoint has been reached. This alarm will clear automatically.
WCC EW-1 Level Low-Low Alarm (LALL) LT-1-1-3	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
WCC EW-1 Level High-High Alarm (LAHH) LT-1-1-4	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
WCC EW-1 Level High Alarm (LAH) LT-1-1-4	Indicates the level high setpoint has been reached. This alarm will clear automatically.
WCC EW-1 Level Low Alarm (LAL) LT-1-1-4	Indicates the level low setpoint has been reached. This alarm will clear automatically.

Table 6-7. Water Treatment System Alarm Messages

Alarm Description	Solution
WCC EW-1 Level Low-Low Alarm (LALL) LT-1-1-4	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level High-High Alarm (LAHH) LT-1-1-5	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level High Alarm (LAH) LT-1-1-5	Indicates the level high setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level Low Alarm (LAL) LT-1-1-5	Indicates the level low setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level Low-Low Alarm (LALL) LT-1-1-5	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level High-High Alarm (LAHH) LT-1-1-6	Indicates the level high-high setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level High Alarm (LAH) LT-1-1-6	Indicates the level high setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level Low Alarm (LAL) LT-1-1-6	Indicates the level low setpoint has been reached. This alarm will clear automatically.
WCC EW-2 Level Low-Low Alarm (LALL) LT-1-1-6	Indicates the level low-low setpoint has been reached. This alarm will clear automatically.
Influent Tank Level High-High Alarm (LAHH) LSHH-2-1	Indicates the influent tank high-high level float switch is active. This will inhibit operation of the Water Treatment System and enable the backup float mode.
Influent Tank Level Low-Low Alarm (LALL) LSLL-2-1	Indicates the influent tank low-low level float switch is active. This will enable the backup float mode.

SECTION 7

Consolidation Facility Sump Pump

EPG Companies has provided an O&M manual for the sump pump and associated equipment installed in the CF sump, including the following, which can be found in Appendix F:

- Sump Pump Wheeled Sump Drainer with vent tube, level sensor, pitless adaptor, and junction boxes
- Franklin Submersible Motor Control Box

SECTION 8

DAT, Static Mixer, and Metering Pump O&M

H2K Technologies has provided an O&M manual for the DAT mixer and metering pump that includes the following, which can be found in Appendix D. The static mixer installed by Arrowhead does not require a separate O&M manual because it is a component of the WTS. The O&M manual in Appendix D covers the following pieces of equipment:

- DAT
- Rotron Regenerative Blower
- Blower Lowe Pressure Switch
- DAT Tank High-Level Switch
- Static Mixer (Westfall Inc.)
- Grundfos Chemical Metering Pump

SECTION 9

Infiltration Treatment Wetland

The infiltration treatment wetland receives the WTS effluent, which enters the wetland via the inlet cascade structure. The water flows down the inlet cascade structure to provide aeration and promote nitrification within the wetland before it infiltrates into the ground. There is not a designated discharge outlet; however, an emergency overflow spillway was constructed within the wetland berm at the southeast portion of the wetland should the water elevation exceed 586.42 feet above sea level. The emergency overflow elevation is designed for capture of the 100-year storm without an overflow.

9.1 Inlet Structure

As shown in Detail 2 on DWG C-04 of the wetland design drawings (Appendix B-2), an inlet cascade structure disperses treated water into the northeast end of the first of three deep zones. The WTS effluent enters an HDPE waterfall spillway and flows down the rock cascade to introduce dissolved oxygen before entering the wetland.

9.2 Overflow Emergency Spillway

The constructed wetland has been designed to provide approximately three feet of freeboard on average to protect the integrity of pond embankments. In addition, the wetland is provided with an emergency spillway to prevent water levels from rising closer than 1 foot from the top of the berm. Since the wetland is constructed to allow infiltration of the WTS effluent water, the overflow structure is solely for emergency purposes. The emergency overflow elevation is designed for capture of the 100-year storm without an overflow.

Although the minimum elevation of freeboard for the wetland cells was designed to contain a 100-year storm event, the emergency spillways (Detail 2, DWG C-03 in Appendix B-2) were sized to have enough capacity to discharge potential flows from extreme weather events and protect the berms from erosion.

9.3 Vegetation Maintenance

Vegetation maintenance is critical for achieving treatment for ammonia within the infiltration treatment wetland system. Vegetative coverage throughout the wetland is a major success factor. Furthermore, exotic species can affect the ecological functions provided by this wetland. If exotic and invasive species are not controlled, they can outcompete the planted wetland vegetation and result in a loss of planted species diversity and ecological value.

To evaluate the success of wetland plantings, vegetation surveys should be conducted on a quarterly or semiannual basis for the first several years of operation, depending on the rate of successful plant establishment. Once it has been determined that the planted wetland vegetation has successfully colonized, vegetation surveys can occur at a less frequent interval. The vegetation maintenance plan should be reassessed frequently as the overall success of management techniques are evaluated.

9.4 Wetland Maintenance

The infiltration treatment wetland initially requires regular maintenance of the planted wetland vegetation until plants are fully established and invasive and exotic species are under control. Once a healthy vegetation community is established, less maintenance will be required mainly due to the seasonal cycling of the water levels that promote succession of the desirable species. Seasonal fluctuations of water levels should encourage establishment of desirable species and inhibit colonization

of invasive ones, even though exotic and invasive species control will still be required. Periodic vegetation surveys should be conducted to ensure planted wetland vegetation is successful and determine if exotic and/or invasive species will need to be controlled. Vegetation surveys can include the use of aerial photography in combination with field surveys. Replanting of the desired wetland vegetation may be required if vegetation surveys indicate less than 90% cover.

Maintenance activities should include:

- Periodic surveys of planted and recruited wetland vegetation to assess overall cover and health of vegetation, which could involve quarterly surveys for the first year, followed by semiannual surveys until a successful plant community has established.
- Assessment of water level operation in relation to wetland plant success, natural recruitment, and control of exotic and undesirable species.
- Evaluation of nuisance and exotic species cover within each cell and planned strategies to control these species during early stages of recruitment.
- Assessment of submerged aquatic vegetation communities to prevent recruitment from undesirable species.
- Semiannual control of nuisance and exotic species by a licensed contractor or manual removal of undesirable species with spot treatment.
- Review of plant cover through field review or aerial photography to determine, if available.

9.4.1 Planted Vegetation Identification

The wetland plant species installed in the wetland cells were categorized into planting zones, which were based on the depth of water at which they best survive. As shown in the design drawing's planting plan, wetland plant categories vary by depth of water and include "emergent marsh plants," "emergent edge plants," and "deep zone plants." The wetland vegetation species located in each zone are provided in Table 9-1. Figure 9-1 presents a pictorial guide to the planted wetland species that were installed in the wetland cells. Each is categorized by the planting zone described in Table 9-1. It is important for an operator to be familiar with the planted wetland species to properly gage the success of the planted species within each cell and understand depth and water level requirements for each species.

Table 9-1. Native Planting Key

Planting Zone	Depth (feet)	Plants
Emergent Marsh Plants	0 to 1	*Schoenoplectus tabernae* (Soft-stemmed Bulrush) *Pontederia Cordata* (Pickerel Weed) *Acorus calamus* (Sweet Flag)
Emergent Edge Plants	-0.5 to +1	*Spartina pectinata* (Prairie Cordgrass) *Juncus effuses* (Common Rush) *Sparganium eurycarpum* (Giant Bur-Reed)
Deep Zone Mix 1	3 to 5	*Nuphar advena* (Spatterdock or yellow lily) *Nymphaea tuberosa* (White Water Lily) *Schoenoplectus acutus* (Hard-Stem Bulrush)
Shrubs	3 to 5	*Cephalantus occidentalis* (Common Bottonbush)

Figure 9-1. Waukegan Wetland Planting Key

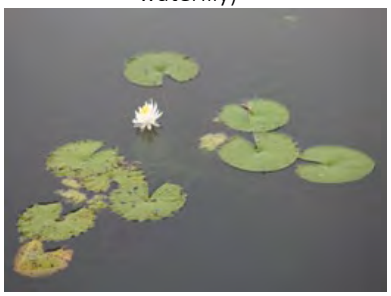
Acorus calamus (sweet flag)[a]

Cephalanthus occidentalis (common buttonbush)[b]

Juncus effusus (soft rush)[c]

Nuphar advena (spatterdock)[d]

Nymphaea tuberosa (American white waterlily)[e]



Pontederia cordata (pickerelweed)[e]

Schoenoplectus acutus (hard-stem bulrush)[f]

Schoenoplectus tabernaemontani (soft-stem bulrush)[e]

Sparganium eurycarpum (giant bur-reed)[g]

Spartina pectinata (prairie cordgrass)[h]

Photo Credits: [a]David Stang, NCSU, [b]Nancy Lowenstein, Auburn University, [c]Brent Sellers, UF/IFAS 2017, [d]KAL, UF/IFAS 2017, [e]CH2M, 2017, [f]Derek Tilley, USDA-NRCS, [g]Robert Freckmann, Wisconsin State Herbarium (UW-Madison), [h]Erv Evans, NCSU

9.4.2 Site Mowing

Maintaining the length of turf is important for stability of the berms and reducing erosion. It is recommended that mowing height be six inches or higher (Ferrell et al. 2012). At this length, turf helps abate the erosion of the soil from rain and wind, retains enough leaf growth to carry out photosynthesis, retains adequate food reserves, and is more persistent to stress periods.

Mowing frequency is important to maintaining a healthy resilient turf. Less frequently mowed grasses are more effective at accumulating food reserves to promote growth following stress periods, such as mowing itself. However, mowing should be performed frequently enough so that no more than one-third of the blade height of the grass must be removed to achieve the desired mowing height. For an ideal mow height of 6 inches, the grass should be mowed when grass height is 9 inches tall.

9.4.3 Exotic and Invasive Species

Exotic and invasive plants are a group of non-native species and invasive plant species native to other areas outside of Illinois. They potentially outcompete and displace the native and planted wetland vegetation and are a hindrance to treatment wetlands. Weeds, invasive, or exotics are terms used to describe undesired plants, though the level of effort required to control the growth of such species largely depends on the species, the level of invasion, and the microclimate in which they are growing. Exotic and invasive species management is critical for the upkeep and growth of the planted wetland vegetation. In the beginning of the operation of the infiltration treatment wetland, aggressive management of these species is required. It is recommended that quarterly assessments for undesirable species be performed in the first year and these species be controlled as quickly as possible. Left unattended, these undesirable species will grow fast and become a very expensive issue to maintain and control.

In constructed wetlands, routine weed removal can performed by either physical or chemical means, ultimately minimizing competition with beneficial and desirable plant species. This section will review and identify exotic and invasive species, as well as physical/manual and chemical removal suggestions.

9.4.3.1 Identification of Exotic and Invasive Species

Appendix G presents information provided by Illinois Cooperative Agricultural Pest Survey Program of identified exotic and invasive aquatic and grass species that may establish at the OMC infiltration treatment wetland. The ability to identify the exotic and invasive species is critical, as early detection of these species allows for easier and more cost-effective eradication of the species.

9.4.3.2 Physical Removal of Weeds

Physical removal of exotic and invasive species can consist of either mechanical or hand removal. For any of the methods used, all undesirable plant material should be removed from the site and sent to a landfill, or incinerated to prevent further spread. Bare areas that remain after removal should be replanted with native vegetation to minimize the risk that these areas will be recolonized with undesirable species.

Mechanical removal involves the use of a mechanical harvester, such as a backhoe or long-arm excavator, to remove unwanted plants. This type of removal is most effective when the treatment area is large since this method greatly disturbs the soil. Hoeing works best on small plants (less than 2 inches in height) and with species that have a single-root mass. It is less effective on larger plants that can regenerate from cut roots. Tilling, or the turning over of soil, is a weed control practice used on agricultural lands that typically has limited usage at wetland sites. Tilling can disturb other desirable vegetation and disrupt the natural chemistry of the soil. In addition, undesirable seeds can proliferate from soil disturbance (CH2M 2006a and 2006b). The fragmenting of weeds should be discouraged

because it could lead to more widespread growth of non-native plants. Weed whipping can be used for adjacent upland areas with wildflowers or herbaceous plant covers. Care should be taken not to trim plants too close to the soil level, because this will kill desired plants and encourage further weed growth (CH2M 2015b).

After mechanically removing the weeds, it is important to seed or plant the native species in the disturbed area to allow them to establish before the weeds. One disadvantage to mechanical removal is the significant turbidity and resuspension of sediment within the cells. Therefore, this method should be used only when the other methods discussed are not effective (CH2M 2015b).

Hand-pulling of undesirable plants, while the most labor-intensive, is one of the most effective methods of weed control. Because of its labor-intensive nature, hand-pulling is most effective only in small areas where the weed problem is contained and localized, and on weed species that have a single-root mass (for example, primrose willow, Carolina willow, and seedling trees), facilitating easy removal. Hand-pulling is less effective in very large areas and with weed species that spread through an underground root system (for example, cattails or torpedograss). Hand removal of weeds also requires skill or training in plant identification. Photographs of native wetland plants and of common weeds (Appendix G) should be provided to field staff for use in determining which plants are to be considered weeds and which are to be protected.

9.4.3.3 Chemical Methods for Weed Removal

Herbicide spraying is a widely used, effective chemical control method for removing invasive weed species, though it should only be used in extreme circumstances where it is the only measure that can control a given invasive species.

Herbicide (organic type preferred) can be used in combination with physical removal. Site conditions are vital to the success of the application of herbicides and should be carefully considered before application. These conditions include assessing the target plant species, seasonal timing of the application, the presence of desirable species and communities, accessibility for the applicator and equipment, weather conditions, depth of water, and the site's sensitivity to trampling (CH2M 2015b). Repeated herbicide application is discouraged along the shoreline as the loss of vegetative cover may cause erosion from wave action and undermine the berms.

Each herbicide can behave differently in the water column due to changes in the solubility, drifts, volatilization and leaching into the groundwater. These factors can differ for the same herbicide depending on the weather conditions. The total rainfall that occurs the first few days after an application can also greatly affect the herbicide treatment. Some herbicides, if improperly applied, may cause droplets or clouds of herbicide to drift and land on non-target vegetation, especially in hot weather (CH2M 2015b).

The only legal herbicides are those registered specifically for use in wetlands and aquatic systems by EPA and discussed further by the North American Lake Management Society (2019). Since herbicides vary for each plant species and the chemical composition of the herbicides often change, it is important to consult a professional for effective and correct herbicide application. Organic herbicides are preferred as they are considered safe for the environment and are less persistent in the water or soils. While it is best to consult with a professional regarding the proper herbicide application, timing, amount, and method (CH2M 2015b), some suggested herbicide application methods for OMC infiltration treatment wetland include:

- For large treatment areas, broadcast foliar application is effective.
- For minor infestations, spot application can be applied to each bundle or plant using a backpack applicator.
- For spot application, the wick application method is effective at controlling single plant infestations.

- For woody vegetation, a physical and herbicidal treatment should be conducted simultaneously, commonly known as the "hack and squirt" method.
- It is important to keep safety in mind when applying herbicides. Here are some general guidelines to follow when using herbicides (CH2M 2015b):
  - Avoid treating areas on cloudy days when dissolved oxygen levels are naturally lower.
  - Never treat more than 1/3 to 1/2 of the plants at once, even when a large portion of the marsh is covered. Always leave time between applications for oxygen recovery.
  - It is best to treat in the early spring as weeds begin their growth and before they proliferate.
  - For best results, use herbicidal treatment when the water temperature is above 60 degrees Fahrenheit to ensure the plants are actively growing.
  - Always use the proper PPE when applying the herbicide to avoid exposure. Always consult a professional.
  - Use caution when mixing or loading herbicides to ensure there are no spills. Immediately, clean any spills to protect from exposure. Notify the proper agency of the spill.

9.4.4 Replacement Planting

The health of the planted native wetland vegetation is vital to the success and function of the OMC infiltration treatment wetland. The health of the native plants should be closely monitored for the first couple years following the wetland planting. If there is a loss of native planted wetland vegetation (due to unsuccessful planting during construction, complications with the operation of the wetland cell, etc.) then replacement planting is required. It is expected that more than 90% of the initial planting areas should have full plant coverage after one year of operation.

Replacement planting may also be necessary if destructive physical or chemical removal is used to control the weeds. As mentioned previously, any bare soil exposed after herbicidal application or physical removing, native plant seeds, bare roots, or potted plantings should be quickly planted to inhibit the invasion of new weeds.

If replacement planting is necessary, the operator should refer to Table 9-1 and the As-Built Wetland Planting Plan (Appendix B-2) for suggested species for planting in the planting zones and specific water depths. It is important to establish dense vegetation cover of native plants to increase wetland treatment performance and to decrease maintenance of wetland cells. Since most vegetation maintenance comes from the removal of weeds, by having densely vegetated native areas, the overall maintenance costs remain low.

9.5 Cell Maintenance

Periodic inspections will be needed to maintain the berms and fences in working order and ensure no sinkholes have opened. Provided enough attention is given to each separate item, these inspections may be conducted simultaneously. There are different actions that must be completed depending on which item of the cell needs maintenance.

9.5.1 Berm Inspection

Conduct berm inspections a minimum of quarterly for the first year and annually thereafter. Conditions such as erosion, burrowing animals, or sinkholes may require more frequent inspections. Things to look for while inspecting the berms include, but are not limited to:

- Animal burrows
- Heavy erosion of the berms
- Any fault or failure of the slopes
- Other irregularities

Animal burrows and erosion have been linked to slope failures which can result in heavy cost implications. Therefore, timely maintenance of these items is important. If any of these conditions are observed, take immediate action to repair the berms to the original condition. If animals or burrows are found in or on the berms, completely remove the animals from within the cell and fully restore the berm with proper backfill and compaction. Burrows may lead to preferential seepage paths which can lead to piping and failure of the berms. In addition, ensure that the proper legal actions are taken to capture and relocate the animal.

9.5.2 Fence Inspections

Inspect quarterly for the first year and annually thereafter. If fences are damaged or burrows are observed beneath the fence, perform repair and increase inspection frequency to verify that similar damage does not continue. If burrows or erosion continue, remediate the source of the damage.

Things to look for during fence inspection include, but are not limited to:

- Burrows under the fence
- Holes or damage to the fence due to animal activity
- Erosion beneath the fence

In addition, inspect the fencing gates and repair damage, as necessary.

9.6 Vector Control

An undesirable component of some wetlands is the potential for production of nuisance populations of mosquitoes. The wetlands can also harbor pests other than mosquitoes. Few indications of increased mosquito-related problems exist in well-designed constructed wetlands (Kadlec and Knight 1996). With growing concern for insect-transmitted diseases such as West Nile Virus, a well-defined vector and pest control plan is advisable to have in constructed wetland projects. Adult mosquitoes favor an environment with shallow water that provides a home for the females to lay their eggs. As a control measure, the growth of natural mosquito predator populations is encouraged by sustaining water levels that are always connected to deeper zones to provide mosquito larvae predators access to the shallow zones and selecting and maintaining vegetation that facilitates predator access to mosquitoes and mosquito larvae such as dragonflies and dragonfly nymphs. Other measures for limiting the propagation of mosquito populations include basin design, microbial larvicides, and chemical control agents.

It is important to understand vector development and control issues as they relate to wetlands. Therefore, the following information is included in this manual to better facilitate the maintenance of wetlands with respect to vector control. Although other pests and disease vectors that may find refuge in wetlands, the primary focus is on mosquitoes.

9.6.1 Mosquitoes

Mosquito control is an important component in the operation of constructed treatment wetlands. Mosquitoes typically concentrate in areas of shallow, stagnant water. While precautions were taken during the wetland design to prevent stagnant water and provide habitat for mosquito predators, it is still important to ensure no issues arise with mosquitoes. Therefore, maintenance must consider the different methods of mosquito control in and around the wetlands with a focus on pest management at the larval and adult stage.

9.6.2 Biological Controls

There are many predators of mosquitoes including insects, birds, fish, frogs, and bats. The copepod genera Mesocyclops and Macrocyclops have also shown promise as effective mosquito control agents. Other natural predators such as backswimmers, predaceous diving beetles, dragonflies, and damselflies are very effective for controlling mosquitoes (IRWD 2003).

Although typically these predators are naturally present in constructed wetlands, if mosquito populations get out of hand, there are methods of increasing the control. The most widely used method is stocking the ponds with fish that feed on the larvae. One of the most typically used fish species is Gambusia affinis commonly known as mosquito fish.

9.6.3 Synthetic Pesticides Control

Synthetic pesticides should be a last resort for mosquito control after natural methods have been tested without success. While synthetic pesticides can be successful, they also have the potential to affect non-target organisms. Before starting a synthetic pesticide control, an expert should be consulted to determine the correct type, amount, and frequency of application (EPA 2016a).

For synthetic pesticides control, the first step is to control mosquitoes at the larval stage.

Synthetic pesticides control targets mosquitoes at the larval stage. The larvicide approach maximizes effectiveness by targeting larvae in the breeding habitat before they can mature to the adult stage. Larvicides tend to be less expensive than controls targeting the adult stage. The type of larvicide should be determined by an expert and depends on several factors including potential human or environmental risk, cost, resistance and ease of use (EPA 2016a). Larvicides are applied directly to the water using sprayers mounted on backpacks, trucks, or aircraft; or can be found in tablet, pellet, granular, and briquette formulations. Three types of larvicides include: bacterial insecticides, insect growth inhibitors, and organophosphate insecticides.

- Bacterial Insecticides affect the larvae by causing them to have trouble digesting the food they eat causing starvation of the larvae after exposure.
- Insect Growth Inhibitors prevent the growth of larvae into adults. There are many forms of this type of larvicide and the determination of which to use should be done by an expert.
- Organophosphate Insecticides prevent the growth of mosquito larvae by affecting their nervous systems.
- Remember to always consult with a professional before attempting to apply any insecticide (EPA 2016b).

If larvicide treatment is not successful, targeting mosquitoes in their adult stage should be considered. The use of adulticides is used primarily for disease control or very high infestations of mosquitoes. These pesticides are best applied by aerial applications by aircraft or by truck-mounted sprayers. The applicators use very small quantities of adulticide and essentially spray micro-sized droplets of adulticides in the air where they directly contact the adult mosquitoes. Organophosphate is one type of

adulticide that kills the mosquito on contact and it is applied by using ultra-low volume sprayers primarily from the ground. Synthetic Pyrethroids are another type of adulticide that targets the nervous system of the mosquitoes, killing them on contact.

These adulticides should never be applied by anyone besides public health officials and trained personnel of mosquito control districts. Always consult a professional on the correct type of adulticide and application method needed (EPA 2017).

9.7 Safe Working in and Around Wetlands

Safety guidelines are provided below for working in and around wetlands:

- Park in areas that provide safe entrance and exit to each wetland cell.
- Wear appropriate PPE (appropriate footwear, eye protection, etc.) and consider snake chaps, gloves, high-top boots, sunscreen, and insect repellent.
- Be aware of loose material, tripping hazards, and especially uneven/soft grounds.
- Be aware of poisonous plants, insects, snakes, animals, and animal waste products and carcasses.
- Take extra precautions to prevent heat and cold stress when working in extreme temperatures. Always bring plenty of water.
- Stay alert to changing weather.

9.7.1 Working Within a Wetland

The following safety guidelines are provided for working within the wetted area of the wetland cells:

- Most work can be done from outside the wetted area. If needing to wade in the water there should always be two people present.
- Use caution with potential hazards associated with the natural surroundings such as water hazards (deep zones and open water zones), insect bites, and extreme temperatures.
- Safety equipment for working in wetlands include:
  - Hip or chest waders
  - Personal flotation equipment when inspecting or performing maintenance work within wetland deep zones
  - Safety glasses (eye protection from sharp plants and other objects)
  - Sunscreen
  - Insect/bug repellant
- All body parts that come into direct contact with water should be thoroughly washed after exposure.
- Never enter/wade into the wetlands without someone on the berm to provide help if needed.

SECTION 10

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Appendix A
ODC PCB Containment Cell - Operations and Maintenance Manual (SulTrac)

OPERATIONS AND MAINTENANCE MANUAL

Plant 2
Outboard Marine Corporation
Waukegan, Illinois

Prepared for:

U.S. Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, IL 60604

Contract No.	:	EP-S5-06-02
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Date Prepared	:	December 28, 2016
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ACRONYMS AND ABBREVIATIONS

amsl	Above Mean Sea Level
cm/sec	Centimeter per second
COC	Chemical of Concern
DNAPL	Dense non-aqueous phase liquid
EPA	U.S. Environmental Protection Agency
FM	Factory Manual
FHWA	Federal Highway Administration
GCL	Geosynthetic Clay Liner
gpm	Gallons per minute
HDPE	High Density Polyethylene
HMI	Human Machine Interface
HOA	Hand-Off-Auto
HP	Horsepower
IAC	Illinois Administrative Code
IC	Institution Control
IDOT	Illinois Department of Transportation
IEPA	Illinois Environmental Protection Agency
I/O	Input/Output
kWh	Kilowatt hours
LDPE	Low Density Polyethylene
mA	Milliamp
NEC	National Electrical Code
NFPA	National Fire Protection Agency
NPL	National Priorities List
NRTL	National Recognized Testing Laboratory
NUC	North Utility Corridor
ODC	Old Die Cast
O&F	Operational and Functional
O&M	Operations and Maintenance
OM&M	Operation, Maintenance and Monitoring
OMC	Outboard Marine Corporation
OU	Operable Unit
PCB	Polychlorinated biphenyl
PID	Proportional Integral Derivative
PLC	Programmable Logic Controller
psi	Pounds per square inch

PVC	Polyvinyl Chloride
RAC	Remedial Action Contract
ROD	Record of Decision
SDR	Standard Dimension Ratio
TCE	Trichloroethene
TDH	Total Dynamic Head
Tetra Tech	Tetra Tech EM Inc.
TSCA	Toxic Substances Control Act
UL	Underwriters Laboratory
VFD	Variable Frequency Drive
VOC	Volatile Organic Compound
WUC	West Utility Corridor

1.0 INTRODUCTION

This Operations and Maintenance (O&M) Manual was prepared by SulTRAC for Operable Unit #4 (OU #4)/Plant 2 at the Outboard Marine Corporation (OMC) site in Waukegan, Lake County, Illinois, for Work Assignment No. 192-RARA-0528 under the Remedial Action Contract (RAC) 2 for Region 5.

This O&M Manual provides the necessary guidance and requirements for operation, maintenance, and monitoring of various components of the selected remedy at OMC Plant 2 site. The City of Waukegan is the current owner of the site. The U.S. Environmental Protection Agency (EPA) implemented the remedial action, and the remediation system operations and maintenance will be transferred to the Illinois Environmental Protection Agency (IEPA).

This O&M Manual discusses the inspection and maintenance required by the operator. This O&M manual and other documents associated with site operations, maintenance, and monitoring will be maintained in the information repositories of the City of Waukegan and U.S. EPA Region 5.

1.1 BACKGROUND AND EXISTING CONDITIONS

The OMC Plant 2 site is located at 90 East Seahorse Drive in Waukegan, Illinois, about 40 miles north of Chicago. The OMC Plant 2 site is the fourth of four OUs of the OMC site on the National Priorities List (NPL). The OMC site also includes the Waukegan Harbor site (OU# 1), the Waukegan Manufactured Gas and Coke Plant (Waukegan Coke Plant) site (OU# 2), and the polychlorinated biphenyl (PCB) Containment Cells (OU# 3). Figure 1 shows the location of the OMC Plant 2 site.

The OMC Plant 2 site includes a 60-acre lakefront parcel that previously included an abandoned 1,060,000-square-foot industrial facility where OMC made outboard motors from about 1948 until 2000. During that time, OMC was the world's largest manufacturer and supplier of outboard motors and the second-largest producer of powerboats. The facility used hydraulic and lubricating oils that contained PCBs in its production lines from 1961 until 1972 and routinely discharged some of the fluids via sewer lines into Waukegan Harbor, thereby becoming the source of very high-level PCB contamination in harbor sediment. OMC also operated several vapor degreasers at the OMC Plant 2 to clean newly made parts with trichloroethene (TCE). Leaking degreasers and TCE storage tanks over the years created a plume of TCE in groundwater and a TCE dense non-aqueous phase liquid (DNAPL) plume beneath the OMC Plant 2 site (CH2MHill 2012).

OMC declared bankruptcy in December 2000 and ceased all manufacturing operations in August 2001. Most of the OMC site is now owned by the City of Waukegan.

EPA had selected a remedial action for soils in a September 2007 record of decision (ROD) for the OMC Plant 2 site that consisted of excavation and off-site disposal of all soils that are contaminated with PCBs above the site cleanup level. However, EPA discovered significantly more (and deeper) soil contamination beneath a portion of the site (the "Old Die Cast" [ODC] building area) than had not been anticipated during implementation of the selected remedy in 2010 and 2011. Additionally, EPA found that excavation of PCB-contaminated soil in the "North" and "West" Utility Corridors was impractical or unsafe given that the utilities are still active in those areas. Therefore, EPA conducted a focused feasibility study to evaluate alternative methods to address the PCB-contaminated soil in ODC and the North Utility Corridor (NUC) and the West Utility Corridor (WUC). EPA issued a Proposed Plan for a ROD amendment to take public comments on its plan to modify the remedial approach in these areas. The ROD amendment was signed on December 12, 2012 (EPA 2012), and identified the selected remedy as Alternative 3, which consists of containing soils in the ODC area with a vertical barrier and cap and capping the utility corridors (NUC and WUC).

Figure 2 shows the site remediation areas. The site has been largely remediated, and site buildings, slabs, sub-slab soils, and defined remediation areas have been addressed by prior actions. The OMC Plant 2 site is currently zoned as a commercial-industrial property. Presently, there are commercial-industrial properties adjacent to OMC Plant 2.

1.2 OVERVIEW OF SELECTED REMEDY

EPA prepared a ROD amendment to describe selected remedial alternatives for the OMC Plant 2 site (EPA 2012). To fulfill the remedial action objectives, the remedy selected in the ROD amendment (EPA 2012) was required to achieve the following:

- Install a 35 Illinois Administrative Code (IAC) Part 811 cap (811 cap) over the ODC building area. The cover, from top to bottom, will consist of 0.5 foot of vegetated topsoil, 3 feet of soil for freeze-thaw protection, and a double-sided drainage geocomposite, 40-mil linear low-density polyethylene (LDPE) geomembrane constructed over a 24-inch layer of low-permeability soil or clay or a geosynthetic clay liner. The final slope shall promote runoff and minimize erosion. The cap shall cover and contain the contaminants, thereby reducing the potential for exposure and off-site migration.
- Install a vertical low-permeability soil-bentonite barrier or slurry wall at least 3 feet into the glacial till layer and extend around the perimeter of the ODC building area. The 811 cap shall extend at least 3 feet horizontally beyond the limits of the vertical barrier to fully enclose the contaminated soil. The vertical barrier shall not only enclose the contaminated soil but also reduce the potential for off-site migration.
- Maintain an inward hydraulic gradient within the containment cell via two groundwater extraction wells. Extract groundwater using two extraction wells at peak elevations of the 811 cap and discharge it to an existing groundwater treatment system that is associated with the

West PCB containment cell. The pumping rates of the extraction wells will be set at flow rates sufficient to maintain an inward gradient within the containment cell and thereby reduce the potential for migration of contaminants through the vertical barrier.

- Install an 811 cap cover over the North and West Utility Corridors with final slopes to promote runoff and minimize erosion. (The installation of an 811 cap was determined to not be feasible because of their locations along property boundaries. Thus, asphalt caps were installed over the NUC and WUC.)
- Implement Institutional Controls (ICs) in the form of a Soil Management Plan, plus deed notices and restrictive covenants to: (1) prevent interference with the remedial actions, (2) ensure proper land uses, and (3) notify property owners that the soils identified at the site pose risks to human health and the environment risk.
- Conduct long-term operation, maintenance, and monitoring (OM&M) of the groundwater extraction system, the vertical barrier, low-permeability cap, and the utility corridor caps. OM&M will be conducted to confirm that the extraction wells are functioning correctly and maintaining an inward hydraulic gradient. OM&M for the caps will be conducted to maintain the structural integrity of the caps and repair any damage. A monitoring program will be implemented to verify that PCBs are not migrating beyond the containment system. Monitoring will be conducted for groundwater downgradient of the contaminated soil areas.

The remedy described above will protect human health and the environment from potential exposure to PCB-contaminated soil in the ODC building area and the North and West Utility Corridors. SulTRAC is responsible for the design of vertical barrier, 811 cap, NUC and, WUC, and the groundwater extraction system. The groundwater treatment system was designed, installed and is operated by another EPA contractor. EPA is responsible for the initial operation, maintenance, and monitoring of the remedial action at OMC Plant 2. As soon as the remedial actions are operational and functional (O&F), the OM&M will be transferred to IEPA.

1.2 REPORT ORGANIZATION

This O&M manual presents the guidelines and procedure for operation, maintenance, and monitoring of various components at OMC Plant 2. The O&M manual is organized with the following sections:

- Section 2.0, which describes the remedial components.
- Section 3.0, which contains information for operations and maintenance of the remedial components.
- Section 4.0, which contains information on reporting.
- Section 5.0, which contains information on emergency response.
- Section 6.0, which contains the references.

Appendix A includes the inspection and repair procedures, checklists, and frequency. Appendix B includes the institutional control compliance monitoring report. Attachments 1 through 3 contain the record drawings, product cut sheets and the project specifications.

2.0 DESCRIPTION OF REMEDIAL COMPONENTS

The remedial system includes the ODC containment cell and utility corridor caps over the NUC and the WUC. Each remedial component is described in the following sections.

2.1 ODC CONTAINMENT CELL

The ODC containment cell prevents exposure of soil containing PCBs and reduces the potential for off-site migration. The ODC containment cell includes the following components:

1. Vertical barrier (Slurry Wall)
2. 811 cap
3. Groundwater Extraction System
4. Performance monitoring piezometers and wells.

The following sections describe each component to the ODC containment cell. Figure 3 shows the layout of the ODC containment cell.

2.1.1 Vertical Barrier

The vertical barrier for the ODC containment cell is constructed of low-permeability materials around the perimeter of the former ODC building. The vertical barrier extends from the existing ground surface to a depth of at least 3 feet into the glacial till layer. The 3-foot key provides a positive connection to the glacial till aquitard and reduces the potential for contaminated groundwater to flow under the barrier.

The length of the vertical barrier is approximately 1,978 linear feet. The elevation of the top of the wall is approximately 584 feet above mean sea level (amsl). The depth of the wall ranges from approximately 22.8 to 28.9 feet below existing ground surface (elevation 555.1 to 561.2 feet amsl) and includes a 3-foot (minimum) key into the underlying glacial till layer around the perimeter of the ODC area. The minimum width of the wall is 27 inches. The permeability of the soil bentonite backfill is less than 1×10^{-7} centimeters per second (cm/sec). The location of the vertical barrier is shown in Figure 3.

2.1.2 ODC Containment Cell Cap

The ODC containment cell has a low-permeability cap in accordance with Title 35 of IAC Part 811 and is installed to reduce the infiltration of precipitation into the containment cell and to reduce the potential for direct contact with the soil.

The “811 cap” is constructed on the ODC containment cell footprint and extends at least 3 feet horizontally beyond the perimeter of the vertical barrier. The 811 cap is constructed of the following layers, from bottom to top: (1) non-Toxic Substances Control Act (TSCA) and nonhazardous excavated trench spoils, (2) a geosynthetic clay liner (GCL) (BentoLiner NSL GCL, manufactured by GSE Environmental [GSE]), (3) a 40-mil LDPE geomembrane (GSE UltraFlex LLDPE 40-mil geomembrane), (4) a geocomposite drainage layer (GSE Double Sided FabriNet 200 Geocomposite, with 6 ounce per square yard nonwoven GSE geotextile) ; (5) a minimum 2.5-foot-thick clay freeze-thaw protection layer; and (6) a 6-inch-thick vegetated topsoil layer that combined with the clay layer will provide the 3-foot freeze-thaw protection.

The record drawings are provided in Attachment 1.

2.1.3 Groundwater Extraction System

A groundwater extraction system is installed within the ODC containment cell to dewater and to provide an inward hydraulic gradient to the containment cell.

The system consists of the following general components:

- Two extraction wells with submersible pumps
- Extraction well pump controls and electrical system
- Groundwater conveyance piping
- Treatment System (designed and operated by others)
- Effluent discharge.

Record drawings are included in Attachment 1. Supporting information, such as product cut sheets, for several components are included in Attachment 2. The project specifications are included in Attachment 3.

2.1.3.1 Extraction Well Construction Details

Two extraction wells (ODC-EW-1 and ODC-EW-2) are installed at the crest of the ODC containment cell — one to the north and one to the south — to provide an inward hydraulic gradient inside the containment cell. The extraction wells are installed to depths of about 1 foot above the low-permeability basal till layer as verified by the field geologist during well installation. Thus, the base of the extraction wells is about 23 feet below current grade, approximately at elevation 565 feet amsl. The extraction well locations are shown on the record drawings.

Extraction wells were installed using hollow-stem auger drilling methods and each extraction well is constructed using 4-inch-diameter polyvinyl chloride (PVC) risers and screens. Extraction well screen openings are 0.020 (20 slot) and are continuous slot PVC screens to increase the open screen area and reduce the potential for screen clogging or fouling. Each extraction well includes two 1-inch-diameter, 0.020-inch slotted PVC piezometers attached to the exterior of the casings with zip ties. One of these 1-inch piezometers is used for manual water level measurement, and the other is used to house the pressure transducer that provides continuous water level monitoring for the groundwater extraction system programmable logic controller (PLC).

A coarse sand filter pack is installed in the annular space around the screen, extending to 1 foot above the top of the screen. The extraction wells have 15-foot-long screens to maximize the well intake length. A 2-foot-thick bentonite seal is installed above the top of the sand filter pack. The annular space from the top of the bentonite seal to the ground surface is pressure grouted. The extraction wells are completed in flush-mounted manholes. Extraction wells were developed by pumping and surging to remove fines.

A pressure transducer (Geotech gauge pressure transducer, vented, Tefzel, 0-15 pounds per square inch [psi], with aneroid bellows option) is installed in one of the 1-inch PVC piezometers associated with each extraction well. The pressure transducer sends a calibrated 4 to 20 milliamp (mA) output signal to the pump control PLC.

2.1.3.2 Extraction Well Pumps and Motors

Each extraction well is equipped with a submersible stainless steel well pump and motor. Each pump has an integral check valve on the discharge to reduce the potential for backflow into the well. Riser pipe from the pump is 1.5-inch schedule 40 stainless steel. The wellhead connection to the horizontal conveyance piping is via a 4- by 1½-inch pitless adapter.

Each extraction well is equipped with a vertical turbine submersible pump manufactured by Grundfos. The design characteristics of each pump summarized in Table 1 include the capacity in gallons per minute (gpm), the total dynamic head (TDH), and the estimated horsepower (HP). High-efficiency motors are used. The motors are manufactured by Grundfos, model 96465624 MS402B (w/cable 3-phase, 230-volt, 60-Hertz, ½-HP).

The extraction well EW-1 pump is capable of up to 14 gpm flow rate, if required. The extraction well EW-2 pump is capable of up to 22 gpm flow rate, if required. The pumps use variable frequency drives (VFD) for the pump motors to allow the extraction wells to efficiently pump at a wide range of flow rates to accommodate the anticipated range of extraction rates.

2.1.3.3 Extraction Well Pump Controls Scheme

The extraction well pumps are controlled by a PLC located at the treatment building. The PLC is connected to the treatment system. When a permissive signal is received (that is, a signal that the treatment system is operating normally and able to treat extracted groundwater), the PLC will turn on both ODC extraction well pumps. Conversely, when a treatment system shutdown occurs, the PLC will shut down both ODC extraction well pumps.

Both extraction well pumps are equipped with VFD that will allow the pumps to modulate their flow rate. The flow rates of the extraction wells are controlled by the PLC in either of the following two user-selectable control schemes: (1) user-selectable extraction well drawdown, or (2) maintain a user-selectable groundwater elevation difference at paired piezometers. Both of these control schemes are further detailed in the following paragraphs. Having two extraction well control schemes allows O&M personnel flexibility in controlling the groundwater extraction system to meet project needs.

The user-selectable extraction well drawdown control scheme (scheme 1) consists of using the groundwater elevation data from both extraction well pressure transducers. O&M personnel can select the desired drawdown and corresponding desired drawdown/groundwater elevation for each extraction well. The PLC modulates the pump speed based on the monitored groundwater elevation in the extraction well. When the groundwater level is below the drawdown setpoint, the PLC will slow the extraction well pump speed. If the flow rate decreases to below the minimum pumping rate (1.5 gpm for ODC-EW-01 or 2 gpm for ODC-EW-02), or the water level in the extraction well drops to 2 feet above the pump, the extraction well pump will shut off until the groundwater level recharges to the user-adjustable elevation and the pump will automatically restart. If the groundwater level is above the drawdown setpoint, the PLC will increase the extraction well pump speed. Using a proportional-integral-derivative (PID) control loop in the PLC, this control scheme is straightforward and simple to implement. However, it requires monitoring the ODC containment cell inward gradient via the five pairs of piezometers, establishing the necessary extraction well drawdown elevations needed to maintain an inward hydraulic gradient. Additionally, groundwater level should be monitored semiannually at each of

the five piezometer pairs to confirm that the extraction well drawdown still maintains an inward hydraulic gradient around the entire perimeter of the cell.

The paired piezometer gradient control scheme (control scheme 2) consists of pressure transducers located in two pairs of piezometers (ODC-PZ-3/ODC-PZ-4 and ODC-PZ-7/ODC-PZ-8) on the inside and outside of the ODC vertical barrier. The flow rate of extraction well ODC-EW1 is electronically linked to the groundwater elevation differential at piezometer pair ODC-PZ-3 and ODC-PZ-4. O&M personnel are able to set the desired groundwater elevation difference between these pairs via the PLC user interface. When the groundwater elevation difference between piezometer pair ODC-PZ-3 and ODC-PZ-4 is below the setpoint, the PLC will increase the flow rate from extraction well ODC-EW1. When the groundwater level difference is above the setpoint, the PLC will decrease or shut off the extraction well, as needed. This paired piezometer control scheme operates the extraction system more efficiently than the drawdown control scheme, by controlling the pumping rate in direct response to the hydraulic gradient across the wall. The PLC records extraction well flow rates along with groundwater levels in the extraction wells and in the two pairs of piezometers.

2.1.3.4 Extraction Well Electrical System

The extraction system is installed according to the 2008 National Electrical Code (NEC) and all applicable sections of National Fire Protection Agency (NFPA) 70E Standard for Electrical Safety in the Workplace.

All equipment used in the construction is listed by a National Recognized Testing Laboratory (NRTL) for the application. Acceptable NRTL listings or approvals are as follows:

1. FM Factory Mutual
2. UL Underwriters Laboratory

Main Feed

The electrical power supply to the well pumps and controls are branch circuits from the treatment system. Details regarding the electrical service (voltage, phase, and amperage) are included in the record drawings.

Grounding System

The grounding system is installed per all applicable national, state, county, regional, and city codes. The ground rods are copper-clad steel rods, 10 feet long. A minimum of one ground rod is driven at each extraction well location.

Ground conductors are stranded or solid copper. Connections are pressure or exothermic weld type.

Electrical Equipment

The electrical equipment is UL listed. Electrical equipment is electrically rated for the intended use to ensure a complete and working system.

Conduit

The underground conduit system is schedule 40 PVC buried at a depth of not less than 24 inches and are provided with metallic warning tape.

A main control panel is located at the treatment system. This control panel houses the PLC, the human-machine interface (HMI) touch screen, and instrumentation. The PLC will record cumulative hours that each extraction well pump has operated.

Electrical and control wiring is underground in separate PVC conduits to the two extraction wells and the two paired piezometers (ODC-PZ-3/ODC-PZ-4 and ODC-PZ-7/ODC-PZ-8). The wiring and conduit routing is shown on the record drawings. Conduit and conductor sizing to each of these locations are shown on the record drawings.

All controls are housed in the treatment building at the site to include an emergency disconnect switch (with a lockout/tagout hasp), pump running indicator lamp, hand-off-auto (HOA) switch, remote Input/Outputs (I/O) to the PLC, and house the VFDs. The VFDs are equipped with overload and undercurrent and overcurrent protection to eliminate the need for a high-pressure switch for pump motor protection.

2.1.3.5 Extraction System Piping

Extraction wellheads are located in 18-inch-diameter flush-mount well boxes. Wellheads are equipped with a 4-inch by 1½-inch pitless adapter, located at least 5 feet below ground surface to reduce the potential for freezing of the pipes. The pitless adapter allows for easy removal of the extraction well pump and allows for the connection to the conveyance piping installed below the frost line (5 feet below

ground surface), in accordance with Waukegan Ordinance Section 890.1150 (a)(3). All piping from the extraction wells to the treatment system is installed below the frost line. The 1½-inch-diameter outlet from the pitless adapter is connected to a 1½-inch stainless steel transition fitting that is used to connect the pitless adapter to the 1½-inch HDPE conveyance pipe. Each well has a separate conveyance pipe to the treatment building, to reduce the changes in discharge pressure that can occur in common pipes and allow for separate flow meters, pressure gauges, valves, and sample ports to be installed at the treatment system. The conveyance pipe consists of 1½- inch diameter, Standard Dimension Ratio (SDR) 11 HDPE piping, rated for 160 psi, which exceeds the maximum discharge pressure of each extraction well pump.

At the treatment system, each extraction well pipeline transitions to a 1½-inch-diameter schedule 40 PVC piping (rated for 198 psi) equipped with the following:

1. 1½-inch isolation ball valve
2. flow meter
3. ¼-inch ball valve sample port
4. 1½-inch isolation ball valve.

After this section, the pipes join a 2-inch diameter, schedule 40 PVC common pipe that discharges into the treatment system.

2.1.3.6 Groundwater Monitoring System

Groundwater levels and groundwater quality are monitored using piezometers and monitoring wells to confirm that the extraction system and containment cell are functioning as designed. Five piezometer pairs are installed around the perimeter of the ODC containment cell to (1) monitor groundwater levels, and (2) monitor groundwater quality in the vicinity of the ODC. One of each piezometer pair is installed within the containment cell, and the second is installed outside of the containment cell but adjacent to the first. Figure 3 shows the locations of the piezometers and monitoring wells. Monitoring well and piezometer construction details are provided in the record drawings in Attachment 1, and the product details are provided in Attachment 2. The project specifications are in Attachment 3.

2.2 NORTH AND WEST UTILITY CORRIDOR CAPS

The northern portion of the NUC and the WUC are capped with 4 inches of compacted aggregate base course and covered with 2 inches of compacted hot mix asphalt. The road portion of the NUC (southern portion) is capped with 8 inches of compacted aggregate base course and covered with 3½ inches of compacted hot mix asphalt. The caps are designed to minimize contact and release of the chemicals of

concern (COCs) in soil at the site. The cap areas are graded to promote runoff. NUC is depicted on Figure 4, and WUC is depicted on Figure 5.

3.0 OPERATIONS AND MAINTENANCE

O&M of the remedial system will be conducted by qualified personnel. Table 2 includes a summary of the operational elements of the site and the qualifications required. The following summarizes each O&M aspect of the remedial system.

3.1 ODC CONTAINMENT CELL OPERATIONS AND MAINTENANCE

The ODC containment cell consists of a vertical barrier, 811 cap, and a dewatering system. Each element of the containment cell requires inspection and maintenance and is discussed below. A summary of the elements to be inspected and the frequency for the ODC containment cell is provided in Table 3.

3.1.1 Vertical Barrier and Cap O&M

The vertical barrier operations can be inferred by visual inspection of the ODC cell cap surface and by groundwater monitoring at monitoring wells installed outside of the containment cell. Monitoring and maintenance of the ODC containment cell cap include the cap grading, drainage, and erosion elements, which are discussed below. The following lists the inspection and maintenance elements to ensure proper function of the vertical barrier and the cap.

Visual Inspection

A general inspection of the site will be conducted on a semiannual basis. The perimeter will be checked and the fencing will be inspected for security breaches. Access roads will be inspected to ensure they are adequate for site operations. The site will be inspected for vandalism or trash or any unwanted material that may be dumped or accumulate at the site. Issues noted in the inspection should be rectified within 60 days after they are discovered.

The 811 cap will be inspected to check for the presence of pooling, puddles, woody vegetation, or any discoloration. Areas will be checked for erosion such as development of swales, gullies, or rill. The presence of any animal borrows will be checked on site. Seeding or planting should be done in accordance with the attached specification for seeding (Attachment 3). Depending on future site use, vegetation should be cut or mowed as deemed necessary. Mowing may be necessary to promote a well-established vegetation or when desired to avoid creation of wildlife habitat. Any unwanted vegetation that grows at a height greater than the predominant grasses must be removed from the site. Removal of any unwanted vegetation should include measures to prevent exposure of subsoil, and necessary measures should be taken to prevent their future growth.

A site walk will be conducted on a semi-annual basis for the O&M activities. Appendix A includes the inspection task and procedures.

Inspections of cover will note the following information:

- Cracks
- Slope failure
- Signs of erosion
- Evidence of depressions, settlement or subsidence
- Proper surface water drainage
- Vandalism
- Signs of burrowing animals
- Presence of wildlife.

Inspection of vegetation will note the following information:

- Bare spots
- Stressed vegetation
- Presence of deep-rooted vegetation
- Presence of unknown species
- Underdeveloped vegetation
- Drooping or wilting vegetation
- Areas of significantly well or sickly growing vegetation.

During inspections, if there is evidence of erosion or faulty drainage, appropriate measures should be implemented to control it. Necessary steps should be taken to repair any deficiencies in accordance with the project specifications.

Maintenance

Proper maintenance of the soil cover will be conducted to ensure the cap remains protective of the containment cell. Routine maintenance will consist of removing deep-rooted vegetation such as brush and trees on a semi-annual basis. Herbicide should be applied as necessary if unwanted plant species grow on site. Brush will be cut or mowed to prevent the establishment of deep-rooted trees or shrubs, which could penetrate and damage the low permeability liner system.

Signs of pooling, puddles, erosion, fissures, or desiccation in the 811 cap will be noted. Any depressions or damage will be filled and areas will be regraded or resurfaced to original record drawings and specifications. In case of erosion, the cap will be repaired to the design thickness. Cracks will be repaired using the same material that was used during cap construction. Storm control measures such as temporary berms, ditches, and straw mulch will be used to curb further erosion before permanent measures will be constructed. Re-seeding or mowing will be done as necessary and in a timely manner. Any burrowing animals present on the cap will be removed from the site.

The cap will be repaired and the cap restored to design conditions as soon as practicable, but no later than 60 days after the owner becomes aware of the breach. Any repairs to the cap should follow the as built-site drawings, the construction specifications, and the manufacturer's recommendations.

Grading

The cap layers were graded to promote drainage from the center of the containment cell to the outer perimeter. The foundation layer was graded to maintain a slope of 3 to 5 percent away from the center of the containment cell area. All subsequent cap layers follow the same grading pattern. Final grading contours for the ODC cap are shown in the record drawings.

Drainage

The cap includes a low-permeability layer (GCL) that is installed on the foundation layer and has a hydraulic conductivity of less than 5×10^{-9} cm/sec. Above the GCL is a 40-mil-thick LDPE polyethylene geomembrane liner. A triaxial geocomposite liner is installed on the geomembrane liner to serve as a drainage layer. This drainage layer allows the precipitation that infiltrates through the freeze-thaw layer to run off to the outer perimeter of the containment cell. The cap will be regularly inspected for signs of improper drainage, such as pools, ponding, or puddling. Drainage features near the ODC containment cell should also be regularly inspected. Future development in surrounding areas can affect the site drainage. Deficiencies in drainage should be addressed if necessary based on inspection results.

Erosion

Grass seeding and erosion control matting are to be installed to reduce erosion until the vegetative layer is fully established. The vegetation will control the erosion and decrease the infiltration by evapotranspiration. The Illinois Department of Transportation (IDOT) Class 3 Northern Illinois slope mix (see Table 4) should be used. This seed mix is shallow rooted and requires low nutrients for

development. In addition, the seed mix is resistant to drought and heat. Re-seeding and proper watering should be conducted to re-establish the vegetation.

Routine Monitoring and Laboratory Testing

A comprehensive groundwater monitoring program will be implemented as described in Section 3.1.5 to evaluate the performance of the vertical barrier. Groundwater samples will be collected for laboratory analysis to demonstrate the effectiveness of the low-permeability barrier.

Recordkeeping

Inspection, maintenance, repair, and monitoring records will be maintained by the O&M contractor and kept on file at the site. Additional copies may be maintained by EPA and IEPA.

3.1.2 Extraction Wells

Two extraction wells are installed to dewater the ODC containment cell. The general operation and maintenance for individual system components of the groundwater extraction system is provided in this section.

Maintenance activities, schedules, and tasks should be followed for individual components based on manufacturer's manual for model, consumables used (oil and filters), and site-specific conditions. The manufacturer's manual should be considered for replacement of system components. The inspection and maintenance checklist with faults and possible troubleshooting options is presented in this section.

Dewatering Pump

Various in-well components (pumps and transducers) will be visually observed to maintain the pump efficiency. The intake screen of the submersible groundwater dewatering pump will be checked for sediment and scale buildup. The pump intake screen and possibly the internal impellers should be cleaned before they are returned to the well. All unwanted material from the pump impeller and pump intake screen should be removed. All parts should be thoroughly cleaned before they are re-assembled or replaced. Typically, these steps should be completed if there is a 25 percent decrease in pumping rate. Refer to the manufacturer's manual for specifics on disassembly or cleaning of pumps.

Well Re-Development and Rehabilitation

The extraction wells may require periodic re-development or rehabilitation. If the specific capacity (pumping rate divided by drawdown) of the well is reduced by 25 percent, the extraction well pump and well should be investigated for pump motor performance, pump fouling, and well fouling.

An electrician should check amperage draw and resistance of the pump motor to assess potential pump motor malfunctioning in certain cases where the pump intake screen is clean and the pump is still non-functional. Based on operational data, the frequency of visual assessment should be adjusted to check the well components. Depending on chemical data for the water and on geological conditions, the frequency for checking the pump system may be increased or decreased. The list of activities that may be performed during the inspection of in-well components is as follows.

- The extraction well pump and drop pipe should be removed and the submersible pump water intake screen inspected for clogging by particulates, scale, or biofouling.
- Well redevelopment should be conducted by an experienced well maintenance contractor using appropriate methods such as airlift pumping, surging and pumping,
- If the extraction well screen is scaled or fouled with biological growth, an experienced well maintenance contractor should rehabilitate the well using appropriate methods and chemicals. Any maintenance chemicals should be introduced into the well in accordance with all state and federal regulations.

Dewatering System Data

The following data should be collected from the dewatering system:

- Water level data from piezometer pairs and extraction wells. Plots will be generated to compare the interior and exterior groundwater levels of the containment cell.
- Extraction well flow rate (instantaneous, total, average for monitoring period, average for project). Plots will be generated showing flow rate vs. time.
- Electrical consumption (kilowatt hours, kWh) (instantaneous, total, average for monitoring period, and average for project).
- Calculation of system uptime/downtime due to maintenance or breakdowns.
- Alarm history.

Spare Parts

The only spare part planned for the ODC containment cell system is a spare extraction well pump, a Grundfos 16S05-5 pump that is stored in the treatment building.

Troubleshooting of Common/Anticipated Remedies

Several types of common problems can occur when the extraction system is operating. Experienced equipment manufacturer technicians should be contacted for guidance in troubleshooting these items. While troubleshooting or disassembling any system component, the personnel should lock out system power to avoid any hazard.

In case of submersible pump malfunction or lower than normal flow rate, an amperage draw test should be done for each pump motor and compared with manufacturer's pump motor characteristics. Motor winding resistance should also be checked.

Annual inspections should include maintenance of pump, motor and attachment. Records of various observations of pump, motor, and various components should be kept. Please see Table 5 for troubleshooting in case of pump failure.

RECORDKEEPING

Inspection, maintenance, repair, and monitoring records will be maintained by the O&M contractor and kept on file at the site. Additional copies may be maintained by the EPA and IEPA.

3.1.3 Treatment System and Effluent Discharge

The treatment system and the effluent discharge were designed and installed by others and are not included in this O&M manual. Details of O&M activities for the treatment system will be provided by others.

3.1.4 Groundwater Monitoring of ODC Containment Cell

Groundwater levels and groundwater quality will be monitored using piezometers and monitoring wells to confirm that the extraction system and containment cell are functioning as designed. Five piezometer pairs are installed around the perimeter of the ODC containment cell to (1) monitor groundwater levels, and (2) monitor groundwater quality in the vicinity of the ODC. One of each piezometer pair is installed within the containment cell, and the second is installed outside of the containment cell but adjacent to the first.

Groundwater elevations will be monitored and recorded continuously with transducers in two piezometer pairs. Groundwater elevations will be measured manually at the remaining three piezometer pairs on a quarterly basis for the first 3 years of operation. The groundwater elevation measurements should be evaluated to confirm an inward hydraulic gradient at each piezometer pair. The continuously recorded transducer monitoring will provide a high resolution data set to validate the hydraulic control of the vertical barrier and dewatering system. Manual groundwater level measurements from ODC-PZ-3, ODC-PZ-4, ODC-PZ-7, and ODC-PZ-8 should be compared with the pressure transducers groundwater level readings quarterly. The pressure transducer should be re-calibrated if the difference between the manual measurement and the pressure transducer readings exceeds 0.2 foot. Table 6 shows the information on piezometer pairs and their monitoring.

Four nested monitoring well pairs (Figure 4) are installed around the ODC containment cell to (1) monitor groundwater elevations, and (2) monitor groundwater quality in the vicinity of the ODC. Groundwater elevations will be gauged manually in these wells. Table 7 describes the eight new monitoring wells.

Groundwater samples will be collected for laboratory analysis of volatile organic compounds (VOCs) and PCBs on a quarterly basis for the first 3 years and on a semi-annually for the remainder of the life of the ODC containment cell.

A separate document describing the groundwater monitoring field sampling plan will include details on sample collection, sample identification numbers, sample preservation and shipping, analytical methods, quality control/quality assurance samples, and reporting.

3.2 UTILITY CORRIDOR CAPS

The northern portion of the NUC and the WUC are capped with 4 inches of compacted aggregate base course and covered with 2 inches of compacted hot mix asphalt. The road (southern) portion of the NUC is capped with 8 inches of compacted aggregate base course and covered with 3½ inches of compacted hot mix asphalt. These caps are designed to minimize contact and release of the COCs in soil at the site. The caps are installed with gentle sloping to promote runoff. The NUC includes an east and a west area that consist of existing asphalt caps. A summary of the elements to be inspected and the frequency for the asphalt corridors is provided in Table 3.

Grading

Each newly installed cap includes a minimum of 4 inches of compacted aggregate base course. A minimum of 2-inch asphalt hot mix layer is installed on top of the base course. The newly installed asphalt caps are constructed with a 1 percent slope to minimize the standing water and promote the flow of runoff to the perimeter area. A crown is present along the center of the southern portion of the WUC to allow the runoff to flow to the sides of the caps. Manhole risers for the storm and sanitary utilities were installed so the manhole covers would be flush with the final cap elevations. The established elevations and limits of the caps are provided in the record drawings.

Drainage

Precipitation will run off the caps as sheet flow from the crown to the sides. The asphalt pavement is moderately impermeable. Some infiltration to the soil underlying the cover may occur. Any future development surrounding the asphalt cap could disturb the site drainage, and any modifications should be addressed on a case-by-case basis.

Inspection of Asphalt Cap

The inspection of asphalt cap drainage and competence will take place on a semi-annual basis and after major storm events. Refer to Appendix A for inspection tasks and procedure. The following items will be noted during asphalt cap inspections:

- Evidence of cracks
- Settlement and subsidence
- Evidence of vegetation growth
- Evidence of depression
- Evidence of improper drainage
- Vandalism
- Heavy traffic

Repair of Asphalt Caps

Damage to the asphalt caps will be restored to the conditions based on the record drawings. Cracks should be filled and the asphalt caps should be sealed annually, or more frequently if routine inspections identify significant cracking that requires immediate repair. Methods and materials for crack filling and sealing should be consistent with Federal Highway Administration (FHWA) procedures (FHWA

1999). The entire asphalt cap should be chip sealed if cracks become widespread and the entire asphalt cap requires repair. Before chip sealing, all cracks should be filled and sealed.

4.0 REPORTING

An annual report will be prepared by the O&M contractor and provided to EPA or IEPA for review and approval.

The annual reports must include, at a minimum, the results of inspections and summary of all repair and maintenance conducted on site. In addition, the results of the groundwater monitoring will be provided in the reports. Additional reports may be generated for repair work for any site features after inspections initiated by flood or other natural event.

Annual reports will be prepared as per the guidelines listed under the Comprehensive Environmental Response, Compensation, and Liability Act.

5.0 EMERGENCY RESPONSE PLAN

A comprehensive emergency plan becomes crucial to execute safe procedures to mitigate any potential hazards to deal effectively in case of emergencies at the OMC Plant 2 site. This section describes the procedures to be followed in case of emergencies. In case of future site development, an updated emergency response plan should be available to the site users at all the time.

Types of Emergencies

There are different potential emergencies for the type of components and activities conducted on site. Each emergency will have a different type of potential impact on people, property, and the environment.

Following are some of the emergencies that are included in this plan.

- Release of potentially contaminated soil (of hazardous solids and/or liquids)
- Vandalism
- Equipment failure
- Power failure
- Fire (including generation of toxic combustion products)
- Flooding.

Several on-site resources to be considered include fire extinguishers, spill containment equipment, and first aid kits. These resources must be maintained and clearly identified. Fire protection and medical resources should be identified. Construction equipment and construction contractors may be included among potential emergency resources. Personnel, equipment, facilities, and material needs for emergency response should be clearly identified, and responsible people supplying these resources must be made aware of their role in the plan. As necessary, emergency response items may be stored on site for their immediate availability.

Emergency Response Procedure

The emergency response procedures must be clearly communicated to all site users. Any new work areas on site may introduce new hazards and should be clearly identified and covered in procedures. The procedures should be reviewed by the Safety representative on a regular basis to address new hazards or significant changes in site conditions. Table 8 shows the threat and response for addressing emergencies.

6.0 REFERENCES

CH2MHill. 2012. Feasibility Study Report for PCB-Contaminated Soil, OMC Plant 2 Site, Waukegan, Illinois. July.

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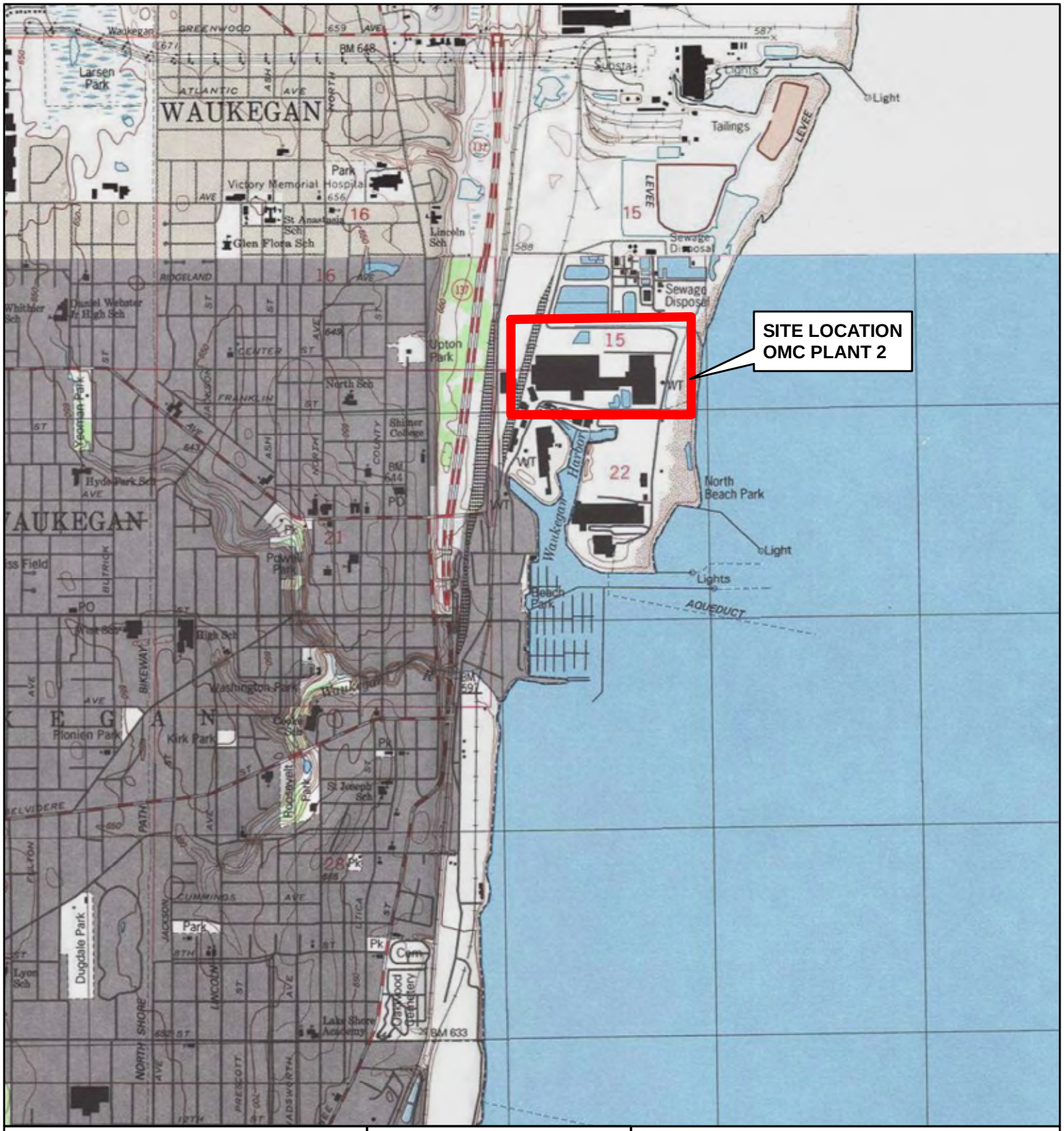
SulTRAC. 2013a. Remedial Design Data Summary Report, Outboard Marine Corporation Site, Waukegan Township, Lake County, Illinois. December.

SulTRAC. 2013b. Remedial Construction Drawings, Outboard Marine Corporation site, Waukegan Township, Lake County, Illinois. December.

U.S. Environmental Protection Agency (EPA). 2012. Record of Decision Amendment, Outboard Marine Corporation Superfund Site, Waukegan, Lake County, Illinois. December.

FIGURES



REFERENCE MAP

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

FIGURE 1
SITE LOCATION MAP

SulTRAC

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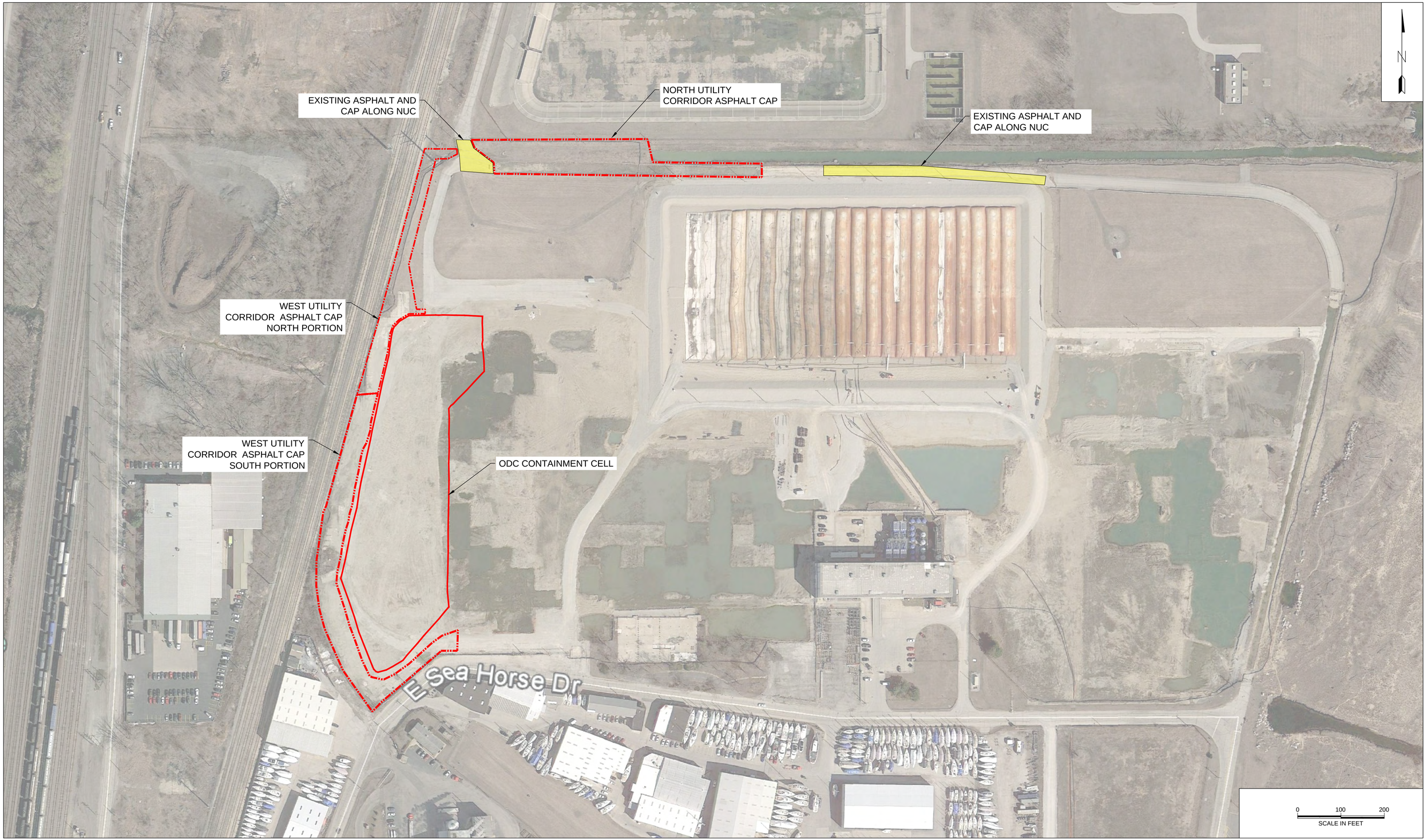

REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED DJB
DRAWN MB
CHECKED CN
DATE 12/14/2016

ST SulTRAC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

SITE MAP SHOWING REMEDIAL ACTION AREAS

WORK ASSIGNMENT NO. WA192

FIGURE 2

6/25/2015

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Legend

- Piezometer Location
- Monitoring Well Location
- Extraction Well Location
- Existing Piezometer Location
- Existing Monitoring Well Location
- Pull Box
- Sewer Sanitary Manhole
- 8" PVC Sanitary Force Main
- 51" Diameter Sanitary Sewer Line
- Storm Sewer
- Natural Gas Line
- Control Cable Conduit
- Electrical Conduit
- Extraction Well Piping
- Location of Vertical Barrier
- Approximate Extent of 811 Cap

N

0 100 200 Feet

REFERENCE MAP

OMC PLANT 2 SITE
WAUKEGAN, ILLINOIS

FIGURE 3
CONTAINMENT CELL LAYOUT

SulTRAC

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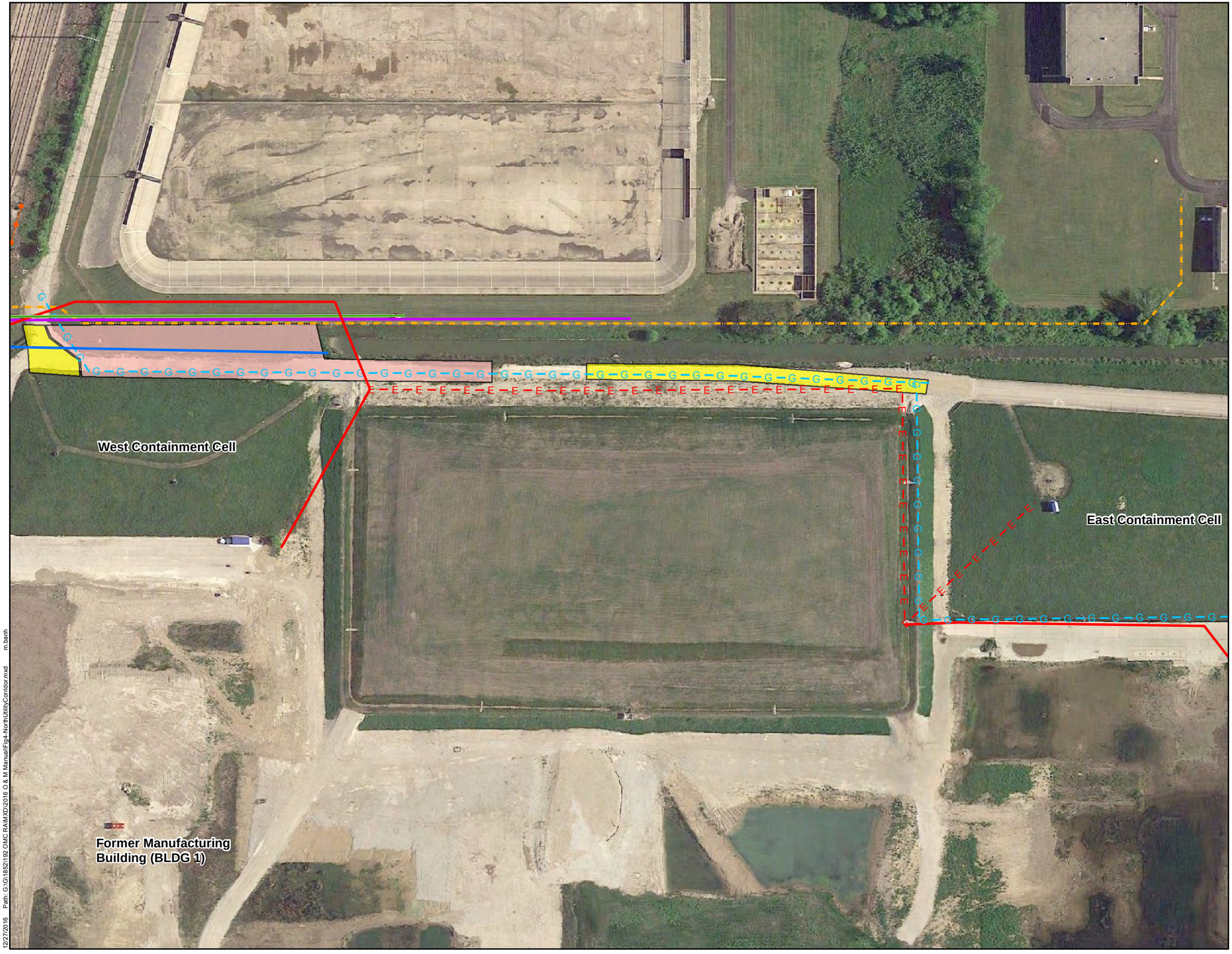

Legend

- NUC Asphalt Cap
- Existing NUC Asphalt Cap
- North Sanitary Main
- 51" Diameter Sanitary Sewer Line
- North 54" Gravity Relief Sewer (Reinforced Concrete)
- Sanitary Force Main
- Storm Sewer
- E — E Underground Electric
- Overhead Electric
- G — G Natural Gas Line

N

0 100 200 Feet

REFERENCE MAP

OMC PLANT 2 SITE
WAUKEGAN, ILLINOIS

FIGURE 4
NORTH UTILITY CORRIDOR
CAP LAYOUT

SulTRAC

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Legend

- Sewer Sanitary Manhole
- 8" PVC Sanitary
- North Sanitary Main
- 51" Diameter Sanitary Sewer Line
- North 54" Gravity Relief Sewer (Reinforced Concrete)
- Sanitary Force Main
- Storm Sewer
- Underground Electric
- Overhead Electric
- Natural Gas Line
- WUC Asphalt Cap
- Location of Vertical Barrier and extent of IAC 811 Cap

N

0 100 200 Feet

REFERENCE MAP

OMC PLANT 2 SITE
WAUKEGAN, ILLINOIS

FIGURE 5
WEST UTILITY CORRIDOR
CAP LAYOUT

SulTRAC

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TABLES

TABLE 1

PUMP DESIGN CHARACTERISTICS

Pump	Extraction Well	Model No.	Capacity – gpm	TDH[1]	HP
1	ODC-EW-01	10S05-6	1.5 to 14	52 feet (23 psi)	1/2
2	ODC-EW-02	16S05-5	2 to 20	68 feet (29 psi)	1/2

Notes:

[1] TDH is based on a 10-gpm flow rate, assumed 10-foot tall surge tank height and a treatment system located approximately 360 feet east of ODC-PZ-3.

gpm Gallons per minute

HP Horsepower

psi Pounds per square inch

TDH Total dynamic head

TABLE 2
OPERATION AND MAINTENANCE OVERSIGHT PERSONNEL

General O&M Component	Qualifications
Retain updated O&M plan	Authorized representative, EPA/IEPA
Financial responsibility	Authorized representative, EPA/IEPA
Recordkeeping	Authorized representative, EPA/IEPA
Institutional Controls	City of Waukegan and O&M Contractor
Land Use	Authorized representative, City of Waukegan
811 Cap – Final Grading	CPESC, QSP, or Civil P.E. (O&M Contractor)
811 Cap – Vegetative Cover	CPESC, QSP, or Civil P.E. (O&M Contractor)
811 Cap – Drainage	CPESC, QSP, or Civil P.E. (O&M Contractor)
811 Cap – Scour and erosion	CPESC, QSP, or Civil P.E. (O&M Contractor)
Slurry wall – wall protection	O&M Contractor
Dewatering system – Extraction wells and piezometers	O&M Contractor
Dewatering system – Pumps	Civil P.E. (O&M Contractor)
Dewatering system – Control system	Electrician, Civil P.E. (O&M Contractor)
NUC – Asphalt cap	CPESC, QSP, or Civil P.E. (O&M Contractor)
WUC – Asphalt cap	CPESC, QSP, or Civil P.E. (O&M Contractor)
Emergency Response	O&M Contractor
Wildlife	Illinois State Biologist

Notes:

CPESC = Certified Professional in Erosion and Sediment Control
O&M = Operation and Maintenance
P.E. = Professional Engineer
QSP = Qualified SWPPP (Stormwater Pollution Prevention Plan) Practitioner
R.G. = Registered Geologist

TABLE 3
INSPECTION SUMMARY

Component	Inspection Item	Frequency
General Site Conditions	• Site perimeter walk, security of area not breached • Site access roads and fences • Vandalism • Trash and unwanted material	Semiannually
Vertical Barrier	• Penetrating roots • Cracks or fissures • Vandalism	Semiannually for the cap lifetime
811 cap	• Drainage – on and off site • Depressions, pools, puddles • Cracks or fissures • Swale, gullies, or ripples • Prevention of erosion • Vegetation • Unwanted deep-rooted species • Slope failure • Vandalism • Burrowing animals	Semiannually for the cap lifetime
Dewatering system	• Well & piezometer: casings, pads • Obstruction • Vandalism or theft • Seals • System operation	Daily for first week, Weekly for first month, Monthly for first quarter, Quarterly for remainder of project.
Asphalt Caps	• Cracks, potholes, or depressions • Degradation • Settlements •	Semiannually for the cap lifetime

Notes:

Inspections should be conducted after major changes in weather or natural event (based on professional judgment and site experience).

Mowing the vegetative cover is not part of the inspection but should be completed semiannually or as needed based on future site use.

TABLE 4
SEED MIX FOR ODC CAP

Common Name	Pounds/Acre
Canada Wild Rye (*Elymus canadensis*)	5 lbs. / acre
Perennial Ryegrass	20 lbs. / acre
Alsike Clover	5 lbs. / acre
Illinois Bundleflower (*Desmanthus illinoensis*)	2 lbs. / acre
Little Bluestem (*Andropogon scoparius*)	12 lbs. / acre
Side-Oats Grama (*Bouteloua curtipendula*)	10 lbs. / acre
Fults Salt Grass	30 lbs. / acre
Oats, Spring	50 lbs. / acre
Slender Wheat Grass	15 lbs. / acre
Buffalo Grass (Cody or Bowie)	5 lbs. / acre

TABLE 5
PUMP TROUBLE SHOOTING

Fault	Cause	Remedy
The pump is functional but does not run water	The discharge is closed	Open the valve
	The suction strainer is locked	Pull the pump and clean the strainer
	Check valve is locked in its closed position	Pull the pump and clean or replace the valve
	Presence of a leakage in riser pipe, low water level in well, or no water in well.	The pump must be submerged at the time under the water level. The motor must not be located under the well screen.
	The pump is defective	Repair/replace the pump
The pump capacity is decreased	The drawdown is bigger and unexpected	Place the pump at a deeper depth, normalize the pump, or substitute it with a smaller capacity model
	The discharge pipe is partially blocked by particle layers, scaling, and/or biofouling	Check and clean or replace the discharge pipe
	The non-return valve of the pump is blocked	Check and clean or substitute the valve
	The valves in the discharge pipe are partially blocked/closed	Check and clean or substitute the valves as necessary.
	Hole in discharge pipe	Replace the pipe
	The pump and riser are partly clogged by impurities, scaling, and/or biofouling	Check and clean or replace the pump. Clean the pipes.
	The riser pipe is faulty	Check and clean or replace the riser pipe
	Under voltage has occurred	Check the electrical supply
	The pump is faulty	Check and clean or replace the pump
Recurrent starts and stops	The differential of the pressure switch between the start and stop pressures is too small	Try to increase the pressure differential. Care should be taken to ensure that stop pressure should not be more than the operating pressure of the pressure tank and start pressure should be provide a substantial water supply.
	The supply voltage is unstable	Check the electrical supply
	The motor temperature is too high	Check the water temperature
	Check valve is leaking or partially blocked	Check and clean or replace the non-return valve
Pump is not functional	No electrical supply	Contact the electricity provider or check circuit breaker
	Overvoltage has occurred	Assess the electrical supply and repair the defects.
	The motor protection has cut off the electricity supply due to overload	Check and clean the motor pump blockage
	The drop cable is faulty	The drop cable be assessed and repaired or replaced as necessary.
	The fuses are blown	Change the blown fuses. In cases where the new fuses blow, contact the electrician to further investigate the line and drop cable.
	The GFI circuit breaker has tripped	Reset the circuit breaker

TABLE 6
PIEZOMETER PAIRS

Location	Zone to be Monitored	Type of operation
OCD-PZ-1/ODC-PZ-2 Northeast of ODC (inside and outside of slurry wall)	Deep	Manual operation
OCD-PZ-3/ODC-PZ-4 North of ODC (inside and outside of slurry wall)	Deep	Transducer operation
OCD-PZ-5/ODC-PZ-6 East of ODC (inside and outside of slurry wall)	Deep	Manual operation
OCD-PZ-7/ODC-PZ-8 South of ODC (inside and outside of slurry wall)	Deep	Transducer operation
OCD-PZ-9/ODC-PZ-10 Southwest of ODC (inside and outside of slurry wall)	Deep	Manual operation

TABLE 7
MONITORING WELLS

Location	Zone to be Monitored	Type of operation
MW-ODC-1 Northwest of ODC (upgradient)	Shallow and deep	Manual operation
MW-ODC-2 Southeast of ODC (downgradient)	Shallow and deep	Manual operation
MW-ODC-3 Southwest of ODC (upgradient)	Shallow and deep	Manual operation
MW-ODC-4 West of ODC (upgradient)	Shallow and deep	Manual operation

Note:

Numerous other well pairs exist at the site for monitoring downgradient groundwater conditions.

TABLE 8
EMERGENCY RESPONSE

Event	Threat Posed	Response
Release of potentially contaminated soil	Health and Safety Hazard	1. Perform a visual inspection of the area and determine the potential impacts and damages. 2. Notify emergency contact or emergency response agencies. Notify the authorized representative. 3. Use appropriate personal protective equipment, depending on the spill material. 4. Cover or block any drains to prevent material from entering into the storm water system. 5. Use caution tape to separate the emergency area from the safe area. 6. If possible, identify the released material. If the waste is non-toxic, try to remove the waste using appropriate material. If the waste is toxic, contact a licensed organization that handles the removal, transportation, and disposal of such waste. 7. Use appropriate labor, equipment, and material to restore the area. *Required Equipment:* Absorbent pads, floor sweeping compound, portable berm, portable pumps, backhoe, tank to accept waste, caution tapes, and sandbags.
Vandalism	• Ineffective remedy • Health and Safety Hazard • Site security compromised • Damage to various components on site	1. Perform a visual inspection of the area and determine the potential impacts and damages. 2. Notify emergency contact or emergency response agencies. Notify the police department and authorized representative. 3. Use caution tape to separate the emergency area from the safe area. 4. If site security, safety and integrity are jeopardized, implement measures to repair or restore the site within 2 weeks (subject to weather and site conditions) to the as-built conditions. 5. As appropriate, provide temporary measures if permanent measures cannot be immediately implemented. 6. Monitor the site regularly if vandalism occurs frequently. 7. Recommend preventative measures and use appropriate labor, equipment, and material to restore the area. *Required Equipment:* Erosion control blanket or similar media, floor sweeping compound, backhoe, loader, compactor, sand, topsoil, chain link fence, bailing wire, and caution tape.

TABLE 8
EMERGENCY RESPONSE

Event	Threat Posed	Response
Equipment Failure	• Ineffective remedy • Health and Safety Hazard • Damage to various components on site	1. Perform a visual inspection of the area and assess the potential impacts and damages. 2. Notify emergency contact or emergency response agencies. 3. Use caution tape to separate the emergency area from the safe area. 4. If site security, safety and integrity are jeopardized, implement measures to repair or restore the site within 2 weeks (subject to weather and site conditions) to the as-built conditions. 5. As appropriate, provide temporary measures if permanent measures cannot be immediately implemented. 6. Monitor the site regularly until the equipment failure is corrected. 7. Recommend preventative measures and use appropriate labor, equipment, and material to restore the area. *Required Equipment:* Erosion control blanket or similar media, floor sweeping compound, backhoe, loader, compactor, sand, topsoil, chain link fence, bailing wire, and caution tape.
Power Failure	• Ineffective remedy • Health and Safety Hazard • Damage to various components on site	1. Perform a visual inspection of the area and determine the potential impacts and damages. 2. Notify emergency contact or emergency response agencies. 3. Use caution tape to separate the emergency area from the safe area. 4. If site security, safety and integrity are jeopardized, implement measures to repair or restore the site within 2 weeks (subject to weather and site conditions) to the as-built conditions. 5. As appropriate, provide temporary measures if permanent measures cannot be immediately implemented. 6. Monitor the site regularly until the power is restored. 7. After power is restored, ensure all equipment and controls are operating correctly. 8. Recommend preventative measures and use appropriate labor, equipment, and material to restore the area. *Required Equipment:* Erosion control blanket or similar media, floor sweeping compound, backhoe, loader, compactor, sand, topsoil, chain link fence, bailing wire, and caution tape.

TABLE 8
EMERGENCY RESPONSE

Event	Threat Posed	Response
Fire	•Health and Safety Hazard •Site security compromised •Damage to various components on site	1. Notify the fire department, emergency response agency, and authorized representative. 2. Perform a visual inspection of the area and assess the potential impacts and damages 3. Use caution tape to separate the emergency area from the safe area. 4. If site security, safety and integrity are jeopardized, implement measures to repair or restore the site within 2 weeks (subject to weather and site conditions) to the as-built conditions. 5. Wait for the rescue service to arrive and follow their instructions. 6. Notify the authorized representative. *Required Equipment:* fire-extinguisher, erosion control blanket or similar media, floor sweeping compound, backhoe, loader, compactor, sand, topsoil, chain link fence, bailing wire, and caution tape.
Flooding	•Health and Safety Hazard •Site security compromised •Damage to various components onsite •Slope failure	1. Notify the fire department, emergency response agency, and the authorized representative. 2. Perform a visual inspection of the area and assess the potential impacts and damages. 3. Use caution tape to separate the emergency area from the safe area. 4. Stop or reduce the flow of water as soon as possible to reduce further damage. 5. If electrical lighting or other electrical equipment has become wet, turn off the supply. Contact the electrician and have the wiring and equipment checked before re-use. Accumulate leaking water in containers 6. Move materials and equipment to a dry location. 7. In case of slope failure, arrange a meeting with geotechnical consultant, as appropriate, to participate in an evaluation of problem area with 48 hours. If necessary, perform a geotechnical investigation of the failure to develop a corrective action plan. 8. Depending on severity and circumstances, contact a contractor or City of Waukegan. 9. If site security, safety and integrity are jeopardized, implement measures to repair or restore the site within 2 weeks (subject to weather and site conditions) to the as-built conditions. 10. Wait for the rescue service to arrive and follow instructions. 11. Investigate preventive measures. 12. Notify the authorized representative. *Required Equipment:* erosion control blankets or media, bulldozer, loader, compactor, sand, clean fill, and cordon tape.

APPENDIX A:
INSPECTION AND REPAIR PROCEDURES, CHECKLISTS, AND FREQUENCY

APPENDIX A
INSPECTION AND REPAIR PROCEDURES, CHECKLISTS, AND FREQUENCY

Periodic inspections of all land disturbing activities at Outboard Marine Corporation (OMC) Plant 2 will be conducted to ensure compliance with approved plans and to evaluate whether the measures in the approved plans are providing effective control. The operations and maintenance (O&M) contractor personnel should at least bring the following items during inspections or maintain them on site. However, this list should be revised over time based on the findings of inspections.

- O&M plan
- Copies of appropriate maps and figures
- Inspection checklist
- O&M logbook
- Camera
- Telephone and contact list
- Items requiring replacement (such as locks, well caps, and well seals)
- Previous inspection reports and photos of concern.

Recordkeeping and reporting of the inspection findings should be maintained regularly. If significant damage has been observed during inspection, the responsible organization should be notified immediately. The frequency of inspections should be increased in case of vandalism or in case of an unusual natural event, such as severe flooding. Inspection reports summarizing the findings of the inspections should be included in the annual reports. This appendix provides the general inspection checklist.

During inspection, repairs identified on site can be minor or significant. Examples of minor repair include replacement of monitoring well locks or protective cap, reseeding, or revegetation. Examples of significant repair include replacing cap elements on the Old Die Cast (ODC) cap or asphalt cap. Depending on the type of repair work, the O&M contractor should bring appropriate equipment, material, and labor on site. The repair work should be in accordance with the design and construction-related documents. Repairs should abide by site-related institutional controls. The procedures to be followed during the site inspection should be revised based on future site development as needed. The equipment manufacturer's O&M manuals for various components used will be included in final O&M manual. All site inspection issues should be documented and appropriate photographs should be taken to record the

issue and associated location. The primary procedures followed during site inspection are listed in the following section.

GENERAL SITE CONDITIONS

- A perimeter site walk should be conducted along the site boundary to check site security for evidences of breach or vandalism.
- The ODC and utility corridor caps should be inspected to check if there is damage to the cap surface or unwanted vegetation.
- Trash or unwanted materials should be removed and disposed of properly.
- Monitoring wells should be checked for damage.
- Significant issues should be communicated with the site operator.
- Necessary repairs should be completed in a timely manner.
- Construction work on site should be done in accordance to the as-built drawings and specifications.

VERTICAL BARRIER

- Inspect the ODC cap surface installed over the vertical barrier for damage, root penetrations, or erosion.
- Remove any deep root vegetation, such as brush or trees, using appropriate equipment to avoid any regrowth.
- Repair measures should be implemented to match the as-built drawings and specifications.
- Document all inspections and record any issues noted in checklists, photographs, and log books.
- Communicate necessary repairs to the system operator.

811 CAP

- Inspect the entire cap area for proper drainages on the slopes, crest, and perimeter.
- Document areas of pooling, puddles, or discoloration and monitor and repair as necessary.
- Document areas of depression and erosion gullies and repair as necessary in accordance with the project specifications and the as-built drawings.
- Document and repair cracks in the 811 cap as necessary in accordance with the project specifications and the as-built drawings.
- Areas should naturally vegetate without any reseeding. In case where the vegetation is not properly growing, reseeding should be conducted in accordance with the project specifications.
- If unwanted plant species grow on site, apply herbicide as necessary.
- Brush should be mowed or cut to prevent establishment of deep-rooted trees or shrubs, which could penetrate and damage the ODC cap.

- Evidence of burrowing animals should be checked on site and monitored over time. The location and dimension of burrows will be documented. Repair by backfilling the burrow with appropriate material as per the as-built drawings and specifications.
- Repairs to the 811 cap should follow the procedures outlined in the construction design reports and specifications and should be based on the as-built drawings.

ODC DEWATERING SYSTEM

- For wells and piezometers, the protective materials (casing and pads) should be checked for integrity. Damage should be documented in reports, and photographs for proof should be collected. Necessary repairs should be completed in timely manner.
- Vandalism and theft of any materials linked to the wells or probes should be remedied promptly.
- The piezometers and wells should be inspected to ensure that they are free of obstacles. There should be no pressure issues, and appropriate water elevations should be maintained in piezometers at all the times.
- All pressure transducer reading should be compared with manually collected groundwater level measurements. If the difference between the manual measurements and the pressure transducer exceeds 0.02 foot, recalibrate the pressure transducer. Manual groundwater measurements and pressure transducer reading should be compared each quarter. If necessary, re-calibrate the transducer.
- If extraction well flows decrease significantly, wells may need to be flushed or treated to remove sediment, scale, or biofouling
- Ensure proper operation of the entire dewatering system. Repair system as needed.
- Inspections along with any issues should be properly documented through checklists, photographs, and log books.
- Significant issues needing immediate attention should be quickly communicated to the system operator.

ASPHALT CAPS (NUC and WUC)

- A methodological inspection of the asphalt cap should done for the entire area. Inspections should be compared with the record drawings to identify changes in the asphalt cap.
- Inspections should check for cracks and potholes. Necessary labor, equipment, and materials should be used to fill the cracks and potholes. If cracking becomes widespread, chip seal the entire area to repair the asphalt cap.
- Inspections should check for depressions. Based on the extent of damage, repair or replacement of asphalt base course or wearing course may be required.
- Inspect the caps for proper drainage.
- Areas of settlement should be recorded. Minor settlement is not an immediate concern but should be monitored over time. Major settlement could require specialized labor and personnel for repair.

GENERAL INSPECTION CHECKLIST

SITE : OMC PLANT 2 SITE, WAUKEGAN, IL
DATE OF INSPECTION:
TIME OF INSPECTION:
INSPECTOR:
REASON FOR INSPECTION: SCHEDULED/ EMERGENCY RESPONSE
SITE CONDITION:

ITEM	ACTION/INSPECTION ITEM	COMMENTS
GENERAL SITE CONDITION		
SECURITY OF AREA	Fence condition	
	Access roads condition	
	Evidence of unauthorized access	
	Evidence of signs	
	Evidence of vandalism	
TRASH	Remove unwanted trash	
DEWATERING SYSTEM		
	General security – repair locks as necessary	
	Well box- remove unwanted material	
	Well casing- remove unwanted material	
	Seal - check for damages	
	Assess system operation	
	Evidence of vandalism	
811 CAP		
Cap layers	Evidence of settlement	
	Evidence of slope failure	
	Evidence of cracking or soil movement	
	Evidence of burrowing animals	
	Evidence of erosion	
Vegetation	Presence of bare areas or no vegetation	
	Presence of unhealthy vegetation areas	
	Need for mowing and watering	
	Evidence of unwanted vegetation with more height than normal vegetation	
Drainage	Evidence of overflow	
	Evidence of ponding or puddles	
	Change in conditions of drainage contributing areas	
	Evidence of erosion along the drainage path	

ITEM	ACTION/INSPECTION ITEM	COMMENTS
VERTICAL BARRIER		
	Evidence of vegetation with deep penetrating roots on ODC cap	
	Evidence of crack or fissure on ODC cap	
ASHPHALT PAVEMENT COVER		
NORTH UTILITY CORRIDOR	Evidence of crack or potholes	
	Evidence of damaged surface	
	Evidence of settlements	
	Evidence of ponding	
	Evidence of change in surface water drainage flow	
WEST UTILITY CORRIDOR	Evidence of crack or potholes	
	Evidence of damaged surface	
	Evidence of settlements	
	Evidence of ponding	
	Evidence of change in surface water drainage flow	

Note:

- Vegetative cover should be mowed semiannually or as needed based on site use.
- Site inspections should be conducted following major weather changes or natural event (based on professional judgment and site experience).

Other observations:

_____

_____

_____

_____

_____

_____

_____

_____

_____

Signature of Inspector _____ Date _____

APPENDIX B:
INSTITUTIONAL CONTROL COMPLIANCE MONITORING REPORT

APPENDIX B
INSTITUTIONAL CONTROL COMPLIANCE MONITORING REPORT

OMC PLANT 2 SITE, WAUKEGAN, ILLINOIS.

PROPERTY OWNER: _____

PERIOD OF INSPECTION: _____

CERTIFICATION CHECKLIST

No	Description	In Compliance	Non-Compliance	See Comment
1	No groundwater use for any purpose. No evidence of damage to wells or piezometers			
2	No planting of vegetables or fruits for human consumption			
3	No land disturbing activities (excavation, demolition, movement of soil from below ground surface to surface)			
4	No altering or disturbing of any remedial action components including dewatering system, 811 cap, vertical barrier, asphalt covers, monitoring wells, or piezometers.			
5	No installation of any type of groundwater wells.			
6	No construction of any type of structure before prior approval from IEPA or U.S. EPA			
7	No damage or removal of well locks, site fencing, monitoring equipment, pipes or other components			
8	No unauthorized change in land use			
9	Any violations of land use controls to be reported within 10 business days. Provide explanation of actions taken within 10 days of notification of discovery			

I, the undersigned, hereby confirm that the above-described land use restrictions have been obeyed with for the period noted. Insufficiencies, issues, and actions to address issues are described in attached explanation of deficiencies.

_____ Signature

_____ Date

Note: Provide photographs and notes to document the conditions certified in the checklist. Send all documents to property operator.

ANNUAL IC COMPLIANCE CERTIFICATE

OMC PLANT 2 SITE, WAUKEGAN, ILLINOIS.

I _____ hereby certify that the attached Institutional Control Compliance Monitoring Report for OMC Plant 2 site is complete and accurate. The requirements of land use controls (LUC) for the site have been met. I further certify that a copy of this compliance certificate and the attached Institutional Control Compliance Monitoring Report for OMC Plant 2 site have been sent to the following addresses:

Mr. XYZ

Illinois Environmental Protection Agency (IEPA)

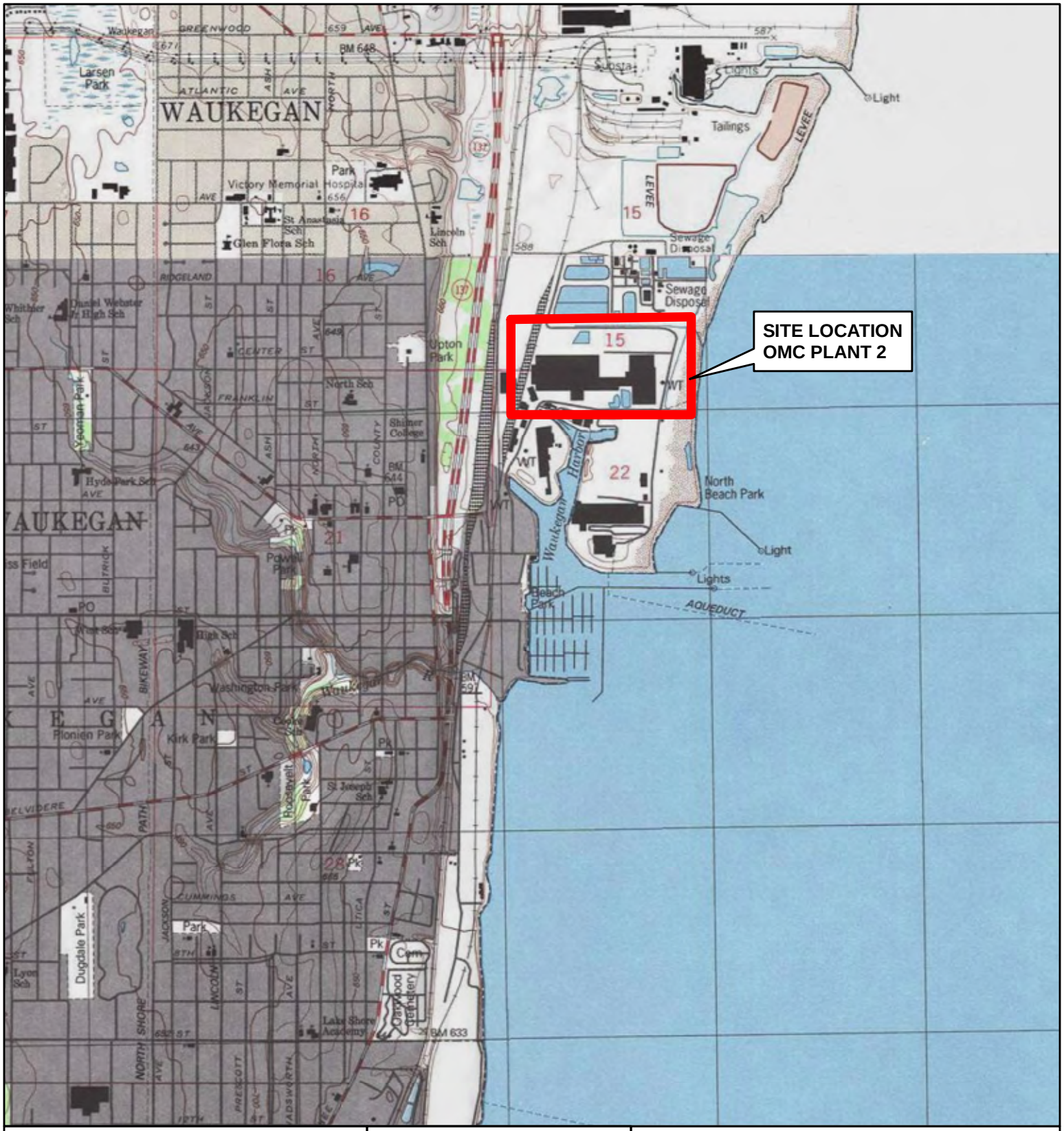
Mr. XYZ

U.S. Environmental Protection Agency (EPA)

_____

Signature.

ATTACHMENT 1:
RECORD DRAWINGS



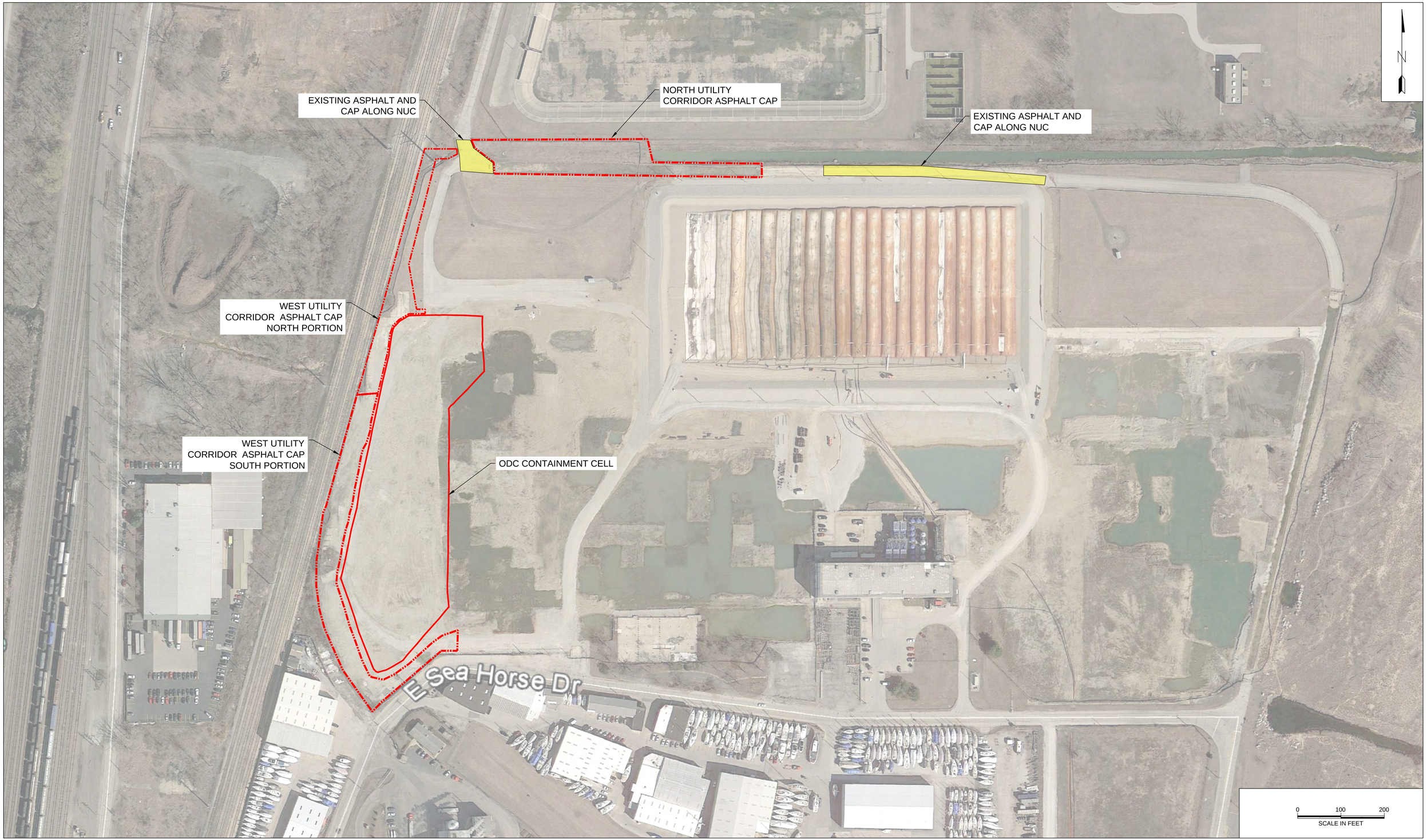
REFERENCE MAP

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

FIGURE 1
SITE LOCATION MAP

SulTRAC

9/9/2015 G:\G\1852\192 OMC RA\MXD\Fig1-SiteLocation.mxd m.banh



REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED DJB
DRAWN MB
CHECKED CN
DATE 12/14/2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

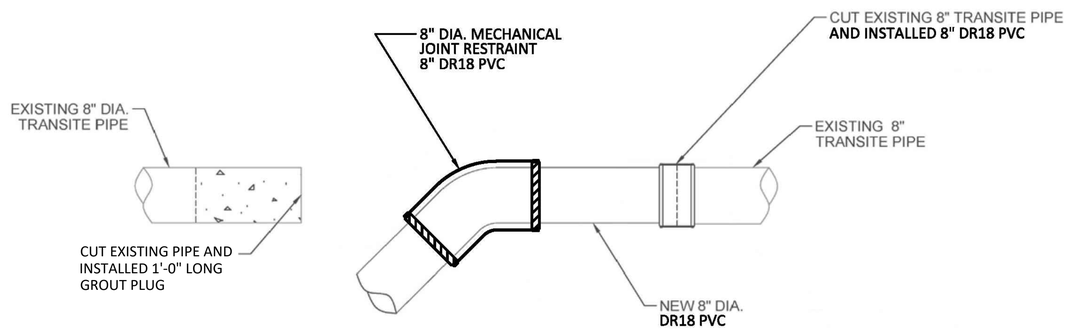
SITE MAP SHOWING REMEDIAL ACTION AREAS

WORK ASSIGNMENT NO. WA192

FIGURE 2

6/25/2015

G:\G\1852\192 OMC RA\dwg\2016-12\Fig2-SiteLayout.dwg

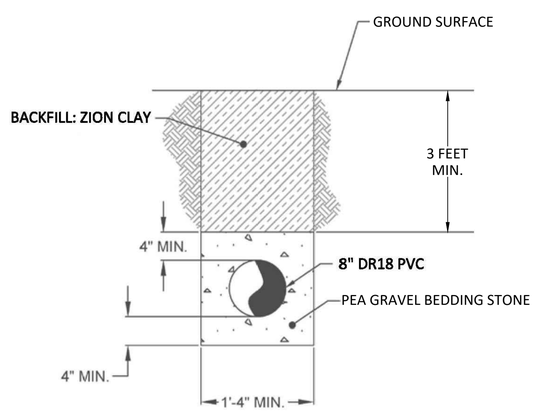


6
C-7 C-11

SANITARY SEWER FORCE MAIN
CONNECTION DETAIL

SCALE: 1" = 1'-0"

0 1 2
SCALE IN FEET



C
C-7 C-11

SANITARY SEWER FORCE MAIN
TRENCH SECTION

SCALE: 1" = 1'-0"

0 1 2
SCALE IN FEET

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12/14/2016

G:\G\1852\192 OMC RA\dwg\2016-12\Fig3-Forcemain Relocation Details.dwg

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DATE December 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

RECORD DRAWINGS FORCEMAIN DETAILS

WORK ASSIGNMENT NO. WA192

FIGURE 3

EXISTING HANDHOLE

ODC-PZ-4

ODC-PZ-3

ODC-PZ-6

ODC-PZ-5

ODC-PZ-8

ODC-PZ-7

ODC-EW-1

ODC-EW-2

ODC-PZ-1

ODC-PZ-2

ODC-PZ-9

ODC-PZ-10

MW-1

MW-2

MW-3

MW-4

P10

W10

STATION EQUATION
9+10 = 9+50

Seahorse Dr

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LEGEND

- Centerline of Vertical Barrier
- ESW — Existing West Containment Cell Slurry Wall
- 585 — Topographic Contour
- SSFM — PVC Sanitary Sewer Force Main
- G — Underground Gas Main
- SD — Concrete Storm Drain
- W — Underground Water Main
- X — Fence Line
- E — Electrical Conduit
- E/W — Extraction Well Piping
- CC — Shallow Control Cable
- CC — Control Cable Conduit
- SS — Concrete Sanitary Sewer
- T — Underground Telephone Line
- W-T — 24-inch diameter Water Transmission Line (aging)
- Abandoned Sanitary Sewer Force Main
- Railroad Tracks
- Site Boundary
- Piezometer
- Sanitary Sewer Manhole
- Storm Sewer Manhole
- Well Location
- Extraction Well
- Pull Box
- Sanitary Sewer Standpipe
- Rip Rap

0 40 80
SCALE IN FEET

REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED THP
DRAWN MB
CHECKED CN
DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

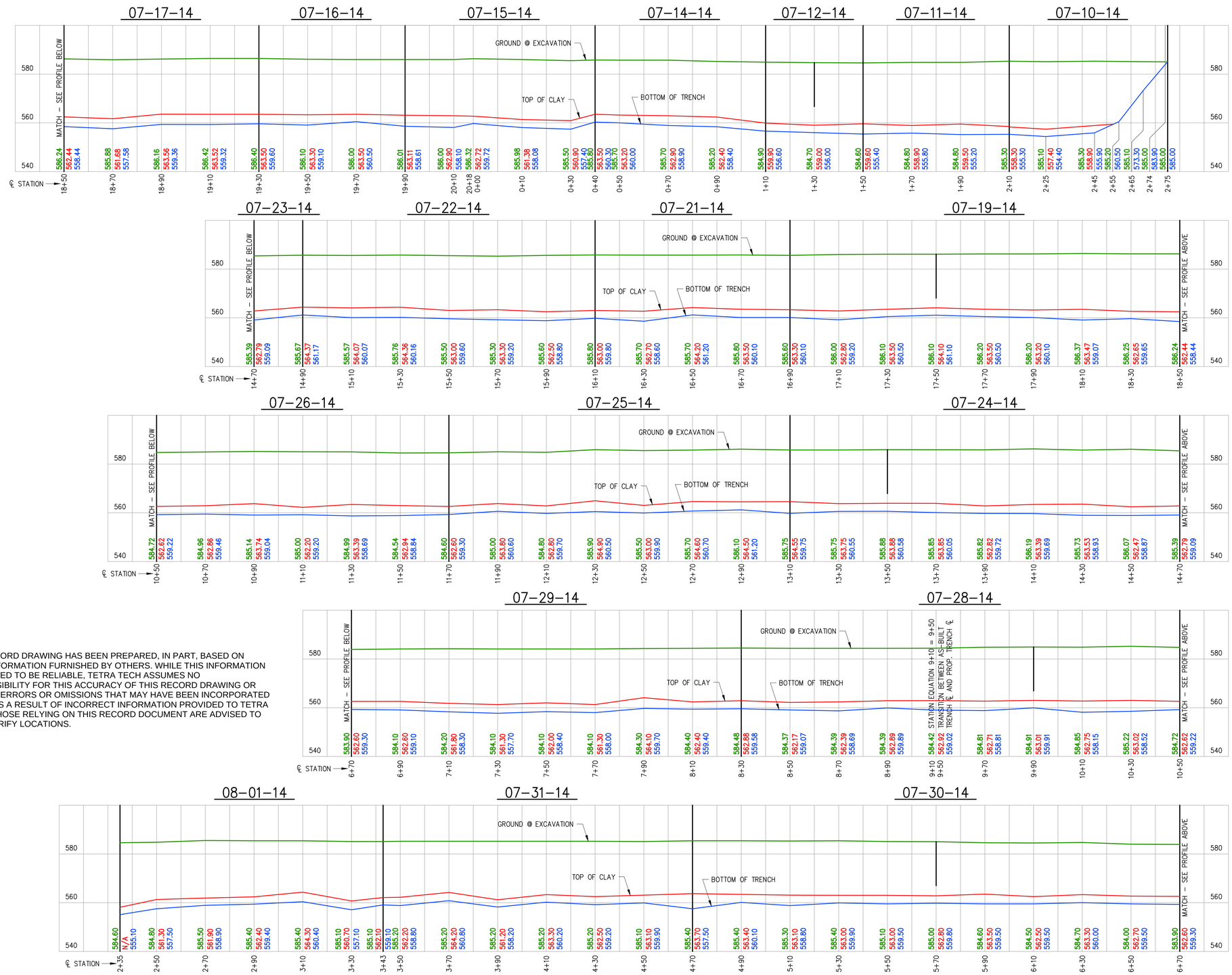
ODC CONTAINMENT CELL LAYOUT
RECORD DRAWINGS

WORK ASSIGNMENT NO. WA192

FIGURE 4

12/27/2016

G:\CI\18521\192_ODC_IRA\dwg\2016-12\Fig4-ODC Layout.dwg



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KEY

585.30 (ELEV. – GROUND @ EXCAVATION)
558.30 (ELEV. – TOP OF CLAY)
555.30 (ELEV. – BOTTOM OF TRENCH)

12/19/2016

G:\G\1853\192 OMC RA\dwg\2016-12\Fig5-Cutoff Wall Xsections.dwg

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DATE DECEMBER 2016

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OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

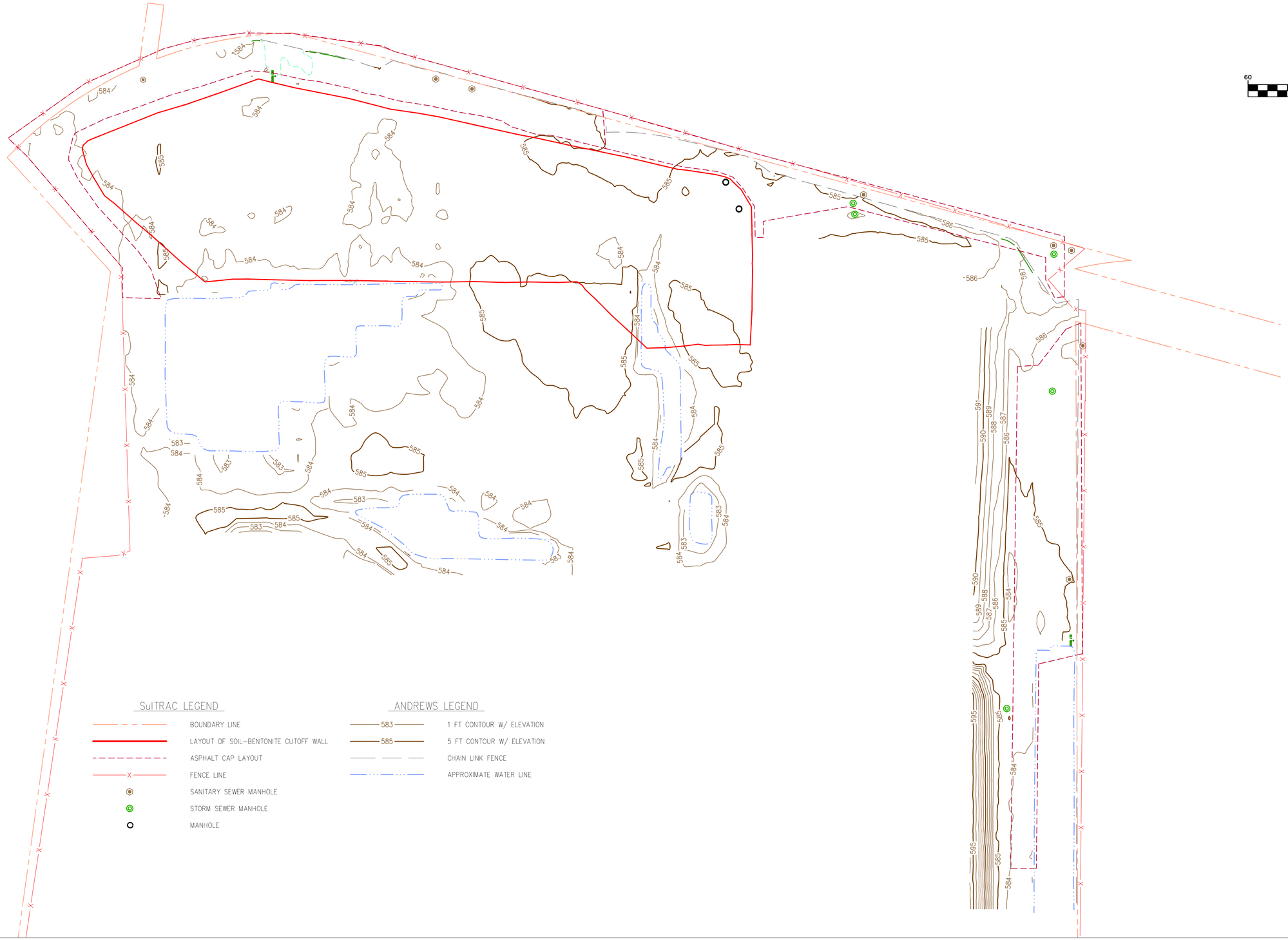
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4
SOIL–BENTONITE CUTOFF WALL
AS–BUILT CROSS SECTIONS (RECORD DRAWINGS)

WORK ASSIGNMENT NO.
WA192

FIGURE
5



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DATE DECEMBER 2016

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OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

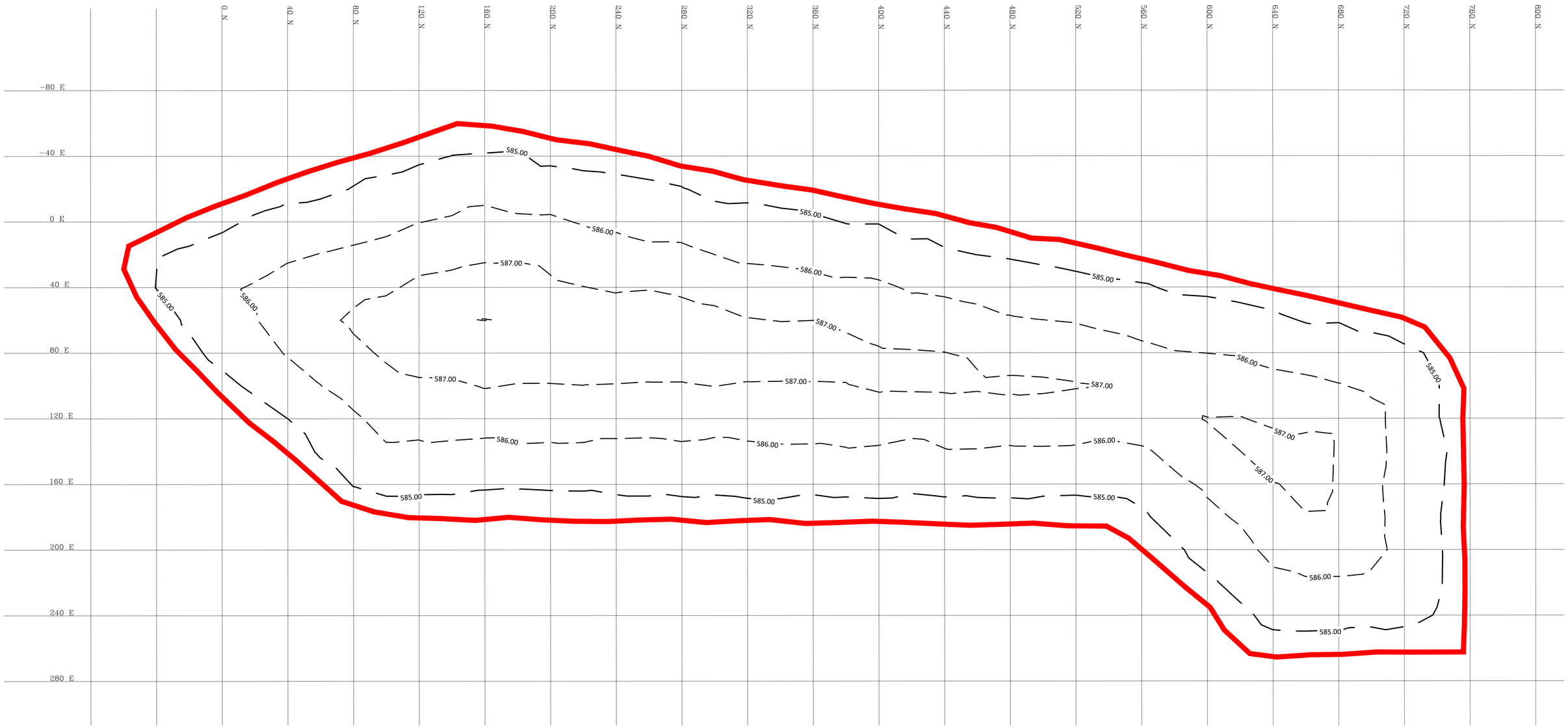
OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4
PRECONSTRUCTION TOPOGRAPHY
JULY 2014

WORK ASSIGNMENT NO. WA192

FIGURE 6

12/27/2016

G:\O\183\192 OMC RA\dwg\2016-12\Fig6-Preconstruction Topo.dwg



LEGEND

Centerline of Vertical Barrier

0 30 60

SCALE: 1" = 30'

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DESIGNED CN
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DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

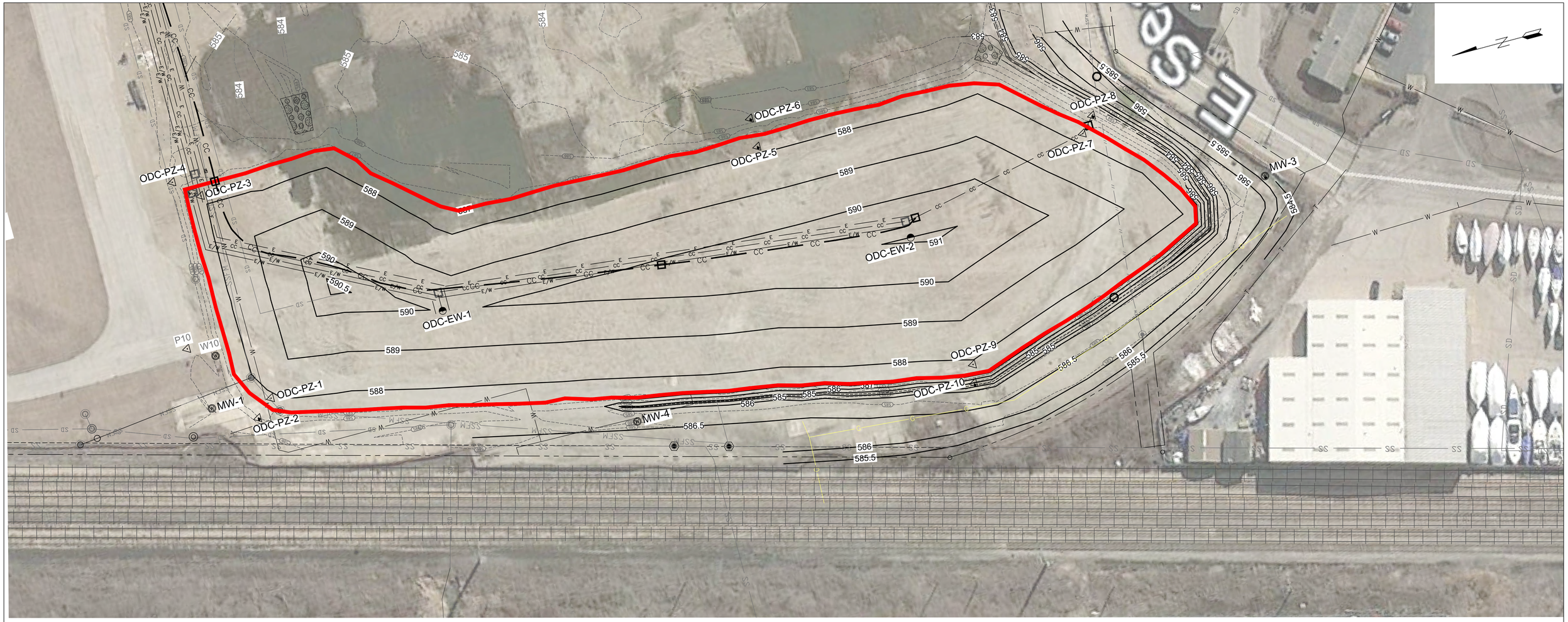
ODC SUBGRADE TOPOGRAPHY
RECORD DRAWINGS

WORK ASSIGNMENT NO.
WA192

FIGURE
7

12/19/2016

C:\G\1852\192 OMC RA\dwg\2016-12\Fig7-Subgrade Topo and Fig8.dwg



LEGEND

	Centerline of Vertical Barrier
ESW	Existing West Containment Cell Slurry Wall
585	Topographic Contour
SSFM	PVC Sanitary Sewer Force Main
G	Underground Gas Main
SD	Concrete Storm Drain
W	Underground Water Main
X	Fence Line
E	Electrical Conduit
E/W	Extraction Well Piping
CC	Shallow Control Cable
CC	Control Cable Conduit
SS	Concrete Sanitary Sewer
T	Underground Telephone Line
W-T	24-inch diameter Water Transmission Line (aging)
// //	Abandoned Sanitary Sewer Force Main
	Railroad Tracks
	Site Boundary
	Sanitary Sewer Standpipe
	Extraction Well
	Pull Box
	Piezometer
	Sanitary Sewer Manhole
	Storm Sewer Manhole
	Sanitary Sewer Force Main Manhole
W	Well Location
	Rip Rap

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0 40 80
SCALE IN FEET

REVISIONS		
NO.	DATE	DESCRIPTION

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DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

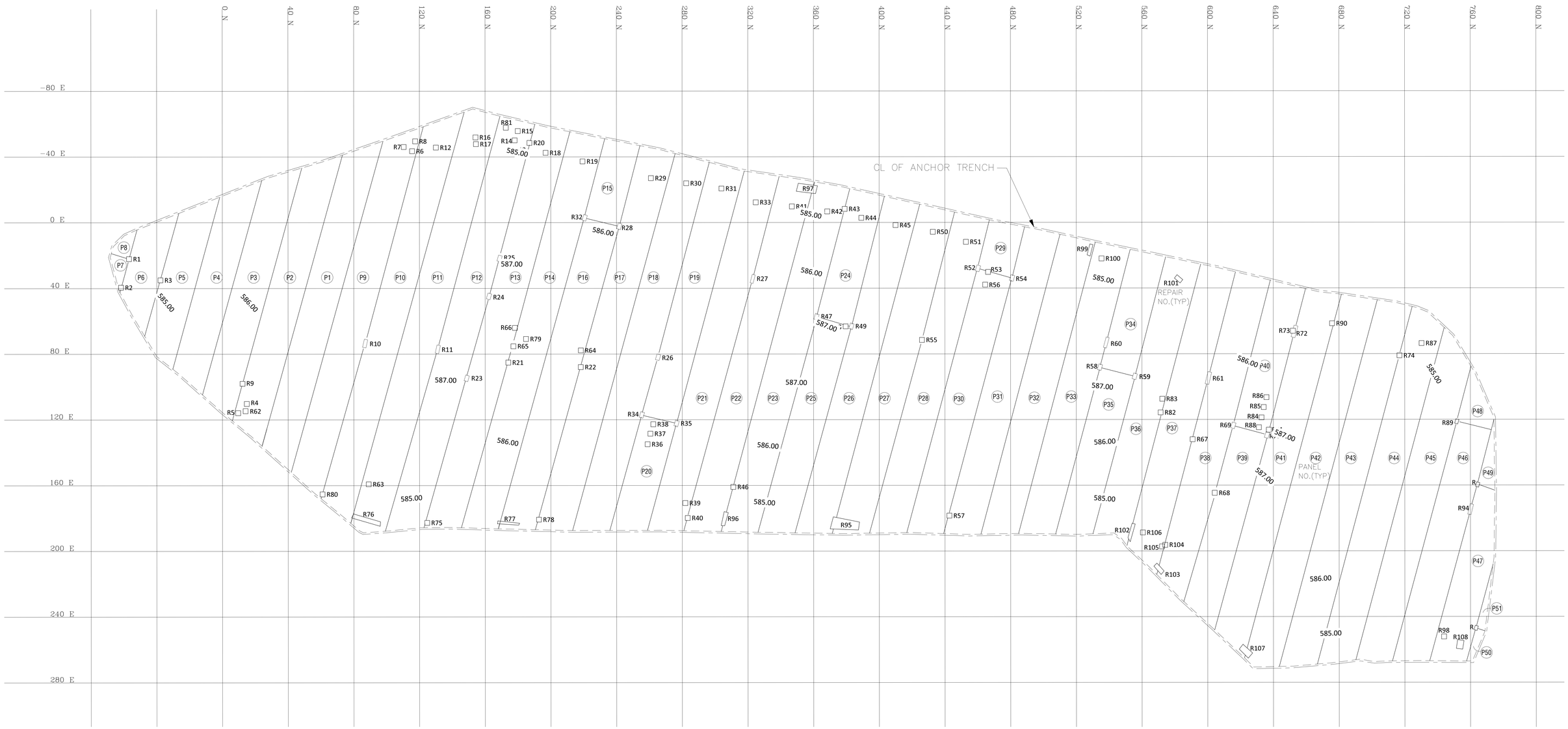
OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

FINAL ODC CONTAINMENT CELL TOPOGRAPHY
RECORD DRAWINGS

WORK ASSIGNMENT NO. WA192

FIGURE 8

G:\G\1852\192 OMC RA\dwg\2016-12\Fig8-ODC Containment Cell Topo.dwg
12/27/2016



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0 30 60
SCALE: 1" = 30'

REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED CN
DRAWN MB
CHECKED CN
DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

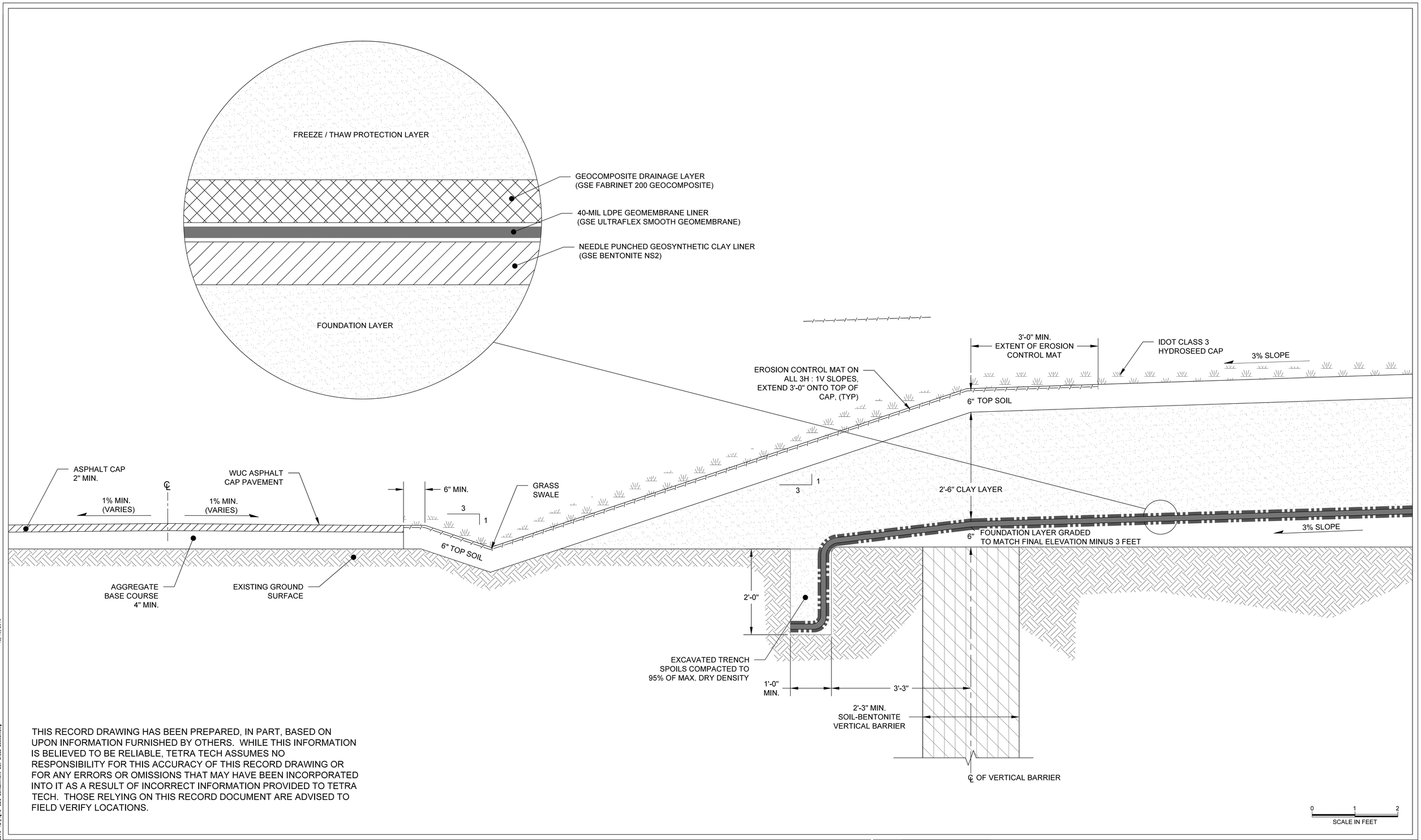
SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4
ODC GEOMEMBRANE PANEL LAYOUT
RECORD DRAWINGS

WORK ASSIGNMENT NO. WA192

FIGURE 9

12/19/2016
G:\G\1852\192 OMC RA\dwg\2016-12\Fig7-Subgrade Topo and Fig9.dwg



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G:\G\1852\192 OMC RA\dwg\2016-12\Fig10-ODC Containment Cell Cross Section.dwg 12/19/2016

REVISIONS		
NO.	DATE	DESCRIPTION
1	08/15/2014	REVISED ANCHOR TRENCH

DESIGNED DJB
DRAWN MB
CHECKED CN
DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

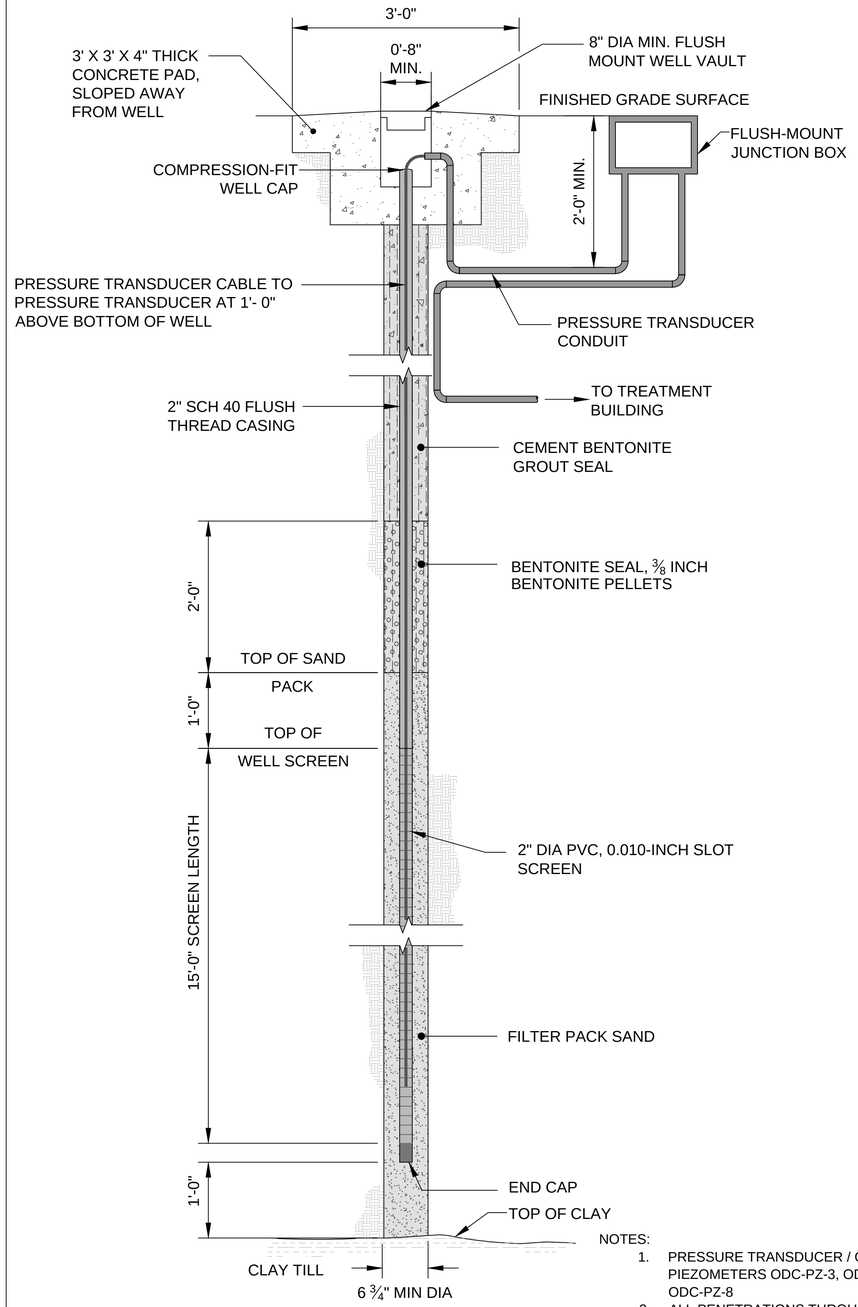
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4
ODC CONTAINMENT CELL CROSS SECTIONAL DRAWING
RECORD DRAWINGS

WORK ASSIGNMENT NO. WA192

FIGURE 10

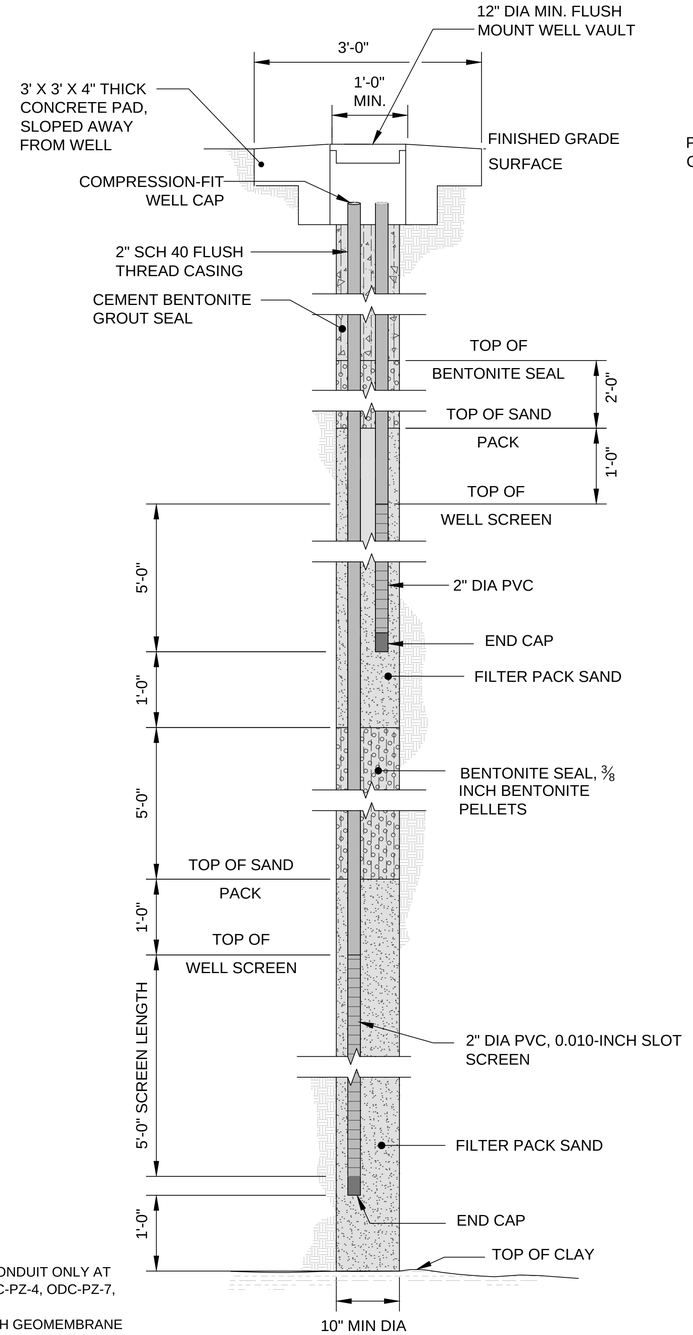


TYPICAL PIEZOMETER SECTION

SCALE: 1" = 1'-0"

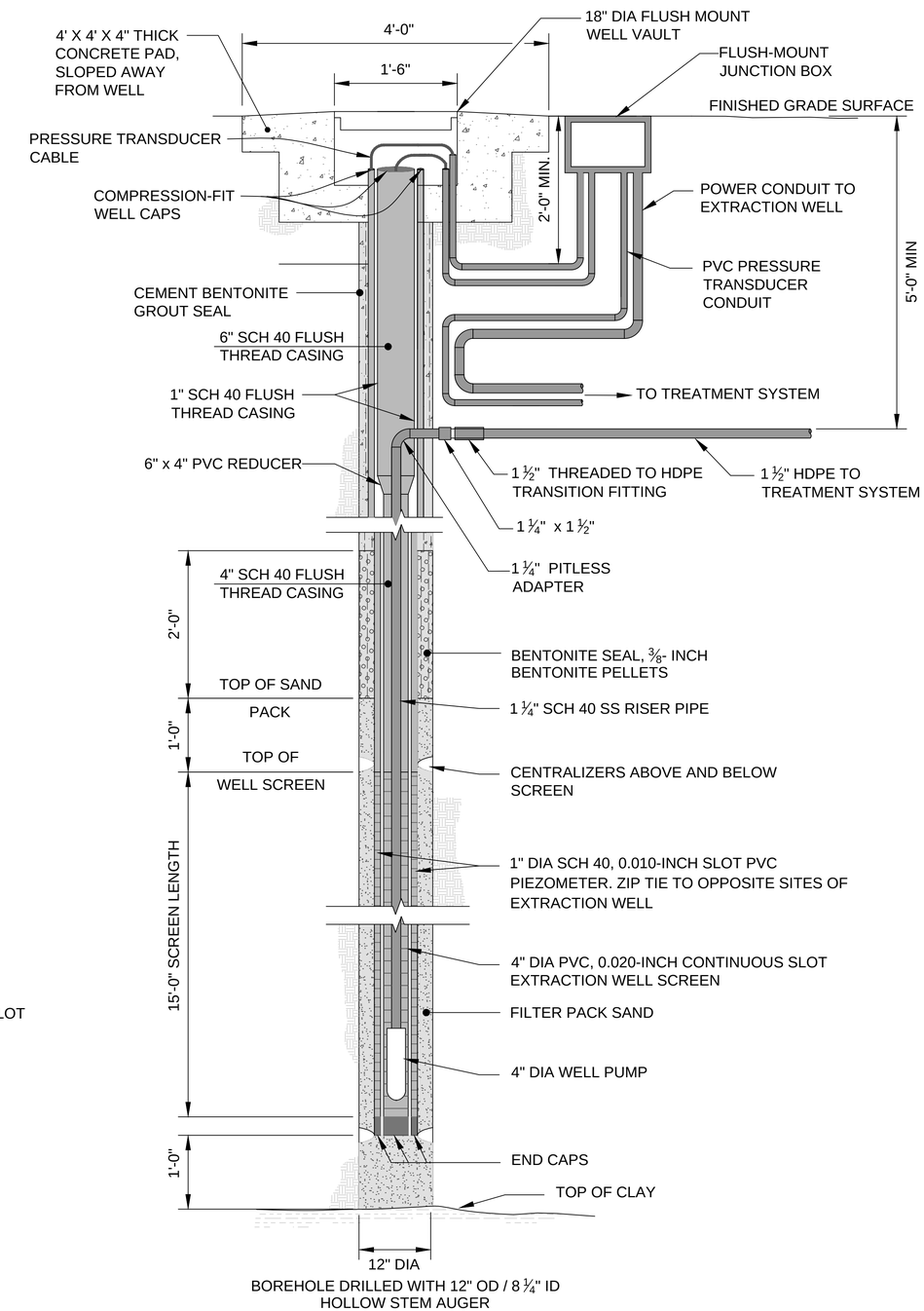
NOTES:

1. PRESSURE TRANSDUCER / CONDUIT ONLY AT PIEZOMETERS ODC-PZ-3, ODC-PZ-4, ODC-PZ-7, ODC-PZ-8
2. ALL PENETRATIONS THROUGH GEOMEMBRANE AND GCL MADE IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
3. FOR EXTRACTION WELLS, PITLESS ADAPATER INSTALLED ON EAST SIDE OF WELL.
4. REFER TO WELL CONSTRUCTION LOGS FOR CONSTRUCTION DETAILS



TYPICAL MONITORING WELL SECTION

SCALE: 1" = 1'-0"



BOREHOLE DRILLED WITH 12" OD / 8 ¼" ID HOLLOW STEM AUGER

TYPICAL EXTRACTION WELL SECTION

SCALE: 1" = 1'-0"

REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED DJB
DRAWN DMF
CHECKED SDD
DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

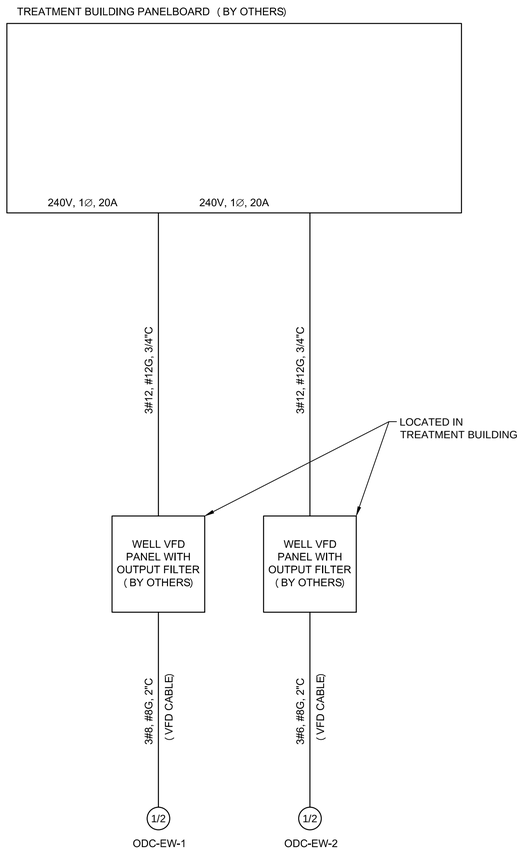
EXTRACTION WELL, MONITORING WELL AND PIEZOMETER DETAILS (RECORD DRAWINGS)

WORK ASSIGNMENT NO. WA192

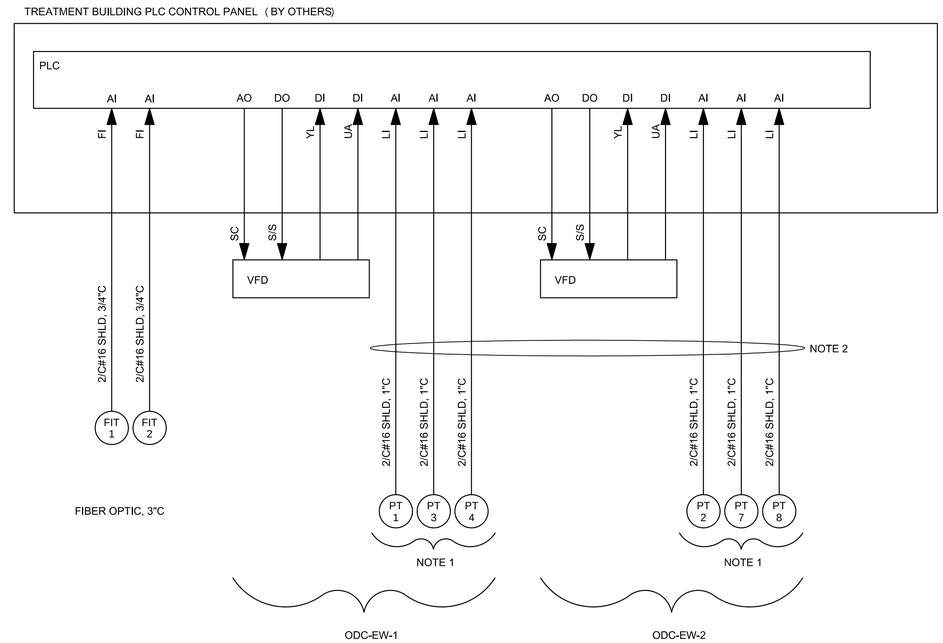
FIGURE 11

12/27/2016

O:\GV\(662)\192 DMC RA\dwg\2016-12\Fig11-Piezometer and Well Details.dwg



ELECTRICAL ONE-LINE DIAGRAM



CONTROL SYSTEM DIAGRAM

NOTES:

1. INSTALL JUNCTION BOX AT MONITORING WELL OR EXTRACTION WELL LOCATION
2. COMBINE IN SINGLE CONDUIT FOR COMMON UNDERGROUND RUNS:
   3 SIGNAL CABLES: 1-1/2" C
   6 SIGNAL CABLES: 2" C
3. PROVIDE HAND HOLE AT STUB LOCATION SHOWN ON DRAWING C-12. LEAVE MINIMUM 75 FT SPARE CABLE (POWER & SIGNAL) FOR FUTURE CONNECTION TO VFD CONTROL PANELS & PLC (BY OTHERS)

ABBREVIATION LIST

AI	ANALOG INPUT
AO	ANALOG OUTPUT
C	CONDIUT
DI	DISCRETE INPUT
DO	DISCRETE OUTPUT
FIT	FLOW INDICATING TRANSMITTER
HMI	HUMAN MACHINE INTERFACE
I/O	INPUT/OUTPUT
LI	LEVEL INDICATOR
PLC	PROGRAMMABLE LOGIC CONTROLLER
PT	PRESSURE TRANSMITTER
SC	SPEED CONTROL
S/S	START/STOP
UA	COMMON ALARM
VFD	VARIABLE FREQUENCY DRIVE

12/27/2016

G:\G\1852\192 OMC RA\dwg\2016-12\Fig12-Extraction Well Power and Control Diagrams.dwg

REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED TM
DRAWN RMP
CHECKED TM
DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

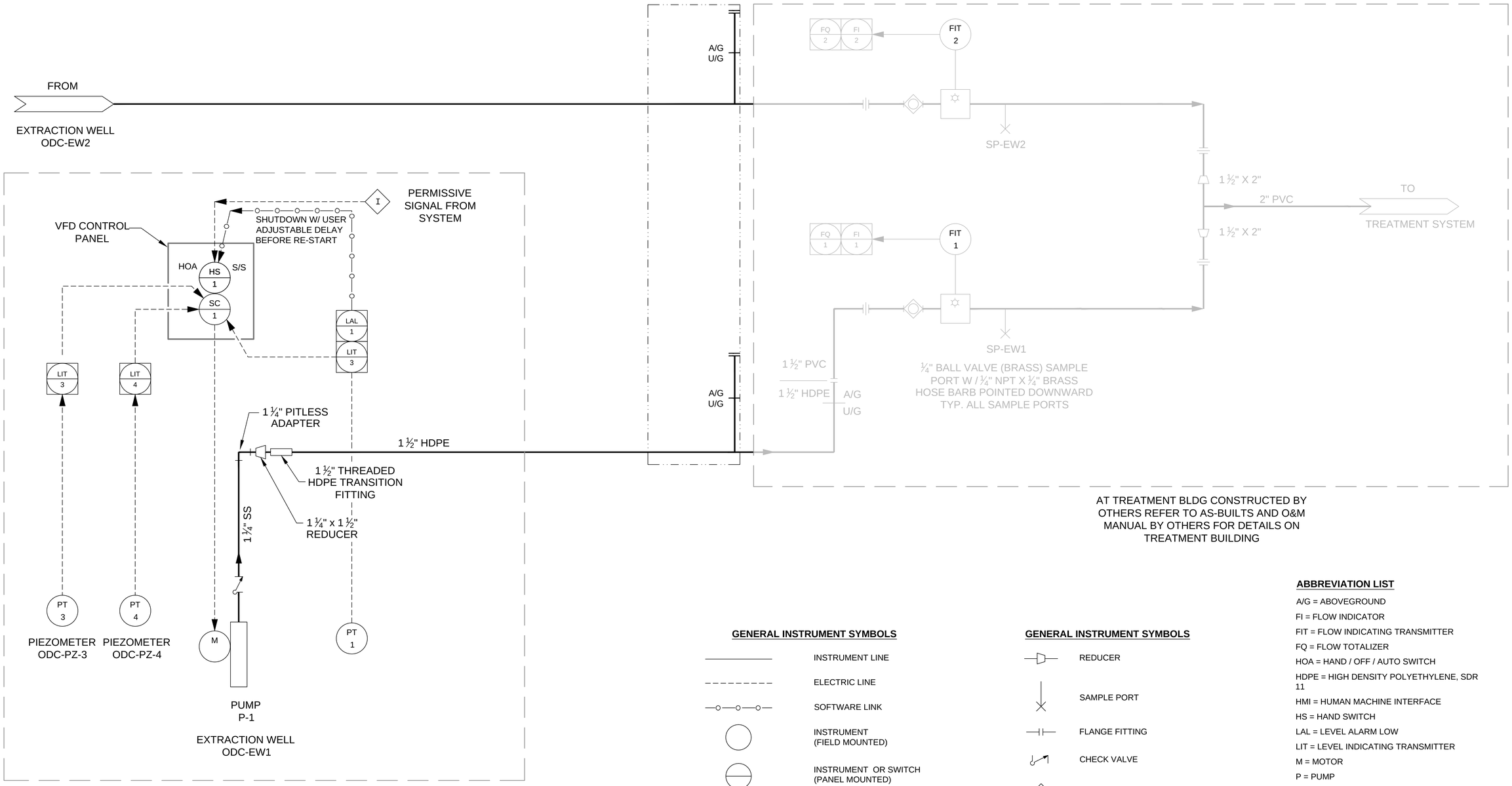
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4
EXTRACTION WELL POWER & CONTROL DIAGRAMS
RECORD DRAWINGS

WORK ASSIGNMENT NO. WA192

FIGURE 12



TYPICAL OF BOTH EXTRACTION WELLS

NOTES:

1. HMI SHALL ALLOW USER TO CHOOSE BETWEEN TWO PUMP SPEED CONTROL STRATEGIES:
   (a) MAINTAIN USER-DEFINED DRAWDOWN IN EXTRACTION WELL AS MEASURED BY EXTRACTION WELL PRESSURE TRANSDUCER PT-1, OR
   (b) MAINTAIN USER-DEFINED DRAWDOWN WITHIN ODC CELL VIA GROUNDWATER LEVEL DIFFERENTIAL AS MEASURED BY PAIRED PIEZOMETERS ODC-PZ-3 AND ODC-PZ-4
2. EXTRACTION WELL ODC-EW2 PUMP SPEED TO BE BASED ON WATER LEVELS IN PIEZOMETERS ODC-PZ-7 AND ODC-PZ-8
3. PROGRAM VFDS TO SHUT DOWN WHEN PUMP SPEED DECREASES TO BELOW MANUFACTURER'S MINIMUM RECOMMENDED FLOW RATE AND RE-START WHEN WATER LEVEL REBOUNDS TO USER-INPUT SETPOINT.

GENERAL INSTRUMENT SYMBOLS

- INSTRUMENT LINE
- ELECTRIC LINE
- SOFTWARE LINK
- INSTRUMENT (FIELD MOUNTED)
- INSTRUMENT OR SWITCH (PANEL MOUNTED)
- PLC OPERATOR INTERFACE INDICATOR, CONTROLLER, RECORDER, OR ALARM POINT WITH HMI DISPLAY ACCESS
- I — STARTUP / SHUTDOWN INTERLOCK
- M — MOTOR

GENERAL INSTRUMENT SYMBOLS

- REDUCER
- SAMPLE PORT
- FLANGE FITTING
- CHECK VALVE
- BALL VALVE
- UNION

ABBREVIATION LIST

A/G = ABOVEGROUND
FI = FLOW INDICATOR
FIT = FLOW INDICATING TRANSMITTER
FQ = FLOW TOTALIZER
HOA = HAND / OFF / AUTO SWITCH
HDPE = HIGH DENSITY POLYETHYLENE, SDR 11
HMI = HUMAN MACHINE INTERFACE
HS = HAND SWITCH
LAL = LEVEL ALARM LOW
LIT = LEVEL INDICATING TRANSMITTER
M = MOTOR
P = PUMP
PLC = PROGRAMMABLE LOGIC CONTROLLER
PT = PRESSURE TRANSMITTER
PVC = POLYVINYL CHLORIDE, SCHEDULE 40
SC = SPEED CONTROL
SP = SAMPLE PORT
SS = 304 STAINLESS STEEL, SCHEDULE 40
S/S = START/STOP
U/G = UNDERGROUND

REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED DJB
DRAWN DMF
CHECKED CN
DATE DECEMBER 2016

SulTRAC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

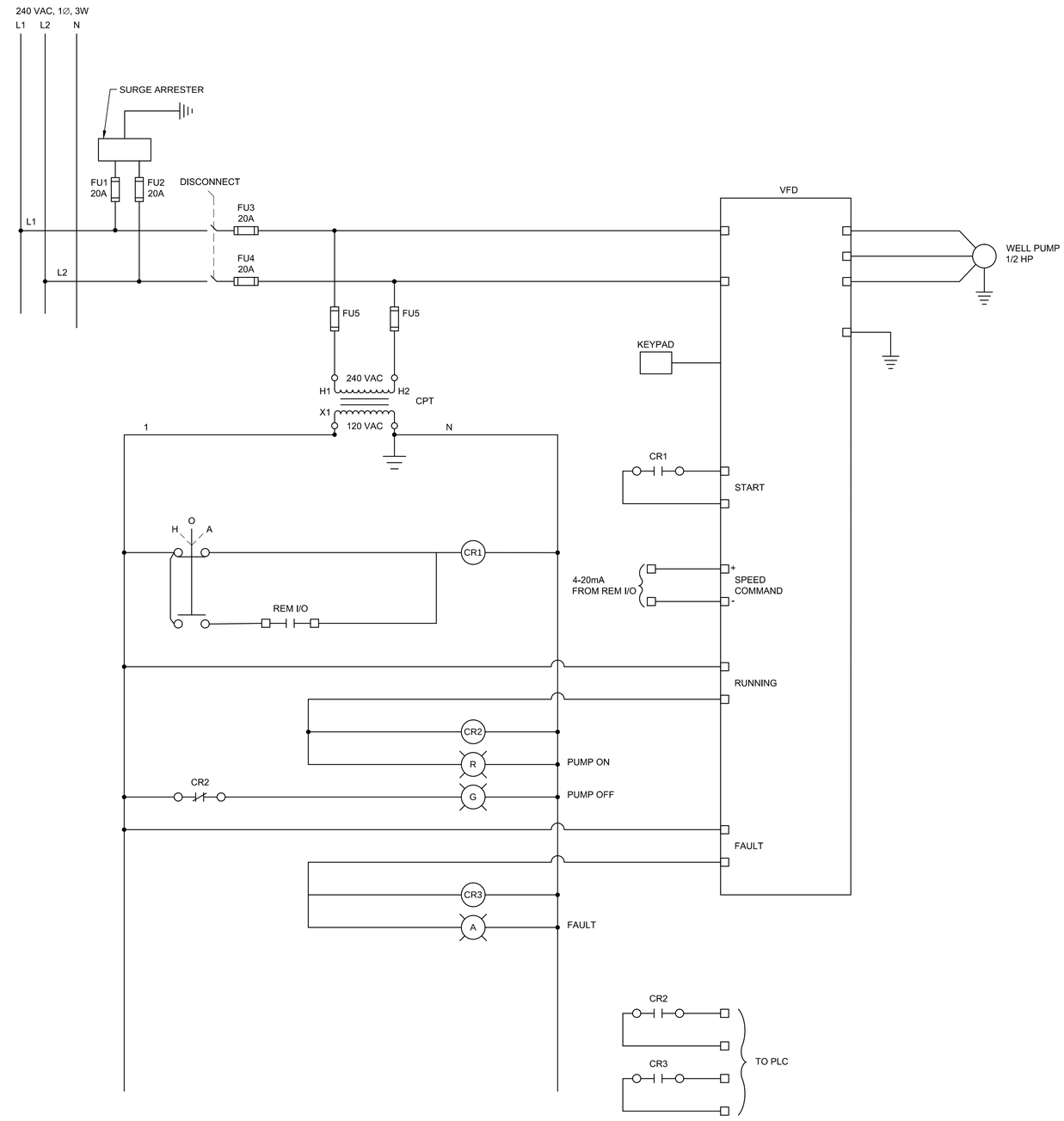
EXTRACTION WELL PIPING AND
INSTRUMENTATION DIAGRAM (RECORD DRAWINGS)

WORK ASSIGNMENT NO.
WA192

FIGURE
13

12/27/2016

G:\SUBSITE\OU2 ODC Rebuild\pdf\16-13\Fig13-Process Flow Diagram.dwg



TYPICAL WELL PUMP CONTROL SCHEMATIC
(VFD CONTROL PANEL BY OTHERS)

REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED DJB
DRAWN MB
CHECKED CN
DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4
WELL CONTROL PANEL
RECORD DRAWINGS

WORK ASSIGNMENT NO.
WA192

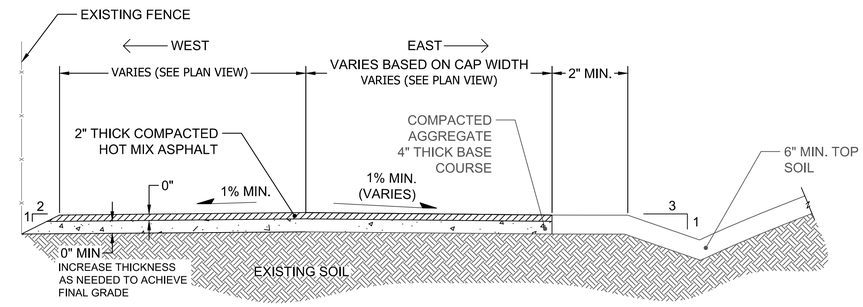
FIGURE
14

G:\G\1852\192 OMC RA\dwg\2016-12\Fig14-Typical Well Control Panel.dwg
12/27/2016

LEGEND

- 585 — Topographic Contour (1-foot intervals)
- T — Underground Telephone Line
- G — Underground Gas Main
- SS — Concrete Sanitary Sewer
- SSFM — PVC Sanitary Sewer Force Main
- ESW — Existing Slurry Wall
- Railroad Tracks
- Centerline of Vertical Barrier
- West Utility Corridor Asphalt Cap (South Portion)
- Site Boundary
- SD — Concrete Storm Drain
- OHT — Overhead Telephone Line
- T — Underground Telephone Line
- Grade Break Line (Swale Bottom)
- W — Underground Water Main
- X — Fence Line
- W-T — 24-inch diameter Water Transmission Line (fragile)
- Sanitary Sewer Standpipe
- Sanitary Sewer Manhole
- Storm Sewer Manhole

0 40 80
SCALE IN FEET



A WESTERN UTILITY CORRIDOR ASPHALT CAP SECTION

SCALE: 1" = 2'-0"

0 2 4
SCALE IN FEET

THIS RECORD DRAWING HAS BEEN PREPARED, IN PART, BASED ON UPON INFORMATION FURNISHED BY OTHERS. WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, TETRA TECH ASSUMES NO RESPONSIBILITY FOR THIS ACCURACY OF THIS RECORD DRAWING OR FOR ANY ERRORS OR OMISSIONS THAT MAY HAVE BEEN INCORPORATED INTO IT AS A RESULT OF INCORRECT INFORMATION PROVIDED TO TETRA TECH. THOSE RELYING ON THIS RECORD DOCUMENT ARE ADVISED TO FIELD VERIFY LOCATIONS.

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NO.	DATE	DESCRIPTION

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DRAWN MB
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DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

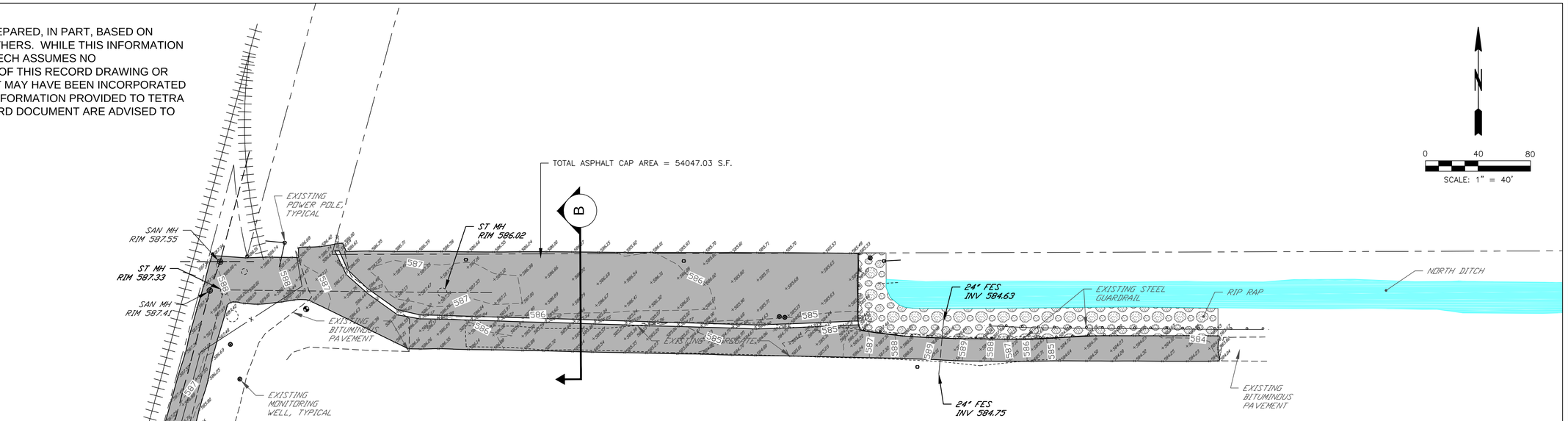
WUC – SOUTH PORTION RECORD DRAWING

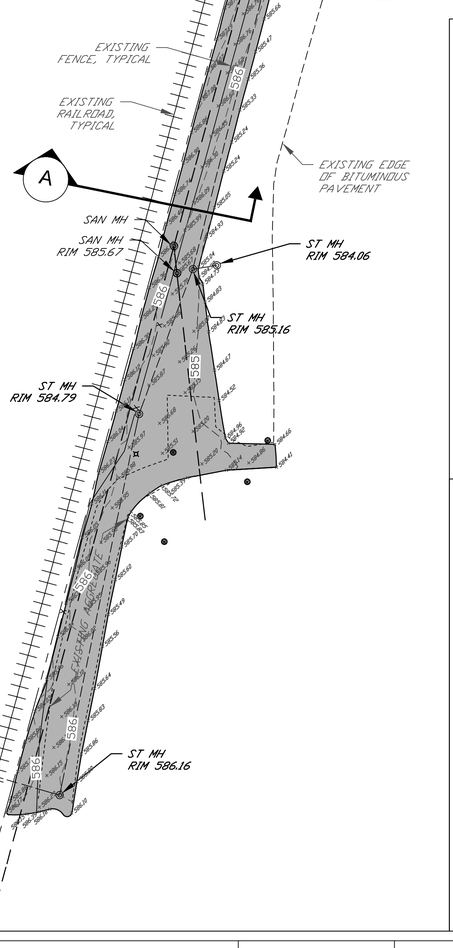
WORK ASSIGNMENT NO. WA192

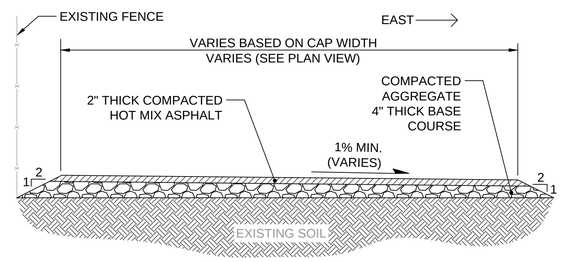
FIGURE 15

G:\G\1852\192 OMC RA\dwg\2016-12\Fig15- WUC South Portion.dwg 12/21/2016

THIS RECORD DRAWING HAS BEEN PREPARED, IN PART, BASED ON UPON INFORMATION FURNISHED BY OTHERS. WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, TETRA TECH ASSUMES NO RESPONSIBILITY FOR THIS ACCURACY OF THIS RECORD DRAWING OR FOR ANY ERRORS OR OMISSIONS THAT MAY HAVE BEEN INCORPORATED INTO IT AS A RESULT OF INCORRECT INFORMATION PROVIDED TO TETRA TECH. THOSE RELYING ON THIS RECORD DOCUMENT ARE ADVISED TO FIELD VERIFY LOCATIONS.







A WESTERN UTILITY CORRIDOR ASPHALT CAP SECTION

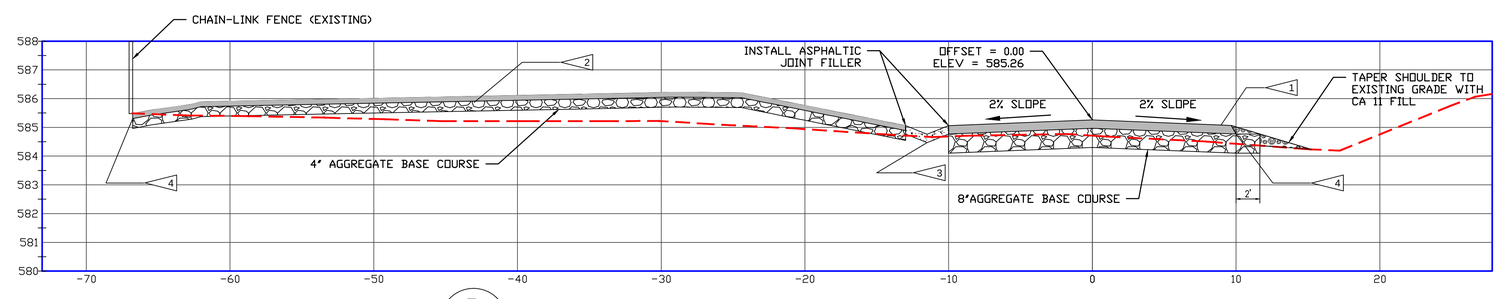
SCALE: 1" = 2'-0"

GENERAL NOTES

1. ROAD CONSTRUCTION IS 3.5-INCH THICK HMA OVER 8-INCH THICK AGGREGATE BASE COURSE. HMA IS 1.5-INCH THICK SURFACE COURSE OVER 2-INCH THICK BINDER COURSE.
2. CAP CONSTRUCTION IS 2-INCH THICK HMA OVER 4-INCH THICK AGGREGATE BASE COURSE.
3. DITCH CONSTRUCTION IS 4-INCH THICK PORTLAND CEMENT CONCRETE. PROVIDE EXPANSION JOINTS EVERY 5 FEET AND INSTALL BITUMINOUS JOINT FILLER.
4. SLOPE EDGE OF HMA AT 1:1.

LEGEND

- HOT-MIX ASPHALT (HMA)
- AGGREGATE BASE COURSE
- RIP RAP
- CONCRETE
- EXISTING GRADE
- IDOT ILLINOIS DEPARTMENT OF TRANSPORTATION



B CAP AT 2+00

HORIZONTAL SCALE: 1" = 5'-0" (0 5 10 SCALE IN FEET)

VERTICAL SCALE: 1" = 2.5'-0" (0 2.5 5 SCALE IN FEET)

VERTICAL EXAGGERATION: 2x

REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED CN
DRAWN MB
CHECKED CN
DATE DECEMBER 2016

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OUTBOARD MARINE CORPORATION SITE
WAUKEGAN, ILLINOIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

SCALES:
HORIZONTAL SCALE: AS SHOWN
VERTICAL SCALE: NA

OUTBOARD MARINE CORPORATION SITE
ODC AND UTILITY CORRIDOR CAPS
OPERABLE UNIT #4

NUC AND WUC NORTHERN PORTION
RECORD DRAWING

WORK ASSIGNMENT NO. WA192

FIGURE 16

12/21/2016

G:\G\1852\192 OMC RA\dwg\2016-02\Fig16-15139 (BRANDENBURG AS-BUILT.dwg

ATTACHMENT 2:
PRODUCT DATA

WELL CONSTRUCTION MATERIALS

THE CRITICAL DIFFERENCE IN JOHNSON SCREENS® PVC SCREENS IS OPEN AREA

JOHNSON SCREENS PVC VEE-WIRE® WELL SCREENS

Commonly used in shallow wells, *Johnson Screens* sonic welded PVC *Vee-Wire* screens present higher open area for given slot than any other non-metallic screen available.

More economical than metal screens, PVC *Vee-Wire* screens resist corrosion from salts and gases commonly found in either salt or fresh water, and are resistant to acid treatments commonly used to clean wells.

PVC screens are furnished with standard flush threads or plain ends for connecting to standard PVC fittings.

Sizes range from 1.25 to 8 in. (32 to 203 mm), and screen slot size can be as small as 0.005 in. (0.13 mm) and up, per customer specifications.

END FITTINGS

PVC screens are supplied with standard flush threads or plain ends for connecting to standard PVC fittings.

BETTER WELL DEVELOPMENT

It is important to remove fines from the filter pack or formation to increase the well's porosity, which enhances well efficiency. For this to be effectively done, development energy must pass through the screen with minimum interference. This requires high open area.

MORE OPEN AREA

Johnson Screens PVC *Vee-Wire* screens have more open area per foot than any other non-metallic screen available. This allows more water to enter at lower velocities, which reduces turbidity and enables a more representative sample to be collected.

JOHNSON SCREENS PVC VEE-PACK™ PRE-PACKED SCREENS

Some subsurface conditions, such as heaving, caving, silty sand make conventional gravel pack placement difficult or impossible.

The solution is *Johnson Screens Vee-Pack* screen. The *Vee-Pack* contains an integral gravel pack that is held in place between two concentric screens. This assembly is then installed in a single operation.

Standard features of the *Vee-Pack* include:

- Smaller borehole
- Slot spacing as small as 0.008 in. (0.203) mm
- Standard 2 and 4 in. (51 and 102 mm) sizes available
- Reduces cutting disposal
- Factory-installed re-sieved silica sand filter pack is uniform, without voids
- Fine-grade pack allows sediment-free sampling
- High screen open area
- Sonic-welded construction eliminates solvents which can affect sample integrity
- Schedule 40 and 80 flush threads available
- Thread-on points ease installation in heaving sands

STAINLESS STEEL WELDED PIPE

TYPE 304 SCHEDULES 40S, 80S ALLOWABLE WORKING PRESSURE

ALLOWABLE WORKING PRESSURES FOR A-312 WELDED PIPE

TYPE 304
Schedules 40S, 80S

TEMPERATURE °F.			-425 to 300	400	500	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
MAX. STRESS			20000	18700	17500	16400	16200	16000	15600	15200	14900	14600	14400	13800	12200	9700	7700	6000	4700	3700	2900	2300	1800	1400
NOM. PIPE SIZE	SCH. NO.	NOM. WALL.	ALLOWABLE WORKING PRESSURES PSIG																					
½	40S	.109	3633	3397	3179	2979	2943	2907	2834	2761	2707	2652	2618	2507	2216	1762	1399	1090	854	672	527	418	327	254
	80S	.147	4900	4582	4288	4018	3969	3920	3822	3724	3651	3577	3528	3381	2989	2377	1887	1470	1152	907	711	564	441	343
¾	40S	.113	3013	2617	2637	2471	2441	2411	2350	2290	2245	2200	2170	2079	1838	1461	1160	904	708	557	437	347	271	211
	80S	.154	4107	3840	3593	3387	3326	3285	3203	3121	3059	2998	2957	2834	2505	1992	1581	1232	965	760	595	472	370	287
1	40S	.133	2832	2648	2478	2322	2294	2266	2209	2152	2110	2067	2039	1954	1727	1373	1090	850	666	524	411	326	255	198
	80S	.179	3811	3584	3335	3125	3087	3049	2973	2897	2839	2782	2744	2630	2325	1849	1467	1143	898	705	553	438	343	267
1¼	40S	.140	2361	2208	2066	1936	1913	1889	1842	1795	1759	1724	1700	1629	1440	1145	909	708	555	437	342	272	213	165
	80S	.191	3222	3012	2819	2642	2610	2577	2513	2448	2400	2352	2320	2223	1965	1563	1240	967	757	596	467	370	290	226
1½	40S	.145	2137	1996	1870	1752	1731	1709	1667	1624	1592	1560	1539	1474	1303	1036	823	641	502	395	310	246	192	150
	80S	.200	2947	2758	2579	2417	2387	2358	2299	2240	2196	2152	2122	2034	1798	1429	1135	884	693	545	427	339	265	206
2	40S	.154	1816	1693	1589	1489	1471	1452	1416	1380	1353	1325	1307	1253	1108	881	699	545	427	336	263	209	163	127
	80S	.218	2570	2403	2249	2107	2082	2058	2005	1953	1915	1876	1850	1773	1588	1247	989	771	604	475	373	296	231	180
2½	40S	.203	1977	1849	1730	1621	1601	1582	1542	1503	1473	1443	1423	1384	1206	959	761	593	465	368	287	227	178	138
	80S	.276	2888	2513	2352	2204	2177	2150	2097	2043	2003	1962	1935	1855	1640	1304	1035	806	632	497	390	309	242	188
3	40S	.216	1728	1616	1512	1417	1400	1362	1348	1313	1287	1261	1244	1192	1054	838	665	518	406	320	251	199	158	121
	80S	.300	2400	2244	2100	1988	1944	1920	1872	1824	1788	1752	1728	1658	1464	1164	924	720	564	444	348	276	218	168
3½	40S	.226	1562	1479	1364	1297	1261	1266	1234	1202	1179	1155	1139	1092	965	767	609	475	372	293	229	182	142	111
	80S	.318	2226	2081	1948	1825	1803	1781	1738	1692	1658	1625	1603	1538	1358	1080	857	666	523	412	323	256	200	156
4	40S	.237	1475	1379	1290	1209	1194	1180	1150	1121	1099	1077	1062	1018	900	715	588	442	347	273	214	170	133	103
	80S	.337	2097	1961	1835	1719	1698	1678	1636	1594	1562	1531	1510	1447	1279	1017	807	629	493	388	304	241	169	147
5	40S	.258	1299	1214	1136	1065	1052	1039	1013	987	967	948	935	896	792	630	500	390	305	240	188	149	117	91
	80S	.375	1667	1765	1652	1548	1529	1510	1472	1434	1406	1378	1359	1302	1151	915	727	566	444	349	274	217	170	132
6	40S	.280	1183	1106	1035	970	959	947	923	899	882	884	852	817	722	574	456	355	278	219	172	136	107	83
	80S	.432	1628	1707	1596	1497	1479	1461	1424	1368	1360	1333	1315	1260	1114	886	703	546	429	338	265	210	164	128
8	40S	.322	1045	977	915	857	847	836	815	794	779	763	753	721	638	507	402	314	246	193	152	120	94	73
	80S	.500	1623	1518	1420	1331	1315	1299	1266	1234	1209	1185	1169	1120	990	787	625	487	381	300	235	187	146	114
10	40S	.385	951	889	832	780	770	761	742	723	708	694	685	658	580	461	386	285	223	176	138	109	86	67
	80S	.500	1302	1218	1140	1068	1055	1042	1016	990	970	951	938	899	794	632	501	391	306	241	189	150	117	91
12	40S	.375	824	770	721	675	667	659	642	626	61	601	593	568	502	399	317	247	194	152	119	95	74	58
	80S	.500	1098	1027	961	900	669	676	856	835	818	802	791	758	670	533	423	329	258	203	159	126	99	77
14	40S	.375	750	701	656	615	608	600	585	570	559	548	540	518	458	364	289	225	178	139	109	86	68	53
	80S	.500	1000	935	875	820	810	800	780	760	745	730	720	690	610	485	385	300	235	185	145	115	90	70
16	40S	.375	656	614	574	538	532	525	512	499	489	479	473	453	400	318	253	197	154	121	95	75	59	46
	80S	.500	875	818	766	718	709	700	683	665	652	639	630	604	534	424	337	263	206	162	127	101	79	61
18	40S	.375	583	545	510	478	473	467	455	443	435	426	420	403	358	263	225	175	137	106	85	67	53	41
	80S	.500	778	727	681	638	630	622	607	591	579	568	560	537	474	377	299	233	183	144	113	89	70	54
20	40S	.375	525	491	459	431	425	420	410	399	391	383	378	362	320	255	202	158	123	97	76	60	47	37
	80S	.500	700	655	613	574	587	560	548	532	522	511	504	483	427	340	270	210	165	130	102	81	63	49
24	40S	.375	438	409	383	359	354	350	341	333	328	319	315	302	267	212	168	131	103	81	63	50	39	31
	80S	.500	583	545	510	478	473	467	455	443	435	426	420	403	358	283	225	175	137	108	85	67	53	41

CMC
Ext.
Well

The Allowable Stress Values used are as shown in Appendix "A" of ANSI B31.3-1993 for welded pipe to ASTM A-312 having a weld joint factor of .80.
The Stress Values at all temperatures above 1000F apply only when the carbon is 0.04% or higher.

PITLESS ADAPTERS

10 - 30 - 13

MARTINSON PITLESS ADAPTERS

Martinson pioneered the original pitless adapter over 40 years ago. Pitless adapters allow for the underground discharge of your water service line. They eliminate expensive pump houses and unsanitary well pits. The sliding tee of the pitless adapter allows for easy and efficient pump service without digging or disturbance of your water line. The B-series is a lighter weight or economy model of the original pitless adapter. The S-series is a heavy duty model for deeper pump settings. All below pitless adapters use teflon coated O-ring seals for watertight connections.

$ 81.25 B10X	**B-10X**	This economy pitless adapter is our most popular model for use with 1" drop pipe. Manufacturer shows the B-10X will support 970' of pipe filled with water, however we recommend its use down to 500' settings only.
$ 19.80	**T22039**	1-7/8" Bi-Metal Hole Saw for B10X Pitless to drill casing hole.
$ 158.00 S10X	**S-10X**	This heavy duty model pitless adapter is for use with 1" drop pipe and will support 1500' of 1" pipe filled with water.
$ 18.75	**T22038**	1-3/4" Bi-Metal Hole Saw for S10X Pitless to drill casing hole.
$ 117.25 B20X	**B-20X**	This is the economy model for 1-1/4" drop pipe. Manufacturer shows the B-20X will support 800' of pipe filled with water, however we recommend its use down to 400' settings only.
$ 22.65	**T22042**	2-1/4" Bi-Metal Hole Saw for B20X & S20X Pitless Adapters.
$ 193.50 S20X	**S-20X**	This heavy duty model pitless adapter is for use with 1-1/4" drop pipe and will support 1000' of 1-1/4" pipe filled with water.
$ 281.00 S70X	**S-70X**	This heavy duty model pitless adapter is for use with 2" drop pipe and will support 700' of 2" pipe filled with water.
$ 32.00	**T22139**	3-1/8" Bi-Metal Hold Saw for S70X Pitless to drill casing hole.
$ 35.90	**T22050**	Mandrel w/Pilot Drill Bit for Hole Saw w/ 3/8" Hex.
$ 246.00 JB55X	**JB-55X**	This 2-pipe pitless adapter is for deep well jet pumps that use 1" and 1-1/4" pipe down to the ejector package.

OMC
Ext well

DICKEN'S CLEARWAY WRAP-AROUNDS

This brass clamp-on pitless adapter is designed for use with plastic well casing. Dicken's wrap-around clamp design leaves the interior of the plastic casing completely open and obstruction free, allowing for its use on small diameter casing (such as 4", 4-1/2", and 5" plastic casing).

$ 130.00 CW410WA	**CW-4-10-WA**	Designed for use with 4" inside diameter plastic well casing and 1" pump drop pipe. Manufacturer shows this unit will support approximately 2000 pounds as a working load limit (approximately 900' of pipe filled with water).
$ 144.00 CW4510WA	**CW-4.5-10-WA**	Designed for use with special 4-1/2" inside diameter plastic well casing and 1" pump drop pipe.
$ 149.50 CW510WA	**CW-5-10-WA**	Designed for use with 5" inside diameter plastic well casing and 1" pump drop pipe.

MAASS CLAMP-ON PITLESS ADAPTERS

The durable cast steel pitless adapter housing is clamped on the outside of the steel or PVC surface casing itself. The water contacts only stainless steel and brass, which eliminates corrosion. When the brass tee insert is pulled, there is no obstruction left in the well and the inside diameter of the casing is completely open. This allows for use with steel and PVC casing as small as 4" in size.

$ 171.50	**4JC114NL**	1-1/4" Clamp On pitless adapter for 4-1/2" O.D. steel or PVC casing.
$ 179.50	**5ODJC114**	1-1/4" Clamp On pitless adapter for 5" O.D. steel or PVC casing.
$ 179.00	**5JC114**	1-1/4" Clamp On pitless adapter for 5-9/16" O.D. steel or PVC casing.

We also stock J-1 and J-1-1/4 weld on pitless adapters here in our Denver stock.

$ 97.00	**J 1**	Designed for use with 4" thru 8" steel casing and 1" pump drop pipe.
$ 139.00	**J 1-1/4**	Designed for use with 4" thru 8" steel casing and 1-1/4" drop pipe.

PITLESS ADAPTERS QUALIFY FOR OUR $ 1,000.00 FULL FREIGHT PREPAID ORDER POLICY
MANY ITEMS ARE ALSO AVAILABLE IN STAINLESS STEEL

Monitoring Well Manholes

A0721 Monitoring Well Manholes

All Emco Wheaton Monitoring Well Manholes incorporate cast-in identification triangles in accordance with API recommendations and meet AASHTO H20 wheel loading.

- Painted ductile iron lid and rim
- Optional galvanized steel or polyethylene skirt
- Bolt-down units have water-tight lids
- Custom skirt heights available
- Stainless steel bolts

Built-in side handle on 18" models - one hand opening and positioning

- Heavy-duty (16 gauge hot rolled carbon steel) skirts available. 100% welded skirt and seam.
  To order, replace the first digit of the variant number with a 2.
- ID tag available on all models; large enough for all new regulatory requirements.
  To order, add ID to the 8-digit part number

A0720 Locking Cap & Collar

The Emco Wheaton A0720 locking cap and collar is used to limit access and seal monitoring wells and can be threaded or solvent welded onto a 4" PVC monitoring well pipe. It displays the monitoring well designation and includes a padlock. The cap and collar are both made of durable ABS plastic.

Model No.	Description	Pipe Size	Weight
A0720-001	Locking Cap and Collar	4"	1.3 lbs.

Replacement Parts

564029 Lock/Key Set A0720

A0721 Monitoring Well Manholes

Size	Model No.	Style	Skirt Type	Overall Height	Clearhole ID	Max. Dia.	Weight
5"	* A0721-105	Bolt-down	Steel	8.5"	3.8"	6.0"	5.7 lbs.
6"	* A0721-106	Bolt-down	Steel	7.5"	4.5"	6.7"	6.3 lbs.
	* A0721-106A	Bolt-down	Steel	9.5"	4.5"	6.7"	6.5 lbs.
8"	* A0721-008	Bolt-down	Poly	12.3"	6.0"	9.9"	11.7 lbs.
	A0721-008CE	BD, Large Bolts, White Lid	Poly	12.3"	6.0"	9.9"	11.1 lbs.
	A0721-008LA	Lay-in	Poly	12.3"	7.8"	9.9"	10.4 lbs.
	A0721-088	Bolt-down	Poly	8.0"	6.0"	9.9"	
	* A0721-108	Bolt-down	Steel	12.7"	6.0"	9.9"	13.7 lbs.
	* A0721-188	Bolt-down	Steel	9.2"	6.0"	9.9"	12.8 lbs.
	A0721-188A	Bolt-down	Steel	7.0"	6.0"	9.9"	
	* A0721-188L	Lay-in	Steel	8.9"	7.8"	9.9"	11.9 lbs.
	A0721-208	Bolt-down	HD Steel***	12.5"	6.0"	9.9"	12.7 lbs.
	A0721-308	BD, 3 Bolts, White Lid	Steel	8.8"	6.4"	9.4"	12.8 lbs.
	A0721-308A	BD, 3 Bolts, White Lid	Steel	12.8"	6.4"	9.4"	13.7 lbs.
	A0722-008**	Bolt-down	Poly	12.3"	6.0"	9.9"	12.4 lbs.
12"	* A0721-001	Bolt-down	Poly	12.0"	9.4"	15.1"	23.0 lbs.
	A0721-001CC	Bolt-down w/Rebar Tabs	Poly	12.0"	9.4"	15.1"	23.1 lbs.
	A0721-001L	Lay-in	Poly	12.0"	11.2"	13.8"	22.8 lbs.
	* A0721-101	Bolt-down	Steel	12.0"	9.4"	15.1"	28.8 lbs.
	A0721-101A	Bolt-down	Steel	18.0"	9.4"	15.1"	31.0 lbs.
	A0721-101L	Lay-in	Steel	12.0"	11.2"	13.8"	28.6 lbs.
	A0721-119	Bolt-down	Steel	19.0"	9.4"	15.1"	36.3 lbs.
	A0721-128	Bolt-down	Poly	8.1"	9.4"	15.1"	21.9 lbs.
	A0721-128A	Bolt-down	Steel	8.0"	9.4"	15.1"	23.6 lbs.
	A0721-201	Bolt-down	HD Steel***	12.0"	9.4"	15.1"	28.0 lbs.
	A0722-001**	Bolt-down	Poly	12.0"	9.4"	15.1"	24.3 lbs.
18"	* A0721-018	Bolt-down	Steel	12.0"	13.8"	18.4"	58.5 lbs.
	A0721-118	Bolt-down	Steel	18.0"	13.8"	18.4"	69.5 lbs.

*Most common variant **Includes locking cap & collar
***Heavy duty

Lid Replacement Parts

Part No.	Lid	Description	Weight
494263	5"	Bolt 1/2" Hex, 3/8" Thd, 0.5 Lg	
569885	5"	Lid Gasket	
569883	5"	Lid Cast Bolt-down	
568692	6"	Lid Ductile Bolt-down	2.4 lbs.
568662	6"	Bolt 1/2" Hex, 5/16" Thd, 0.75 Lg	
568820	6"	Lid Gasket	0.1 lbs.
569106	8"	Lid Ductile Bolt-down	5.4 lbs.
569285	8"	Lid Ductile Lay-in	6.0 lbs.
567150	8"	Lid Ductile BD, White	6.0 lbs.
494260	8"	Bolt/O-ring 15/16" Hex, 5/8" Thd, 1.0 Lg	
494261	8"	Bolt/O-ring 9/16" Hex, 3/8" Thd, 1.0 Lg	
566419	8"	O-ring for 9/16" Bolt	0.4 oz.

Part No.	Lid	Description	Weight
566334	8"	O-ring for 5/8" Bolt	0.4 oz.
567146	8"	Lid Gasket	0.1 lbs.
563980	12"	Lid Ductile Bolt-down	12.6 lbs.
569723	12"	Lid Ductile Lay-in	12.0 lbs.
494262	12"	Bolt/O-ring 15/16"Hex, 5/8"Thd, 1.75 Lg	0.2 lbs.
566334	12"	O-ring for 5/8" Bolt	0.3 oz.
563593	12"	Lid Gasket	0.1 lbs.
567712	18"	Lid Ductile Bolt-down	35.0 lbs.
494262	18"	Bolt/O-ring 15/16"Hex, 5/8"Thd, 1.75 Lg	0.2 lbs.
494375	18"	Bolt/O-ring 9/16" Hex, 3/8" Thd, 2.0 Lg	0.2 lbs.
566419	18"	O-ring for 9/16" Bolt	
567995	18"	Lid Gasket	0.3 lbs.

MODEL 12″ WATERTIGHT MANHOLE WITH HEAVY DUTY STEEL SKIRT

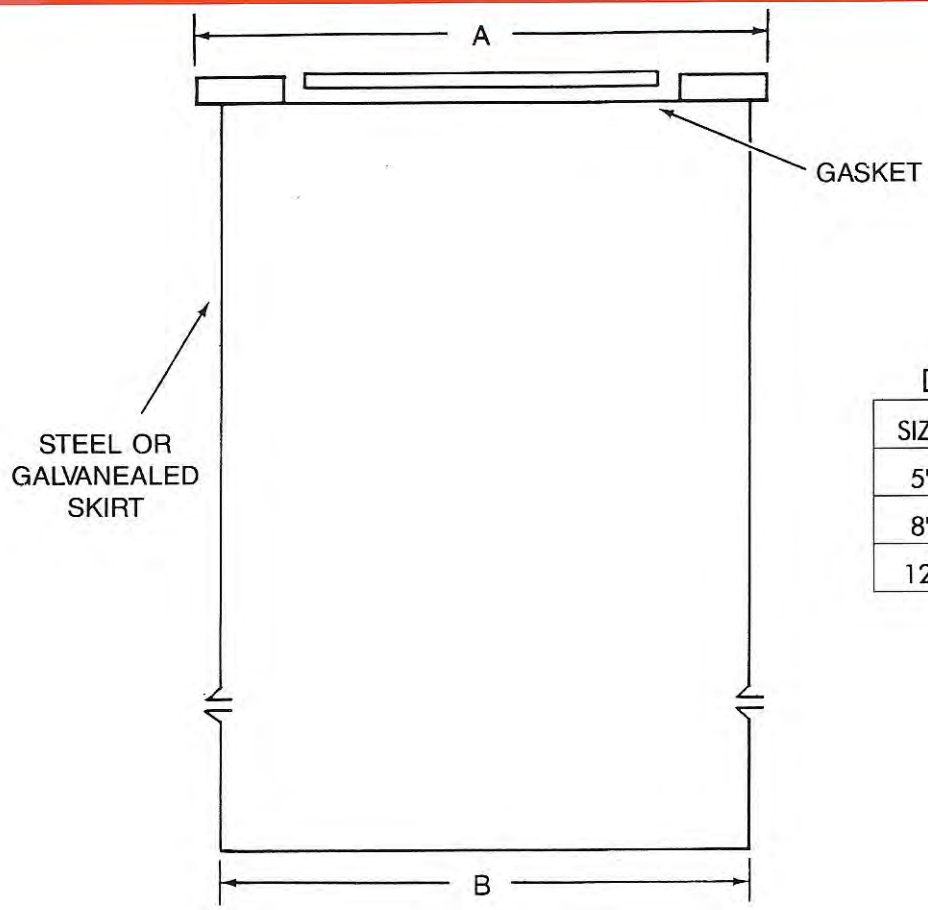
ITEM #	SKIRT LENGTH	WEIGHT (LBS.)
318130750	7½″ (19.05 cm)	42
318131200	12″ (30.48 cm)	50

MODEL 12″ WATERTIGHT MANHOLE WITH GALVANEALED SKIRT

ITEM #	SKIRT LENGTH	WEIGHT (LBS.)
318130751	7½″ (19.05 cm)	30
318131201	12″ (30.48 cm)	32

MODEL **12″ LAY-IN MANHOLE WITH GALVANEALED SKIRT**

ITEM #	SKIRT LENGTH	WEIGHT (LBS.)
318135751	7½″ (19.05 cm)	30
318141201	12″ (30.48 cm)	32



DIMENSIONS

SIZE	A	B
5"	6"	5 1/8"
8"	9 3/4"	8 5/8"
12"	13 1/8"	12 1/2"

BEARING STRENGTH TEST RESULTS

6" Diameter Monitor Well Covers
(Morris 5") Monitor Well Assembly

TEST PERFORMED: The submitted sample was tested for its ability to withstand a proof load in accordance with the procedures outlined in AASHTO M306-89. The test date was January 19, 1996.

RESULTS: The submitted sample is considered to meet the requirements of AASHTO M306-89 for proof load testing.

Procedure: On 8" diameter monitor well cover assembly a compressive load was applied with 6¼" diameter head centered on cover surface.

On 12" diameter monitor well cover assembly a compressive load was applied with 9⅝" diameter head centered on cover surface.

Lab. #	Diameter of Cover	Outer Diameter of the Assembly	Break Load
92-M117	8.5"	9.81"	65,000 lbs.
93-M046	12.0"	13.25"	59,000 lbs.

FULL COPIES OF TEST RESULTS ARE AVAILABLE UPON REQUEST.

FOSTCO, Inc. 4” Standard Centralizer Submittal

A. Manufacturer:

FOSTCO, Inc.
P.O. Box 456, Davenport, WA 99122
(509) 725-3765, (509) 725-3785 Fax.
www.fostco.com

B. Construction:

4” Centralizers are fabricated of 100% stainless steel, with worm drive clamps on the top and bottom. Worm drive clamps feature a slotted 5/16” hex head that will allow installation and tightening by the use of a common screwdriver, 5/16” open or socket wrench, or 5/16” nut driver.

Worm Drive Clamp Band, "Housing" & "Saddle" Material:
304 Stainless Steel Coiled Strip Steel
SAE-AMS (Chemistry only)

Worm Drive Clamp Screw Material:
410 Stainless Steel Coiled Strip Steel

Worm Drive Clamps are attached to the bow spring staves by resistance (spot) welding. Straps are 301 Stainless Steel Coiled Strip Steel SAE-AMS (Chemistry only), ½ hard spring. Straps are 15” long, .025” thick and 3/4” wide.

4” centralizers have 4 straps equally spaced at 90 degree approximate centers.

Centralizers are fabricated to allow installation on the OD of 4” PVC or Stainless Steel Pipe (pipe OD is 4.50”).

C. **Adjustment Range:**

4” Centralizers have an adjustment range to allow centralization of 4” casing or screen, up to a 16” bore hole.

D. **U.S. Content:**

FOSTCO 4” centralizers are made from clamps and stainless steel bow spring staves that are U.S. made. All fabrication, packaging and shipping is performed by FOSTCO in Davenport, WA by legal U.S. taxpaying citizens.

2" Torquer Locking Well Plug

6" Torquer Locking Well

Bentonite Plug

Black Hills Bentonite Plug MSDS Sheet

Description

BENTONITE PLUG is pure, naturally occurring, sodium bentonite, which is mined and processed here in Wyoming. BENTONITE PLUG'S unique ability to absorb 7-10 times its weight in water (forming a non-toxic plug) makes it ideal as an economical method for many sealing and plugging applications

Application

BH PLUG'S many uses include the sealing of abandoned water wells, drill holes, and monitor well casing. BENTONITE PLUG can also be used for the sealing of animal stock tanks, irrigation ditch leaks, and seismic shot holes. When used for seismic exploration, BENTONITE PLUG, forms a tough plug which seals the hold plus provides a barrier to the explosive charge, keeping the energy down-hole.

Typical Chemical Analysis

Element	%	Element	%
SiO_2	64.7	CaO	1.8
Al_2O_3	17.8	K_2O	.46
Fe_2O_3	4.4	Na_2O	2.5
MgO	1.8	TiO_2	.16
		H_2O (Crystal)	5.9

Specifications

Typical Screen Analysis

BP 3/8"			BP 3/4"		
%		Mesh	%		Mesh
45.0	Retained on	3/8"	1.0	Retained on	3/4"
45.0	Retained on	1/4"	98.0	Retained on	3/8"
9.5	Retained on	20	.5	Retained on	20
.5	Passing	20	.5	Passing	20

Method of Application:

1. Open top of BENTONITE PLUG bag.

2. Hold bag about two feet above hole.

3. Pour BENTONITE PLUG slowly into hole
(approx. 2 minutes per bag)

4. Fill hole as required (above static water level or near ground surface)

5. Observe all regulatory specifications

Typical Physical properties:

BP 3/8" 69 lb / ft³

BP 3/4" 69 lb / ft ³

MOISTURE: 15-17%

PERMEABILITY OF HYDRATED PLUG: K = 2.0 X 10^-9 cm/sec

PACKAGING: Bentonite PLUG is packaged in mulitwall polylined bags containing 50.0 lbs (22.7 kg)

Hole Size and volume Table

Hole Diameter Inches	Hole Volume cu/ft/foot	Pounds BENTONITE PLUG To Fill One Foot	Feet Filled By One Bag BENTONITE PLUG	Bags Bentonite Plug To Fill 100 ft
2	0.022	1.6	31.3	3.2
2-1/2	0.034	2.5	20.0	5.0
3	0.049	3.5	14.3	7.0
3-1/2	0.067	4.8	10.4	9.6
4	0.087	6.3	7.9	12.6
4-1/2	0.110	7.9	6.3	15.8
5	0.136	9.8	5.1	19.6
5-1/2	0.165	11.9	4.2	23.8
6	0.196	14.1	3.5	28.2
6-1/2	0.230	16.6	3.0	33.2
7	0.267	19.2	2.6	38.4
7-1/2	0.307	22.1	2.3	44.2
8	0.349	25.1	2.0	50.2
8-1/2	0.394	28.4	1.8	56.8
9	0.442	31.8	1.6	63.6
9-9/2	0.492	35.4	1.4	70.8
10	0.545	39.2	1.3	78.4
11	0.660	47.5	1.1	95.0

12	0.785	56.5	0.89	113.0
15	1.227	88.3	0.57	176.6
18	1.767	127.2	0.39	254.4
20	2.1817	157.1	0.32	314.2
25	3.409	245.4	0.20	490.8
30	4.909	353.4	0.14	706.8

IES Drilling Supplies

104 E. DeVore St, Pearl City, IL 61032

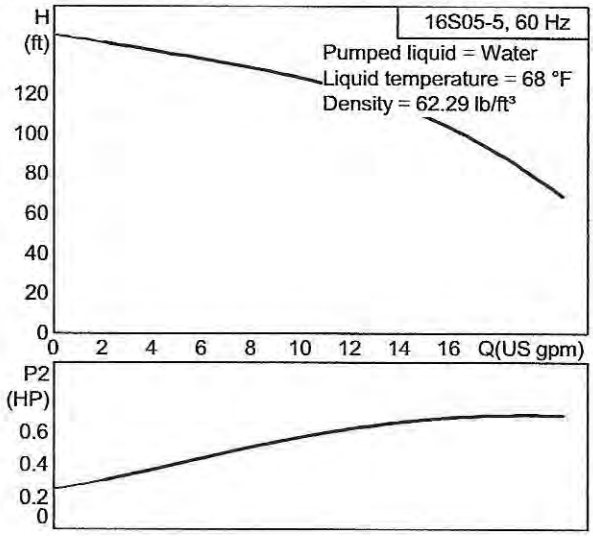
Ph: 800-388-2906 Fax: 815-443-2893

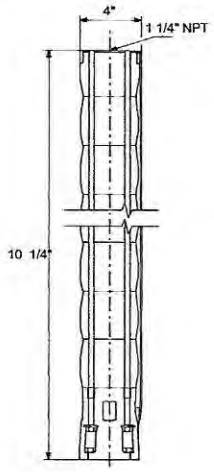
10/20 Sand Also Known as #5 Sand

	GM Weight	% Ret	Cum%Ret	Cum%Pass
8	**25.9**	**5.2%**	**5.2%**	**94.8%**
10	85.6	17.2%	22.4%	77.6%
12	**101.6**	**20.4%**	**42.8%**	**57.2%**
14	123.6	24.8%	67.6%	32.4%
16	**65.9**	**13.2%**	**80.8%**	**19.2%**
18	43.8	8.8%	89.6%	10.4%
20	**25.6**	**5.1%**	**94.7%**	**5.3%**
25	13.8	2.8%	97.5%	2.5%
30	**7.3**	**1.5%**	**98.9%**	**1.1%**
35	4.1	0.8%	99.8%	0.2%
40	**0.7**	**0.1%**	**99.9%**	**0.1%**
Pan	0.5	0.1%	100.0%	0.0%

DEWATERING SYSTEM MATERIALS

Description	Value
Product name:	16S05-5
Product Number:	10010005
EAN number:	5700390303396
Technical:	
Speed for pump data	3450 rpm
Actual calculated flow:	17.6 US gpm
Flow range	2.07 .. 20 US gpm
Max flow:	20 US gpm
Resulting head of the pump:	93.5 ft
Stages:	5
Model:	B
Valve:	pump with built-in non-return valve
Materials:	
Pump:	Stainless steel DIN W.-Nr. 1.4301 AISI 304
Impeller:	Stainless steel DIN W.-Nr. 1.4301 AISI 304
Installation:	
Pump outlet:	1 1/4" NPT
Motor diameter:	4 inch
Liquid:	
Maximum liquid temperature:	104 °F
Liquid temp:	68 °F
Density:	998.2 kg/m³
Electrical data:	
Applic. motor:	GRUNDFOS
Power (P2) required by pump	0.738 HP
Main frequency:	60 Hz
Start. method:	direct-on-line
Others:	
Sales region:	Namreg





16S EASY SELECTION CHART

16 GPM

SELECTION CHARTS

(Ratings are in GALLONS PER MINUTE-GPM)

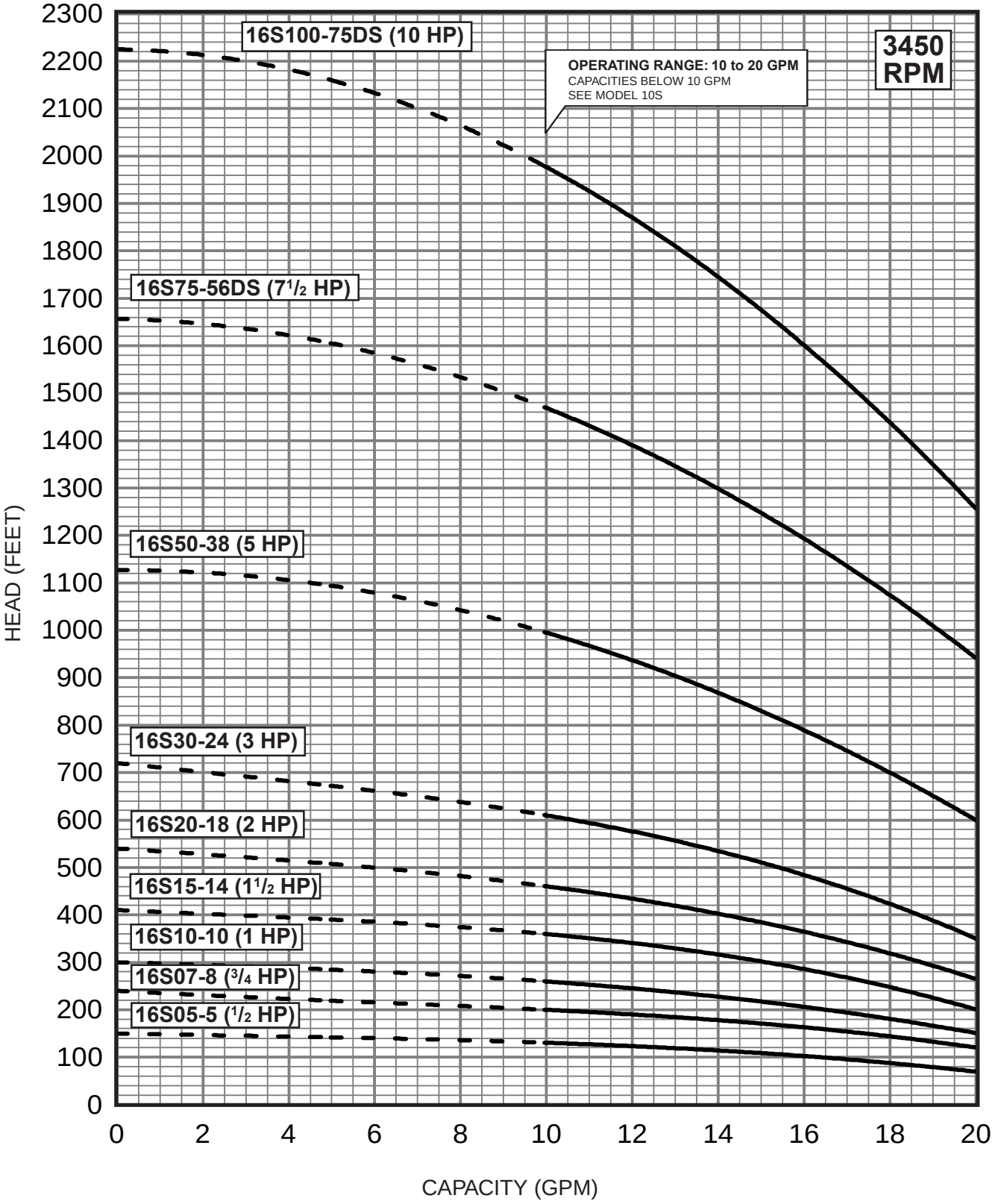
FLOW RANGE
(10 TO 20 GPM)

PUMP OUTLET
1 1/4 " NPT

			DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																								
PUMP MODEL	**HP**	**PSI**	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**340**	**400**	**460**	**520**	**600**	**700**	**800**	**900**	**1000**	**1100**
16S05-5	**1/2**	20	20.3	18.2	14.1	10.0	5.0																				
		30	17.3	14.4	8.0	1.6																					
		40	12.7	8.0	4.0																						
		50	6.5																								
		60	2.9																								
SHUT-OFF PSI:			58	49	40	32	23	14																			
16S07-8	**3/4**	0					20.5	19.2	17.5	15.8	12.8	9.8	5.2														
		20			20.1	18.8	16.9	15.2	11.8	8.5	4.3																
		30	21.2	19.9	18.4	16.9	14.3	11.8	7.5	3.2	1.6																
		40	19.7	18.3	16.3	14.3	10.8	7.2	3.6																		
		50	17.9	16.3	13.5	10.7	6.2	1.7																			
		60	15.7	13.5	9.6	5.8	2.9																				
SHUT-OFF PSI:			97	88	80	71	62	54	45	36	28	19	10														
16S10-10	**1**	0						20.8	19.8	18.8	17.3	15.9	13.7	11.4	8.0	4.7											
		20				20.5	19.4	18.3	16.8	15.3	12.9	10.5	7.0	3.5	1.8												
		30			20.3	19.3	18.1	16.8	14.8	12.8	9.8	6.7	3.3														
		40		20.2	19.1	18.0	16.4	14.8	12.2	9.6	5.9	2.3															
		50	20.0	19.0	17.7	16.3	14.2	12.0	8.8	5.6	2.8																
		60	18.8	17.6	15.8	14.1	11.3	8.6	4.8																		
SHUT-OFF PSI:			123	115	106	97	89	80	71	63	54	45	37	28	19	11											
16S15-14	**1 1/2**	0								21.0	20.3	19.6	18.8	18.0	16.9	15.8	14.3	10.7	3.3								
		20							20.1	19.3	18.5	17.7	16.6	15.4	13.8	12.2	10.0	5.1									
		30					20.7	20.0	19.2	18.4	17.4	16.5	15.1	13.7	11.8	9.8	7.3	2.4									
		40				20.6	19.8	19.1	18.3	17.4	16.0	15.0	13.3	11.6	9.3	7.0	4.3										
		50			20.4	19.8	18.9	18.2	17.2	16.1	14.7	13.2	11.2	9.1	6.5	3.9	2.0										
		60		20.3	19.6	18.8	18.0	17.1	15.8	14.5	12.8	11.0	8.6	6.3	3.4												
SHUT-OFF PSI:				167	158	149	141	132	123	115	106	97	89	80	71	63	54	37	28								
16S20-18	**2**	0										21.2	20.6	20.0	19.5	18.9	18.2	16.7	13.5	8.8	2.7						
		20									20.4	19.8	19.3	18.7	18.0	17.3	16.4	14.3	10.0	4.2							
		30								20.3	19.8	19.2	18.6	17.9	17.2	16.3	15.3	12.8	7.9	1.9							
		40							20.3	19.7	19.1	18.5	17.8	17.1	16.1	15.2	13.9	11.1	5.7								
		50						20.2	19.6	19.0	18.3	17.7	16.8	16.0	14.9	13.8	12.3	9.2	3.2								
		60					20.1	19.5	18.9	18.3	17.5	16.8	15.8	14.8	13.5	12.3	10.6	7.0									
SHUT-OFF PSI:							194	186	177	168	160	151	142	134	125	116	108	90	65	39	13						
16S30-24	**3**	0																19.6	18.3	16.5	14.2	9.8	2.1				
		20													20.3	19.9	19.5	18.6	17.0	14.8	11.8	6.5					
		30												20.3	19.8	19.4	19.0	18.0	16.3	13.7	10.4	4.7					
		40											20.2	19.8	19.3	18.9	18.4	17.3	15.3	12.5	8.9	2.8					
		50										20.2	19.8	19.3	18.8	18.3	17.8	16.7	14.3	11.3	7.3						
		60									20.1	19.7	19.2	18.8	18.3	17.8	17.2	15.8	13.3	9.8	5.5						
SHUT-OFF PSI:											239	230	221	213	204	195	187	169	143	117	91	57	13				
16S50-38	**5**	0																			21.5	20.4	18.7	16.5	13.4	8.9	2.1
		20																			20.9	19.6	17.7	15.2	11.5	6.1	
		30																		21.4	20.5	19.2	17.2	14.5	10.5	4.5	
		40																		21.1	20.2	18.8	16.7	13.7	9.3	2.7	
		50																	21.6	20.7	19.8	18.4	16.1	12.8	8.0	0.8	
		60																	21.3	20.4	19.4	17.9	15.4	11.9	6.6		
SHUT-OFF PSI:																			314	288	262	227	184	141	98	54	11

See 16S performance curves for higher head models.
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

FLOW RANGE: 10 -20 GPM **OUTLET SIZE: 1¼ " NPT** **NOMINAL DIA. 4"**

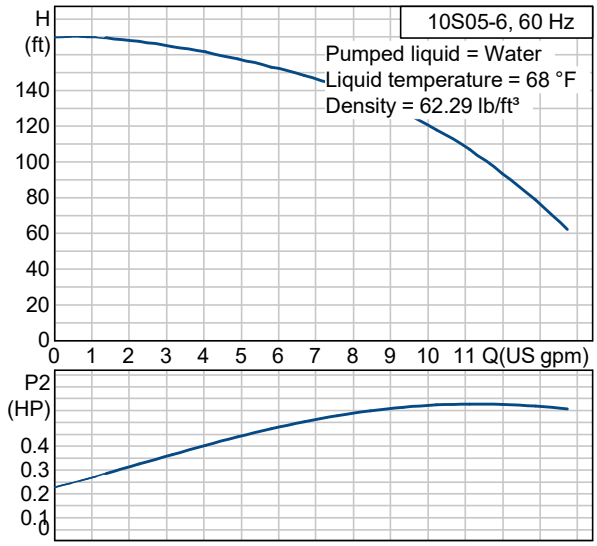


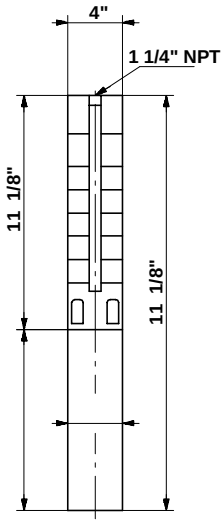
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, .5 -5 HP/3450 RPM.
6" MOTOR STANDARD,7.5 -10HP/3450 RPM.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 2 feet.

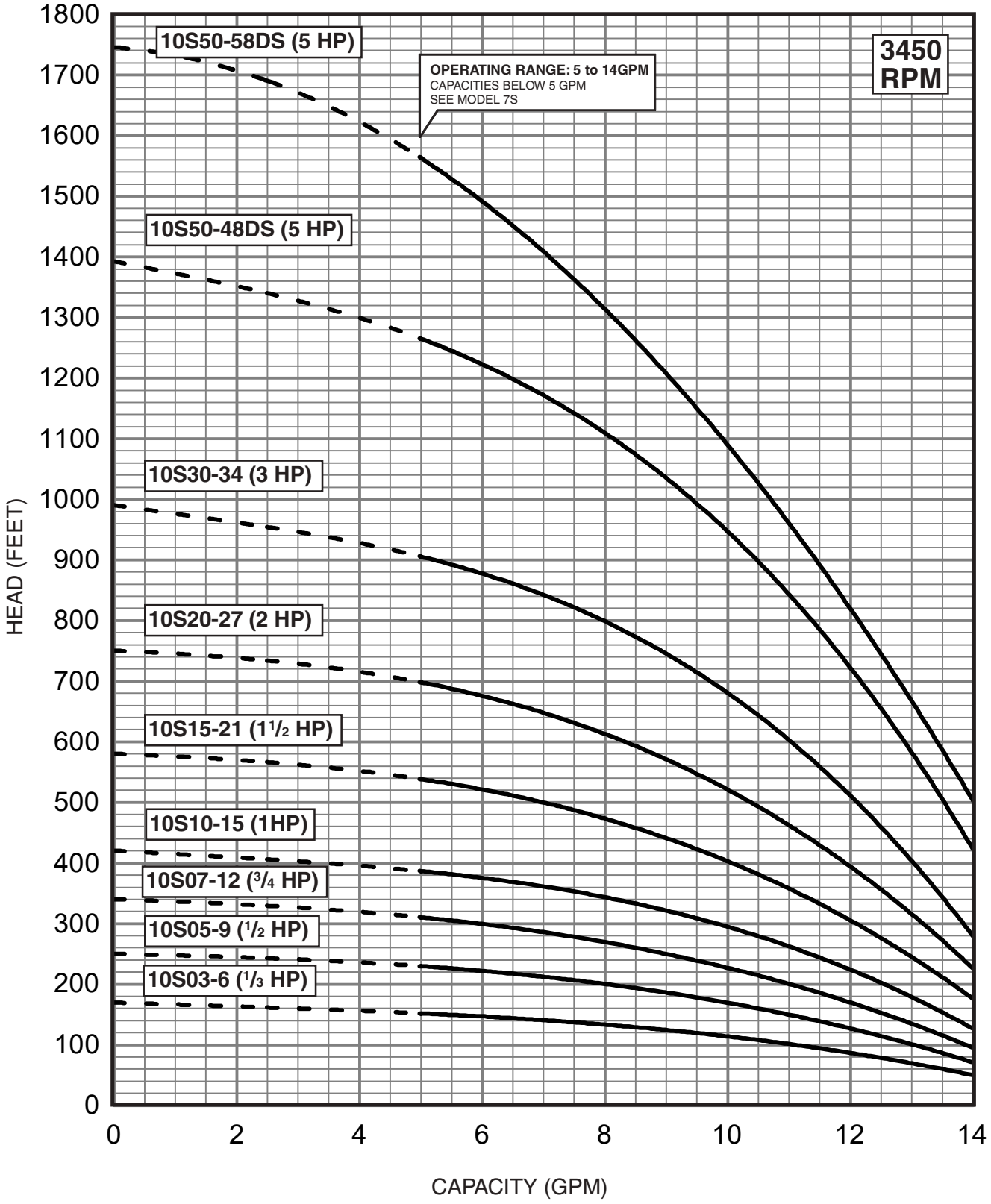
Company name: PexUniverse.com
Created by: PexUniverse.com
Phone: 800-818-3201
Fax: 800-818-3211
Date: 01/01/2011

Description	Value
Product name:	10S05-6
Product Number:	09010006
EAN number:	5700390279554
Technical:	
Speed for pump data	3450 rpm
Actual calculated flow:	8.81 US gpm
Flow range	1.36 .. 14 US gpm
Max flow:	14 US gpm
Resulting head of the pump:	133 ft
Stages:	6
Model:	B
Valve:	pump with built-in non-return valve
Materials:	
Pump:	Stainless steel
	DIN W.-Nr. 1.4301
	AISI 304
Impeller:	Stainless steel
	DIN W.-Nr. 1.4301
	AISI 304
Installation:	
Pump outlet:	1 1/4" NPT
Motor diameter:	4 inch
Liquid:	
Maximum liquid temperature:	104 °F
Liquid temp:	68 °F
Density:	998.2 kg/m³
Electrical data:	
Applic. motor:	GRUNDFOS
Power (P2) required by pump	0.496 HP
Main frequency:	60 Hz
Start. method:	direct-on-line
Others:	
Sales region:	Namreg





FLOW RANGE: 5 -14 GPM **OUTLET SIZE: 1¼ " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 3450 RPM.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 2 feet.

10 GPM

SELECTION CHARTS

(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE (5 TO 14 GPM)

PUMP OUTLET 1 1/4" NPT

			DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																							
PUMP MODEL	**HP**	**PSI**	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**340**	**400**	**460**	**520**	**600**	**700**	**800**	**900**	**1000**	**1100**
10S03-6	**1/3**	20	14.0	13.2	12.4	10.6	8.9	5.3																			
		30	13.2	11.8	10.4	8.4																					
		40	11.9	10.1	8.3																						
		50	9.8	7.5																							
		60	7.7	3.9																							
SHUT-OFF PSI:			64	55	47	38	29	21	12	3																	
10S05-9	**1/2**	0				14.1	13.4	12.4	11.4	10.4	9.5	8.3	6.6	3.5													
		20		13.9	13.1	12.1	11.1	10.1	9.2	7.9	5.8	2.0															
		30	13.8	13.0	12.0	11.0	10.0	9.0	7.6	5.3	1.2																
		40	12.8	11.8	10.8	9.8	8.8	7.3	4.8																		
		50	11.7	10.7	9.7	8.6	7.0	4.3																			
		60	10.5	9.5	8.4	6.7	3.7																				
SHUT-OFF PSI:			100	92	83	74	66	57	48	40	31	23	14	5													
10S07-12	**3/4**	0					14.3	13.8	13.2	12.5	11.7	11.0	10.2	9.5	8.7	7.6	6.0										
		20			14.2	13.6	12.9	12.2	11.5	10.7	10.0	9.3	8.4	7.2	5.4	2.6											
		30		14.1	13.5	12.9	12.1	11.4	10.6	9.9	9.2	8.2	7.0	5.0	2.0												
		40	14.0	13.4	12.8	12.0	11.3	10.5	9.8	9.0	8.1	6.7	4.7	1.4													
		50	13.3	12.6	11.9	11.1	10.4	9.7	8.9	7.9	6.5	4.2															
		60	12.5	11.8	11.0	10.3	9.6	8.8	7.7	6.2	3.8																
SHUT-OFF PSI:			137	129	120	111	103	94	85	77	68	59	51	42	33	25	16										
10S10-15	**1**	0							14.1	13.6	13.1	12.5	11.9	11.3	10.7	10.1	9.6	8.2	3.8								
		20					13.9	13.5	12.9	12.3	11.7	11.1	10.5	10.0	9.4	8.7	7.9	5.2									
		30				13.9	13.4	12.8	12.2	11.6	11.0	10.5	9.9	9.3	8.6	7.7	6.6	2.6									
		40		14.2	13.8	13.3	12.7	12.1	11.5	10.9	10.4	9.8	9.2	8.5	7.6	6.3	4.6										
		50	14.1	13.7	13.2	12.6	12.1	11.4	10.9	10.3	9.7	9.1	8.3	7.4	6.1	4.3	1.7										
		60	13.6	13.1	12.6	12.0	11.4	10.8	10.2	9.6	9.0	8.2	7.2	5.9	3.9												
SHUT-OFF PSI:			174	165	157	148	139	131	122	113	105	96	87	79	70	61	53	35	10								
10S15-21	**1 1/2**	0									14.2	13.9	13.6	13.3	12.9	12.5	12.0	11.2	9.9	8.5	6.3						
		20							14.1	13.9	13.5	13.1	12.7	12.3	11.9	11.5	11.0	10.2	8.9	6.9	2.9						
		30						14.1	13.8	13.5	13.1	12.7	12.3	11.8	11.4	11.0	10.5	9.7	8.3	5.7							
		40					14.1	13.8	13.4	13.0	12.6	12.2	11.8	11.3	10.9	10.5	10.1	9.2	7.5	4.1							
		50				14.0	13.7	13.3	13.0	12.5	12.1	11.7	11.3	10.8	10.4	10.0	9.6	8.7	6.5	2.0							
		60		14.2	14.0	13.6	13.3	12.9	12.5	12.1	11.6	11.2	10.8	10.4	9.9	9.5	9.1	8.0	5.1								
SHUT-OFF PSI:				237	229	220	211	203	194	185	177	168	159	151	142	133	125	107	81	55	29						
10S20-27	**2**	0												14.1	13.9	13.7	13.4	12.8	11.8	10.8	9.8	8.3	4.7				
		20										14.1	13.8	13.6	13.3	13.0	12.7	12.0	11.0	10.0	9.0	7.1	1.5				
		30									14.0	13.8	13.5	13.3	12.9	12.6	12.3	11.6	10.6	9.7	8.6	6.2					
		40							14.2	14.0	13.8	13.5	13.2	12.9	12.6	12.2	11.9	11.2	10.3	9.3	8.1	5.2					
		50						14.2	14.0	13.7	13.5	13.2	12.8	12.5	12.2	11.9	11.5	10.9	9.9	8.9	7.4	3.8					
		60					14.1	13.9	13.7	13.4	13.1	12.8	12.5	12.1	11.8	11.5	11.1	10.5	9.5	8.4	6.6	2.1					
SHUT-OFF PSI:							285	276	268	259	250	242	233	224	216	207	198	181	155	129	103	68	25				
10S30-34	**3**	0																13.8	13.2	12.5	11.9	10.9	9.6	7.9	4.8		
		20														13.9	13.7	13.3	12.7	12.0	11.3	10.3	8.9	6.7	2.7		
		30													13.9	13.7	13.5	13.1	12.4	11.7	11.0	10.0	8.5	6.0	1.3		
		40											14.0	13.8	13.7	13.5	13.3	12.8	12.2	11.5	10.8	9.7	8.0	5.1			
		50										14.0	13.8	13.6	13.4	13.2	13.0	12.6	11.9	11.2	10.5	9.4	7.5	4.2			
		60										13.8	13.6	13.4	13.2	13.0	12.8	12.3	11.6	10.9	10.2	9.0	6.9	3.1			
SHUT-OFF PSI:												332	324	315	306	298	289	272	246	220	194	159	116	73	29		

See 10S performance curves for higher head models.
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

Company name:	-
Created by:	-
Phone:	-
Fax:	-
Date:	-

Position	Count	Description
	1	**MS 402**

Product photo could vary from the actual product

Product No.: 79302002
The motor is a 3-phase motor of the canned type with a sand shield, liquid-lubricated bearings and pressure-equalizing diaphragm.

Liquid:
Max liquid temperature at 0.15 m/sec: 104 °F

Technical:

Shaft seal for motor:	LIPSEAL
Approvals on nameplate:	CE,GOST2,CSACOMP

Materials:

Motor:	Stainless steel DIN W.-Nr. 1.4301 AISI 304

Installation:

Maximum ambient pressure:	218 psi
Motor diameter:	4 inch

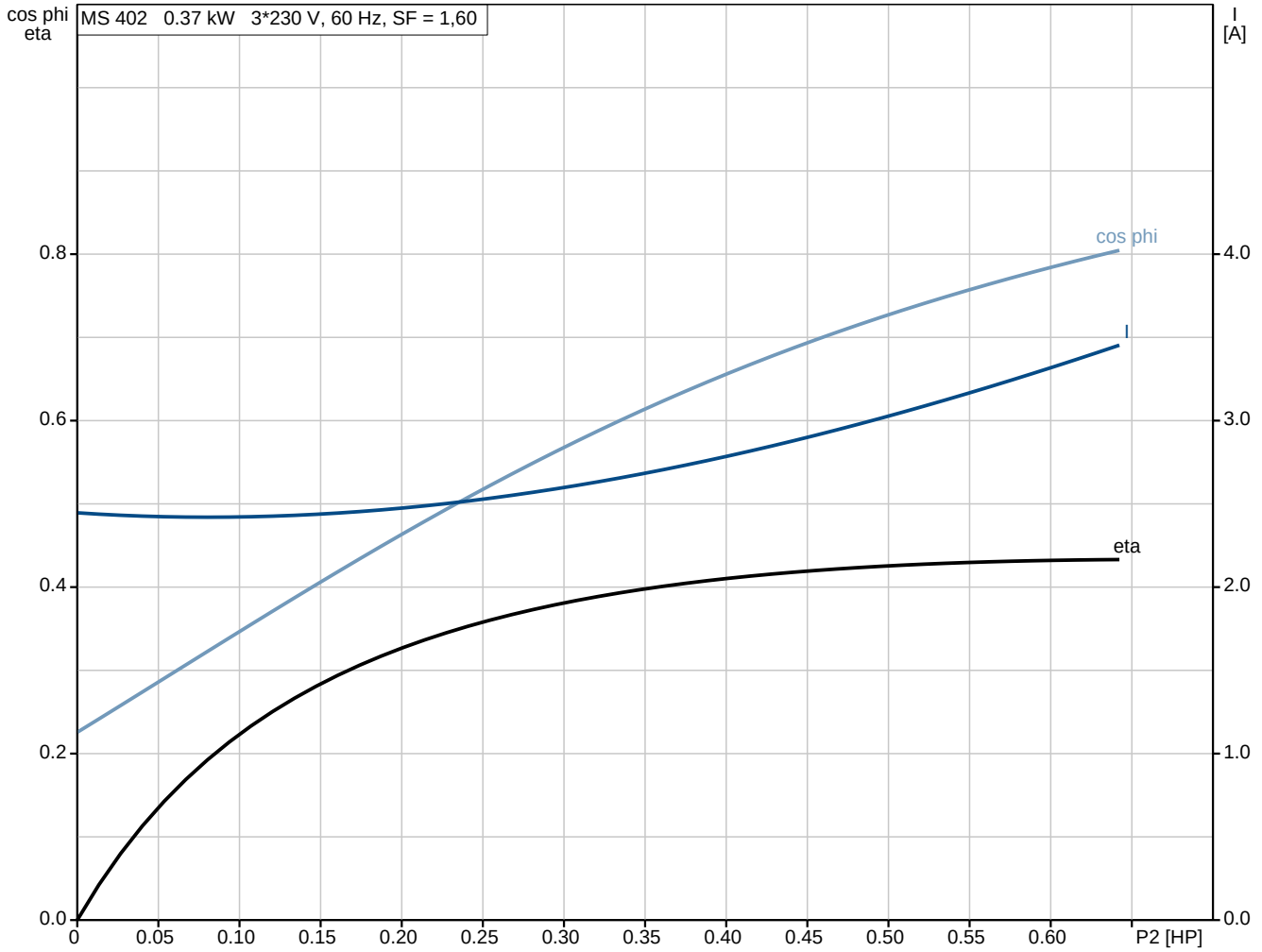
Electrical data:

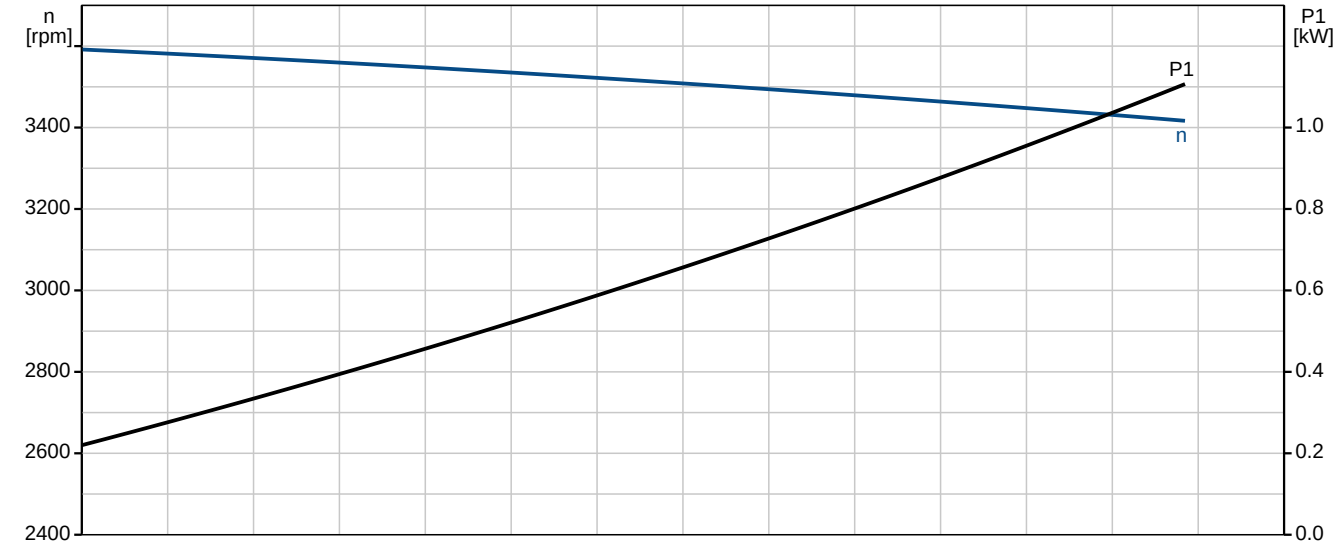
Motor type:	MS402
Rated power - P2:	0.5 HP
Main frequency:	60 Hz
Rated voltage:	3 x 230 V
Voltage tolerance:	+10/-10 %
Start. method:	direct-on-line
Service factor:	1,60
Rated current:	3.15 A
Starting current:	460 %
Cos phi - power factor:	0,72
Rated speed:	3450 rpm
Locked-rotor torque:	230 %
Moment of inertia:	0.008 lb ft²
Enclosure class (IEC 34-5):	IP68
Insulation class (IEC 85):	B

Position	Count	Description
		Built-in temperature transmitter: No

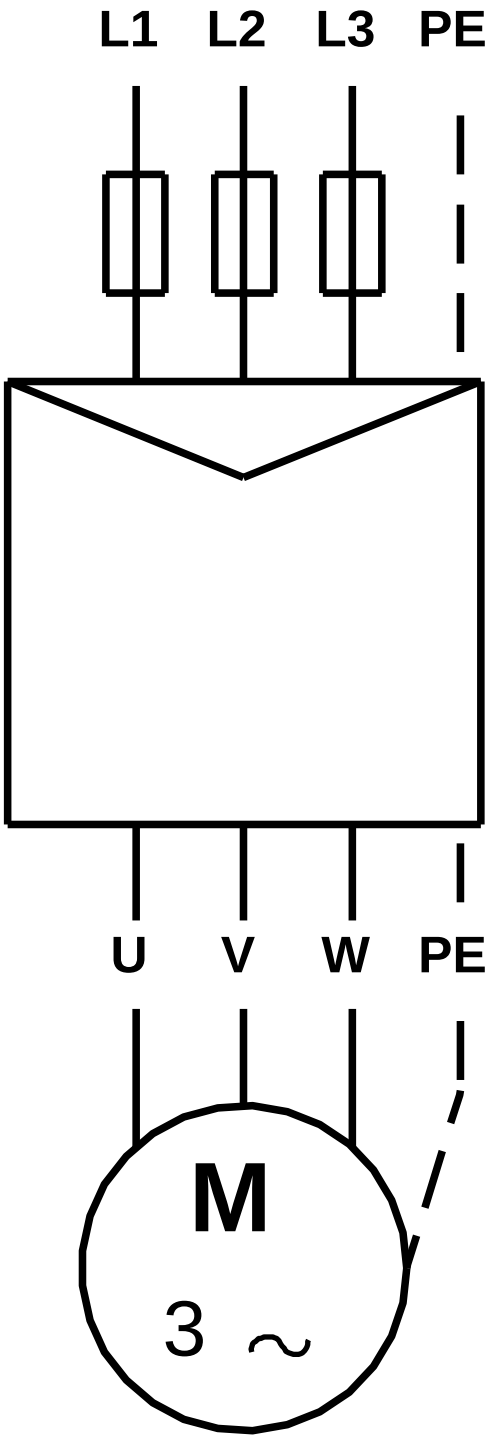
Company name:	-
Created by:	-
Phone:	-
Fax:	-
Date:	-

79302002 MS 402 60 Hz





79302002 MS 402 60 Hz



All units are [mm] unless otherwise presented.

Ordering data

79302002 MS 402 60 Hz **Product No.: 79302002**

Company name:	-	Date:	-
Created by:	- Phone: -	Fax:	-
Project:	-	Client number:	-
Contact:	-	Reference number:	-

Electrical data:

Frequency		60 Hz
Rated motor voltage		230 V
Rated motor power		0.5 HP
Rated motor speed		3450 rpm
Rated motor torque	-	-
Wiring connection	-	-
Rated motor current		3.15 A
Max motor current	-	-
Efficiency class	-	-
Full load Efficiency %	-	-
Power factor		0,72
Starting- / Rated motor current (50/60)		/
Breakdown- / Rated motor torque (50/60)		/ %
Starting- / Rated motor torque (50/60)		/

Mechanical data:

Noise measurements (50/60)	-	-
Moment of inertia		0.008 lb ft²
Drain holes		Yes (closed)
Bearing DE		-
Bearing NDE		-
Bearing arrangement		NDE-locked
Type of bearing DE		-
Bearing seal DE		-
Characteristic of grease DE		-
Type of bearing NDE		-
Bearing seal NDE		-
Characteristic of grease NDE		-
Regreasing device		No
Type of lubrication		-
Relubrication interval		-
Quantity of grease for relubrication		-
External grounding		-
Color/type		-

Explosion protection:

Type of protection	-

Ambient conditions:

Ambient temperature	
Altitude above sea level	3280 ft
Approvals and specifications	IEC 60034

General data:

Frame size	MS402
Type of construction	-
Weight, without optional accessories	-
Frame material	-
Degree of protection	IP IP68
Method of cooling, TEFC	-
Vibration class	
Insulation class	155(F) to 130(B)
Duty type	-
Direction of rotation	/

Terminal box:

Material of terminal box	-
Cable entry	-
Cable gland	-

Protection:

Built-in protection	-

Grundfos A/S reserves the right to change the specifications without further notice. Grundfos A/S cannot be held responsible for any missing, inaccurate or obsolete data. There may be discrepancies between calculated and rating plate values.

Submittal Data

PROJECT:	_____	UNIT TAG:	_____	QUANTITY:	_____
	_____	TYPE OF SERVICE:	_____		_____
REPRESENTATIVE:	_____	SUBMITTED BY:	_____	DATE:	_____
ENGINEER:	_____	APPROVED BY:	_____	DATE:	_____
CONTRACTOR:	_____	ORDER NO.:	_____	DATE:	_____

Product photo could vary from the actual product

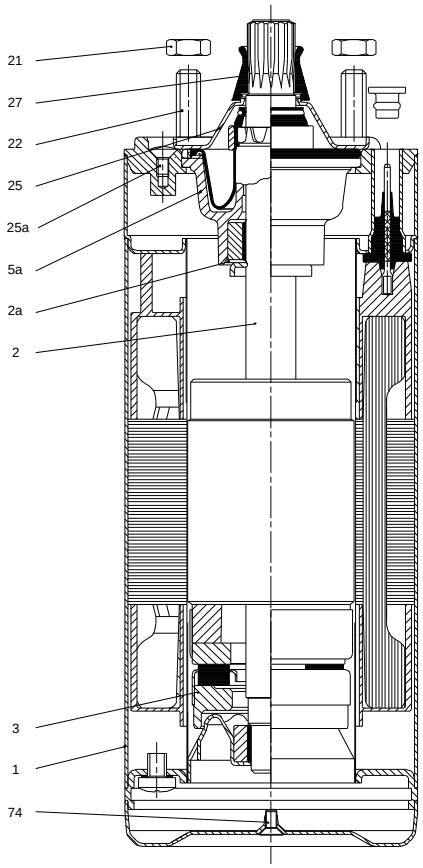
MS 402

Submersible motors

Conditions of Service	
Flow:	_____
Head:	_____
Efficiency:	_____
Liquid:	_____
Temperature:	_____
NPSH required:	_____
Viscosity:	_____
Specific Gravity:	_____

Pump Data	
Approvals:	CE,EAC,CSACOMP
Product number:	79302002

Motor Data	
Rated power - P2:	0.5 HP
Rated voltage:	230 V
Main frequency:	60 Hz
Enclosure class:	IP68
Insulation class:	B
Motor protection:	NONE
Thermal protection:	external
Motor type:	MS402



Materials:

Motor: Stainless steel
DIN W.-Nr. 1.4301
AISI 304

Company name:
Created by:
Phone:

Date: 1/5/2016

Position	Count	Description
	1	**MS 402**

Product photo could vary from the actual product

Product No.: 79302002
The motor is a 3-phase motor of the canned type with a sand shield, liquid-lubricated bearings and pressure-equalizing diaphragm.

Liquid:
Max liquid temperature at 0.15 m/sec: 104 °F

Technical:

Shaft seal for motor:	LIPSEAL
Approvals on nameplate:	CE,EAC,CSACOMP
Motor version:	T40

Materials:

Motor:	Stainless steel DIN W.-Nr. 1.4301 AISI 304

Installation:

Maximum ambient pressure:	218 psi
Motor diameter:	4 inch

Electrical data:

Motor type:	MS402
Maximum current consumption:	3.15 A
Rated power - P2:	0.5 HP
Main frequency:	60 Hz
Rated voltage:	3 x 230 V
Voltage tolerance:	+10/-10 %
Start. method:	direct-on-line
Service factor:	1,60
Rated current:	3.15 A
Starting current:	460 %
Cos phi - power factor:	0,72
Rated speed:	3450 rpm
Locked-rotor torque:	230 %
Moment of inertia:	0.008 lb ft²
Enclosure class (IEC 34-5):	IP68
Insulation class (IEC 85):	B
Built-in temperature transmitter:	No
Winding resistance:	8,10 ohm

Company name:
Created by:
Phone:

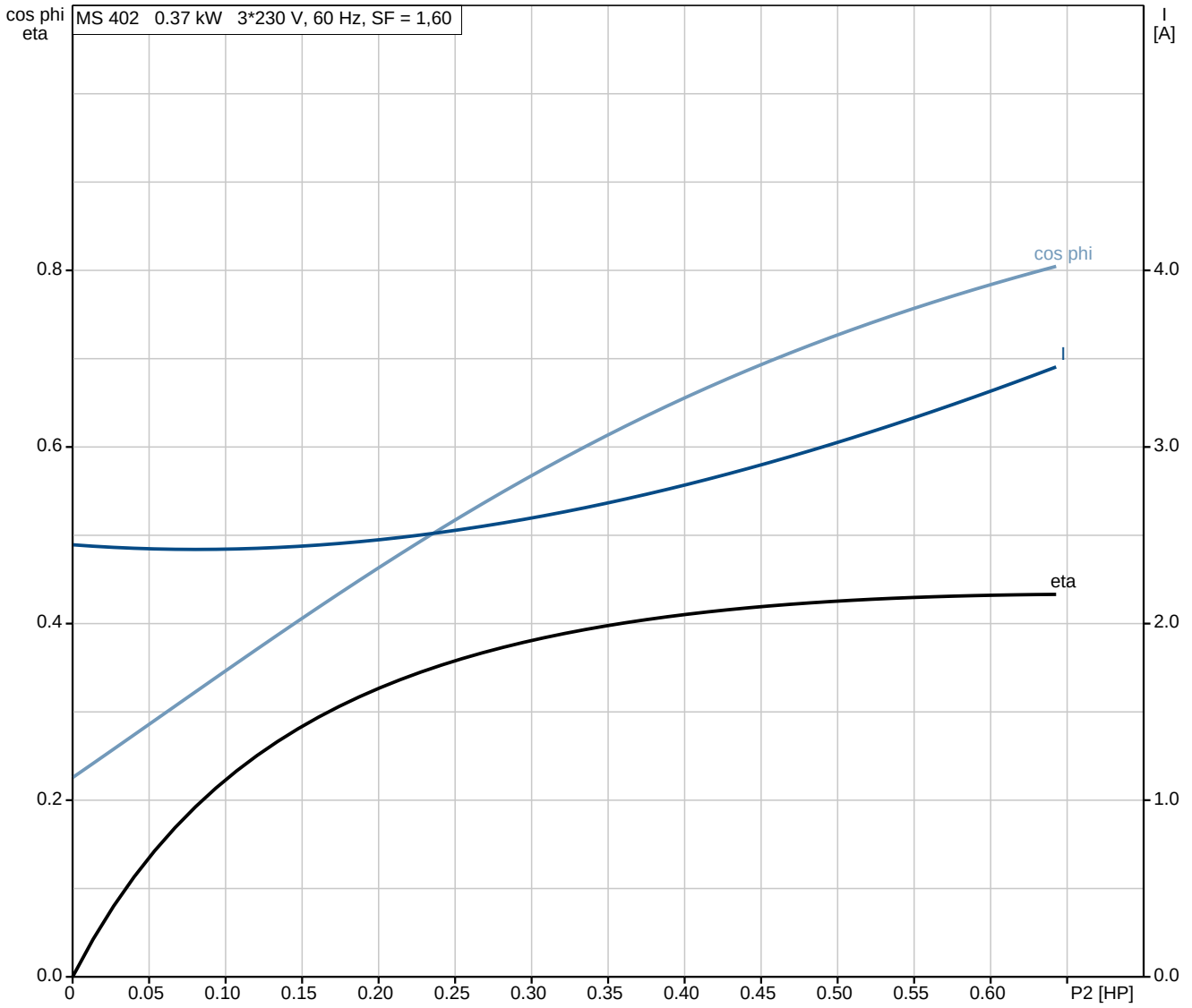
Date: 1/5/2016

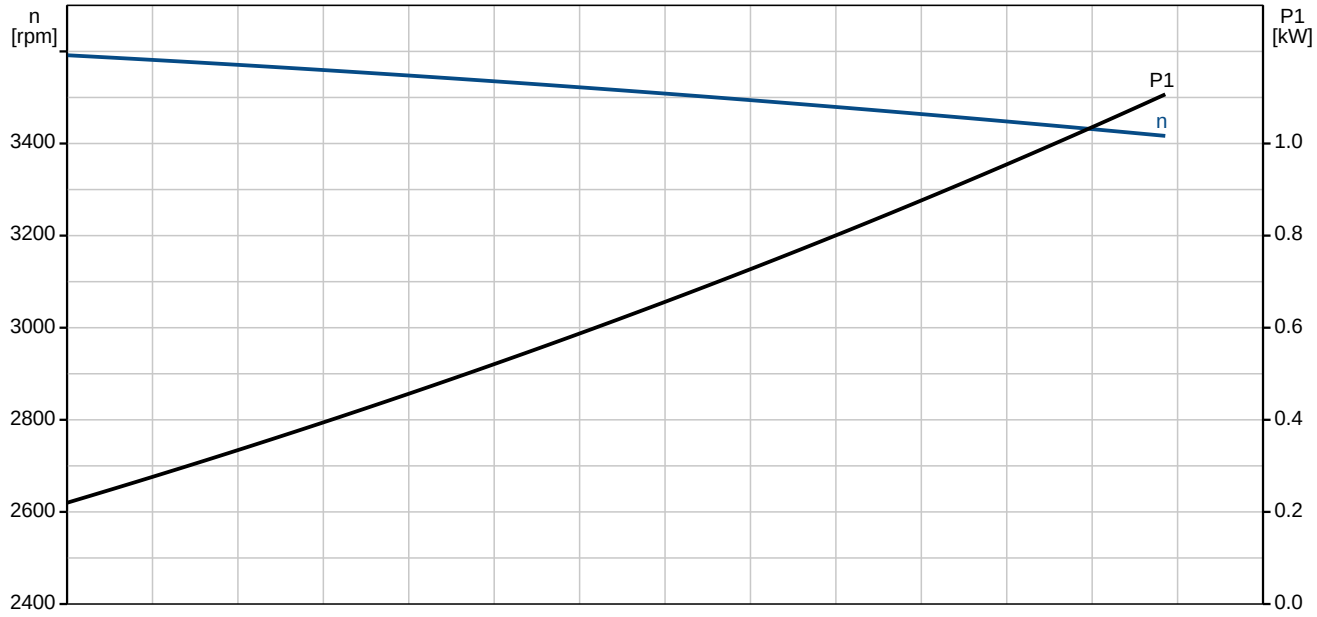
Description	Value
General information:	
Product name:	MS 402
Product No.:	79302002
EAN:	5700390655136
Price:	On request
Technical:	
Shaft seal for motor:	LIPSEAL
Approvals on nameplate:	CE,EAC,CSACOMP
Model:	B
Motor version:	T40
Materials:	
Motor:	Stainless steel
	DIN W.-Nr. 1.4301
	AISI 304
Installation:	
Maximum ambient pressure:	218 psi
Motor diameter:	4 inch
Staybolt:	5/16-24 UNF
Liquid:	
Max liquid temperature at 0.15 m/sec:	104 °F
Electrical data:	
Motor type:	MS402
Maximum current consumption:	3.15 A
Rated power - P2:	0.5 HP
KVA code:	N
Main frequency:	60 Hz
Rated voltage:	3 x 230 V
Voltage tolerance:	+10/-10 %
Start. method:	direct-on-line
Service factor:	1,60
Rated current:	3.15 A
Starting current:	460 %
Cos phi - power factor:	0,72
Rated speed:	3450 rpm
Locked-rotor torque:	230 %
Moment of inertia:	0.008 lb ft²
Axial load max:	772 lb
Enclosure class (IEC 34-5):	IP68
Insulation class (IEC 85):	B
Motor protection:	NONE
Thermal protec:	external
Built-in temperature transmitter:	No
Winding resistance	8,10 ohm

Company name:
Created by:
Phone:

Date: 1/5/2016

79302002 MS 402 60 Hz

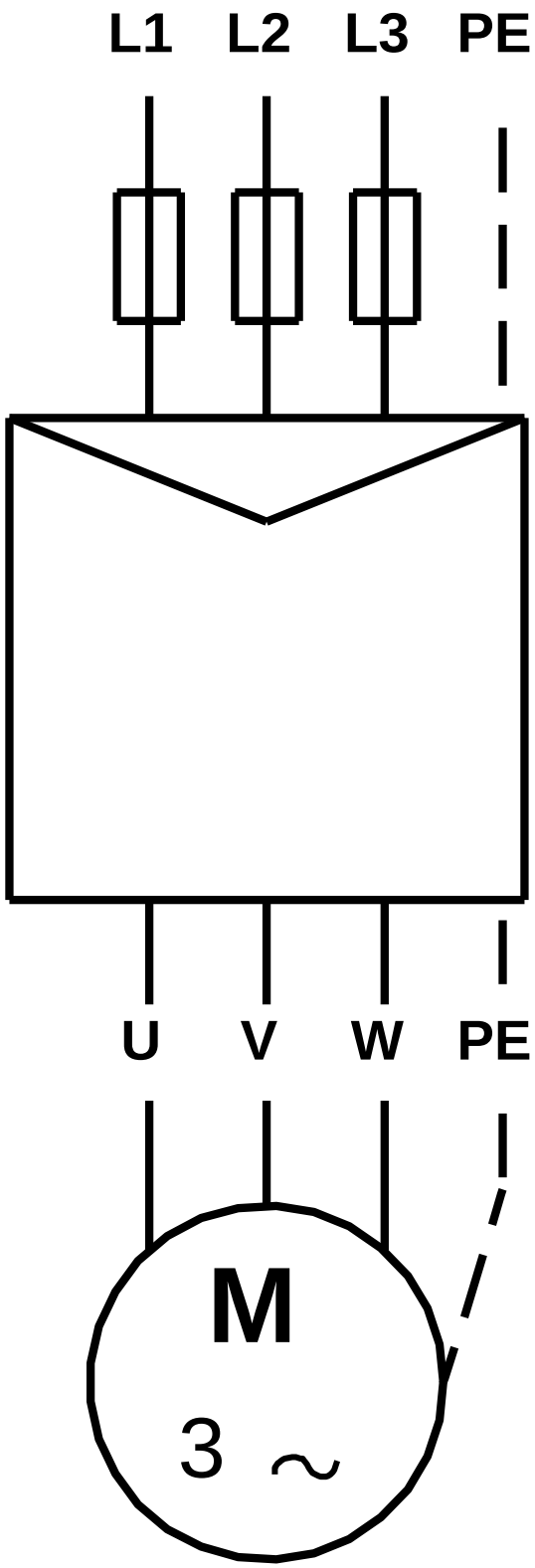




Company name:
Created by:
Phone:

Date: 1/5/2016

79302002 MS 402 60 Hz



All units are [mm] unless otherwise presented.

Ordering data

79302002 MS 402 60 Hz **Product No.: 79302002**

Company name: Date: 1/5/2016
Created by: Phone: Fax:

Project: Client number:
Contact: Reference number:

Electrical data:

Frequency		60 Hz
Rated motor voltage		230 V
Rated motor power		0.5 HP
Rated motor speed		3450 rpm
Rated motor torque	-	-
Wiring connection	-	-
Rated motor current		3.15 A
Max motor current		3.15 A
Efficiency class	-	-
Full load Efficiency %	-	-
Power factor		0,72
Starting- / Rated motor current (50/60)		/
Breakdown- / Rated motor torque (50/60)		/ %
Starting- / Rated motor torque (50/60)		/

Mechanical data:

Noise measurements (50/60)	-	-
Moment of inertia	0.008 lb ft²	
Drain holes	Yes (closed)	
Bearing DE	-	
Bearing NDE	-	
Bearing arrangement	NDE-locked	
Type of bearing DE	-	
Bearing seal DE	-	
Characteristic of grease DE	-	
Type of bearing NDE	-	
Bearing seal NDE	-	
Characteristic of grease NDE	-	
Regreasing device	No	
Type of lubrication	-	
Relubrication interval	-	
Quantity of grease for relubrication	-	
External grounding	-	
Color/type	-	

Explosion protection:

Type of protection	-

Ambient conditions:

Ambient temperature	
Altitude above sea level	3281 ft
Approvals and specifications	IEC 60034

General data:

Frame size	MS402
Type of construction	-
Weight, without optional accessories	-
Frame material	-
Degree of protection	IP IP68
Method of cooling, TEFC	-
Vibration class	
Insulation class	155(F) to 130(B)
Duty type	-
Direction of rotation	/

Terminal box:

Material of terminal box	-
Cable entry	-
Cable gland	-

Protection:

Built-in protection	-

Grundfos A/S reserves the right to change the specifications without further notice. Grundfos A/S cannot be held responsible for any missing, inaccurate or obsolete data. There may be discrepancies between calculated and rating plate values.

Company name:
Created by:
Phone:

Date: 1/5/2016

Order Data:

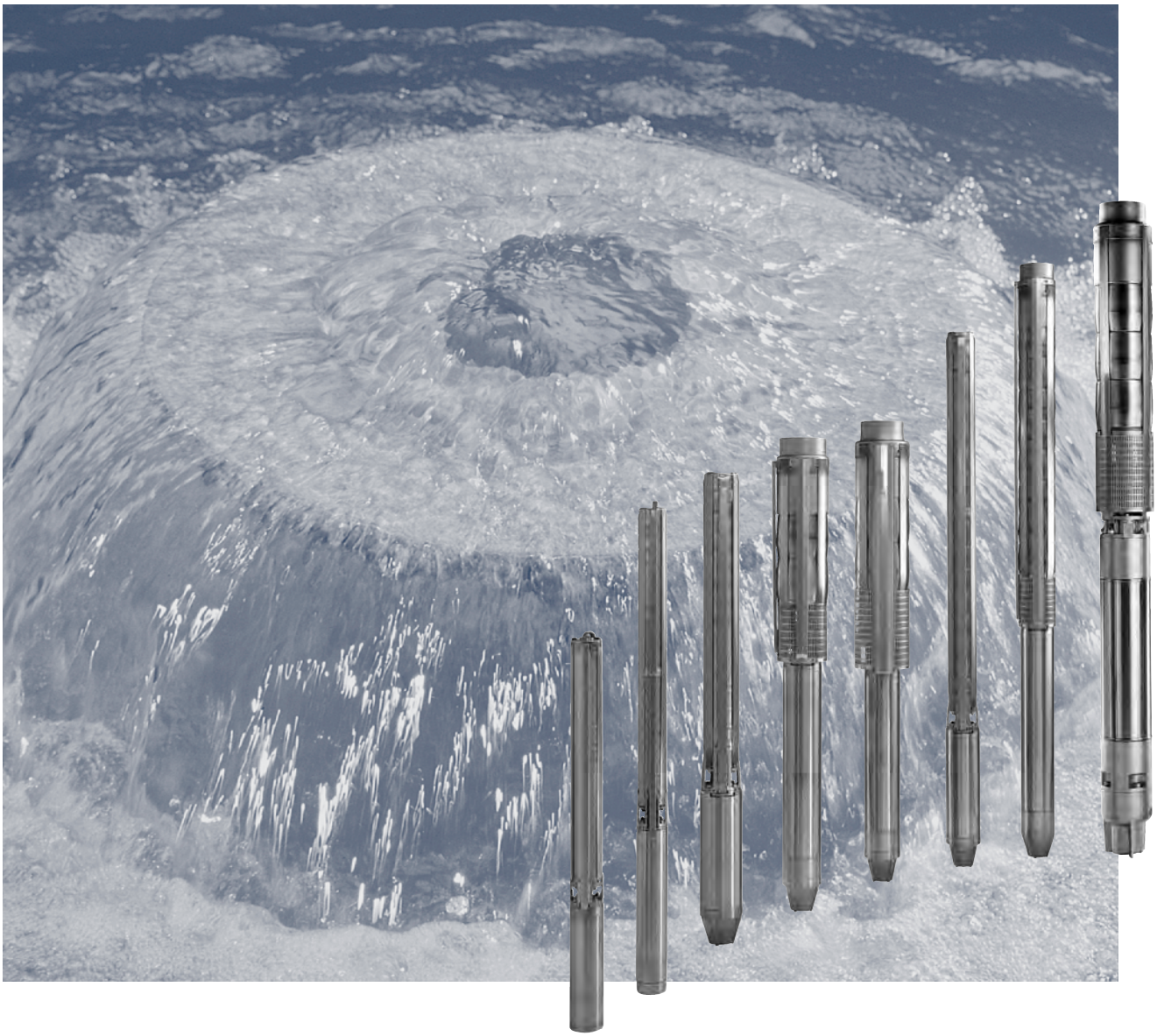
Product name:	MS 402
Amount:	1
Product No.:	79302002
Price:	On request

Total: Price on request

GRUNDFOS **PRODUCT GUIDE**

SP

Submersible pumps, motors, and accessories
60 Hz



BE > THINK > INNOVATE >

GRUNDFOS

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1. Product introduction

Introduction

The Grundfos SP range of submersible pumps is renowned for high efficiency and reliability. Made entirely of corrosion resistant stainless steel, SP pumps are ideal for a wide variety of applications.

Grundfos SP pumps represent state-of-the-art hydraulic design. Built to deliver optimum efficiency during periods of high demand, SP pumps provide low long-term costs and high operating reliability regardless of the application.

The SP range offers high efficiency, high resistance to sand and other abrasives, motor burnout protection, and easy maintenance. A complete monitoring and control system is available for constant optimization of the pumping system.

TM05 0051 0611

Fig. 1 Grundfos SP pumps

Applications

Grundfos Large SP submersible pumps are suitable for:

- Groundwater supply to waterworks
- Irrigation in horticulture and agriculture
- Groundwater lowering (dewatering)
- Pressure boosting
- Industrial applications
- Domestic water supply.

Pumped liquids

Grundfos SP pumps are suitable for pumping clean, thin, non-aggressive liquids without solid particles or fibers.

SP offers stainless steel construction which ensures good wear resistance and a reduced risk of corrosion where the water has minor chloride content.

Optional, upgraded stainless steel construction is available for pumping more aggressive liquids:

A complete range of zinc anodes for cathodic protection is available; see p. 97 for applications (for example, sea water applications).

For slightly polluted liquids (for example, containing oil), Grundfos offers a complete range of stainless steel SP NE pumps with all rubber parts made of FKM.

Features and benefits

Grundfos SP submersible pumps offer these features and benefits:

- State-of-the-art hydraulics provide high efficiency and low operating costs
- 100 % stainless steel components inside and outside for long service life
- Sand resistant
- Resistant to aggressive water
- Motor burnout protection via CU 301
- Dry-running protection
- Monitoring, protection and communication via protection unit MP204, and remote control, R100.

A wide pump range

Grundfos offers energy-efficient SP submersible pumps with a performance range of up to 1,400 gpm and 2,100 ft of head.

The pump range consists of many pump sizes, and each pump size is available with an optional number of stages to match any duty point.

High pump efficiency

Often pump efficiency is given less consideration than the price of a pump; however, owners who choose efficiency will find substantial savings in energy costs over time. See fig. 2 for an illustration of SP efficiencies in relation to flow.

Example

For example, a pump and motor with a 10 % higher efficiency than a cheaper, less efficient pump, can save its owner more than $80,000.00 over 10 years*.

* If producing 880 gpm at 325 ft of head for 10 years @ 13.8 cents per kWh. U.S. kWh costs range from 6 cents to more than 20 cents, depending on region.

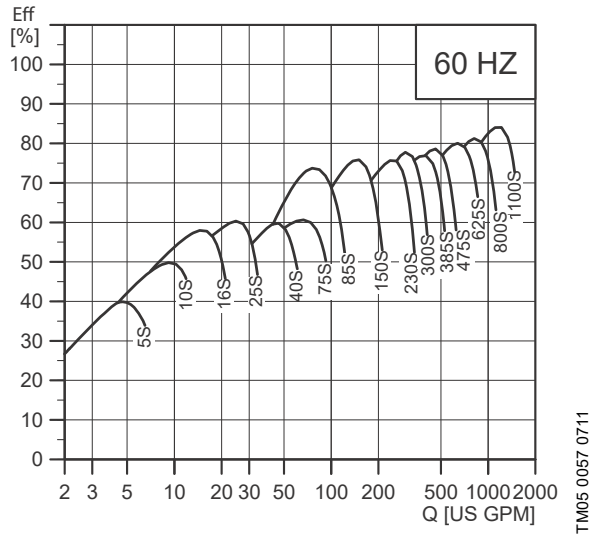


Fig. 2 SP pump/motor efficiencies in relation to flow

Pump design

Grundfos SP submersible pumps feature components that contribute to the superior performance and durability of the range.

Lower installation costs

Stainless steel means low weight for ease in the handling of pumps, resulting in lower equipment costs and reduced installation and service time.

Bearings with sand channels

All bearings are water-lubricated and have a squared shape enabling sand particles, if any, to leave the pump together with the pumped liquid.

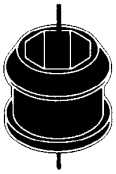


Fig. 3 Bearing

Inlet strainer

The inlet strainer prevents particles over a certain size from entering the pump.

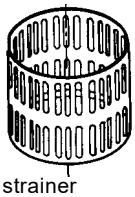


Fig. 4 Fig. Inlet strainer

Non-return valve

All pumps are equipped with a reliable check valve in the valve casing preventing back flow in connection with pump stoppage.

Furthermore, the short closing time of the check valve means that the risk of destructive water hammer is reduced to a minimum.

The valve casing is designed for optimum hydraulic properties to minimize the pressure loss across the valve and thus to contribute to the high efficiency of the pump.

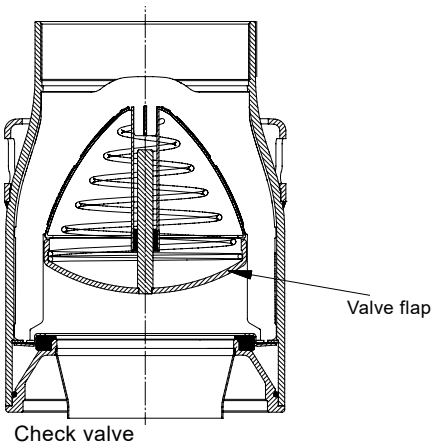


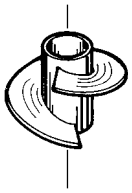
Fig. 5 Check valve

Priming screw

All Grundfos 4" pumps are fitted with a priming screw. Consequently, dry running is prevented, because the priming screw will make sure that pump bearings are always lubricated.

Due to the semi-axial impellers of large SP pumps this priming is provided automatically.

However, it applies to all pump types that if the water table is lowered to a level below the pump inlet neither pump nor motor will be protected against dry running.



TM00 7304 1096

Fig. 6 Priming screw

Stop ring

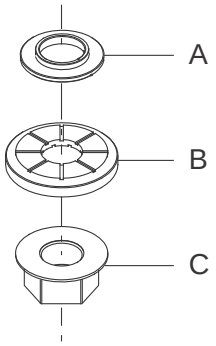
The stop ring prevents damage to the pump during transport and in case of up-thrust in connection with start-up.

The stop ring, which is designed as a thrust bearing, limits axial movements of the pump shaft.

Example: SP 385S

The stationary part of the stop ring (A) is secured in the upper intermediate chamber.

The rotating part (B) is fitted above the split cone (C).



TM01 3327 0412

Fig. 7 Stop ring (rotating and stationary part) and the split cone

Grundfos submersible motors

A complete motor range

Grundfos offers a complete submersible motor range in different voltages. For an overview of motor types, sizes and voltages, see page 85.

MS 402 is designed for the domestic ground water market and covers outputs. The MS 4000 and MS6 series are designed for use in a variety of applications in water supply. When equipped with features like oversized motor, temperature measurement, cooling jacket, and SiC/SiC mechanical shaft seals, these motors are suitable for heavy-duty industrial applications such as dewatering operations.

As a standard, all external surfaces of the Grundfos MS motors in contact with water are made of AISI 304 stainless steel. For aggressive water, such as seawater or brackish water, R-versions made of AISI 904 are available.

Grundfos rewindable MMS motor range

Grundfos MMS motors are suitable for any submersible installation, including heavy-duty industrial applications and dewatering operations (when equipped with temperature control, oversized motor, cooling jacket, and SiC/ SiC mechanical shaft seals).

As a standard the MMS motors are supplied with black cast-iron end-bells. Optionally, the range is available in all-stainless steel AISI 316 or AISI 904 versions.

The 2-pole Grundfos MMS submersible motors are all easy to rewind. The windings of the stator are made of a special water-proof wire of pure electrolytic copper sheathed with special non-hydroscopic thermoplastic material. The fine dielectric properties of this material allow direct contact between the windings and the liquid for efficient cooling of the windings.

TM00 7305 1096 - GrA4011 - GrA4013

Fig. 8 Grundfos MS motors

TM01 7873 4799

Fig. 9 Grundfos MMS motors

Industrial submersible motors and MS6 T60-versions

For heavy-duty applications Grundfos offers a complete motor range of industrial motors with up to 5 % higher efficiency than that of Grundfos' standard motors. The industrial motors are available in sizes as from 3 Hp up to 30 Hp.

The cooling of the motor is very efficient due to the large motor surface. The efficient cooling makes it possible to increase the liquid temperature to 140 °F (60 °C) at a minimum flow of 0.49 ft/s (0.15 m/s) past the motor.

The industrial motors are for customers who value low operating costs and long life higher than price.

Grundfos industrial motors are developed for difficult operating conditions. These motors will stand a higher thermal load than standard motors and thus have a longer life when subjected to high load. This applies whether the high load is caused by bad power supply, hot water, bad cooling conditions, high pump load etc.

Please note that heavy duty motors are longer than motors for standard conditions.

Overtemperature protection

Accessories for protection against overtemperature are available for both Grundfos MS and MMS submersible motors. When the temperature becomes too high, the protection device will cut out and damage to the pump and motor be avoided.

Restart of the motor after cut-out can be achieved in two ways:

- manual restart
- automatic restart.

Automatic restart means that the MP 204 attempts to restart the motor after 15 minutes. If the first attempt is not successful, restarting will be reattempted at 30-minute intervals.

MS

The Grundfos MS submersible motors (with the exception of MS 402) are available with a built-in Tempcon temperature transmitter for protection against overtemperature. By means of the transmitter, it is possible to read out and/or monitor the motor temperature via an MP 204 or a PR 5714 relay.

The Grundfos MS6 submersible motors can be fitted with a Pt100. The Pt100 is fitted in the motor and connected directly to the MP 204 or monitored by the PR 5714 relay.

MMS

For the protection of the Grundfos MMS submersible motors against overtemperature Grundfos offers the Pt100 temperature sensor as an optional extra.

The Pt100 is fitted in the motor and connected directly to the MP 204 or monitored by the PR 5714 relay.

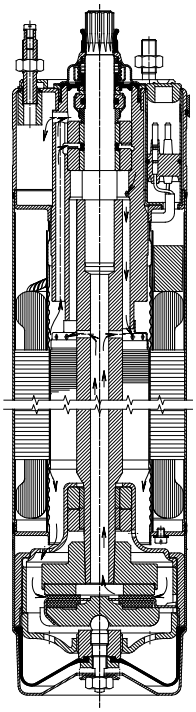
Protection against upthrust

In case of a very low counter pressure in connection with start-up there is a risk that the entire chamber stack may rise. This is called upthrust. Upthrust may damage both pump and motor. Both Grundfos pumps and motors are protected against upthrust as standard, preventing upthrust from occurring during the critical start-up phase. The protection consists of either a built-in stop ring or hydraulic balancing.

Built-in cooling chambers

In all Grundfos MS submersible motors, efficient cooling is ensured by cooling chambers at the top and at the bottom of the motor, and by an internal circulation of motor liquid.

See fig. 10. As long as the required flow velocity past the motor is maintained, cooling of the motor will be efficient.



TM00 5698 0996

Fig. 10 MS 4000

Lightning protection

The smallest Grundfos submersible motors, such as the MS 402, are all insulated in order to minimize the risk of motor burnout caused by lightning strike.

Reduced risk of short-circuit

The embedded stator winding in the Grundfos MS submersible motor is hermetically enclosed in stainless steel. The result is high mechanical stability and optimum cooling. Also, this eliminates the risk of short-circuit of the windings caused by water condensation.

Shaft seal

MS 402

The shaft seal is of the lip seal type characterized by low friction against the rotor shaft.

The rubber material offers good wear resistance, good elasticity and resistance to particles, and it is approved for use in drinking water.

MS 4000, MS6

The material is ceramic/tungsten carbide providing optimum sealing, optimum wear resistance and long life.

The spring loaded shaft seal is designed with a large surface and a sand shield. The result is a minimum exchange of pumped and motor liquids and no penetration of particles.

Motors, version R, are supplied with a SiC/SiC shaft seal. Other combinations are available request. See fig. 11 and fig. 12 for an illustration of shaft seal components and configuration.

MMS rewindable motors

The standard shaft seal is a ceramic/carbon mechanical shaft seal. The shaft seal is replaceable.

The material features good wear resistance and resistance to particles.

Together with the shaft seal housing, the sand shield forms a labyrinth seal, which during normal operating conditions prevents penetration of sand particles into the shaft seal.

On request, motors can be supplied with a SiC/SiC seal.

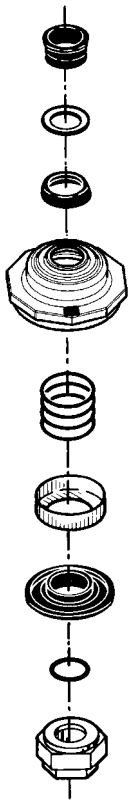


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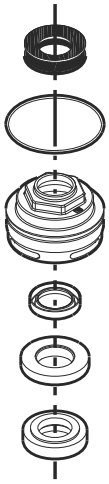
Fig. 11 Shaft seal, MS 4000



TM03 9225 3607

Fig. 12 Shaft seal, MS6

Identification

Type key, SP pumps

Example	475	S	500	-	5	-	A	B
Rated flow rate in gpm								
Type range Stainless steel parts of material S= AISI 304 N= AISI 316 R= AISI 904L								
Hp of motor								
Number of impellers								
First reduced-diameter impeller (A, B or C)								
Second reduced-diameter impeller (A, B or C)								

Type key, MS 4000 motors

Example	MS	4	000	R
Motor submersible				
Min. borehole diameter in inches				
Generation				
- = Stainless steel AISI 304 R = Stainless steel AISI 904L I = Stainless steel AISI 304 + De-rated RE = Stainless steel AISI 904 L + FKM EI = Stainless steel AISI 304 + De-rated + FKM				

Type key, MS 402 motors

Example	MS	4	02
Motor submersible			
Min. borehole diameter in inches			
Generation			
- = Stainless steel AISI 304			

Type key, MMS motors

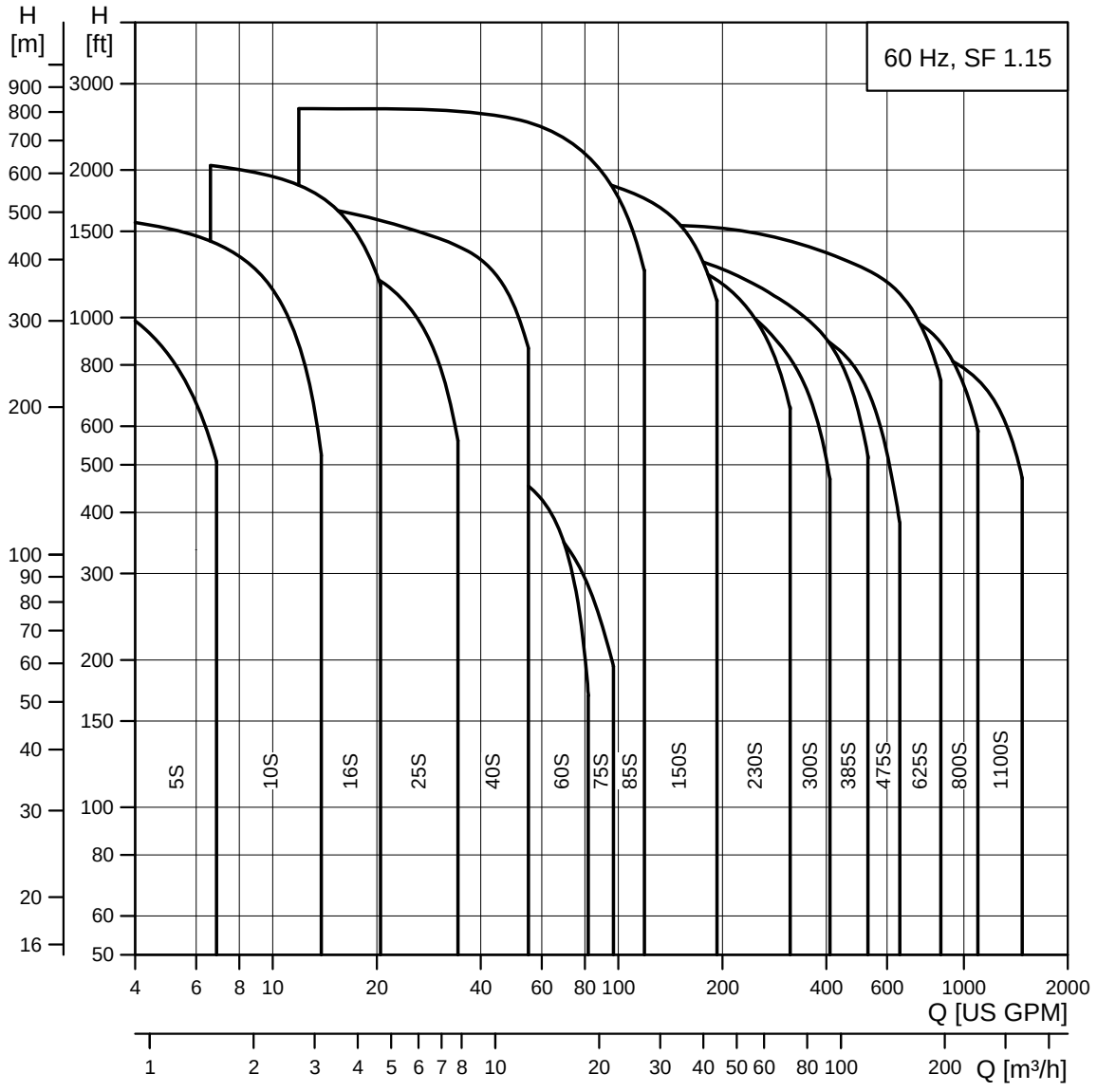
Example	MMS	6	000	N
Type range				
Min. borehole diameter in inches				
Generation				
Material: = Cast iron EN-JL1040 N = DIN/EN 1.4401 (AISI 316)				

Type key, MS6 motors

Example	MS	6	R	E	S	W	D	T60
Type range (**M**otor **S**ubmersible)								
Motor diameter in inches								
Material • Blank = stainless steel EN 1.4301 (AISI 304) • R = stainless steel EN 1.4539 (AISI 904L)								
Rubber parts • Blank = NBR • E = FKM								
Shaft seal • Blank = ceramics/carbon • S = SiC/SiC								
Radial bearings • Blank = carbon/stainless steel • W = SiC/tungsten carbide								
Motor liquid • Blank = SML-3 • D = demineralized water								
Maximum liquid temperature • T30 = 86 °F (30 °C) • T60 = 140 °F (60 °C)								

2. Product overview

Performance range 60 Hz



TM05 0056 0112

Pump range

Type		5S	10S	16S	25S	40S	60S	75S	85S	150S	230S	300S	385S	475S	625S	800S	1100S
AISI 304 stainless steel		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
AISI 316 stainless steel				●	●	●		●	●	●	●	●	●	●	●	●	●
AISI 904L stainless steel					●	●			●	●	●	●	●	●	●	●	●
Connection ★	NPT	1"	1.25"	1.25"	1.5"	2"	2"	2"	(3")	(3")	3" (4")	3" 4"	5"	5"	6"	6"	6"
Flange connection: Grundfos flange													5"	5"	6"	6"	6"

★ Figures in brackets ( ) indicate connection for pumps with sleeve.

Motor range

Motor output [hp]	0.5	0.75	1.0	1.5	1.5	3.0	5.0	7.5	10.0	15	20	25	30	40	50	60	75	100	125	150	175	200	250
Single-phase	●	●	●	●	●	●																	
Three-phase	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Industrial motor and MS6 T60-versions						●	●	●	●	●	●	●	●										
Rewindable motor							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steel: AISI 304	●	●	●	●	●	●	●	●	●	●	●	●	●	●									
Steel: AISI 304 and cast iron							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steel: AISI 316							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steel: AISI 904L			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			
Built-in temperature transmitter in motor			●	●	●	●	●	●	●	●	●	●	●	●									

Direct-on-line starting is recommended up to 100 hp.
Soft starter or autotransformer is recommended above 100 hp.
Motors with star/delta are available from 7.5 hp.

Motor protection and controllers

Motor output [hp]	0.5	0.75	1.0	1.5	1.5	3.0	5.0	7.5	10.0	15	20	25	30	40	50	60	75	100	125	150	175	200	250
MP 204	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Pt100							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Zinc anode				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Vertical flow sleeve	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Horizontal flow sleeve	●	●	●	●	●	●		●	●	●	●	●	●	●									
SA-SPM	●	●	●	●	●	●	●																
R100	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RS-485 communication module	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
G100	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Motor protection of single-phase motors, see page 85.

3. Construction

Sectional drawing, SP pump, 4"

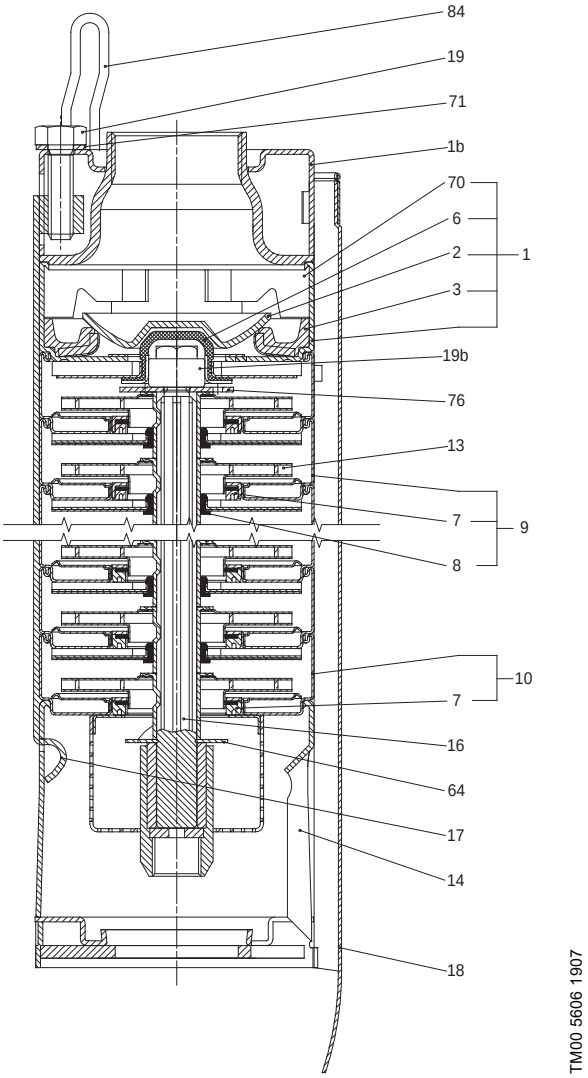


Fig. 13 SP pump, 4"

Material specification, SP pump, 4"

Pos.	Component	Materials	Standard
			AISI
1	Valve casing	Stainless steel	304
1b	Discharge piece	Stainless steel	304
2	Valve cup	Stainless steel	304
3	Valve seat	Stainless steel/NBR	304
6	Top bearing	NBR	
7	Neck ring	NBR/PBT	
8	Intermediate ring	NBR	
9	Intermediate chamber	Stainless steel	304
10	Bottom intermediate chamber	Stainless steel	304
13	Impeller	Stainless steel	304
14	Suction interconnector	Stainless steel	304
16	Shaft	Stainless steel	304
17	Strap	Stainless steel	304
18	Cable guard	Stainless steel	304
19	Hexagon screw	Stainless steel	304
19a	Nut	Stainless steel	316
19b	Nut	Stainless steel	304
20	Motor cable		
64	Priming disc	Stainless steel	304
70	Valve guide	Stainless steel	304
71	Washer for pos. 19	Stainless steel	316
76	Washer	Stainless steel	304
78	Nameplate	Stainless steel	316
84	Hook	Stainless steel	304

Sectional drawing, SP pump, 6"

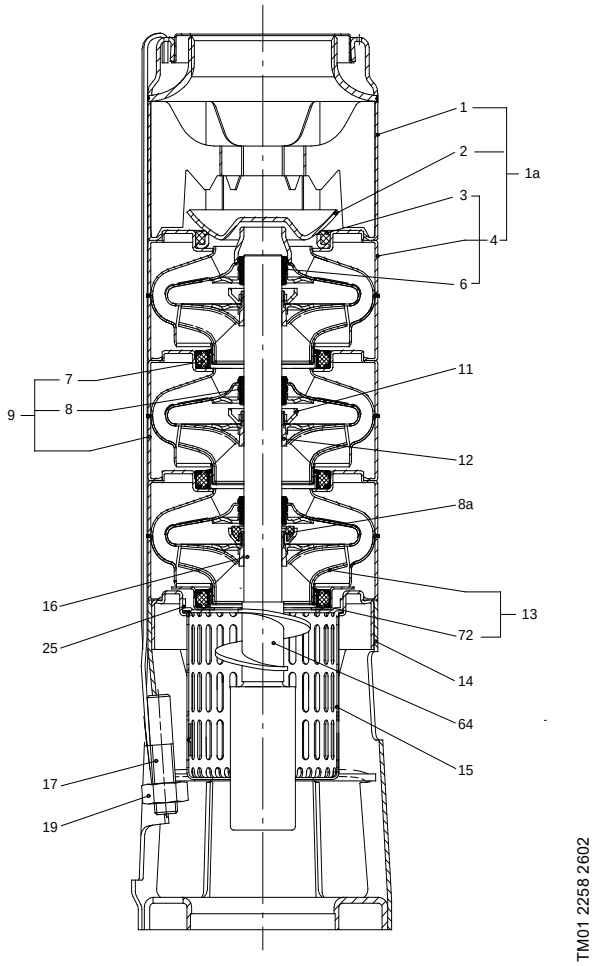


Fig. 14 SP pump, 6"

Material specification, SP pump, 6"

Pos.	Component	Materials	Standard	N-version	R-version
			AISI		
		Valve casing			
1	Valve casing	Stainless steel	304	316	904 L
2	Valve cup	Stainless steel	304	316	904 L
3	Valve seat	Stainless steel	304	316	904 L
4	Top chamber	Stainless steel	304	316	904 L
		Chamber stack			
7	Neck ring	NBR/PPS			
8	Bearing	NBR			
8a	Spacing washer	Carbon/ graphite HY22 in PTFE mass			
9	Chamber	Stainless steel	304	316	904 L
11	Nut for split cone	Stainless steel	304	316	904 L
12	Split cone	Stainless steel	304	316	904 L
13	Impeller	Stainless steel	304	316	904 L
16	Shaft with coupling	Stainless steel	431	329	Si 31 803
18	Cable guard	Stainless steel	304	316	904 L
23	Rubber guard	NBR			
25	Neck ring retainer	Stainless steel	304	316	904 L
64	Priming screw	Stainless steel	304	316	904 L
72	Wear ring	Stainless steel	304	316	904 L
		Suction interconnector			
14	Suction interconnector	Stainless steel	304	316	904 L
	Intermediate piece for 6" motor over 40 Hp	Stainless steel	316	316	316
15	Strainer	Stainless steel	304	316	904 L
17	Strap	Stainless steel	304	316	904 L
19	Nut for strap	Stainless steel	304	316	904 L
19a	Nut	Stainless steel	316	316	316
20	Motor cable				
78	Nameplate	Stainless steel	316	316	316
		Pumps in sleeve			
	Clamping flange (counter)	Stainless steel	304	316	904 L
	Clamping flange	Stainless steel	304	316	904 L
	Connecting piece	Stainless steel	304	316	904 L
	Sleeve	Stainless steel	304	316	904 L
	Stay bolt	Stainless steel	304	316	904 L
	Hexagon socket head screw	Stainless steel	304	316	904 L

Sectional drawing, SP pump, 8"

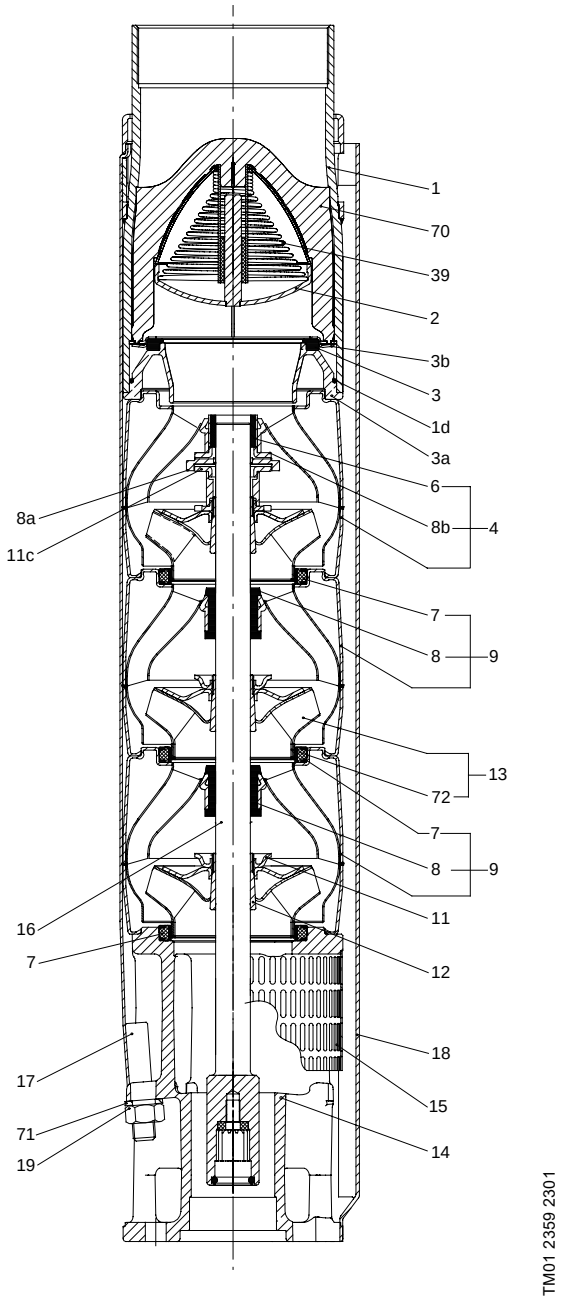
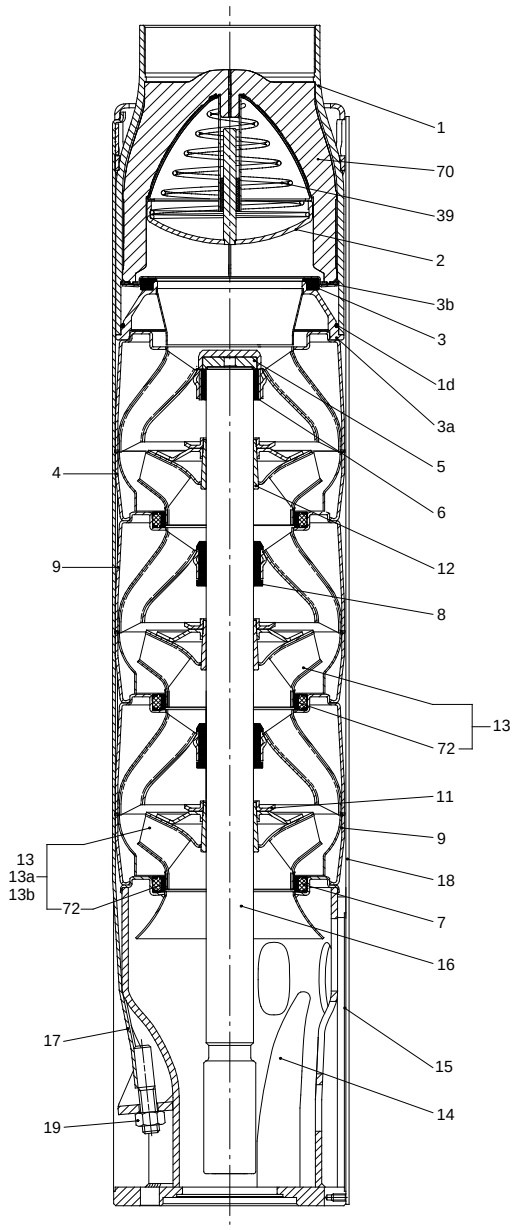


Fig. 15 SP pump, 8"

Material specification, SP pump, 8"

Pos.	Component	Materials	Standard	N-version	R-version
				AISI	
1	Valve casing	Stainless steel	304	316	904L
1d	O-ring	NBR			
2	Valve cup	Stainless steel	304	316	904L
3	Valve seat	Standard/ N- version: NBR R-version: FKM			
3a	Lower valve seat retainer	Stainless steel	316	316	(DIN 1.4517)
3b	Upper valve seat retainer	Stainless steel	304	316	904L
4	Top chamber	Stainless steel	304	316	904L
6	Upper bearing	Stainless steel/NBR	304	316	904L
7	Neck ring	NBR/PPS			
8	Bearing	NBR			
8a	Washer for stop ring	Carbon/ graphite HY22 in PTFE mass			
8b	Stop ring	Stainless steel	316	316	904L
9	Chamber	Stainless steel	304	316	904L
11	Split cone nut	Stainless steel	304	316	904L
11c	Nut for stop ring	Stainless steel	316	316	904L
12	Split cone	Stainless steel	304	316	904L
13	Impeller	Stainless steel	304	316	904L
14	Suction inter-connector	Stainless steel	CF8M	A744 CD4-MCu	(DIN 1.4517)
15	Strainer	Stainless steel	304	316	904L
16	Shaft complete	Stainless steel	431	329	329
17	Strap	Stainless steel	304	316	904L
18	Cable guard	Stainless steel	304	316	904L
19	Nut for strap	Stainless steel	304	316	904L
39	Spring for valve cup	Stainless steel	304	316	SAF 2205
70	Valve guide	Stainless steel	304	316	904L
71	Washer	Stainless steel	316	316	904L
72	Wear ring	Stainless steel	304	316	904L

Sectional drawing, SP pump, 10"



TM01 2363 2701

Fig. 16 SP pump, 10"

Material specification, SP pump, 10"

Pos.	Description	Material	Standard	N version
			AISI	
		Valve casing		
1	Valve casing	Stainless steel	304	316
1d	O-ring	NBR		
2	Valve cup	Stainless steel	304	316
3	Valve seat	Stainless steel	304	316
3a	Lower valve seat retainer	Stainless steel	304	316
3b	Upper valve seat retainer	Stainless steel	304	316
39	Spring for valve cup	Stainless steel	301	316
70	Valve guide	Stainless steel	304	316
78	Nameplate	Stainless steel	304	316
79	Rivet	Stainless steel	304	316
63	Connecting piece	Stainless steel	304	316
		Chamber stack		
4	Top chamber	Stainless steel	304	316
5	Upthrust disc	Carbon/ graphite HY22 in PTFE mass		
6	Top bearing	Stainless steel/ NBR	304	316
7	Neck ring	NBR/PPS		
8	Bearing	NBR		
9	Chamber	Stainless steel	304	316
11	Nut for split cone	Stainless steel	304	316
12	Split cone	Stainless steel	304	316
13	Impeller	Stainless steel	304	316
16	Shaft with coupling	Stainless steel	431	329
18	Cable guard	Stainless steel	304	316
18a, 18b	Screw for cable guard	Stainless steel	304	316
23	Rubber guard	NBR		
72	Wear ring	Stainless steel	304	316
		Suction interconnector		
14	Suction interconnector	Stainless steel	304	316
15	Strainer	Stainless steel	304	316
17	Strap	Stainless steel	304	316
19	Nut for strap	Stainless steel	304	316
19a	Nut	Stainless steel	316	316
20	Motor cable			
22	Bolts	Stainless steel	316	316
28, 28a	Lock for strainer	Stainless steel	329	329

Sectional drawing - MS motors

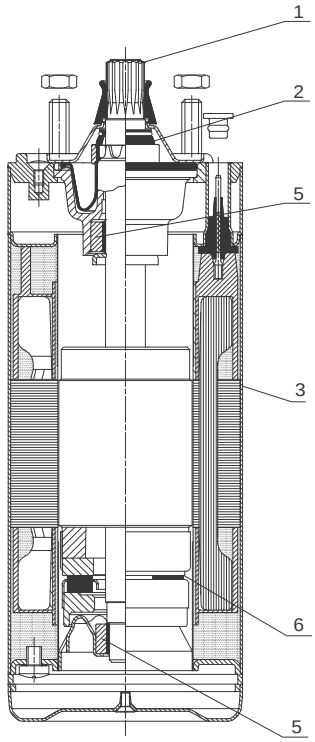


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Fig. 17 MS 402 motor

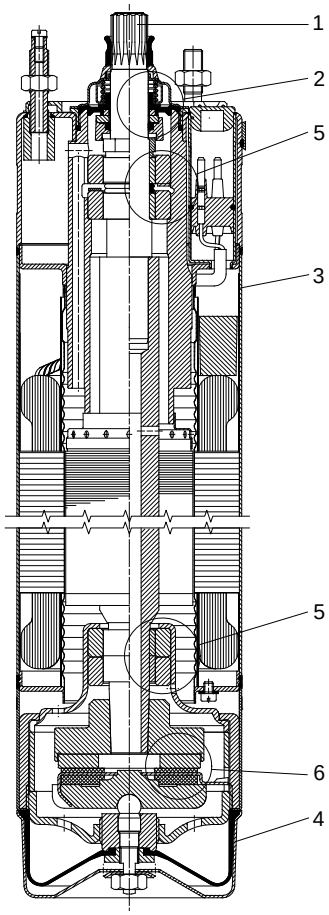

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Fig. 18 MS 4000 motor

Material specification, MS 402 and MS 4000 motors

Pos.	Part	MS 402	MS 4000
		AISI	
1	Shaft	431	431
2	Shaft seal	NBR	Tungsten carbide/ ceramic
3	Motor sleeve	304	304
4	Motor end shield		304
5	Radial bearing	Ceramic	Ceramic/ tungsten carbide
6	Axial bearing	Ceramic/carbon	Ceramic/carbon
	Rubber parts	NBR	NBR

R-version motor

Pos.	Part	MS 4000
1	Shaft	318 LN
2	Shaft seal	NBR/ceramic
3	Motor sleeve	904L
4	Motor end shield	904L
5	Radial bearing	Ceramic/tungsten carbide
6	Thrust bearing	Ceramic/carbon
	Rubber parts	NBR

Sectional drawing - MS6 motors

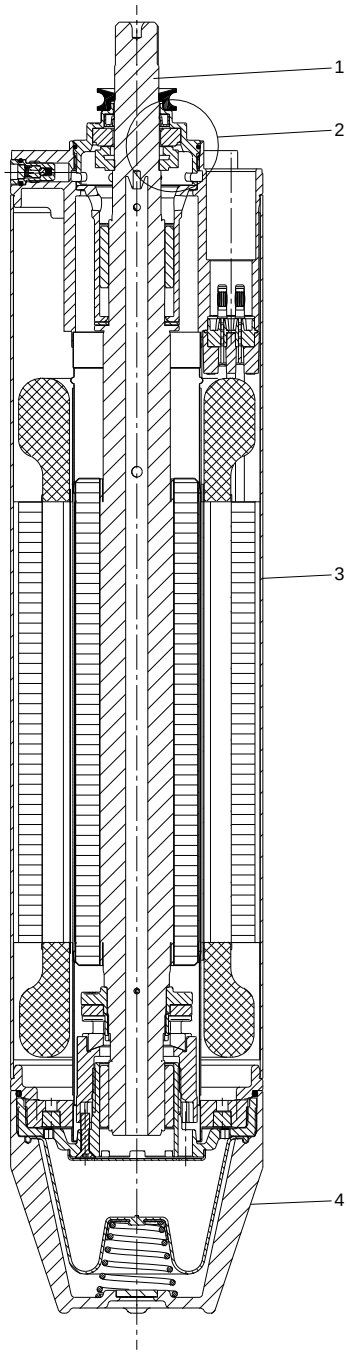


Fig. 19 MS6 motor

Material specification - MS6 motors

Pos.	Part	MS6
202	Shaft with rotor	318LN
2	Shaft seal	Ceramic/carbon
3	Motor sleeve	304
4	Motor end cover	304
	Rubber parts	NBR/FKM

R-version motor

Pos.	Part	MS6
1	Shaft	318LN
2	Shaft seal	SiC/SiC
3	Motor sleeve	904L
4	Motor end cover	(DIN 1.4517)
	Rubber parts	FKM

Sectional drawing - MMS motors

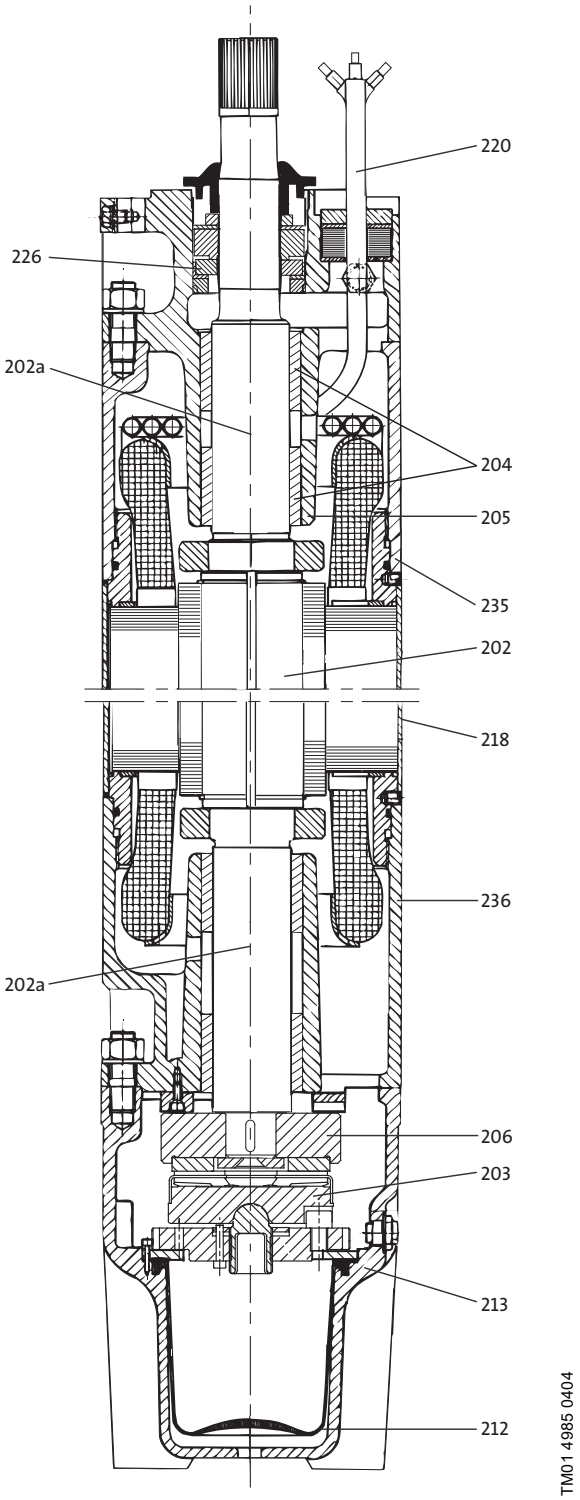


Fig. 20 MMS 10000

Material specification

MMS motors, submersible rewindable versions

Pos.	Component		Material	AISI
202	Shaft		Steel	(EN 1.0533)
202a	Shaft ends		Stainless steel	316/329
203/206	Thrust bearing Stationary/ rotating part	6", 0.5 - 20 Hp	Hardened steel/ EPDM	
		6", 25 - 50 Hp	Ceramic/ carbon	
		8" - 10"		
204	Bearing bush	6" - 10"	Carbon	
205	Bearing housing, upper		Cast iron	A126 Class B
212	Diaphragm		CR	
213	Motor end shield		Cast iron	A126 Class B
218	Motor sleeve		Stainless steel	304
220	Motor cable		EPDM	
226	Shaft seal		Ceramic/ carbon	
235	Intermediate housing		Cast iron	A126 Class B
236	Bearing housing, lower		Cast iron	A126 Class B

MMS motors, N- and R-versions

Pos.	Component		Material	Version N	Version R*
				AISI	
202	Shaft		Steel	(EN 1.0533)	(EN 1.0533)
202a	Shaft ends		Stainless steel	316/329	318LN
203/206	Thrust bearing Stationary/ rotating part	6", 0.5 - 20 Hp	Hardened steel/EPDM		
		6", 25 - 50 Hp	Ceramic/ carbon		
		8"-10"			
204	Bearing bush	6"-10"	Carbon		
205	Bearing housing, upper		Stainless steel	316	904L
212	Diaphragm		CR		
213	Motor end shield		Stainless steel	316	904L
218	Motor sleeve		Stainless steel	316	904L
220	Motor cable		EPDM		
226	Shaft seal		Ceramic/ carbon		
235	Intermediate housing		Stainless steel	316	904L
236	Bearing housing, lower		Stainless steel	316	904L

* Only MMS 6000 and MMS 8000 are available in R-versions

4. Operating conditions

Operating conditions

Flow rate, Q: 0.44 - 1475 gpm (0.1-335 m^3/h).

Head, H: Maximum 2657 ft (810 m).

Maximum liquid temperature

Motor	Installation		
	Flow velocity past motor	Vertical [°F (°C)]	Horizontal [°F (°C)]
Grundfos MS 4"and MS6 T30-versions	0.49 ft/s (0.15 m/s)	86 (30)	86 (30)
Grundfos 4" MS industry versions	0.49 ft/s (0.15 m/s)	140 (60)	140 (60)
Grundfos MS6 T60-versions	3.28 ft/s (1.0 m/s)	140 (60)	140 (60)
Grundfos MMS 6" to 12" rewindable with PVC in the windings	0.49 ft/s (0.15 m/s)	77 (25)	77 (25)
	1.64 ft/s (0.50 m/s)	86 (30)	86 (30)
Grundfos MMS 6" to 12" rewindable with PE/PA in the windings	0.49 ft/s (0.15 m/s)	104 (40)	104 (40)
	1.64 ft/s (0.50 m/s)	113 (45)	113 (45)

Note: Note: For MMS 6000, 0.5 hp; MMS 8000, 150 hp; the maximum liquid temperature is 9 °F (5 °C) lower than the values stated in the table. For MMS 10000, 250 hp, the temperature is 18 °F (10 °C) lower.

Operating pressure

Motor	Maximum operating pressure
Grundfos MS 4" and 6"	870 psi (6 Mpa) (60 bar)
Grundfos MMS 6" to 10" rewindable	

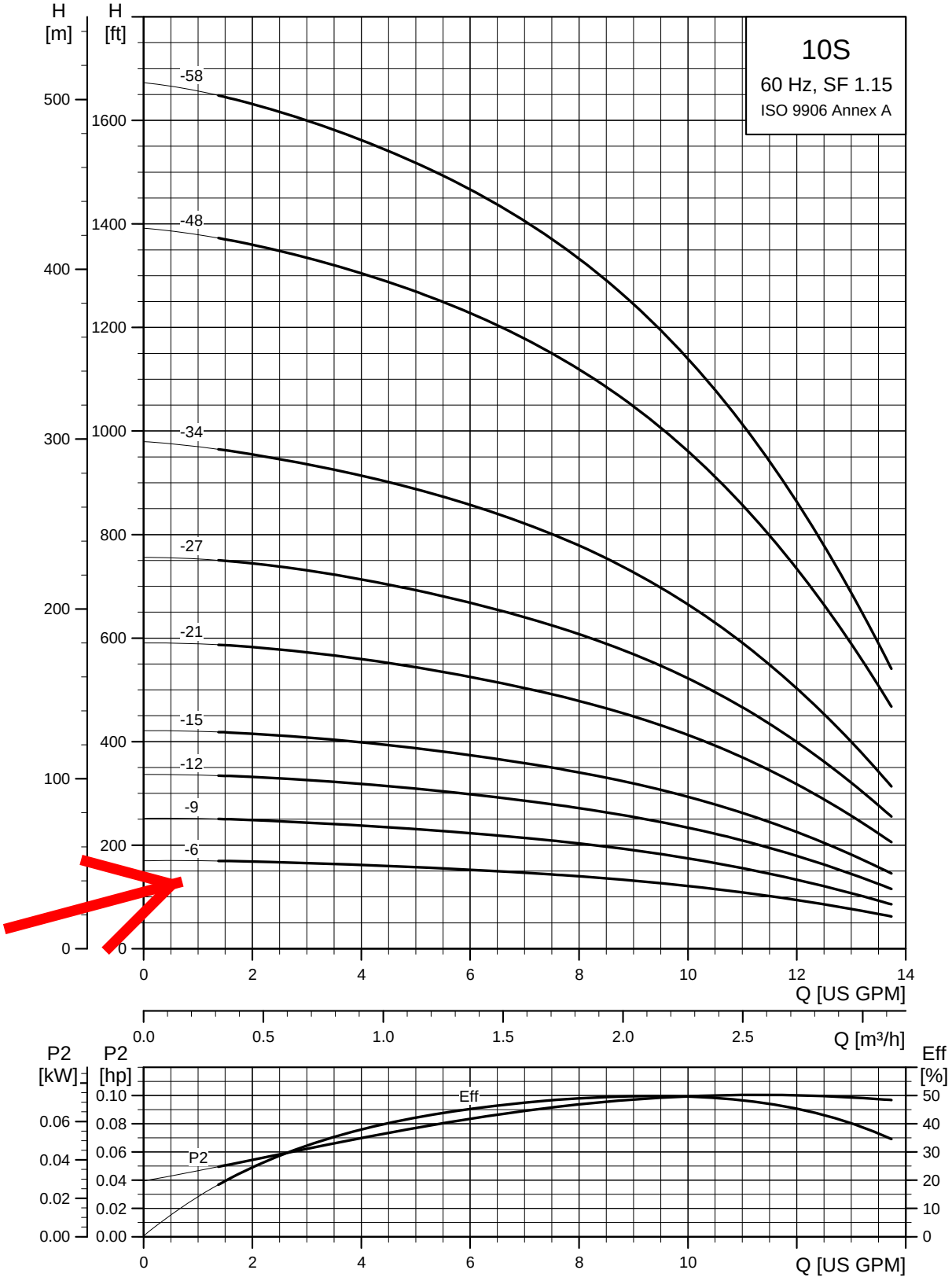
Curve conditions

The conditions below apply to the curves shown on pages 20 - 84:

General

- Curve tolerances according to ISO 9906, Annex A.
- The performance curves show pump performance at actual speed, cf. standard motor range.
  The speeds of the motors are approximately these:
  4" motors: n = 3470 min^{-1}
  6" motors: n = 3460 min^{-1}
  8" to 10" motors: n = 3525 min^{-1}
- The measurements were made with airless water at a temperature of 68 °F (20 °C). The curves apply to a kinematic viscosity of 1 mm^2/s (1 cSt). When pumping liquids with a density higher than that of water, use motors with correspondingly higher outputs.
- The **bold** curves indicate the recommended performance range.
- The performance curves are inclusive of possible losses such as non-return valve loss.
- **Q/H:** The curves are inclusive of valve and inlet losses at the actual speed.
  Operation without non-return valve will increase the actual head at rated performance by 0.5 to 1.0 m.
- **NPSH:** The curve is inclusive of pressure loss in the suction interconnector and shows required inlet pressure.
- **Power curve:** P_2 shows pump power input at the actual speed of each individual pump size.
- **Efficiency curve:** Eta shows pump stage efficiency. If Eta for the actual pump size is needed, please consult WinCAPS or WebCAPS.

10S (10 gpm)



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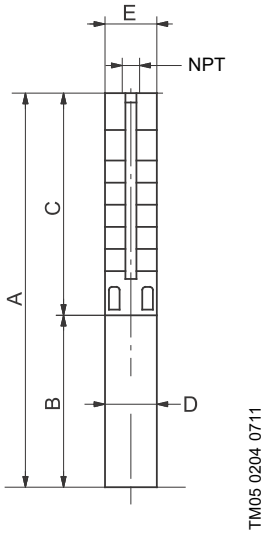
10S (10 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
10S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 10 gpm (1.25" NPT)											
10S05-6	116	1	230	.5	■	22.05 (560)	10.99 (279)	11.07 (281)	3.74 (95)	3.97 (101)	20.7
10S05-9	174	1	115	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	24.3
			230	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	23.4
10S07-12	233	1	230	.75	■	27.60 (701)	11.58 (294)	16.03 (407)	3.74 (95)	3.97 (101)	24.3
10S10-15	291	1	230	1	■	30.67 (779)	12.17 (309)	18.51 (470)	3.74 (95)	3.97 (101)	29.7
10S15-21	407	1	230	1.5	■	37.17 (944)	13.71 (348)	23.47 (596)	3.74 (95)	3.97 (101)	35.1
10S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 10 gpm (1.25" NPT)											
10S05-6	116	1	230	.5	■	24.77 (629)	13.71 (348)	11.07 (281)	3.74 (95)	3.97 (101)	21.6
10S05-9	174	1	115	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	25.4
			230	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	24.3
10S07-12	233	1	230	.75	■	27.60 (701)	11.58 (294)	16.03 (407)	3.74 (95)	3.97 (101)	28.8
10S10-15	291	1	230	1	■	30.67 (779)	12.17 (309)	18.51 (470)	3.74 (95)	3.97 (101)	29.7
10S15-21	407	1	230	1.5	■	37.17 (944)	13.71 (348)	23.47 (596)	3.74 (95)	3.97 (101)	35.1
		3	230	1.5	■	35.63 (905)	12.17 (309)	23.47 (596)	3.74 (95)	3.97 (101)	32.4
			460	1.5	■	35.63 (905)	12.17 (309)	23.47 (596)	3.74 (95)	3.97 (101)	36.0
10S20-27	524	1	230	2	●	47.92 (1217)	19.49 (495)	28.43 (722)	3.74 (95)	3.97 (101)	45.9
		3	230	2	■	42.13 (1070)	13.71 (348)	28.43 (722)	3.74 (95)	3.97 (101)	44.1
			460	2	■	42.13 (1070)	13.71 (348)	28.43 (722)	3.74 (95)	3.97 (101)	44.1
10S30-34	659	1	230	3	●	58.59 (1488)	22.6 (574)	35.99 (914)	3.74 (95)	3.97 (101)	81.9
		3	230	3	●	53.98 (1371)	18.00 (457)	35.99 (914)	3.74 (95)	3.97 (101)	74.7
			460	3	●	53.98 (1371)	18.00 (457)	35.99 (914)	3.74 (95)	3.97 (101)	74.7
10S50-48DS	931	1	230	5	●	74.18 (1884)	26.62 (676)	47.56 (1208)	3.74 (95)	3.97 (101)	103.5
		3	230	5	●	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	3.97 (101)	103.5
			460	5	●	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	3.97 (101)	103.5
10S50-58DS	1124	1	230	5	●	89.49 (2272)	26.62 (676)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3
		3	230	5	●	85.48 (2171)	22.60 (574)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3
			460	5	●	85.48 (2171)	22.60 (574)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3

10S

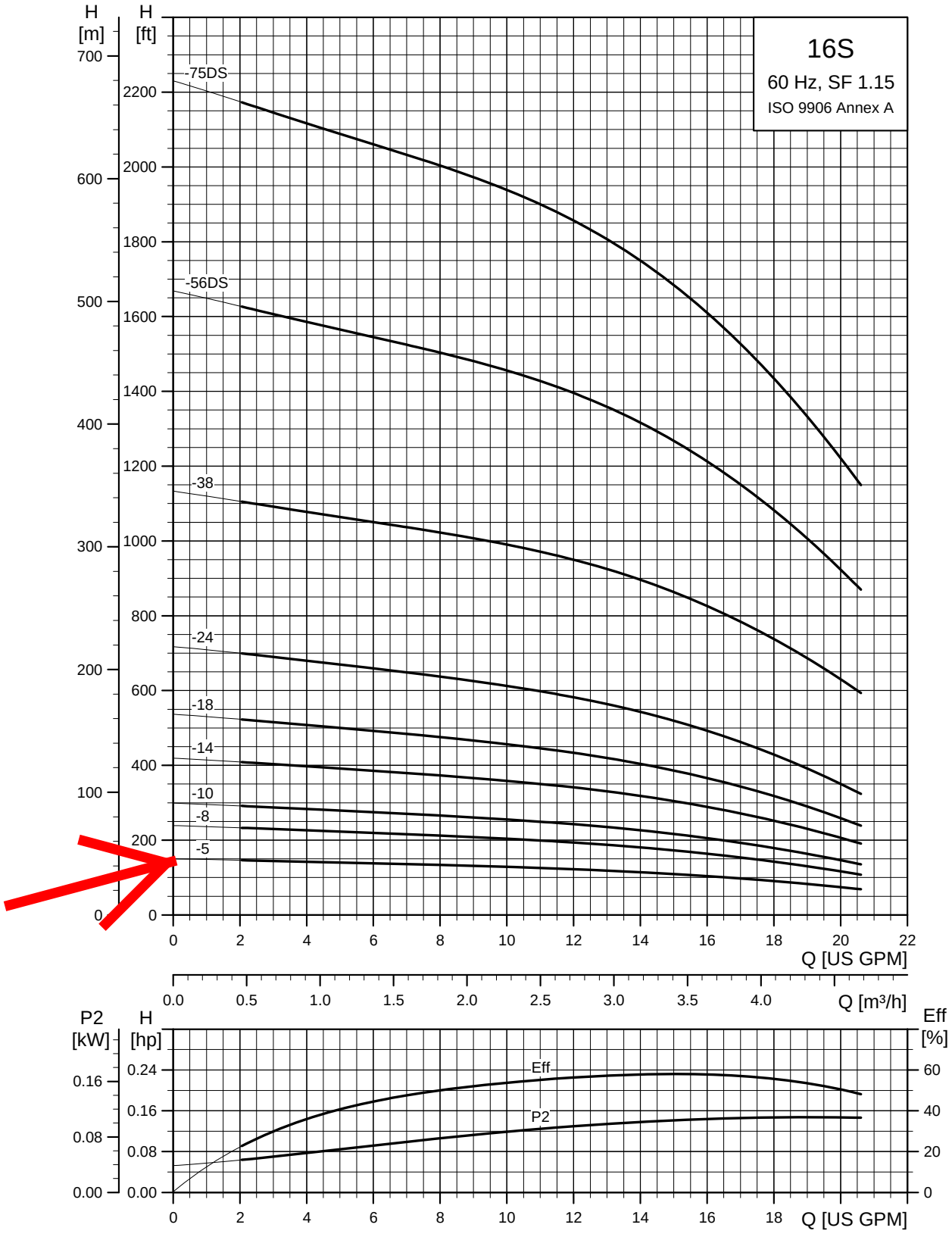


E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1-1/4" NPT, 6" minimum well diameter.

■ MS402 motor.
● MS4000 motor.
▲ MS6 motor.
∧ MMS6000 motor.
★ MMS8000 motor.
♦ Takes MS6 motor; not available as complete.
☼ Takes MMS6000 motor; not available as complete.
* Takes MMS8000 motor; not available as complete.
† Takes MMS10000 motor; not available as complete.

16S (16 gpm)



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Electrical data

Grundfos submersible pump motors - 60 Hz

Grundfos submersible pump motors - 60 Hz												
Hp	Ph	Volt [V]	S.F.	Circuit breaker or fuses		Amperage		Full load		Max. thrust [lbs]	Nameplate number	Product number
				Std.	Delay	Start [A]	Max. [A]	Eff. [%]	Power factor [%]			
4-inch, single-phase, 2-wire motors (control box not required)												
.5	1	115	1.60	35	15	55.0	12.0	62	76	900	79922102	96465574
.5	1	230	1.60	15	7	34.5	6.0	62	76	750	79952102	96465616
.75			1.50	20	9	40.5	8.4	62	75	750	79952103	96465618
1			1.40	25	12	48.4	9.8	63	82	750	79952104	96465620
1.5			1.30	35	15	62.0	13.1	64	85	750	79952105	96465622
4-inch, single-phase, 3-wire motors												
.5	1	115	1.60	35	15	42.5	12.0	61	76	900	79423102	96023039
.5	1	230	1.60	15	7	21.5	6.0	62	76	750	79453102	96465606
.75			1.50	20	9	31.4	8.4	62	75	750	79453103	96465608
1			1.40	25	12	37.0	9.8	63	82	750	79453104	9646510
1.5			1.30	35	15	45.9	11.6	69	89	750	79453105	96465612
4-inch, three-phase, 3-wire motors												
1.5	3	230	1.30	15	8	40.3	7.3	75	72	750	79302005	96465629
		460	1.30	10	4	20.1	3.7	75	72	750	79362005	96465651
		575	1.30	10	4	16.1	2.9	75	72	750	79392005	96785912
2	3	230	1.25	20	10	48	8.7	76	75	750	79302006	96465630
		460	1.25	10	5	24	4.4	76	75	750	79362006	96465652
		575	1.25	10	4	19.2	3.5	76	75	750	79392006	96785917
3	3	230	1.15	30	15	56	12.2	77	75	1000	79304507	96405801
		460	1.15	15	7	28	6.1	77	75	1000	79354507	96405810
		575	1.15	15	6	22	4.8	77	75	1000	79394507	96405815
5	3	230	1.15	40	25	108	19.8	80	82	1000	79304509	96405802
		460	1.15	20	12	54	9.9	80	82	1000	79354509	96405811
		575	1.15	15	9	54	7.9	80	82	1000	79394509	96405816
7.5	3	230	1.15	60	30	130	25.0	81	82	1000	79305511	96405805
		460	1.15	35	15	67	13.2	81	82	1000	79355511	96405814
		575	1.15	30	15	67	10.6	81	82	1000	79395511	96405819
6-inch, three-phase, 3-wire motors												
7.5	3	230	1.15	60	35	119	26.4	80.5	76	1000	78305511	96405781
		460	1.15	30	15	59	13.2	80.5	76	1000	78355511	96405794
10	3	230	1.15	80	45	156	34.0	82.5	79	1000	78305512	96405782
		460	1.15	40	20	78	17.0	82.0	79	1000	78355512	96405795
15	3	230	1.15	150	80	343	66.0	84.0	81	4400	78305516	96405784
		460	1.15	60	30	115	24.5	82.5	82	4400	78305514	96405796
20	3	230	1.15	150	80	343	66.0	84	81	4400	78305516	96405784
		460	1.15	80	40	172	33.0	84	82	4400	78355516	96405797
25	3	460	1.15	100	50	217	41.0	84.5	80	4400	78355517	96405798
30	3	460	1.15	110	60	237	46.5	85	83	4400	78355518	96405799
40	3	460	1.15	150	80	320	64.0	85	82	4400	78355520	96405800
50	3	460	1.15	225	125	470	68.7	84	83	13000	96476890	96023200
8-inch, three-phase, 3-wire motors												
40	3	460	1.15	175	100	380	55.7	83	85	13000	96530180	96023204
50	3	460	1.15	225	125	550	67.8	84	85	13000	96530182	96023205
60	3	460	1.15	250	150	640	80.4	86	85	13000	96476891	96023206
75	3	460	1.15	300	175	580	97.4	86	86	13000	96476892	96023207
100	3	460	1.15	400	225	570	130.4	87	86	13000	96476893	96023208
125	3	460	1.15	500	300	600	160.0	87	87	13000	96476894	96023209
150	3	460	1.15	600	350	580	191.3	86	87	13000	96511375	96023210
10-inch, three-phase, 3-wire motors												
175	3	460	1.15	700	400	570	230.4	88	85	13000	96521619	96937300
200	3	460	1.15	800	500	620	265.2	87	82	13000	96540302	96937302
250	3	460	1.15	1100	600	610	352.2	87	79	13000	96463669	96937316

Other motor manufacturers

- Hitachi motors: Refer to the Hitachi submersible motors application maintenance manual.
- Franklin motors: Refer to the Franklin submersible motors application maintenance manual.

7. Accessories

MP 204

The MP 204 is an electronic motor protector, designed for the protection of an asynchronous motor or a pump.

The motor protector consists of:

- a cabinet incorporating transformers and electronics
- a control panel with operating buttons and display for reading of data.

The MP 204 operates with two sets of limits:

- a set of warning limits and
- a set of trip limits.

If one or more of the warning limits are exceeded, the motor continues to run, but the warnings will appear in the MP 204 display.

Some values only have a warning limit.

The warning can also be read out by means of the Grundfos R100 remote control.

If one of the trip limits is exceeded, the trip relay will stop the motor. At the same time, the signal relay is operating to indicate that the limit has been exceeded.

Applications

The MP 204 can be used as a stand-alone motor protector.

The MP 204 can be monitored via a Grundfos GENIbus.

The power supply to the MP 204 is in parallel with the supply to the motor. Motor currents up to 120 A are passed directly through the MP 204. The MP 204 protects the motor primarily by measuring the motor current by means of a true RMS measurement. The MP 204 disconnects the contactor if, for example, the current exceeds the preset value.

Secondarily, the motor is protected via temperature measuring by a Tempcon sensor, a Pt100/Pt1000 sensor and a PTC sensor/thermal switch.

The MP 204 is designed for single- and three-phase motors. In single-phase motors, the starting and run capacitors are also measured. Cos φ is measured in both single- and three-phase systems.

Benefits

The MP 204 offers these benefits:

- Suitable for both single- and three-phase motors
- Dry-running protection
- Overload protection
- Very high accuracy
- Made for submersible pumps.

Many monitoring options

The MP 204 monitors the following parameters:

- Insulation resistance before start-up
- Temperature (Tempcon, Pt sensor and PTC/thermal switch)
- Overload/underload
- Overvoltage/undervoltage
- Phase sequence
- Phase failure
- Power factor
- Power consumption
- Harmonic distortion
- Operating hours and number of starts.

TM03 1471 2205

Fig. 21 MP 204

Five sizes of single-turn transformers, 120-999 A.
Note: Monitoring of motor temperature is not possible when single-turn transformers are used.

TM03 2033 3505

Fig. 22 Single-turn transformers

Product numbers

Product	Product number
MP 204	96079927
R100	625333

Functions

- Phase-sequence monitoring
- Indication of current or temperature (user selection)
- Indication of temperature in °F or °C (user selection)
- 4-digit, 7-segment display
- Setting and status reading with the R100
- Setting and status reading via the GENIbus.

Tripping conditions

- Overload
- Underload (dry running)
- Temperature (Tempcon sensor, PTC/thermal switch and Pt sensor)
- Phase failure
- Phase sequence
- Overvoltage
- Undervoltage
- Power factor (cos φ)
- Current unbalance.

Warnings

- Overload
- Underload
- Temperature (Tempcon and Pt sensor)
- Overvoltage
- Undervoltage
- Power factor (cos φ)
  Note: In connection with single- and three-phase connection.
- Run capacitor (single-phase operation)
- Starting capacitor (single-phase operation)
- Loss of communication in network
- Harmonic distortion.

Learning function

- Phase sequence (three-phase operation)
- Run capacitor (single-phase operation)
- Starting capacitor (single-phase operation)
- Identification and measurement of Pt100/Pt1000 sensor circuit.

External current transformers

When fitted with external current transformers, the MP 204 unit can handle currents from 120 to 999 A. Grundfos can supply approved current transformers from stock (200/5A, 300/5A, 500/5A, 750/5A, 1000/5A).

Remote control R100

The R100 remote control from Grundfos allows for wireless infrared remote control of your MP 204 unit.

With the R100, you get access to a full range of options such as factory setting adjustment, service and fault finding.

Ready for bus communication

The MP 204 allows for monitoring and communication via GENIbus — a Grundfos-designed bus for exchange of pump data, alarms, status information, and setpoints. This enables users to connect the MP 204 to, for instance, SCADA systems.

Technical data - MP 204

Enclosure class	IP 20
Ambient temperature	–4 °F to +140 °F (–20 °C to +60 °C)
Relative air humidity	99%
Voltage range	100-480 VAC
Current range	3-999 A
Frequency	50 to 60 Hz
IEC trip class	1-45
Special Grundfos trip class	0.1 to 30 s
Voltage variation	–25 %/+15 % of nominal voltage
Approvals	EN 60947, EN 60335, UL/CSA 508
Marking	CE, cUL, C-tick
Consumption	Max. 5 W
Plastic type	Black PC / ABS

	Measuring range	Accuracy	Resolution
Current without external current transformers	3-120 A	±1 %	0.1 A
Current with external current transformers	120-999 A	±1 %	1 A
Phase-to-phase voltage	80-610 VAC	±1 %	1 V
Frequency	47-63 Hz	±1 %	0.5 Hz
Power	0-1 MW	±2 %	1 W
Power factor	0-0.99	±2 %	0.01
Energy consumption	0-4x10^9 kWh	±5 %	1 kWh

IO 112	Description	Product number
	The IO 112 is a measuring module and a 1-channel protection unit for use in connection with the MP 204 motor protection unit. The module can be used for protection of pump against other factors than the electrical conditions, for instance dry-running. It can also be used as a stand-alone protection module. The IO 112 interface has three inputs for measured values one potentiometer for setting of limits indicator lights indicating the • measured value of the input • value of the limit set • alarm source • pump status. **Electrical data:** • Supply voltage: 24 VAC ±10% 50/60 Hz or 24 VDC ±10% • Supply current: Min. 2.4 A; max. 8 A • Power consumption:Max. 5 W Ambient temperature: –13 °F to+149 °F (–25 °C to +65 °C) • Enclosure class: IP 20	96651601

Control functions

This table describes the protection provided by MP 204.

Control parameters	Function	Problem	Advantages
Temperature	**MS** The motor temperature is measured by means of the built-in Tempcon temperature transmitter and a signal is sent to MP 204 via the phase leads. In MP 204 the measured temperature is compared with the factory-set value (167 °F (75 °C)). **MMS** The motor temperature is measured by means of the Pt100. The signal is sent to the MP 204 where the measured temperature is compared with the factory-set value. Temperature protection requires a submersible motor with a Pt100. The motor temperature must be monitored during frequency converter operation.	Overload, frequent starts/stops, operation against blocked discharge pipe, insufficient flow velocity past the motor.	Longer motor life, safe operating conditions, service indication.
Overvoltage/ undervoltage	If the set trip value is exceeded, the motor will stop.	The installation is close to a transformer. The mains do not absorb load variations.	Important installation parameter, possibility of improving operating conditions.
Overload	The motor power input is measured on each of the three phases. The registered power input is an average of these three values. If the factory-set value is exceeded, the motor will stop.	Incorrect sizing of pump/motor, voltage supply failure, defective cable, blocking, wear or corrosion.	Longer pump life, safe operating conditions, service indication.
Underload (dry running)	The motor power input is measured on each of the three phases. The registered power input is an average of these three values. If the average value is lower than the factory-set value, the motor will stop.	Pump exposed to dry running or underload, for example caused by wear.	Traditional dry-running protection is no longer necessary, no extra cables.
Current unbalance	The power input of the motor is measured on each of the three phases.	Mains load is uneven, incipient motor defect, phase voltages diverging.	Motor protection against overload, service indication.
Phase sequence	MP 204 and motor are installed so that the phase sequence corresponds to correct direction of rotation. MP 204 monitors changes in the phase sequence.	Two phases are wrongly connected.	Ensures correct pump performance.
Phase failure	MP 204 checks the phases connected, phase failure will cause an alarm.	Phase failure	Indication of phase failure, and alarm.

R100 menus

0. GENERAL

See the operating instructions for the R100.

1. OPERATION

- Operating mode
- Actual trip
- Actual warning 1
- Actual warning 2
- Alarm log 1
- Alarm log 2
- Alarm log 3
- Alarm log 4
- Alarm log 5.

2. STATUS

Display of

- Supply overview
- Average current
- Average voltage
- Tempcon sensor
- Pt100/Pt1000 sensor
- *Power input and energy consumption* (described in the following)
- Energy trip counter
- Phase sequence
- Current unbalance
- Operating hours and number of starts
- Trip counter of hours and starts
- Starting capacitor
- Run capacitor
- Insulation resistance
- Cos φ
- Harmonic distortion.

3. LIMITS

Display and setting of warning and trip limits.

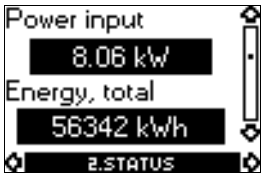
- Tempcon sensor
- Pt sensor
- Tripping current
- Current warning
- Nominal voltage
- Voltage limits
- Current unbalance
- Starting capacitor
- Run capacitor
- Insulation resistance
- Cos φ trip
- Cos φ warning.

4. INSTALLATION

Setting and display of

- Supply mains
- Trip class (described in the following)
- Trip delay
- External current transformers
- Power-on delay
- Restarting (described in the following)
- Automatic restarting (described in the following)
- Tempcon sensor
- Pt sensor
- Insulation resistance measurement
- PTC/thermal switch
- Resetting of trip counters
- Service interval
- Number of automatic restarts
- Units/display
- MP 204 display
- GENIbus ID number
- Learning function.

Power input and energy consumption



Actual input power and motor energy consumption.

The energy consumption is an accumulated value which cannot be reset.

The power is calculated like this:

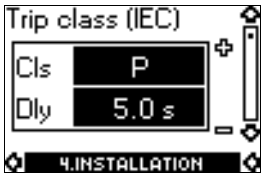
$$U_{average} = \frac{U_{L1-L2} + U_{L2-L3} + U_{L3-L1}}{3} [V]$$

$$I_{average} = \frac{I_{L1} + I_{L2} + I_{L3}}{3} [A]$$

$$\cos\varphi_{average} = \frac{\cos\varphi_{L1} + \cos\varphi_{L2} + \cos\varphi_{L3}}{3} [-]$$

$$P = (U_{average} \times I_{average} \times \sqrt{3} \times \cos\varphi_{average}) [W]$$

Trip class



Line 1: Select IEC trip class (1 to 45).

If manual indication of trip delay in the case of overload is required, select trip class "P".

Factory setting:

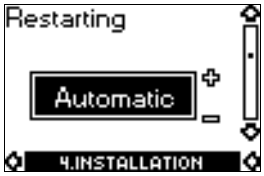
- Cls (trip class): P.

Line 2: Select trip delay.

Factory setting:

- Dly (trip delay): 10 s.

Restarting



Set whether restarting after tripping is to be

- *Automatic* (factory setting)
- *Manual*.

Setting of time, see section "Automatic restarting".

Automatic restarting

Set the time after which the MP 204 is to attempt automatic restarting of motor after cut-out.

The time runs from the moment when the value which triggered the fault has returned to normal.

Factory setting:

- 300 s.

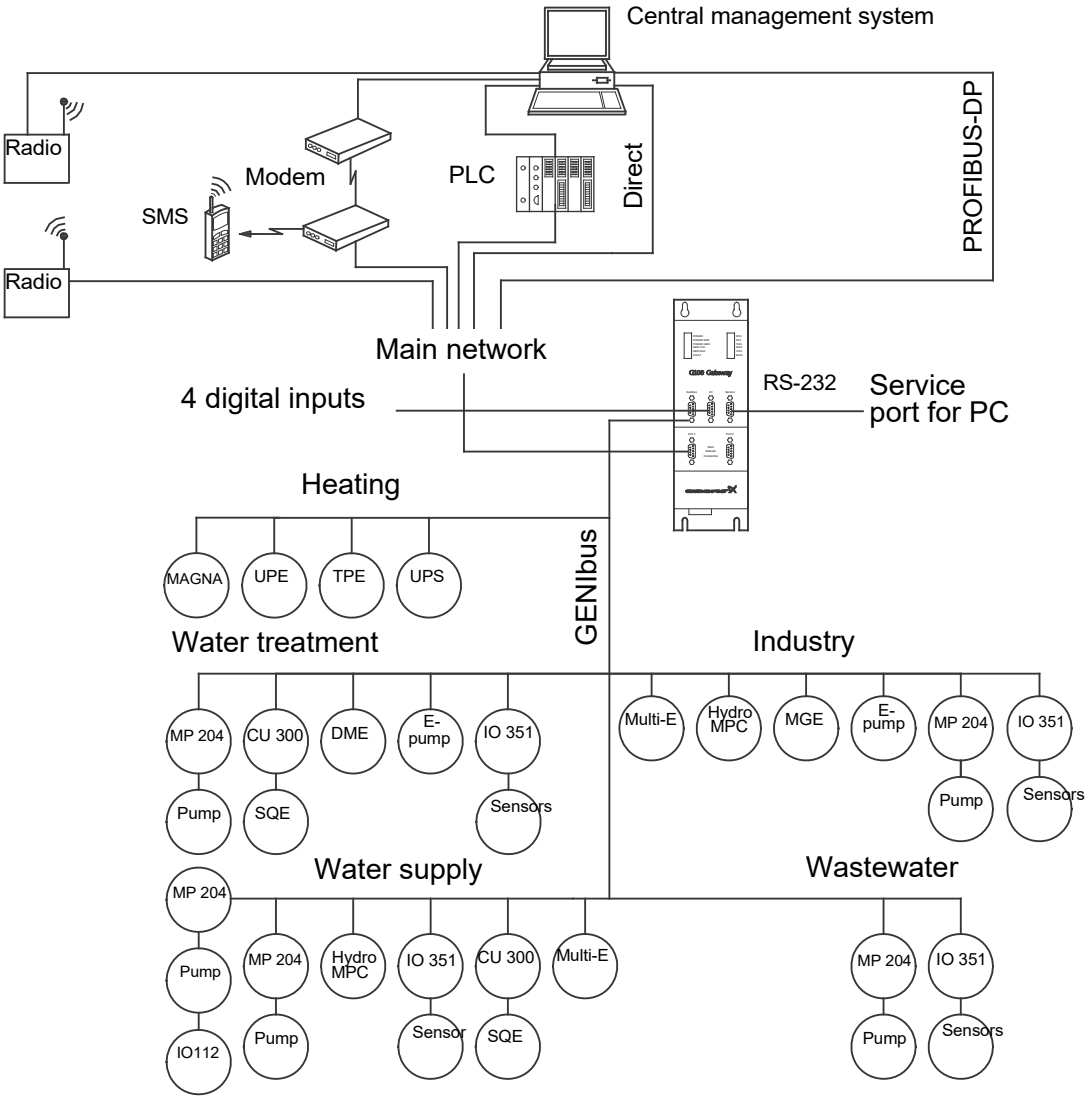
G100 gateway for communication with Grundfos products

The G100 offers a wide selection of options for integration of Grundfos products provided with GENIbus interface into main control and monitoring systems.

The G100 enables a pump installation to meet future demands for optimum pump operation in terms of reliability, operating costs, centralization and automation.

GR5940

Fig. 23 G100



TM03 9224 3607

Fig. 24 Examples of G100 applications

Product description

The G100 Gateway enables communication of operating data, such as measured values and setpoints, between Grundfos products with GENIbus interface and a main network for control and monitoring.

As indicated in the illustration on page 92, the G100 is suitable for use in applications such as water supply, water treatment, wastewater, building automation and industry.

Common to above applications is that downtime is usually costly, and extra investments are therefore often made to achieve maximum reliability by monitoring selected operating variables.

The day-to-day operation, such as starting and stopping of pumps and changing of setpoints, can also be effected from the main system by communication with the G100. In addition, the G100 can be set up to send event-controlled status indications such as alarms via the SMS to mobile phones, and to make automatic alarm call-backs to a central management system.

Data logging

Besides the possibility of data communication, the G100 offers logging of up to 350,000 time-stamped data. The logged data can be transmitted to the main system or a PC for further analysis in a spreadsheet or similar program.

For the data logging, the "PC Tool G100 Data Log" software tool is used. The tool is part of the PC Tool G100 package, which is supplied with the G100.

Other features

- Four digital inputs.
- Stop of all pumps in case of failing communication with the management system (optional).
- Access code for modem communication (optional).
- Alarm log.

Installation

Installation of the G100 is effected by the system integrator. The G100 is connected to the GENIbus as well as to the main network. All units on the GENIbus can thus be controlled from a central management system on the main network.

The "G100 Support Files" CD-ROM supplied with the G100 contains examples of programs to be used when the G100 is connected to the various main network systems. Included is also a description of the data points available in Grundfos products with GENIbus interface.

The "PC Tool G100" software tool included can be used for the installation and use of G100.

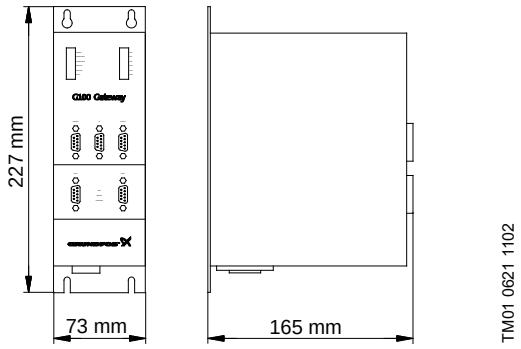


Fig. 25 Dimensional sketch

Technical data

Overview of protocols

Main system	Software protocol
PROFIBUS-DP	DP
Radio	Satt Control COMLI/Modbus
Modem	Satt Control COMLI/Modbus
PLC	Satt Control COMLI/Modbus
GSM mobile phone	SMS, UCP

Other possible connections

GENIbus RS-485:	Connection of up to 32 units.
Service port RS-232:	For direct connection to a PC or via radio modem.
Digital inputs:	4.
Voltage supply:	1 x 110-240 V, 50/60 Hz.
Ambient temperature:	In operation: –4 °F to +140 °F (–20 °C to +60 °C).
Enclosure class:	IP 20.
Weight:	1.8 kg.

Accessories

- PC Tool G100 package (supplied with the product)
- G100 Support Files CD-ROM (supplied with product)

Product numbers

Product	Product number
G100 with Profibus-DP expansion board*	96411135
G100 with Radio/Modem/PLC expansion board*	96411136
G100 Basic Version*	96411137
PC Tool G100 package	96415783

* CD-ROM with G100 Support Files included.

Connecting pieces

The tables below show the range of connecting pieces for connection of thread-to-flange and thread-to-thread.

Thread-to- thread

TM01 2397 1698 - GrA2555

Fig. 26 Dimensional sketch and photo of connecting piece thread-to-thread

Type	Connecting piece	Dimensions			Product number	
		Thread-to-thread		L [in (mm)]		
		A	B		304 stainless steel	316 stainless steel
385S 475S	NPT 5→ NPT 4	NPT 5	NPT 4	4.76 (121)	190064	190586
	NPT 5→ NPT 6	NPT 5	NPT 6	5.91 (150)	190070	190592
625S 800S 1100S	NPT 6→ NPT 5	NPT 6	NPT 5	5.91 (150)	200135	200645

Zinc anodes

Application

Cathodic protection by means of zinc can be used for corrosion protection of SP pumps in chloride-containing liquids such as brackish water and seawater.

Sacrificial anodes are placed on the outside of the pump and motor as protection against corrosion.

The number of anodes required depends on the pump and motor in question.

Please contact Grundfos for further details.

Liquid temperatures

- Seawater:
  Up to 95 °F (35 °C).
- Brackish water (min. 1500 ppm (g/m^3) chloride):
  Up to 95 °F (35 °C).

Anode life

The zinc anodes have a life of one to four years, depending on operating conditions (temperature, flow and chloride content).

Product numbers of zinc anodes

Zinc anodes for pumps										
Product number	Used for pump type									
	SP 5S to 75S	85S	150S	230S	300S	385S	475S	625S	800S	1100S
96421444	●	-	-	-	-	-	-	-	-	-
96421445	-	●	●	●	●	-	-	-	-	-
96421447	-	-	-	-	-	●	●	-	-	-
96421448	-	-	-	-	-	-	●	-	-	-
96421449	-	-	-	-	-	-	-	●	-	-
96421450	-	-	-	-	-	-	-	●	●	●

Zinc anodes for motors			
4" motors	6" motors	8" motors	10" motors
96421444	96421446	96421450	96564808

SA-SPM 5 control boxes

Application

SA-SPM 5 control boxes are used as starting units for single-phase, 3-wire motors, types MS 402B with power input lower than or equal to 1.5 hp (1.1 kW).

SA-SPM 5 is available in two versions, standard and DeLuxe. The standard version incorporates a motor -protective circuit breaker and thus protects the motor against overload. The DeLuxe version is identical to the standard version with the following addition a motor contactor is included for connection and disconnection of the power supply.

Technical data

Enclosure class:	IP 42.
Ambient temperature:	–4 °F to +140 °F (–20 °C to +60 °C).
Relative humidity:	Maximum 95 %, normal non-aggressive atmosphere.

TM03 8150 0607

Fig. 27 SA-SPM 5 control box

Product numbers

Product	Description					Product number
	1 x 220-230 V	1.5 hp	2.0 hp	3.0 hp	5.0 hp	
SA-SPM 5 (Standard version)	●	●	-	-	-	91126212
SA-SPM 5 (DeLuxe version)	●	●	-	-	-	91126213
SA-SPM 5 (Standard version)	●	-	●	-	-	91126214
SA-SPM 5 (DeLuxe version)	●	-	●	-	-	91126215
SA-SPM 5 (Standard version)	●	-	-	●	-	91126216
SA-SPM 5 (DeLuxe version)	●	-	-	●	-	91126217
SA-SPM 5 (Standard version)	●	-	-	-	●	91126218
SA-SPM 5 (DeLuxe version)	●	-	-	-	●	91126219

Pt100

The Pt100 sensor offers these features:

- Continuous monitoring of the motor temperature
- Protection against too high motor temperature.

Protecting the motor against too high motor temperature is the simplest and cheapest way of avoiding that motor lifetime is reduced. Pt100 ensures that operating conditions are not exceeded and indicates when it is time for service of the motor.

Monitoring and protection by means of Pt100 require the following parts:

- Pt100 sensor
- Relay, type PR 5714
- Cable.

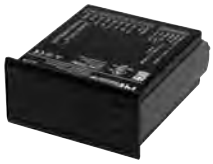
The PR 5714 relay is fitted with a Pt100 module. For both relays the following temperature limits are preset on delivery:

- +60 °C (+140 °F) warning limit
- +75 °C (+167 °F) stop limit.

Technical data

	Relay type
	PR 5714
Enclosure class	IP 65 (mounted in a control panel)
Ambient temperature	–4 °F to +140 °F (–20 °C to +60 °C)
Relative humidity	95 % (condensating)
Voltage variation	• 1 x 24-230 VAC ±10 %, 50 - 60 Hz. • 24-250 VDC ±20 %.
Approvals	UL, DNV
Mark	CE

Pt100 sensor with/without PR 5714 relay and cable	Cable length [ft (m)]	PR 5714	Product number		
			MS6	MMS 6000, MMS 8000	MMS 10000, MMS 12000
	65.6 (20)	Yes	96408953	96494596	96437287
	131.2 (40)	Yes	96408681	96494597	96437288
	196.9 (60)	Yes	96408954	96494598	96437289
	262.5 (80)	Yes	96408955	96494599	96437290
	328.1 (100)	Yes	96408956	96494610	96437291
	65.6 (20)	No	96658626	96658629	96658633
	131.2 (40)	No	96658627	96658630	96658634
	196.9 (60)	No	96658628	96658631	96658635
	262.5 (80)	No	96658637	96658632	96658636
	328.1 (100)	No	96658638	96658639	96658640

PR 5714 relay	Voltage	Product number
	24-230 VAC, 50/60 Hz / 24-250 VDC	96621274

Pt100 sensor including cable	Cable length [ft (m)]	Product number	
		MS6, MMS 6000, MMS 8000	MMS 10000 MMS 12000
	65.6 (20)	96408957	96437784
	131.2 (40)	96408684	96437785
	196.9 (60)	96408958	96437786
	262.5 (80)	96408959	96437787
	328.1 (100)	96408960	96437788

Staybolts for Pt100	Description	Product number
	Bolt KIT for Pt100 (for MS6)	96611899

8. Energy consumption

Energy consumption of submersible pumps

The percentage distribution of service life costs of a submersible pump for water supply is:

5 % initial costs (pump)
85 % operating costs / energy consumption
10 % maintenance costs.

It is obvious that the highest savings can be achieved within energy consumption!

The annual energy consumption, E, of a submersible pump can be calculated as follows:

E = c x h x P_1 (EURO)

c = specific energy price (EURO/kWh)

h = operating hours/year (hours)

P_1 = power input of the submersible pump (kW).

Example: Calculation of the annual energy consumption of the submersible pump, type 625S-3.

625S-3 with MS 8000, 45 kW, 3 x 460 V, 60 Hz.

Duty point:
Flow rate: Q = 120 m^3/h

Total head: H = 102 m

Specific energy price: c = EURO 0.1/kWh
(consisting of day and night rate)

Operating hours/year: h = 3200.

$$P_1 = \frac{Q \times H \times \rho}{367 \times \eta_{pump} \times \eta_{motor}} \text{ in kW}$$

Q = m^3/h

H = m

Density ρ = kg/dm^3 (assumed 1)

367 = conversion factor

η_{motor} = (example 84.5 %, in equation 0.845)

η_{pump} = (not to be confused with the stage efficiency curve).

By showing the P_2/Q curve we make it easier for you to calculate the energy consumption.

$$P_1 = \frac{P_2}{\eta_{motor}}$$

P_2 = 26 kW (power requirement of 625S-3 pump at 20 m^3/h, from curve P_2 / Q on page 72).

Calculation of motor efficiency at duty point
As standard the SP 625S-3 is equipped with a 45 kW MS6 motor.

At duty point (Q = 120 m^3/h) the pump requires 44 kW, thus:

a motor load of 87 % (44 kW / 45 kW) and a power reserve of 2 %.

From the table on page 72 the motor efficiency can be read as:

84.6 % at a load of 75 %. ($\eta_{75\,\%}$)
85.6 % at a load of 100 %. ($\eta_{100\,\%}$)
The interpolated value in this example is
η_{motor} = 85.1 %, η_{motor} = 0.851.

$$P_1 = \frac{44}{0.851} = 51.7 \text{ kW}$$

E = 0.1 EURO/kWh x 3200 h x 51.7 kW.
The annual energy costs amount to EURO 16544.

The pay-off time, A, (months) is calculated as follows:

$$A = \frac{\text{Purchase price of energy} - \text{efficiency pump}}{\text{Energy savings/year}} \times 12$$

Cable sizing
In order to obtain an economical duty of the pump the voltage drop should be low.

Today large water works already size cables for a maximum voltage drop of 1 %).

The hydraulic resistance in the discharge pipe should be as low as possible.

9. Cables

Grundfos offers submersible drop cables for all applications: 3-core cable, 4-core cable, single leads.

Cables for Grundfos 4" submersible motors are available with or without plugs. The submersible drop cable is chosen according to application and type of installation.

Standard version: Max. liquid temperature +140 °F +60 °C).

Hot water version: Max. liquid temperature +158 °F (+70 °C), for short periods up to 194 °F (+90 °C) (for MS only).

Tables indicating cable dimension in borehole

The tables indicate the maximum length of drop cables in meters from motor starter to pump at direct-on-line starting at different cable dimensions.

If star/delta starting is used the current will be reduced by $\sqrt{3}$ (I x 0.58), meaning that the cable length may be $\sqrt{3}$ longer (L x 1.73) than indicated in the tables.

If for example the operating current is 10 % lower than the full-load current, the cable may be 10 % longer than indicated in the tables.

The calculation of the cable length is based on a maximum voltage drop of 1 % to 3 % of the rated voltage and a water temperature of maximum +86 °F (30 °C).

In order to minimize operating losses the cable cross section may be increased compared to what is indicated in the tables. This is economical only if the borehole provides the necessary space, and if the operational time of the pump is long, especially if the operating voltage is below the rated voltage.

The table values are calculated on the basis of the formula:

Max. cable length of a single-phase submersible pump:

$$L = \frac{U \times \Delta U}{I \times 2 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times X_L\right)} [m]$$

Max. cable length of a three-phase submersible pump:

$$L = \frac{U \times \Delta U}{I \times 1.73 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times X_L\right)} [m]$$

where

U = Rated voltage [V]

ΔU = Voltage drop [%]

I = Rated current of the motor [A]

q = Cross-section of submersible drop cable [mm^2]

X_L = Inductive resistance: 0.078 x 10^{-3} [Ω/m]

cosφ= Power factor

$\sin\varphi = \sqrt{1 - \cos^2\varphi}$

ρ = Specific resistance: 0.02 [Ω mm^2/m]

Example

Motor size: 30 kW, MMS 8000

Rated current: 64.0 A

Rated voltage: 3 x 460 V, 60 Hz

Starting method: Direct-on-line

Power factor: cosφ = 0.85

Voltage drop: 3 %

Cross-section: 16 mm^2

sinφ: 0.53

$$L = \frac{460 \times 3}{64.0 \times 1.73 \times 100 \times \left(0.85 \times \frac{0.02}{16} + 0.53 \times 0.078 \times 10^{-3}\right)}$$

L = 113 m

Cable dimensions at 1 x 220 V, 60 Hz

Motor	kW	I_n [A]	1.5 mm^2	2.5 mm^2	4 mm^2	6 mm^2	10 mm^2
4"	0.25	3.3	96	159	254	379	624
	0.37	4.4	73	121	192	286	472
	0.55	6.6	48	80	127	189	311
	0.75	7.7	37	62	98	147	243
	1.1	9.0	30	50	79	118	196

Maximum cable length in meters from motor starter to pump.

Cable sizing chart

1 phase, 60 Hz

Motor rating		Copper wire size												
Volts	Hp	14	12	10	8	6	4	2	0	00	000	0000	250	300
		Maximum motor cable length (motor service to entrance) [ft/m]												
115	0.33	130 (40)	210 (64)	340 (104)	540 (165)	840 (256)	1300 (396)	1960 (597)	2910 (887)					
	0.5	100 (30)	160 (49)	250 (76)	390 (119)	620 (189)	960 (293)	1460 (445)	2160 (658)					
	0.33	550 (168)	880 (268)	1390 (424)	2190 (668)	3400 (1036)	5250 (1600)	7960 (2426)						
	0.5	400 (122)	650 (198)	1020 (311)	1610 (491)	2510 (765)	3880 (1183)	5880 (1792)						
	0.75	300 (91)	480 (146)	760 (232)	1200 (366)	1870 (570)	2890 (881)	4370 (1332)	6470 (1972)					
	1	250 (76)	400 (122)	630 (192)	990 (302)	1540 (469)	2380 (725)	3610 (1100)	5360 (1634)	6520 (1987)				
	1.5	190 (58)	310 (94)	480 (146)	770 (235)	1200 (366)	1870 (570)	2850 (869)	4280 (1305)	5240 (1597)				
	2	150 (46)	250 (76)	390 (119)	620 (189)	970 (296)	1530 (466)	2360 (719)	3620 (1103)	4480 (1366)				
	3	120 (37)	190 (58)	300 (91)	470 (143)	750 (229)	1190 (363)	1850 (564)	2890 (881)	3610 (1100)				
	5			180 (55)	280 (85)	450 (137)	710 (216)	1110 (338)	1740 (530)	2170 (661)				
	7.5				200 (61)	310 (94)	490 (149)	750 (229)	1140 (347)	1410 (430)				
	10					250 (76)	390 (119)	600 (183)	930 (283)	1160 (354)				

3 phase, 60 Hz

Motor rating		Copper wire size												
Volts	Hp	14	12	10	8	6	4	2	0	00	000	0000	250	300
		Maximum motor cable length (motor service to entrance) [ft/m]												
208	1.5	310 (94)	500 (152)	790 (241)	1260 (384)									
	2	240 (73)	390 (119)	610 (186)	970 (296)	1520 (463)								
	3	180 (55)	290 (88)	470 (143)	740 (226)	1160 (354)	1810 (552)							
	5		170 (52)	280 (85)	440 (134)	690 (210)	1080 (329)	1660 (506)						
	7.5			200 (61)	310 (94)	490 (149)	770 (235)	1180 (360)	1770 (539)					
	10				230 (70)	370 (113)	570 (174)	880 (268)	1330 (405)	1640 (500)				
	15					250 (76)	390 (119)	600 (183)	910 (277)	1110 (338)	1340 (408)			
	20						300 (91)	460 (140)	700 (213)	860 (262)	1050 (320)	1270 (387)		
	25							370 (113)	570 (174)	700 (213)	840 (256)	1030 (314)	1170 (357)	
	30							310 (94)	470 (143)	580 (177)	700 (213)	850 (259)	970 (296)	1110 (338)
230	1.5	360 (110)	580 (177)	920 (280)	1450 (442)									
	2	280 (85)	450 (137)	700 (213)	1110 (338)	1740 (530)								
	3	210 (64)	340 (104)	540 (165)	860 (262)	1340 (408)	2080 (634)							
	5		200 (61)	320 (98)	510 (155)	800 (244)	1240 (378)	1900 (579)						
	7.5			230 (70)	360 (110)	570 (174)	890 (271)	1350 (411)	2030 (619)					
	10				270 (82)	420 (128)	660 (201)	1010 (308)	1520 (463)	1870 (570)				
	15					290 (88)	450 (137)	690 (210)	1040 (317)	1280 (390)	1540 (469)			
	20						350 (107)	530 (162)	810 (247)	990 (302)	1200 (366)	1450 (442)		
	25						280 (85)	430 (131)	650 (198)	800 (244)	970 (296)	1170 (357)	1340 (408)	
	30							350 (107)	540 (165)	660 (201)	800 (244)	970 (296)	1110 (338)	1270 (387)
460	1.5	1700 (518)												
	2	1300 (396)	2070 (631)											
	3	1000 (305)	1600 (488)	2520 (768)										
	5	590 (180)	950 (290)	1500 (457)	2360 (719)									
	7.5	420 (128)	680 (207)	1070 (326)	1690 (515)	2640 (805)								
	10	310 (94)	500 (152)	790 (241)	1250 (381)	1960 (597)	3050 (930)							
	15			540 (165)	850 (259)	1340 (408)	2090 (637)	3200 (975)						
	20			410 (125)	650 (198)	1030 (314)	1610 (491)	2470 (753)	3730 (1137)					
	25				530 (162)	830 (253)	1300 (396)	1990 (607)	3010 (917)	3700 (1128)				
	30				430 (131)	680 (207)	1070 (326)	1640 (500)	2490 (759)	3060 (933)	3700 (1128)			
	40						790 (241)	1210 (369)	1830 (558)	2250 (686)	2710 (826)	3290 (1003)		
	50						640 (195)	980 (299)	1480 (451)	1810 (552)	2190 (668)	2650 (808)	3010 (917)	
	60							830 (253)	1250 (381)	1540 (469)	1850 (564)	2240 (683)	2540 (774)	2890 (881)
	75								1030 (314)	1260 (384)	1520 (463)	1850 (564)	2100 (640)	2400 (732)
	100									940 (287)	1130 (344)	1380 (421)	1560 (475)	1790 (546)
	125											1080 (329)	1220 (372)	1390 (424)
	150												1050 (320)	1190 (363)
	200												1080 (329)	1300 (396)
	250													1080 (329)

3 phase, 60 Hz														
Motor rating		Copper wire size												
Volts	Hp	14	12	10	8	6	4	2	0	00	000	0000	250	300
		Maximum motor cable length (motor service to entrance) [ft/m]												
575	1.5	2620 (799)												
	2	2030 (619)												
	3	1580 (482)	2530 (771)											
	5	920 (280)	1480 (451)	2330 (710)										
	7.5	660 (201)	1060 (323)	1680 (512)	2650 (808)									
	10	490 (149)	780 (238)	1240 (378)	1950 (594)									
	15		530 (162)	850 (259)	1340 (408)	2090 (637)								
	20			650 (198)	1030 (314)	1610 (491)	2520 (768)							
	25			520 (158)	830 (253)	1300 (396)	2030 (619)	3110 (948)						
	30				680 (207)	1070 (326)	1670 (509)	2560 (780)	3880 (1183)					
	40					790 (241)	1240 (378)	1900 (579)	2860 (872)	3510 (1070)				
	50						1000 (305)	1540 (469)	2310 (704)	2840 (866)	3420 (1042)			
	60						850 (259)	1300 (396)	1960 (597)	2400 (732)	2890 (881)	3500 (1067)		
	75							1060 (323)	1600 (488)	1970 (600)	2380 (725)	2890 (881)	3290 (1003)	

CAUTION: Use of wire size smaller than listed will void warranty.
Notes:
1. If aluminum conductor is used, multiply lengths by 0.5 Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

10. Friction loss tables

Friction loss table - SCH 40 steel pipe										
		.5"	.75"	1"	1.25"	1.5"	2"	2.5"	3"	4"
U.S. gpm	U.S. gph	ID 0.622"	ID 0.824"	ID 1.049"	ID 1.380"	ID 1.610"	ID 2.067"	ID 2.469"	ID 3.068"	ID 4.026"
		Friction loss in feet of head per 100 feet of pipe								
2	120	4.8								
3	180	10.0	2.5							
4	240	17.1	4.2							
5	300	25.8	6.3	1.9						
6	360	36.5	8.9	2.7						
7	420	48.7	11.8	3.6						
8	480	62.7	15.0	4.5						
9	540	78.3	18.8	5.7						
10	600	95.9	23.0	6.9						
12	720		32.6	9.6	2.5	1.2				
14	840		43.5	12.8	3.3	1.5				
16	960		56.3	16.5	4.2	2.0				
20	1,200		86.1	25.1	6.3	2.9				
25	1,500			38.7	9.6	4.5	1.3			
30	1,800			54.6	13.6	6.3	1.8			
35	2,100			73.3	18.2	8.4	2.4			
40	2,400			95.0	23.5	10.8	3.1	1.3		
45	2,700				29.4	13.5	3.9	1.6		
50	3,000				36.0	16.4	4.7	1.9		
60	3,600				51.0	23.2	6.6	2.7		
70	4,200				68.8	31.3	8.9	3.6	1.2	
80	4,800				89.2	40.5	11.4	4.6	1.6	
90	5,400					51.0	14.2	5.8	2.0	
100	6,000					62.2	17.4	7.1	2.4	
120	7,200						24.7	10.1	3.4	
140	8,400						33.2	13.5	4.5	1.2
160	9,600						43.0	17.5	5.8	1.5
200	12,000						66.3	27.0	8.9	2.3
260	15,600							45.0	14.8	3.7
300	18,000							59.6	19.5	4.9

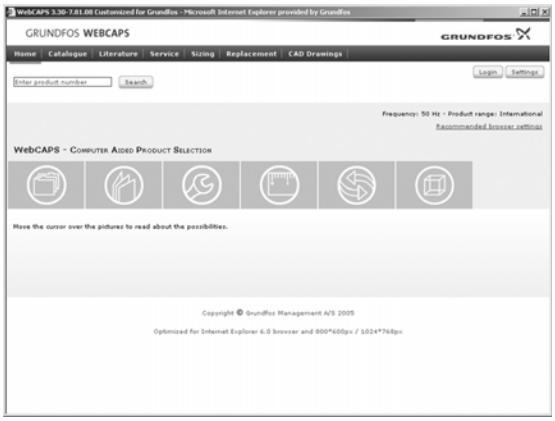
Friction loss table - SCH 40 PVC pipe										
		.5"	.75"	1"	1.25"	1.5"	2"	2.5"	3"	4"
U.S. gpm	U.S. gph	ID 0.622"	ID 0.824"	ID 1.049"	ID 1.380"	ID 1.610"	ID 2.067"	ID 2.469"	ID 3.068"	ID 4.026"
		Friction loss in feet of head per 100 feet of pipe								
2	120	4.1								
3	180	8.7	2.2							
4	240	14.8	3.7							
5	300	22.2	5.7	1.8						
6	360	31.2	8.0	2.5						
7	420	41.5	10.6	3.3						
8	480	53.0	13.5	4.2						
9	540	66.0	16.8	5.2						
10	600	80.5	20.4	6.3	1.7					
12	720		28.6	8.9	2.3	1.1				
14	840		38.0	11.8	3.1	1.4				
16	960		48.6	15.1	4.0	1.9				
20	1,200		60.5	22.8	6.0	2.8				
25	1,500			38.7	9.1	4.3	1.3			
30	1,800				12.7	6.0	1.8			
35	2,100				16.9	8.0	2.4			
40	2,400				21.6	10.2	3.0	1.1		
45	2,700				28.0	12.5	3.8	1.4		
50	3,000					15.4	4.6	1.7		
60	3,600					21.6	6.4	2.3		
70	4,200					28.7	8.5	3.0	1.2	
80	4,800					36.8	10.9	3.8	1.4	
90	5,400					45.7	13.6	4.8	1.8	
100	6,000					56.6	16.5	5.7	2.2	
120	7,200						23.1	8.0	3.0	
140	8,400						30.6	10.5	4.0	1.1
160	9,600						39.3	13.4	5.0	1.4
200	12,000						66.3	20.1	7.6	2.1
260	15,600							32.4	12.2	3.4
300	18,000							42.1	15.8	4.4

Type of fitting and application	Pipe and fitting	Nominal size of fitting and pipe						
		1/2"	3/4"	1"	1.25"	1.5"	2"	2.5"
		Friction loss in equivalent length of straight pipe in feet						
Insert coupling	Plastic	3	3	3	3	3	3	3
Threaded adapter (plastic to thread)	Plastic	3	3	3	3	3	3	3
90° standard elbow	Steel	2	2	3	4	4	5	6
	Plastic	2	2	3	4	4	5	6
Standard tee (flow through run)	Steel	1	2	2	3	3	4	4
	Plastic	1	2	2	3	3	4	4
Standard tee (flow through side)	Steel	4	5	6	7	8	11	13
	Plastic	4	5	6	7	8	11	13
Gate valve[1]	Steel	1	1	1	1	2	2	2
Swing check valve[1]	Steel	5	7	9	12	13	17	21

Notes:
Based on Schedule 40 steel and plastic fittings
[1]Friction loss figures are for screwed valves and are based on equivalent lengths of steel pipe.

11. Further product documentation

WebCAPS



WebCAPS is a **Web**-based **C**omputer **A**ided **P**roduct **S**election program available on www.grundfos.com.

WebCAPS contains detailed information on more than 185,000 Grundfos products in more than 20 languages.

In WebCAPS, all information is divided into 6 sections:

- Catalog
- Literature
- Service
- Sizing
- Replacement
- CAD drawings.

Catalog

This section is based on fields of application and pump types, and contains

- technical data
- curves (QH, Eta, P1, P2, etc) which can be adapted to the density and viscosity of the pumped liquid and show the number of pumps in operation
- product photos
- dimensional drawings
- wiring diagrams
- quotation texts, etc.

Literature

In this section you can access all the latest documents of a given pump, such as

- product guides
- installation and operating instructions
- service documentation, such as Service kit catalog and Service kit instructions
- quick guides
- product brochures, etc.

Service

This section contains an easy-to-use interactive service catalog. Here you can find and identify service parts of both existing and discontinued Grundfos pumps.
Furthermore, this section contains service videos showing you how to replace service parts.

Sizing

This section is based on different fields of application and installation examples, and gives easy step-by-step instructions in how to

- select the most suitable and efficient pump for your installation
- carry out advanced calculations based on energy consumption, payback periods, load profiles, life cycle costs, etc.
- analyse your selected pump via the built-in life cycle cost tool
- determine the flow velocity in wastewater applications, etc.

Replacement

In this section you find a guide to selecting and comparing replacement data of an installed pump in order to replace the pump with a more efficient Grundfos pump.
The section contains replacement data of a wide range of pumps produced by other manufacturers than Grundfos.

Based on an easy step-by-step guide, you can compare Grundfos pumps with the one you have installed on your site. When you have specified the installed pump, the guide will suggest a number of Grundfos pumps which can improve both comfort and efficiency.

CAD drawings

In this section it is possible to download 2-dimensional (2D) and 3-dimensional (3D) CAD drawings of most Grundfos pumps.

These formats are available in WebCAPS:

2-dimensional drawings:
- .dxf, wireframe drawings
- .dwg, wireframe drawings.

3-dimensional drawings:
- .dwg, wireframe drawings (without surfaces)
- .stp, solid drawings (with surfaces)
- .eprt, E-drawings.

WinCAPS

Fig. 28 WinCAPS CD-ROM

WinCAPS is a **Win**dows-based **C**omputer **A**ided **P**roduct **S**election program containing detailed information on more than 185,000 Grundfos products in more than 20 languages.

The program contains the same features and functions as WebCAPS, but is an ideal solution if no Internet connection is available.

WinCAPS is available on CD-ROM and updated once a year.

BE > THINK > INNOVATE >

Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

L-SP-PG-001 0212
Repl. L-SP-PG-001 Rev. 0206
US
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GRUNDFOS®

SP4”

4-Inch Stainless Steel Submersible Pumps

US Installation and operating instructions

CLASSIFIED

WATER QUALITY
DRINKING WATER
SYSTEM COMPONENTS
ANSI/NSF 61
65 GM
30°C/86°F
PUMP END ONLY

Please leave these instructions with the pump for future reference.

SAFETY WARNING

WARNING: Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment.

NOTICE: This product is designes for pumping water only. Third party agency evalustions are based on pumping water only.

Pre-Installation Checklist

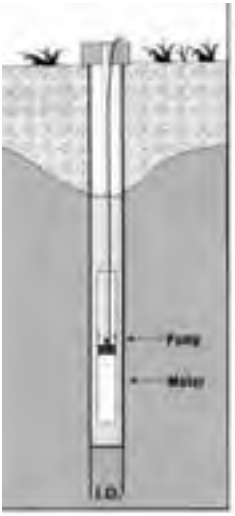
1. Well Preparation

If the pump is to be installed in a new well then the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the GRUNDFOS submersibles make it resistant to abrasion; however, no pump made of any material can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, the well must be blown or bailed clear of oil.

2. Make Sure You Have The Right Pump

Determine the maximum depth of the well, and the draw-down level at the pump's maximum capacity. Pump selection and setting depth should be based on this data.



3. Pumped Fluid Requirements

CAUTION: Submersible well pumps are designed for pumping clear, cold water; free of air or gases. Decreased pump performance and life expectancy can occur if the water is not cold, clear or contains air or gasses. Water temperature should not exceed 102°F.

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum drawdown level of the well. The bottom of the motor should never be installed lower than the top of the screen or within five feet of the well bottom.

Ensure that the requirement for minimum flow past the motor is met, as shown in the table below:

Minimum Water Flow Requirements for Submersible Pump Motors

MINIMUM DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. GPM FLOW PASSING THE MOTOR
4-Inch	4	1.2
	5	7
	6	13
	7	21
	8	30

NOTES: For proper motor cooling, a flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor. The minimum water velocity past 4" motors is 0.25 feet per second.

PRE-INSTALLATION CHECKLIST

4. Splicing the Motor Cable

If the splice is carefully made, it will be as efficient as any other portion of the cable, and will be completely watertight. There are a number of cable splicing kits available today – epoxy filled, rubber-sealed and so on. Many perform well if the manufacturer's directions are followed carefully. If one of these kits is not used, we recommend the following method for splicing the motor cable.

Examine the motor cable and drop cable carefully for damage. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads. Be sure to match the colors. Strip back and trim off one-half inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation. Insert a properly sized Sta-kon-type connector on each pair of leads, again making sure that colors are matched. Using Sta-kon crimping pliers, indent the lugs. Be sure to squeeze down hard on the pliers, particularly when using large cable. Form a piece of electrical insulation putty tightly around each Sta-Kon. The putty should overlap on the insulation of the wire. Use a good quality tape such as ***#33 Scotch Waterproof*** or ***Plymouth Rubber Company Slipknot Grey***. Wrap each wire and joint tightly for a distance of about 2-1/2 inches on each side of the joint. Make a minimum of four passes over each joint and overlap each pass approximately one inch to assure a completely watertight seal.

INSTALLATION PROCEDURES

1. Attach the Pump to the Motor

When attaching the pump to the motor we recommend the pump be bolted down in a cross pattern around the four bolts. Starting from the back (opposite the cable opening) and using a cross pattern, tighten the motor bolts to 13.5 ft-lbs, using progressive tightening until torque is met. (See figure 1 for example).

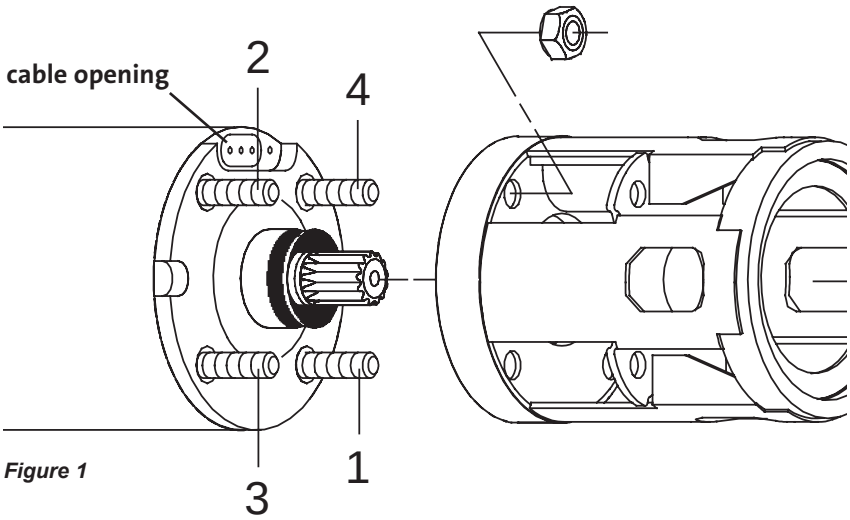


Figure 1

INSTALLATION PROCEDURES

2. Attach the Pump to the Pipe

A back-up wrench should be used when riser pipe is attached to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. Under no circumstances grip the body of the pump, cable guard or motor. When tightened down, the threaded end of the first section of the riser pipe or the nipple must not come in contact with the check valve retainer in the discharge chamber of the pump. After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. Do not clamp the pump. When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only. It is recommended that plastic-type riser pipe be used only with the smaller domestic submersibles. The manufacturer or representative should be contacted to ensure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the specific pipe manufacturer. Besides making sure that points are fastened, we recommend the use of a torque arrestor when using plastic pipe.

3. Lower the Pump Into the Well

Make sure the electrical cables are not cut or damaged in any way when the pump is being lowered in the well. Do not use the power cables to support the weight of the pump.

To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade utilizing a locally approved well seal or pitless adaptor unit. We recommend that steel riser pipes always be used with the larger submersibles. A pipe thread compound should be used on all joints. Make sure that the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

The drop cable should be secured to the riser pipe at approximately every 10 ft/3 m to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above each joint.

Figure 2

Figure 3

IMPORTANT: *Plastic pipe tends to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave three to four inches of slack between clips or taped points. This tendency for plastic pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge chamber of GRUNDFOS 4-inch submersibles is designed to accommodate this cable. (See Figures 2 & 3.)*

Check Valves: A check valve should always be installed at the surface of the well and one at a maximum of 25 feet above static water level. In addition, for installations deeper than 200 feet, check valves should be installed at no more than 200 foot intervals.

4. Electrical Connections

WARNING: Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment.

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor electrical data can be found on page 6. If voltage variations are larger than ± 10%, do not operate the pump. Single-phase motor control boxes should be connected as shown on the wiring diagram mounted on the inside cover of the control box supplied with the motor. The type of wire used between the pump control boxes should be approved for submersible pump application. The conductor insulation should be type RW, RUW, TW or equivalent.

A high-voltage surge arrestor should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated surge arrestor should be installed on the supply (line) side of the control box or starter (See Figure 4a & 4b). The arrestor must be grounded in accordance with the National Electric Code and local governing regulations.

PUMPS SHOULD NEVER BE STARTED UNLESS THE PUMP IS TOTALLY SUBMERGED. SEVERE DAMAGE MAY BE CAUSED TO THE PUMP AND MOTOR IF THEY ARE RUN DRY.
The control box shall be permanently grounded in accordance with the National Electric Code and local governing codes or regulations. The ground wire should be a bare stranded copper conductor at least the same size as the drop cable wire size. Ground wire should be as short a distance as possible and securely fastened to a true grounding point. True grounding points are considered to be: a grounding rod driven into the water strata; steel well casing submerged into the water lower than the pump setting level; and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first, then to the terminal in the control box.

Single Phase Hookup

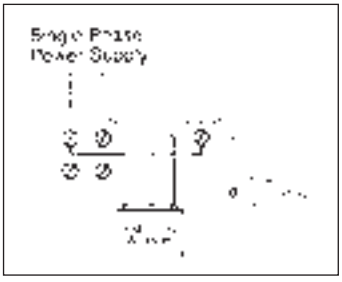


Figure 4a

Three Phase Hookup

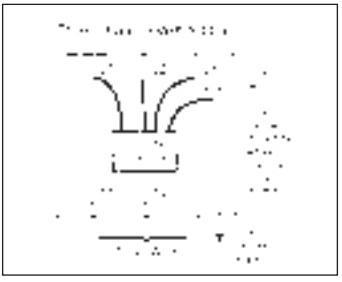
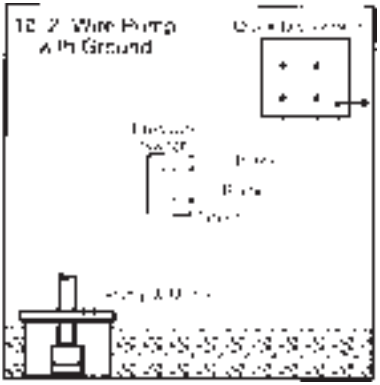


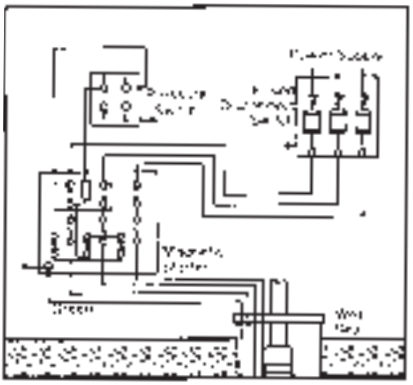
Figure 4b

INSTALLATION PROCEDURES

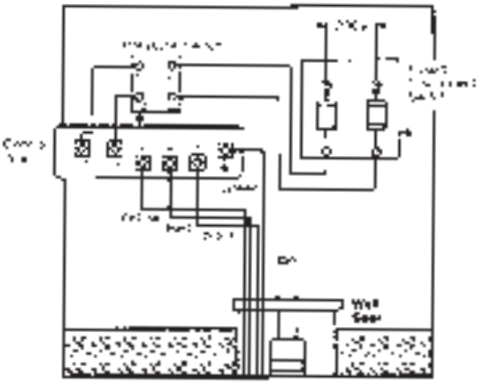
Single-Phase 2-Wire Wiring Diagram for Submersible Motors



Three-Phase Wiring Diagram for Submersible Motors



Single-Phase 3-Wire Control Box for Submersible Motors



4. Starting the Pump for the First Time

A. Attach a temporary horizontal length of pipe to the riser pipe.
B. Install a gate valve and another short length of pipe to the temporary pipe.
C. Adjust the gate valve one-third of the way open.
D. Verify that the electrical connections are in accordance with the wiring diagram.
E. After proper rotation has been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.
F. Slowly open the valve in small increments as the water clears until the valve is all the way open. The pump should not be stopped until the water runs clear.
G. If the water is clean and clear when the pump is first started, the valve should still be opened until it is all the way open.

MOTOR INFORMATION

Grundfos motors specifications

1- Phase motors

HP	Ph	Volt	Service factor	Amperage		Full load		Max. thrust (lbs)	Line-to-Line resistance ( )		KVA code	Nameplate no.
				SF	Start	Eff. (%)	Pwr fact.		Blk-Yel	Red-Yel		
4-inch, single phase, 2-wire motors (control box not required)												
1/3	1	230	1.75	4.6	25.7	59	77	900	6.8-8.2		S	79952101
1/2	1	115	1.60	12.0	55	62	76	900	1.1-1.3		R	79922102
1/2	1	230	1.60	6.0	34.5	62	76	900	5.2-6.3		R	79952102
3/4	1	230	1.50	8.4	40.5	62	75	900	3.2-3.8		N	79952103
1	1	230	1.40	9.8	48.4	63	82	900	2.5-3.1		M	79952104
1 1/2	1	230	1.30	13.1	62	64	85	900	1.9-2.3		L	79952105
4-inch, single phase, 3-wire motors												
1/3	1	115	1.75	9.0	29	59	77	900	1.55-1.9	2.4-3	M	79423101
1/3	1	230	1.75	4.6	14	59	77	900	6.8-8.3	17.3-21.1	L	79453101
1/2	1	115	1.60	12.0	42.5	61	76	900	0.9-1.1	1.9-2.35	L	79423102
1/2	1	230	1.60	6.0	21.5	62	76	900	4.7-5.7	15.8-19.6	L	79453102
3/4	1	230	1.50	8.4	31.4	62	75	900	3.2-3.9	14-17.2	L	79453103
1	1	230	1.40	9.8	37	63	82	900	2.6-3.1	10.3-12.5	K	79453104
1.5	1	230	1.30	11.6	45.9	69	89	900	1.9-2.3	7.8-9.6	H	79453105
2	1	230	1.25	13.2	57	72	86	1500	1.5-1.8	3.4-4.1	G	79454506
3	1	230	1.15	17.0	77	74	93	1500	1.2-1.4	2.45-3	F	79454507
5	1	230	1.15	27.5	110	77	92	1500	0.65-0.85	2.1-2.6	F	79454509

3-Phase motors

HP	Ph	Volt	Service factor	Amperage		Full load		Max. thrust (lbs)	Line-to-Line resistance ( )		KVA code	Nameplate no.
				SF	Start.	Eff. (%)	Pwr fact.		Blk-Yel	Red-Yel		
4-inch, three phase, 3-wire motors												
1 1/2	3	230	1.30	7.3	40.3	75	72	900	3.9		K	79302005
		460	1.30	3.7	20.1	75	72	900	15.9		K	79362005
		575	1.30	2.9	16.1	75	72	900	25.2		K	79392005
3	3	230	1.25	8.7	48	76	75	900	3.0		J	79302006
		460	1.25	4.4	24	76	75	900	12.1		J	79362006
		575	1.25	3.5	19.2	76	75	900	18.8		J	79392006
3	3	230	1.15	12.2	56	77	75	900	2.2		H	79302006
		460	1.15	6.1	28	77	75	900	9.0		H	79362007
		575	1.15	4.8	22	77	75	900	13.0		H	79395507
5	3	208/230	1.15	18.6/17.4	108	80	82	1500	1.2		H	79304509
		440/460	1.15	8.65/8.65	54	80	82	1500	5.0		H	79354509
		575	1.15	7.9	54	80	82	1500	7.3		H	79394509
7 1/2	3	208/230	1.15	27.0/25.0	130	81	82	1500	0.84		H	79305511
		440/460	1.15	12.8/12.6	67	81	82	1500	3.24		J	79355511
		575	1.15	10.6	53	81	82	1500	5.2		J	79395511
10	3	440/460	1.15	18.0/18.6	90	81	80	1500	1.16		H	79355512
		575	1.15	14.4	72	81	80	1500	1.84		H	79395512

*All Grundfos 4” motors have a ground (green wire)

GRUNDFOS Control Box SA-SPM5

RATING		GRUNDFOS MOTOR MODEL	GRUNDFOS CONTROL BOX	GRUNDFOS STANDARD #’s	GRUNDFOS RUN CAP/DELUXE #’s
HP	VOLT				
1/3	115	MS402B	SA-SPM5	91126150	–
1/3	230	MS402B	SA-SPM5	91126151	–
1/2	115	MS402B	SA-SPM5	91126152	–
1/2	230	MS402B	SA-SPM5	91126153	–
3/4	230	MS402B	SA-SPM5	91126154	–
1	230	MS402B	SA-SPM5	91126155	91126211
1.5	230	MS402B	SA-SPM5	91126212	91126213
2	230	MS4000	SA-SPM5	91126214	91126215
3	230	MS4000	SA-SPM5	91126216	91126217
5	230	MS4000	SA-SPM5	91126218	91126219

MOTOR INFORMATION

The key to long submersible motor life is good cooling. Most submersible pumps rely on moving heat away from the motor by forced convection. The ambient/produced fluid is typically drawn by the motor in the course of pumping to accomplish this task. Submersible motors used in the water supply industry are typically designed to operate at full load in water up to 30°C (86°F), provided the flow velocity can be maintained at a minimum of 0.5 feet per second (fps).

Required Cooling Flow and Velocity

AWWA specifications state the maximum motor diameter and the minimum inside diameter of the well shall be in such relationship that under any operating condition the water velocity past the motor shall not exceed 12 fps (3.7 m/s) nor be less than 0.5 fps (0.15 m/s). The AWWA specification are principally applicable to motors 6-inch and larger, as most 4-inch motor designs are based on a minimum cooling flow velocity of 0.25 fps (0.08 m/s) at rated ambient temperature. Table 8 relates flow, casing and motor size requirements to accomplish minimum cooling velocity.

Table 8: Minimum Submersible Cooling Flow Requirements

Casing/Sleeve I.D. (inches)	4” Motor (0.25 fps)	6” Motor (0.5 fps)
	(gpm)	
4	1.2	–
5	7.0	–
6	13	9
7	20	25
8	30	45
10	50	90
12	80	140
14	110	200
16	150	280
18	–	380

Notes:
1. Minor irregularities associated with motor shape and diameter variations between manufactures are not accounted for in the table.
2. At the velocity specified in the table the temperature differential between the motor surface and ambient water will range from 5° - 15°C (10-30°F).

Some submersible motor manufactures require no cooling fluid flow past the motor, when the produced fluid temperature is 20°C (68°F) or less. Cooling by free convection in such cases, is only permitted in the vertical position and is contingent on no adverse operating conditions present such as; poor power, high stop/start frequency, presence of incrustating deposits on the motor surface, etc. Detramental operating conditions are difficult to identify or predict, and for this reason, the minimum cooling flow should be provided whenever possible - regardless of the ambient fluid temperature.

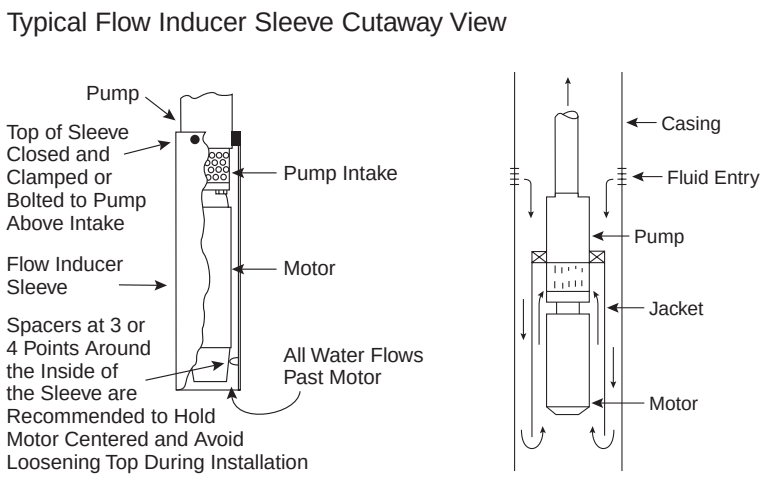
Typical Motor Jacket/Shroud Configurations.

The motor shroud is generally of the next nominal diameter of standard pipe larger than the motor or the pump, depending on the shroud configuration used. The tubular/pipe material can be plastic or thin walled steel (corrosion resistant materials preferred). The cap/top must accommodate power cable without damage and provide a snug fit, so that only a very small amount of fluid can be pulled through the top of the shroud. The fit should not be completely water tight as ventilation is often required to allow escape of the air or gas that might accumulate. The shroud body should be stabilized to prevent rotation and maintain the motor centered within the shroud. The shroud length should extend to a length of 1-2 times the shroud diameter beyond the bottom of the motor when possible. Shrouds are typically attached immediately above the pump intake or at the pump/column correction.

A typical motor sleeve/shroud selection example is sited below and illustrated in Figure 8:

If a well feeds water from above the pump, has a casing/chamber too small to allow a motor jacket/sleeve on the pump, and does not have adequate level and flow to allow raising the pump above the inflow, it is difficult to properly cool the motor. When possible, the casing depth should be increased to allow flow to come from below the motor. If this is not practical, adequate flow past the motor can usually be attained by employing a motor jacket with a stringer pipe or by using a jet tube.

Figure 8: Typical Motor Jacket Installation Scenarios



MOTOR INFORMATION

Single-Phase 60 Hz

MOTOR RATING		COPPER WIRE SIZE (AWG)								
VOLTS	HP	14	12	10	8	6	4	2	0	00
115	1/3	130	210	340	540	840	1300	1960	2910	
	1/2	100	160	250	390	620	960	1460	2160	
230	1/3	550	880	1390	2190	3400	5250	7960		
	1/2	400	650	1020	1610	2510	3880	5880		
	3/4	300	480	760	1200	1870	2890	4370	6470	
	1	250	400	630	990	1540	2380	3610	5360	6520
	1-1/2	190	310	480	770	1200	1870	2850	4280	5240
	2	150	250	390	620	970	1530	2360	3620	4480
	3	120	190	300	470	750	1190	1850	2890	3610
	5			180	280	450	710	1110	1740	2170

Three-Phase 60 Hz

MOTOR RATIN		COPPER WIRE SIZE (AWG)						
VOLTS	HP	14	12	10	8	6	4	2
208	1-1/2	310	500	790	1260			
	2	240	390	610	970	1520		
	3	180	290	470	740	1160	1810	
		5170	280	4690	1080			1660
230	1-1/2	360	580	920	1450			
	2	280	450	700	1110	1740		
	3	210	340	540	860	1340	2080	
	5		200	320	510	800	1240	1900
460	1-1/2	1700						
	2	1300	2070					
	3	1000	1600	2520				
	5	590	950	1500	2360			
575	1-1/2	2620						
	2	2030						
	3	1580	2530					
	5	920	1480	2330				

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

TROUBLESHOOTING

SUPPLY VOLTAGE

How to Measure

By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box or starter. On single-phase units, measure between line and neutral.

What it Means

When the motor is under load, the voltage should be within ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

CURRENT MEASUREMENT

How to Measure

By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box. See page 6, for motor amp draw information.

Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA), check for the following:

1. Loose terminals in control box or possible cable defect. Check winding and insulation resistances.
2. Too high or low supply voltage.
3. Motor windings are shorted.
4. Pump is damaged causing a motor overload.

WINDING RESISTANCE

How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms.

Zero-adjust the meter and measure the resistance between leads. Record the values. Motor resistance values can be found on page 6.

What it Means

If all the ohm values are normal, and the cable colors correct, the windings are not damaged. If any one ohm value is less than normal, the motor may be shorted. If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open.

If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values on page 6.

INSULATION RESISTANCE

How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohm or mega ohmmeter, set the scale selector to Rx 100K and zero-adjust the meter. Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

What it Means

For ohm values, refer to table below. Motors of all Hp, voltage, phase and cycle duties have the same value of insulation resistance.

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
2,000,000 (or more)	2.0	**Motor not yet installed:** New Motor.
1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
500,000 - 1,000,000	0.5 - 1.0	**Motor in well** (Ohm readings are for drop cable plus motor): A motor in reasonably good condition.
20,000 - 500,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

TROUBLESHOOTING

Pump Won't Start

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
No power at the motor	Check for voltage at the control box or panel.	If there is no voltage at the control panel, check the feeder panel for tripped circuits and reset those circuits.
Fuses are blown or the circuit breakers have tripped	Turn off the power and remove the fuses. Check for continuity with an ohmmeter.	Replace the blown fuses or reset the circuit breaker. If the new fuses blow or the circuit breaker trips, the electrical installation, motor, and wires must be check for defects.
***(3-phase motors only)* Motor starter overloads are burned or have tripped**	Check for voltage on the line and load side of the starter. Check the amp draw and make sure the heater is sized correctly.	Replace any burned heaters or reset. Inspect the starter for other damage. If the heater trips again, check the supply voltage. Ensure that heaters are sized correctly and the trip setting is appropriately adjusted.
***(3-phase motors only)* Starter does not energize**	Energize the control circuit and check for voltage at the holding coil.	If there is no voltage, check the control circuit fuses. If there is voltage, check the holding coil for weak connections. Ensure that the holding coil is designed to operate with the available control voltage. Replace the coil if defects are found.
Defective controls	Check all safety and pressure switches for defects. Inspect the contacts in control devices.	Replace worn or defective parts or controls.
Motor or cable is defective	Turn off the power and disconnect the motor leads from the control box. Measure the lead-to-lead resistance with an ohmmeter (set to R x 1). Measure the lead-to-ground values with an ohmmeter (set to R x 100K).	If an open or grounded winding is found, remove the motor from the well and recheck the measurements with the lead separated from the motor. Repair or replace the motor or cable.
***(1-phase motors only)* Defective capacitor**	Turn off the power and discharge the capacitor by shorting the leads together. Check it with an analog ohmmeter (set to R x 100k).	When the meter is connected to the capacitor, the needle should jump toward 0 (zero) ohms and slowly drift back to infinity (A). Replace capacitor if it is defective.
Defective pressure switch or the tubing to it is plugged	Watch the pressure gauges as the pressure switch operates. Remove the tubing and blow through it.	Replace as necessary.
The pump is mechanically bound or stuck	Turn off the power and manually rotate the pump shaft. Also check the motor shaft rotation, the shaft height, and the motor's amp draw (to see if it indicates a locked rotor).	If the pump shaft doesn't rotate, remove the pump and examine it. If necessary, dismantle it and check the impellers and seal for obstruction. Check for motor corrosion.

Pump Does Not Produce Enough Flow (GPM)

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
***(3-phase motors only)* Shaft is turning in the wrong direction**	Check to make sure the electrical connections in the control panel are correct.	Correct the wiring. For single phase motors, check the wiring diagram on the motor. For three phase motors, simply switch any two power leads.
Pump is operating at the wrong speed (too slow)	Check for low voltage and phase imbalance.	Replace defective parts or contact power company, as applicable.
Check valve is stuck (or installed backwards)	Remove the check valve.	Re-install or replace.
Parts or fittings in the pump are worn **– or –** **Impellers or Inlet Strainer is clogged**	Install a pressure gauge near the discharge port, start the pump, and gradually close the discharge valve. Read the pressure at shutoff. (Do not allow the pump to operate for an extended period at shutoff.)	Convert the PSI you read on the gauge to Feet of Head by: **PSI x 2.31 ft/PSI = _____ ft.** **Specific Gravity** Add to this number the number of feet (vertically) from the gauge down to the water's pumping level. Refer to the pump curve for the model you are working with to determine the shutoff head you should expect for that model. If that head is close to the figure you came up with (above), the pump is probably OK. If not, remove the pump and inspect impellers, chambers, etc.
The water level in the well may be too low to supply the flow desired **– or –** **Collapsed well**	Check the drawdown in the well while the pump is operating.	If the pumping water level (including drawdown) is not **AT LEAST 3 FEET** above the pump's inlet strainer, either: 1. Lower the pump further down the well. 2. Throttle back the discharge valve to decrease the flow, thereby reuding drawdown.
Broken shaft or coupling	Pull pump and inspect.	Replace as necessary.
There are leaks in the fittings or piping	Pull the pump out of the well.	The suction pipe, valves, and fittings must be made tight. Repair any leaks and retighten all loose fittings.

TROUBLESHOOTING

Fuses Blow or Heaters Trip

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
Improper voltage	Check the voltage at the control box or panel.	If the voltage varies by more than 10% (+ or -), contact the power company.
	If the incoming voltage is OK, check the wire size and the distance between the pump motor and the pump control panel.	Rewire with correct gauge. Undersized wire and a great distance between the control panel and the pump motor increases resistance and decreases the voltage by the time it reaches the pump motor.
The starter overloads are set too low	Cycle the pump and measure the amperage.	Increase the heater size or adjust the trip setting. Do not, however, exceed the recommended rating.
(3-phase motors only) **The three-phase current is imbalanced**	Check the current draw on each lead to the motor.	The current draw on each lead must be within 5% of each other (+ or -). If they are not, check the wiring.
The wiring or connections are faulty	Check to make sure the wiring is correct and there are no loose terminals.	Tighten any loose terminals and replace any damaged wire.
(1-phase motors only) **Capacitor is defective**	Turn off the power and discharge the capacitor. Check the capacitor with an ohmmeter (set at R x 100k). See page 15 for instructions.	When the meter is connected to the capacitor, the needle should jump toward 0 (zero) ohms and then slowly drift back to infinity (¥). Replace capacitor if it is defective.
Fuse, heater, or starter are the wrong size	Check the fuses and heaters against the motor manufacturer's specification charts.	Replace as necessary.
The control box location is too hot	Touch the box with your bare hand during the hottest part of the day – you should be able to keep your hand on it without burning.	Shade, ventilate, or move the control box so its environment does not exceed 120°F.
(1-phase motors only) **Wrong control box**	Check requirements for the motor against the control box specifications.	Replace as necessary.
Defective pressure switch	Watch gauges as pressure switch operates.	Replace as necessary.
The motor is shorted or grounded.	Turn off the power and disconnect the wiring. Measure the lead-to-lead resistance with an ohmmeter (set to R x 1). Measure the lead-to-ground values with an ohmmeter (set to R x 100K) or a megaohmmeter. Compare these measurements to the rated values for your motor.	If you find an open or grounded winding, remove the motor and recheck the leads. If OK, check the leads for continuity and for bad splice.
Poor motor cooling	Find the internal diameter of the well casing (or sleeve, if used). For proper cooling, the flow of water **must not be less than the GPM shown across the bottom scale on page __.**	Throttle up the pump flow (GPM) so proper cooling is possible. – or – Pull the pump out of the well and add a sleeve with a smaller internal diameter.

Pump Cycles Too Often

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
The pressure switch is defective or is not properly adjusted	Check the pressure setting on the switch. Check the voltage across closed contacts.	Readjust the pressure switch or replace it if defective.
The tank is too small	Check the tank size and amount of air in the tank. The tank volume should be approximately 10 gallons for each Gallon-Per-Minute of pump capacity. At the pump cut-in pressure, the tank should be about 2/3 filled with air.	Replace the tank with one that is the correct size.
There is insufficient air charging of the tank or piping is leaking	Pump air into the tank or diaphragm chamber. Check the diaphragm for leaks. Check the tank and piping for leaks with soapy water. Check the air-to-water ratio in the tank.	Repair as necessary.
Plugged snifter valve or bleed orifice (causing pressure tank to be waterlogged)	Examine them for dirt or erosion.	Repair or replace as necessary.
Leak in the pressure tank or piping	Apply soapy water to pipes and tank, then watch for bubbles, indicating leaks.	Repair or replace as necessary.
The level control is defective or is not properly set	Check the setting and operation of the level control.	Readjust the level control setting (according to the manufacturer's instructions) or replace it if defective.
Pump is oversized for the application. It is outpumping the yield of the well and pumping itself dry.	Check the yield of the well (determined by the well-test) against the pump's performance curve.	Reduce the flow by throttling back the valve. – or – Change the pump.

LIMITED WARRANTY

Products manufactured by GRUNDFOS are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS' manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

MANUFACTURER WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE. EXCEPT AS EXPRESSLY HEREIN PROVIDED THE GOODS ARE SOLD "AS IS", THE ENTIRE RISK AS TO QUALITY AND FITNESS FOR A PARTICULAR PURPOSE, AND PERFORMANCE OF THE GOODS IS WITH THE BUYER, AND SHOULD THE GOODS PROVE DEFECTIVE FOLLOWING THEIR PURCHASE, THE BUYER AND NOT THE MANUFACTURER, DISTRIBUTOR, OR RETAILER ASSUMES THE ENTIRE RISK OF ALL NECESSARY SERVICING OR REPAIR.

Some jurisdictions do not allow the exclusion or limitation of implied warranties of merchantability and fitness for a particular purpose, of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last or require you to pay certain expenses as set forth above. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

BE > THINK > INNOVATE >

Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

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L-SP-TL-048 Rev. 3/09(US)

HDPE Pipe

- **Items highlighted in Blue indicates standard stocking items that are more readily available.**
- **Pressures are based on using water at 23°C (73°F).**
- **Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.**
- **Service factors should be utilized to compensate for the effect of liquids other than water, and for other temperatures.**
- **Other piping sizes or DR's may be available upon request.**
- **Standard Lengths:**
  40' for 2"-24"
  50' for 26" and larger
  Coils available for 3/4"-6"(8" by special order)

PE 4710 IPS HDPE Pipe Sizes

Pressure Rating	Nominal Size	1"	1 1/4"	1 1/2"	2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"
	Actual O.D.	1.32"	1.660"	1.90"	2.38"	3.500"	4.50"	5.563"	6.625"	8.625"	10.750"	12.75"	14.00"	16.00"	18.00"
DR 7 (333psi)	Min. wall	0.188"	0.237"	0.271"	0.339"	0.500"	0.643"	0.795"	0.946"	1.232"	1.536"	1.821"	2.000"	2.286"	2.571"
	Average I.D.	0.917"	1.157"	1.325"	1.656"	2.440"	3.137"	3.878"	4.619"	6.013"	7.494"	8.889"	9.760"	11.154"	12.549"
	Weight lb/lf	0.291	0.463	0.607	0.950	2.060	3.402	5.200	7.374	12.498	19.416	27.312	32.930	43.010	54.435
DR 7.3 (312psi)	Min. wall	0.180"	0.227"	0.260"	0.325"	0.479"	0.616"	0.762"	0.908"	1.182"	1.473"	1.747"	1.918"	2.192"	2.466"
	Average I.D.	0.933"	1.178"	1.348"	1.685"	2.484"	3.193"	3.947"	4.701"	6.120"	7.628"	9.047"	9.934"	11.353"	12.773"
	Weight lb/lf	0.281	0.450	0.590	0.920	1.990	3.290	5.022	7.130	12.070	18.750	26.380	31.810	41.550	52.580
DR 9 (250psi)	Min. wall	0.146"	0.184"	0.211"	0.264"	0.389"	0.500"	0.618"	0.736"	0.958"	1.194"	1.417"	1.556"	1.778"	2.000"
	Average I.D.	1.005"	1.269"	1.452"	1.816"	2.676"	3.440"	4.253"	5.064"	6.593"	8.218"	9.747"	10.702"	12.231"	13.760"
	Weight lb/lf	0.235	0.374	0.490	0.770	1.664	2.751	4.204	5.963	10.110	15.700	22.085	26.630	34.780	44.020
DR 11 (200psi)	Min. wall	0.120"	0.151"	0.173"	0.216"	0.318"	0.409"	0.506"	0.602"	0.784"	0.977"	1.159"	1.273"	1.455"	1.636"
	Average I.D.	1.062"	1.340"	1.534"	1.917"	2.825"	3.633"	4.491"	5.348"	6.963"	8.678"	10.293"	11.302"	12.916"	14.531"
	Weight lb/lf	0.200	0.314	0.411	0.642	1.395	2.310	3.523	5.000	8.470	13.160	18.510	22.320	29.150	36.890
DR 13.5 (160psi)	Min. wall	---	---	---	0.176"	0.259"	0.333"	0.412"	0.491"	0.639"	0.796"	0.944"	1.037"	1.185"	1.333"
	Average I.D.	---	---	---	2.002"	2.950"	3.793"	4.689"	5.585"	7.271"	9.062"	10.748"	11.801"	13.487"	15.173"
	Weight lb/lf	---	---	---	0.534	1.160	1.920	2.928	4.152	7.040	10.932	15.380	18.540	24.220	30.651
DR 15.5 (138psi)	Min. wall	---	---	---	0.153"	0.226"	0.290"	0.359"	0.427"	0.556"	0.694"	0.823"	0.903"	1.032"	1.161"
	Average I.D.	---	---	---	2.050"	3.021"	3.885"	4.802"	5.719"	7.445"	9.280"	11.006"	12.085"	13.812"	15.538"
	Weight lb/lf	---	---	---	0.470	1.020	1.687	2.580	3.656	6.197	9.626	13.530	16.310	21.300	26.950
DR 17 (125psi)	Min. wall	---	---	---	0.140"	0.206"	0.265"	0.327"	0.390"	0.507"	0.632"	0.750"	0.824"	0.941"	1.059"
	Average I.D.	---	---	---	2.079"	3.064"	3.939"	4.869"	5.799"	7.549"	9.409"	11.160"	12.254"	14.005"	15.755"
	Weight lb/lf	---	---	---	0.431	0.940	1.550	2.360	3.360	5.690	8.834	12.430	14.983	19.570	24.770
DR 21 (100psi)	Min. wall	---	---	---	---	---	0.214"	0.265"	0.315"	0.411"	0.512"	0.607"	0.667"	0.762"	0.857"
	Average I.D.	---	---	---	---	---	4.046"	5.001"	5.956"	7.754"	9.665"	11.463"	12.587"	14.385"	16.183"
	Weight lb/lf	---	---	---	---	---	1.270	1.940	2.750	4.662	7.242	10.190	12.282	16.042	20.304
DR 26 (80 psi)	Min. wall	---	---	---	---	---	0.173"	0.214"	0.255"	0.332"	0.413"	0.490"	0.538"	0.615"	0.692"
	Average I.D.	---	---	---	---	---	4.133"	5.109"	6.085"	7.922"	9.873"	11.710"	12.858"	14.695"	16.532"
	Weight lb/lf	---	---	---	---	---	1.035	1.582	2.250	3.800	5.910	8.312	10.022	13.090	16.570
DR 32.5 (63 psi)	Min. wall	---	---	---	---	---	0.138"	0.171"	0.204"	0.265"	0.331"	0.392"	0.431"	0.492"	0.554"
	Average I.D.	---	---	---	---	---	4.206"	5.200"	6.193"	8.062"	10.049"	11.918"	13.087"	14.956"	16.826"
	Weight lb/lf	---	---	---	---	---	0.835	1.280	1.811	3.070	4.770	6.710	8.090	10.561	13.370

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IPS HDPE Fittings

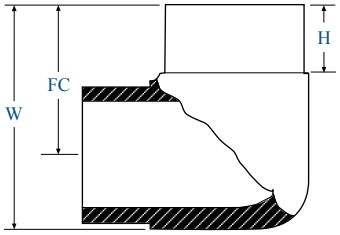
Pressure Rating of Molded Fittings are equal to pipe of same DR.

Molded Fittings from 3608 resin:	
DR	**Pressure Rating**
7	267 psi
9	200 psi
11	160 psi
13.5	128 psi
15.5	110 psi
17	100 psi
21	80 psi
26	64 psi
32.5	51 psi

Molded Fittings from 4710 resin:	
DR	**Pressure Rating**
7	333 psi
9	250 psi
11	200 psi
13.5	160 psi
15.5	138 psi
17	125 psi
21	100 psi
26	80 psi
32.5	63 psi

Note: *Size/DR listings shown are commonly requested. Many DR options not listed are available. Please consult an ISCO representative for availability.*

IPS Molded 90° Elbow



IPS Molded 90° Elbow

Nominal Size(in)	Pipe OD(in)	DR	Part #	Dimensions H (in)	FC (in)	W (in)	Weight (lbs)	Shipping Method
3/4	1.05	11	ISMF9007511IPS	2.05	2.68	3.2	0.05	FedEx
1	1.315	11	ISMF900111IPS	2.17	2.91	3.57	0.1	FedEx
1-1/4	1.66	11	ISMF9012511IPS	2.44	3.35	4.18	0.15	FedEx
1-1/2	1.9	11	ISMF901511IPS	2.64	3.7	4.65	0.22	FedEx
2	2.375	09	ISMF900209IPS	2.5	4.25	5.815	0.5	FedEx
		11	ISMF900211IPS	"	"	"	0.43	"
3	3.5	09	ISMF900309IPS	3	5.25	7.4	1.5	FedEx
		11	ISMF900311IPS	"	"	"	1.2	"
		17	ISMF900317IPS	"	"	"	0.8	"
4	4.5	09	ISMF900409IPS	3	5.875	8.25	3	FedEx
		11	ISMF900411IPS	"	"	"	2.4	"
		17	ISMF900417IPS	"	"	"	1.6	"
6	6.625	09	ISMF900609IPS	4.125	8	12.5	7	FedEx
		11	ISMF900611IPS	"	"	"	6.7	"
		17	ISMF900617IPS	"	"	"	4.8	"
8	8.625	11	ISMF900811IPS	6	12	16.5	15	FedEx
		17	ISMF900817IPS	"	"	"	10	"
10	10.75	11	ISMF901011IPS	6	13.25	18.875	27	FedEx
		17	ISMF901017IPS	"	"	"	18	"
12	12.75	11	ISMF901211IPS	7.5	15.88	22.555	41	FedEx
		17	ISMF901217IPS	"	"	"	27	"

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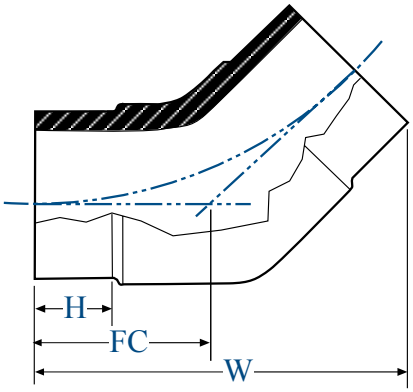
IPS Molded 45° Elbow



IPS Molded 45° Elbow

Nominal Size(in)	Pipe OD(in)	DR	Part #	Dimensions H (in)	FC (in)	W (in)	Weight (lbs)	Shipping Method
3/4	1.05	11	ISMF4507511IPS	2.05	2.28	4.29	0.05	FedEx
1	1.315	11	ISMF450111IPS	2.17	2.48	4.69	0.08	FedEx
1-1/4	1.66	11	ISMF45012511IPS	2.44	2.83	5.31	0.14	FedEx
1-1/2	1.9	11	ISMF4501511IPS	2.64	3.07	5.91	0.21	FedEx
2	2.375	11	ISMF450211IPS	2.64	3.23	6.38	0.35	FedEx
3	3.5	09	ISMF450309IPS	3.125	5.25	10.20	2.5	FedEx
		11	ISMF450311IPS	"	"	"	1.5	"
		17	ISMF450317IPS	"	"	"	1	"
4	4.5	09	ISMF450409IPS	3.125	5	10.13	3	FedEx
		11	ISMF450411IPS	"	"	"	2	"
		17	ISMF450417IPS	"	"	"	2	"
6	6.625	09	ISMF450609IPS	4.125	9	17.70	6	FedEx
		11	ISMF450611IPS	"	"	"	5.5	"
		17	ISMF450617IPS	"	"	"	5	"
8	8.625	11	ISMF450811IPS	6	11	21.8	12	FedEx
		17	ISMF450817IPS	"	"	"	11	"
10	10.75	11	ISMF451011IPS	6	13.25	26.42	22	FedEx
		17	ISMF451017IPS	"	"	"	20	"
12	12.75	11	ISMF451211IPS	7.5	15.75	31.39	32	FedEx
		17	ISMF451217IPS	"	"	"	29	"

IPS
HDPE
Fittings

Pressure Rating of Molded Fittings are equal to pipe of same DR.

Molded Fittings from 3608 resin:

DR	Pressure Rating
7	267 psi
9	200 psi
11	160 psi
13.5	128 psi
15.5	110 psi
17	100 psi
21	80 psi
26	64 psi
32.5	51 psi

Molded Fittings from 4710 resin:

DR	Pressure Rating
7	333 psi
9	250 psi
11	200 psi
13.5	160 psi
15.5	138 psi
17	125 psi
21	100 psi
26	80 psi
32.5	63 psi

Note: *Size/DR listings shown are commonly requested. Many DR options not listed are available. Please consult an ISCO representative for availability.*

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IPS HDPE Fittings

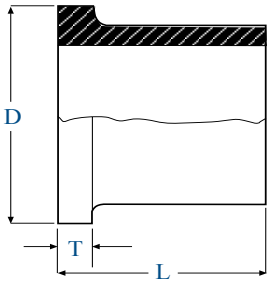
Pressure Rating of Flanges are equal to pipe of same DR.

Flanges from 3608 resin:	
DR	**Pressure Rating**
7	267 psi
9	200 psi
11	160 psi
13.5	128 psi
15.5	110 psi
17	100 psi
21	80 psi
26	64 psi
32.5	51 psi

Flanges from 4710 resin:	
DR	**Pressure Rating**
7	333 psi
9	250 psi
11	200 psi
13.5	160 psi
15.5	138 psi
17	125 psi
21	100 psi
26	80 psi
32.5	63 psi

Note: *Size/DR listings shown are commonly requested. Many DR options not listed are available. Please consult an ISCO representative for availability.*

IPS Flange Adapter



IPS Flange Adapter

Nominal Size	Pipe OD (in)	DR	D (in)	Dimensions T(in)	L (in)	Weight (lbs)	Shipping Method
3/4	1.05	11	2	0.2	4	0.1	FedEx
1	1.315	11	2.375	0.21 - 0.24	4	0.1	FedEx
1-1/4	1.66	11	2.75	0.25	4 - 6	0.2	FedEx
1-1/2	1.9	11	3.125	0.29 - 0.3	4 - 6	0.2	FedEx
2	2.375	7	3.75 - 4.0	0.39 - 0.44	5.5 - 6	1	FedEx
		9	“	0.39 - 0.44	5.5 - 6	1	“
		11,17	“	0.3 - 0.55	5.5 - 6.125	1	“
3	3.5	7,9	4.625 - 5	0.6 - 0.63	6	2	FedEx
		11,17	“	0.4 - 0.67	6 - 6.125	2	“
4	4.5	7	6.0 - 6.625	0.54 - 0.8	6	3	FedEx
		9	“	0.54 - 0.8	6	3	“
		11,17,21	“	0.5 - 0.8	6 - 7.125	3	“
6	6.625	7	8.125 - 8.625	1.1 - 1.14	8 - 8.125	8	FedEx
		9	“	1.1 - 1.14	8 - 8.125	8	“
		11,17,21	“	0.7 - 1.02	8 - 8.07	4.07 - 7	“
		26, 32.5	“	1	8	7	“
8	8.625	7	10.6 - 10.75	1.4 - 1.5	8.625 - 9	11	FedEx
		9	“	1.13 - 1.47	8.625 - 9	10.0 - 11	“
		11	“	0.8 - 1.26	9.02 - 11	7.0 - 10	“
		17	“	0.9 - 1.02	9.02 - 11	5.0 - 10	“
		21,26, 32.5	“	0.9 - 1	11	5.0 - 10	“
10	10.75	7	12.75 - 13	1.28 - 2	8.75 - 12	19	FedEx
		9	“	1.28 - 2	8.75 - 12	19	“
		11	“	1.1 - 1.38	9.02 - 12	18	“
		17	“	0.9 - 1.28	9.02 - 12	18	“
		21,26, 32.5	“	1.1 - 1.28	11.0 - 12	18	“
12	12.75	7	15 - 15.75	1.54 - 2.3	9.125 - 12	25	FedEx
		9	“	1.54 - 2.3	9.125 - 12	25	“
		11	“	1.3 - 1.54	10.79 - 12	24	“
		17	“	1 - 1.54	10.79 - 12	24	“
		21,26, 32.5	“	1.3 - 1.5	11.0 - 12	24	“
14	14.00	7	17.0 - 17.5	1.5 - 2.35	12	41.8	FedEx
		9	“	1.5 - 2.35	12	35.9	“
		11	“	1.5 - 1.7	11.0 - 12	40	“
		17	“	1.1 - 1.6	11.0 - 12	40	“
		21,26, 32.5	“	1.5 - 1.6	11 - 11.5	40	“
16	16.00	7	19.5 - 20	1.75 - 2.69	12	56.2	FedEx
		9	“	1.75 - 2.69	12	48.5	“
		11	“	1.7 - 1.9	11.5 - 12	60	“
		17	“	1..2 - 1.8	11.5 - 12	60	“
		21,26, 32.5	“	1.7 - 1.8	11.5 - 12	60	“

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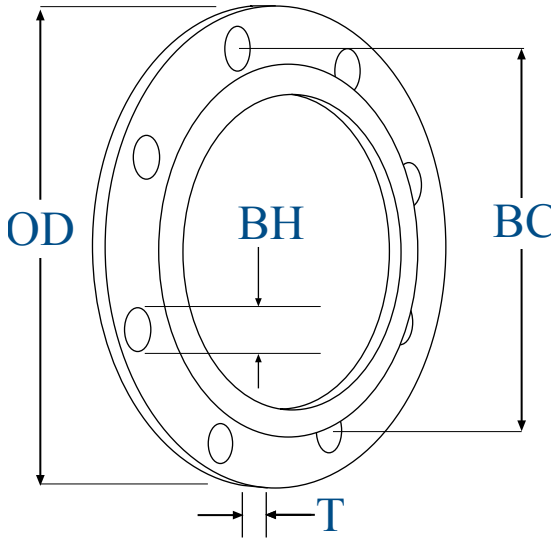
IPS Back-Up Rings (For use with the Flange Adapter)



IPS Back-Up Rings (For use with the Flange Adapter)

Nominal Size(in)	Pipe OD(in)	Material	Dimensions OD(in)	T(in)	Bolts(#)	BH(in)	BC(in)	Pressure Rating	Weight (lbs)	Shipping Method
3/4	1.05	Ductile Iron	3.875	0.5 - 0.53	4	0.625	2.75	267	1	FedEx
1	1.315	Ductile Iron	4.25	0.53 - 0.56	4	0.625	3.125	267	1	FedEx
		Stainless Steel	“	0.56	“	“	“	267	2	“
1 1/4	1.66	Ductile Iron	4.625	0.63	4	0.625	3.5	267	2	FedEx
1 1/2	1.9	Ductile Iron	5	0.69	4	0.625	3.875	267	2	FedEx
		Stainless Steel	“	0.69	“	“	“	267	2	“
2	2.375	Ductile Iron	6	0.5, 0.75	4	0.75	4.75	160, 267	1.5, 3	FedEx
		PP Coated DI	6.5	0.71	“	“	“	128, 275	1.8	“
		Stainless Steel	6	0.4, 0.75	“	“	“	160, 267	2, 2.6	“
3	3.5	Ductile Iron	7.5	0.53, 0.94	4	0.75	6	160, 267	2.5, 4.5	FedEx
		PP Coated DI	7.8	0.71, 0.73	“	“	“	128, 275	2.4 “	
		Stainless Steel	7.5	0.4, 0.94	“	“	“	128, 267	3, 5“	
4	4.5	Ductile Iron	9	0.55, 0.94	8	0.75	7.5	160, 267	3.5, 5.5	FedEx
		PP Coated DI	9.21	0.71, 0.98	“	“	“	128, 275	2.5, 4.2	“
		Stainless Steel	9	0.5 - 0.94	“	“	“	128, 267	5, 6“	
6	6.625	Ductile Iron	11	0.63, 1	8	0.875	9.5	160, 267	4.5, 7.5	FedEx
		PP Coated DI	11.57	0.79, 1.18	“	“	“	128, 275	4.0, 7.1	“
		Stainless Steel	11	0.6, 1	“	“	“	128, 267	6, 9“	
8	8.625	Ductile Iron	13.5	0.85, 1.125	8	0.875	11.75	160, 267	8, 12	FedEx
		PP Coated DI	13.86	1.1, 1.34	“	“	“	128, 275	7.5, 11.6	“
		Stainless Steel	13.5	0.7 - 1.13	“	“	“	128, 267	9, 13	“
10	10.75	Ductile Iron	16	0.98, 1.19	12	1	14.25	160, 267	12, 16	FedEx
		PP Coated DI	16.61	1.22, 1.52	“	“	“	128, 275	10.5, 16	“
		Stainless Steel	16	0.9, 1.19	“	“	“	128, 267	12, 18	“
12	12.75	Ductile Iron	19	1.25 - 1.5	12	1	17	160 - 267	20, 25	FedEx
		PP Coated DI	19.37	1.61, 2.01	“	“	“	128, 275	17.5, 28.2	“
		Stainless Steel	19	1.05 - 1.77	“	“	“	128 - 267	21 - 37	“

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IPS HDPE Fittings

Pressure Rating of Con. Reducers are equal to pipe of same DR.

Reducers from 3608 resin:

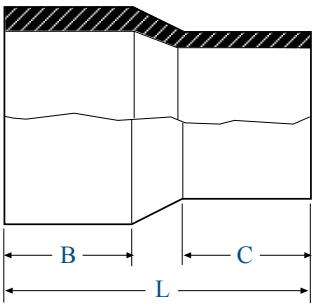
DR	Pressure Rating
7	267 psi
9	200 psi
11	160 psi
13.5	128 psi
15.5	110 psi
17	100 psi
21	80 psi
26	64 psi
32.5	51 psi

Reducers from 4710 resin:

DR	Pressure Rating
7	333 psi
9	250 psi
11	200 psi
13.5	160 psi
15.5	138 psi
17	125 psi
21	100 psi
26	80 psi
32.5	63 psi

Note: *Size/DR listings shown are commonly requested. Many DR options not listed are available. Please consult an ISCO representative for availability.*

IPS Concentric Reducer



IPS Concentric Reducer

Nominal Size(in)	Pipe OD(in)	DR	Part #	Dimensions L (in)	B (in)	C (in)	Weight (lbs)	Shipping Method
1 x 3/4	1.315 x 1.05	09	ISMFCR01X3/49.3	4.5	1.5	2.5	0.1	FedEx
		11	ISMFCR01X3/411	"	"	"	"	"
1-1/4 x 1	1.66 x 1.315	11	ISMFCR0125X111	4.3	1.8	1.25	0.1	FedEx
1-1/2 x 3/4	1.9 x 1.05	09	ISMFCR015X3/49I	5.688	2.5	2.5	0.2	FedEx
		11	ISMFCR015X3/411	"	"	"	"	"
1-1/2 x 1	1.9 x 1.315	09	ISMFCR015X0193I	6	3.25	1.25	0.2	FedEx
		11	ISMFCR015X0111	"	"	"	"	"
1-1/2 x 1-1/4	1.9 x 1.66	11	ISFFCR01.5X1.25	4	1.88	2	0.2	FedEx
2 x 3/4	2.375 x 1.05	11	ISMFCR02X07511I	6.25	3.25	1.25	0.3	FedEx
2 x 1	2.375 x 1.315	11	ISMFCR02X0111IP	6.25	3.25	1.25	0.3	FedEx
2 x 1-1/4	2.375 x 1.66	11	ISMFCR02X012511	6.25	3.25	2.25	0.3	FedEx
2 x 1-1/2	2.375 x 1.9	09	ISMFCR02X01509I	7	3	2.5	0.3	FedEx
		11	ISMFCR02X01511I	"	"	"	"	"
3 x 2	3.5 x 2.375	09	ISMFCR03X0209IP	6.75	3	2.5	0.7	FedEx
		11	ISMFCR03X0211IP	"	"	"	"	"
4 x 2	4.5 x 2.375	11	ISMFCR04X0211IP	7.5	3	2.5	1.2	FedEx
		17	ISMFCR04X0217IP	"	"	"	0.8	"
4 x 3	4.5 x 3.5	09	ISMFCR04X0309IP	7.25	2.75	2.75	4	FedEx
		11	ISMFCR04X0311IP	"	"	"	3	"
		17	ISMFCR04X0317IP	"	"	"	2	"
5 x 4	5.563 x 4.5	11	ISMFCR05X0411IP	3.75	1.75	1.25	2.5	FedEx
6 x 3	6.625 x 3.5	11	ISMFCR06X0311IP	11.42	5.12	3.94	3	FedEx
		17	ISMFCR06X0317IP	"	"	"	2	"
6 x 4	6.625 x 4.5	09	ISMFCR06X0409IP	11	4.5	3.5	4	FedEx
		11	ISMFCR06X0411IP	"	"	"	3.5	"
		17	ISMFCR06X0417IP	"	"	"	2.4	"
6 x 5	6.625 x 5.563	11	ISMFCR06X0511IP	3.75	1.75	1.25	2.5	FedEx
8 x 6	8.625 x 6.625	09	ISFFCR08X0609IP	12	4.5	4	9	FedEx
		11	ISMFCR08X0611IP	"	"	"	7.3	"
		17	ISMFCR08X0617IP	"	"	"	5	"
10 x 8	10.75 x 8.625	09	ISFFCR10X0809IP	16	6	6	16	FedEx
		11	ISFFCR10X0811IP	"	"	"	13	"
		17	ISFFCR10X0817IP	"	"	"	9	"
12 x 8	12.75 x 8.625	11	ISFFCR12X0811IP	16	6	6	19	FedEx
		17	ISFFCR12X0817IP	"	"	"	13	"
12 x 10	12.75 x 10.75	09	ISFFCR12X1009IP	16	6	6	25	FedEx
		11	ISFFCR12X1011IP	"	"	"	21	"
		17	ISFFCR12X1017IP	"	"	"	14	"
14 x 12	14.0 x 12.75	09	ISFFCR14X1209IP	18	7	7	34	FedEx
		11	ISFFCR14X1211IP	"	"	"	28	"
		17	ISFFCR14X1217IP	"	"	"	19	"

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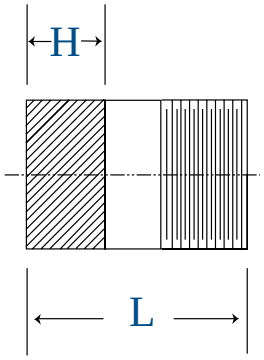
IPS Male Threaded Transition Fitting



IPS Male Threaded Transition

Nominal Size (in)	Pipe OD (in)	Material	Part #	Dimensions L (in)	Dimensions H (in)	Weight (lbs)	Shipping Method
3/4	1.05	Steel	ISFFTF003/411IP	4	2.4	.17	FedEx
		Stainless Steel	ISFFTF003/411SS	"	"	"	"
		Brass	ISFFTF003/411BI	"	"	"	"
1	1.315	Steel	SFFTF0111IPS	5	3	.27	FedEx
		Stainless Steel	ISFFTF0111IPSSS	"	"	"	"
		Brass	ISFFTF0111BIPS	"	"	"	"
1 1/4	1.66	Steel	ISFFTF01.2511IP	5	3.4	.27	FedEx
		Stainless Steel	ISFFTF01.2511SS	"	"	"	"
		Brass	ISFFTF01.2511BI	"	"	"	"
1 1/2	1.9	Steel	ISFFTF01.511IPS	6	3.4	.55	FedEx
		Stainless Steel	ISFFTF01.5011SS	"	"	"	"
		Brass	ISFFTF01.511BIP	"	"	"	"
2*	2.375	Steel	ISFFTF0211IPS	8	4.5	1	FedEx
		Stainless Steel	ISFFTF0211IPSSS	"	"	"	"
		Brass	ISFFTF0211BIPS	"	"	"	"
3	3.5	Steel	ISFFTF0311IPS	8	4	2.4	FedEx
		Stainless Steel	ISFFTF0311IPSSS	"	"	"	"
		Brass	ISFFTF0311BIPS	"	"	"	"
4	4.5	Steel	ISFFTF0411IPS	8	4	4.3	FedEx
		Stainless Steel	ISFFTF0411IPSSS	"	"	"	"
6	6.625	Steel	ISFFTF0611IPS	12	7.5	12	FedEx
		Stainless Steel	ISFFTF0611IPSSS	"	"	"	"
8	8.625	Steel	ISFFTF0811IPS	13	6	20.7	FedEx
		Stainless Steel	ISFFTF0811IPSSS	"	"	"	"
10	10.75	Steel	ISFFTF1011IPS	15	7	38.1	FedEx
		Stainless Steel	ISFFTF1011IPSSS	"	"	"	"
12	12.75	Steel	ISFFTF1211IPS	16	7	57.1	FedEx
		Stainless Steel	ISFFTF1211IPSSS	"	"	"	"

*** Consider a using transition union (to PVC) on page 130 of this catalog as an atlernate connection fitting for/to HDPE.**
****Female Transitions available through 8" in same materials as male counterparts.**

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GO TO GEOTECH

Pressure Transducers

Geotech Gauge Pressure Transducers

Geotech's submersible pressure transducers are designed for ruggedness and long life to meet the harsh environments encountered in liquid level measurement and control.

FEATURES

- **High static accuracy and repeatability**
- **100% computer tested, calibrated and temperature compensated**
- **750' (229m) maximum cable length**
- **All wetted materials are #316 stainless steel**
- **Sensor has ¼" NPT process fitting with protective cap**
- **Vent line in cable allows barometric compensation of level readings**
- **Field replaceable vent line desiccant cartridge, or the maintenance-free aneroid bellows option is available**
- **Optional surge suppressor for lightning protection**

SPECIFICATIONS

Electrical:	**Supply Voltage**	12-36 Volt DC
	Supply Current	25 mA
	Output	1-5 Volt DC, 4-20 mA
Performance:	**Pressure Ranges (psi)**	0-3, 0-5, 0-15, 0-30, 0-50, 0-100, 0-150
	Pressure Ranges (bar)	0-.2, 0-.34, 0-1, 0-2, 0-3.5, 0-7, 0-10 Custom ranges available
	Accuracy	±0.1% of full scale
	Non-linearity	.07% of full scale
	Repeatability	0.015% of full scale
	Pressure Hysteresis	0.010% of full scale
	Zero Error	±0.1% of full scale
	Span Error	±0.1% of full scale
	Compensated Temperature	-4° to 185°F (-20° to 85°C)
	Operating Temperature	-40° to 257°F (-40° to 125°C)
	Response Time	2 milliseconds
	Life	1 million pressure cycles
Physical:	**Sensor Length (Includes 2" Strain Relief)**	8.6" (21.8 cm) with Surge Suppressor 7.7" (19.6 cm) without Surge Suppressor
	Sensor Diameter	.72" (1.8 cm)
	Sensor Weight	4.3 oz. (122 g)
	Proof Pressure	3x psi
	Burst Pressure	5x psi
	Media Compatibility	Liquids or gases compatible with 316 SS
Cable:	**Jacket**	Polyurethane or Tefzel®
	Diameter	.25" ±.01" (6.35mm ±.25mm)
	Conductors	2-24 AWG 7/32 tinned copper Red – White
	Drain	24 AWG 7/32 tinned copper bare
	Vent Tube	Nylon 6 / 6 vent tube

Note: Probe is protected from reverse polarity supply connection.

Field Replaceable Vent Line Desiccant Cartridge

Maintenance-Free Aneroid Bellows Option

Gauge Pressure Transducer

Gauge Pressure Transducer with Optional Surge Suppressor

APPLICATIONS

- **Groundwater Monitoring**
- **Surface Water Monitoring**
- **Well Monitoring**
- **Wetland Studies**
- **Remediation Pump Control**
- **Landfill Pump Control**
- **Fluid Level Control**

CALL GEOTECH TODAY (800) 833-7958

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ELECTRICAL AND CONTROL SYSTEM MATERIALS

KELSO-BURNETT Co.

1378 Saint Paul Ave · Gurnee, IL 60031 · 847 / 746-2300 · Fax 847 / 746-2340 · Cell 847 / 997-9304

Electrical Submittals

TO: The Denovo Group
1884 E. Fabyan Pkwy
Batavia, IL 60510
Attn: Ben O'Connor

July 8, 2013

SUBJECT: Outboard Marine Project – Waukegan: Electrical Submittals (Cable Only)

Kelso-Burnett is submitting the following electrical items for approval:

1) Cable for ODC-EW-1 and ODC-EW-2:
   Nexans Ultrex VN: #697904, 4C/#8 Cable replaced in 2016
   ~~Nexans Ultrex VN: #627968, 4C/#6~~
   The partial Belden part # in the specifications doesn't correspond to any type of cable we would use for this application.
   See attached
2) Cable for ODC-PZ-#'s:
   Lake Cable: #TX162S (Lead time for this cable is 3 weeks)
   See Attached

Sincerely,

Kris Murray

Kris Murray
Project Manager/Estimator

Contact
Industrial Cables
Phone: 845-469-2141
USA.IndustrialCable@nexans.com

ULTREX® VN Unshielded Tray Cable - DuPont Construction*

Type THHN/THWN-2: UL Type TC, 600 V, rated 90ºC dry and wet - LEAD FREE - Exposed Run (ER) Rated**

Description

Applications

Nexans 600 V Ultrex VN Tray Cables are listed as type TC / TC-ER under UL 1277 Electrical Power and Control Cables. These cables may be installed in wet or dry locations; in cable trays, raceways and open air; and are suitable for exposure to weather, direct burial and for Class I, Div. 2 (also Zone 2) and Class II, Div. 2 hazardous locations per NEC 2008 and NEC 2011. Cables with three or more conductors are UL listed for exposed runs (ER) when installed in accordance with NEC 2008 and NEC 2011 Article 336.10(7).

Construction

Conductor:

Bare, annealed copper conforming to ASTM B3 and Class B stranded in accordance to ASTM B8, from 18 AWG to 500 kcmil. Compressed copper for 14 AWG through 500 kcmil.

Insulation:

Flame-retardant PVC/Nylon type THHN/THWN-2 per UL 83 for sizes 14 AWG to 500 kcmil.

Assembly:

Non-shielded: cables with 3 or more conductors and cabled in concentric layers with interstices filled with suitable fillers, as required. Two-conductor cables are supplied in a flat/parallel configuration. Ground wires, are sized as required by UL 1277 (refer to applicable product tables for the standard sizes provided). Sizes 14 AWG to 6 AWG have an insulated green ground wire. Size 4 AWG and larger have a bare ground wire. Where necessary, a binder tape of synthetic material assembles the core in a tight circular configuration.

Shielded: cabled in concentric layers with interstices filled with suitable fillers as required. A helically wrapped aluminum tape, with synthetic backing, gives 100% shielding. A tinned copper drain wire is placed in contact with the aluminum side of the tape, to lower the resistance and to assist in the termination of the shield.

Jacket:

UL listed sunlight and moisture resistant, sequentially length marked, black, flame retardant polyvinyl chloride (PVC) material meeting the requirements of UL 1277. A Nylon ripcord is included for ease of jacket removal.

Standards

National ICEA S-73-532; ICEA S-95-658; UL 1277; UL 83

Rated Voltage Uo/U (Um)
600 V

Maximum operating temperature
90 °C

All drawings, designs, specifications, plans and particulars of weights, size and dimensions contained in the technical or commercial documentation of Nexans is indicative only and shall not be binding on Nexans or be treated as constituting a representation on the part of Nexans.

Contact
Industrial Cables
Phone: 845-469-2141
USA.IndustrialCable@nexans.com

ULTREX® VN Unshielded Tray Cable - DuPont Construction*

Characteristics

Construction characteristics	
Conductor material	Copper
Electrical characteristics	
Rated Voltage Uo/U (Um)	600 V
Usage characteristics	
Maximum operating temperature	90 °C

Rated Voltage Uo/U (Um)
600 V

Maximum operating temperature
90 °C

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USA.IndustrialCable@nexans.com

ULTREX® VN Unshielded Tray Cable - DuPont Construction*

Unshielded ULTREX® VN Tray Cable - DuPont Construction*

Type THHN/THWN-2: UL Type TC / TC-ER, 600 V, 90°C dry / wet rated – LEAD FREE

Part Number	# of Conductors	Jacket Thickness		Nominal Diameter over Jacket		Approximate Net Cable Weight		Ampacity (2)
		mils	mm	inches	mm	lb/kft	kg/km	amps
Multiconductor 14 AWG Type THHN/THWN-2 Insulation Thickness: 15 mils / 0.38 mm PVC, 4 mils /0 .10 mm Nylon Covering								
697821	2	45	1.14	0.207x0.320	5.26x8.13	57	85	25
627505	3	45	1.14	0.370	9.398	79	118	25
631192	4	45	1.14	0.373	9.474	99	147	20/25(1)
684738	5	45	1.14	0.395	10.033	119	177	20
697839	7	45	1.14	0.439	11.151	152	226	17.5
627653	9	45	1.14	0.510	12.954	200	298	17.5
631523	19	60	1.52	0.690	17.526	400	595	12.5
Multiconductor 12 AWG Type THHN/THWN-2 Insulation Thickness: 15 mils / 0.38 mm PVC, 4 mils /0 .10 mm Nylon Covering								
631168	2	45	1.14	0.225x0.355	5.72x9.02	77	114	30
631515	3	45	1.14	0.384	9.754	108	161	30
631176	4	45	1.14	0.419	10.643	137	203	24/30(1)
684688	7	45	1.14	0.490	12.446	217	323	21
Multiconductor 10 AWG Type THHN/THWN-2 Insulation Thickness: 20 mils / 0.51 mm PVC, 4 mils / 0.10 mm Nylon Covering								
-----	2	45	1.14	0.261x0.428	6.63x10.87	112	166	40
627224	3	45	1.14	0.456	11.582	158	236	40
627232	4	45	1.14	0.498	12.649	202	301	32/40(1)
627828	7	60	1.52	0.613	15.570	348	517	28
Multiconductor 8 AWG Type THHN/THWN-2 Insulation Thickness: 30 mils /0 .76 mm PVC, 5 mils /0 .13 mm Nylon Covering								
627166	2	60	1.52	0.560	14.224	202	301	55
697870	3	60	1.52	0.588	14.935	254	378	55
697904	4	60	1.52	0.644	16.485	324	482	55(1)
Multiconductor 6 AWG Type THHN/THWN-2 Insulation Thickness: 30 mils /0 .76 mm PVC, 5 mils /0 .13 mm Nylon Covering								
627513	2	60	1.52	0.636	16.154	293	436	75
697862	3	60	1.52	0.680	17.272	363	540	75
627968	4	60	1.52	0.741	18.821	469	689	75(1)
Multiconductor 4 AWG Type THHN/THWN-2 Insulation Thickness: 40 mils / 1.02 mm PVC, 6 mils / 0.15 mm Nylon Covering								
627943	3	80	2.03	0.866	21.996	588	875	95
627950	4	80	2.03	0.950	24.130	757	1126	95(1)
Multiconductor 2 AWG Type THHN/THWN-2 Insulation Thickness: 40 mils / 1.02 mm PVC, 6 mils /0 .15 mm Nylon Covering								
684837	3	80	2.03	0.982	24.943	889	1323	130
684894	4	80	2.03	1.090	27.686	1114	1658	130(1)

Rated Voltage Uo/U (Um)
600 V

Maximum operating temperature
90 °C

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Contact
Industrial Cables
Phone: 845-469-2141
USA.IndustrialCable@nexans.com

ULTREX® VN Unshielded Tray Cable - DuPont Construction*

Unshielded ULTREX® VN Tray Cable - Composite Conductor Type THHN/THWN-2 with Insulated Ground - DuPont Construction*

Type THHN/THWN-2: UL Type TC / TC-ER, 600 V, 90°C dry / wet rated – LEAD FREE Composite: 4 Control Conductors with 3 Power Conductors and 1 Insulated Green Ground

Part Number	Control Size	Insulation Thickness PVC/Nylon		Power Size	Insulation Thickness PVC/Nylon		Ground Size	Jacket Thickness		Nominal Diameter over Jacket		Approximate Net Cable Weight		Control Ampacity	Power Ampacity
	AWG	mils	mm	AWG	mils	mm	AWG	mils	mm	inches	mm	lb/kft	kg/km	amps	amps
697813	14	45	1.14	12	45	1.14	12	60	1.52	0.515	13.08	220	328	17.5	21
697805	14	45	1.14	10	45	1.14	10	60	1.52	0.575	14.61	288	429	17.5	28

Bend Radius: 5 x overall diameter installed
8 x overall diameter during installation pull-in.

Notes for DuPont Constructions:

- **Dimensions and weights shown are nominal values, subject to standard industry tolerances.**
- **Cables with 3 or more conductors are UL listed for exposed runs (ER) when installed in accordance with NEC 2008 and NEC 2011 Article 336.10(7).**

(1) Where the 4th conductor is the neutral of a balanced 3 phase system.
(2) Conductor ampacities are in accordance with NEC 2008 Table 310.16 or NEC 2011 Table 310.15(B)(16) for conductors in a raceway or direct buried at 30°C ambient temperature and 90°C rated condcutors. Ampacities for cables having more than three conductors have been derated per NEC 2008 Table 310.15(B)(2)(a) or NEC 2011 Table 310.15(B)(3)(a).

- **For correction factors for different ambient temperatures and ampacitities at different conductor temperature ratings see NEC 310.16 or NEC 2011 Table 310.15(b)(16).**
- **NEC 2008 and NEC 2011 Article 240.4(D) requires that overcurrent protection not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper conductors after any correction factors for ambient temperature and number of conductors have been applied. Exceptions to this may be covered in NEC 2008 and NEC 2011 Article 240.4(D) through (G).**

***DuPont construction means:**
- **Conductor identification black insulation with white print - number conductors (Method 4).**
- **Nylon fillers - where applicable**
- **Mylar tape around core**

Selling delivery information

OPTIONS

The following constructions can be provided on special orders:

- Insulated green ground conductors for non-composite construction #14 to #6 AWG
- Uninsulated ground conductors for non-composite construction sizes #4 AWG and larger

* Use in Hazardous locations:
Please note that no investigation of these cables has been performed regarding the transmission of gases or vapors through the core. When these cables are used in hazardous locations they should be sealed properly as required by the NEC.

Rated Voltage Uo/U (Um)
600 V

Maximum operating temperature
90 °C

All drawings, designs, specifications, plans and particulars of weights, size and dimensions contained in the technical or commercial documentation of Nexans is indicative only and shall not be binding on Nexans or be treated as constituting a representation on the part of Nexans.

529 Thomas Drive, Bensenville, IL 60106 | TF: 888.518.8086 | FX: 630.860.5944 | www.lakecable.com

Specification Sheet

Lake Cable Part #: TX162S

Description: 16 AWG 2 conductors 7 strand bare copper wire, XLPE insulation, shielded, with an overall flame retardant PVC jacket, (UL) PLTC, ITC.

1. **Conductor**
   - 1.1. AWG Size & Stranding: 16 AWG 7 Strands Class B
   - 1.2. Material: Annealed Bare Copper
   - 1.3. **Conductor** Count: 2 Conductors

2. **Insulation**
   - 2.1. Material: Cross Linked Polyethylene
   - 2.2. Wall Thickness: 0.015"
   - 2.3. Color Code: Black, White

3. **Assembly**
   - 3.1. Nominal Lay Length: 2.75" LHL 4.36 Tw/Ft)
   - 3.2. Binder: N/A
   - 3.3. Shield: Aluminum mylar - 100% coverage
   - 3.4. Drain Wire: 18AWG 7 Strand Tinned Copper

4. **Jacket**
   - 4.1. Material: Polyvinylchloride (PVC)
   - 4.2. Wall thickness: 0.035"
   - 4.3. Diameter: 0.251"
   - 4.4. Color: Black
   - 4.5. Ripcord: Yes
   - 4.6. Weight: 43 Lbs/Mft

5. **Markings**
   - 5.1. Type: Cable shall be permanently identified via surface inkjet print
   - 5.2. Legend: LAKE CABLE E171202 16AWG 2C SHLD (UL) PLTC OR (UL) ITC XLPE 90'C DRY/WET PVC JACKET SUN RES DIR BUR FT-4 'ROHS"
   - 5.3. Footage Markers: Yes

6. **Standards**
   - 6.1. Cable suitable for installations under NEC (NFPA 70) article 725 guidelines
   - 6.1. Cable suitable for use in Class I Division II hazardous locations
   - 6.2. UL listed as Type PLTC per UL Standard 13 and ITC Type per (UL) Standard 2250
   - 6.3. UL approved for Sunlight Resistant & Direct Burial applications
   - 6.4. Meets IEEE 1202 flame test
   - 6.5. All materials used in the manufacture of this cable are RoHS compliant
   - 6.6. Recommended Operating Voltage: 300V
   - 6.7. Made in the USA

Your signature constitutes that you have read and agreed to this specification sheet and upon confirmation of your order; this item may be non-cancelable and non-returnable.

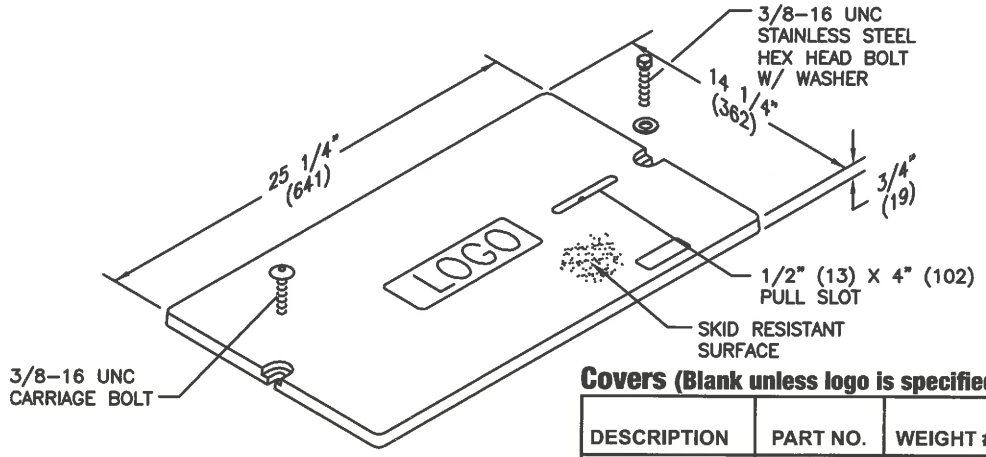
Signature

Company

ALL SPECIFIED PARAMETERS ARE NOMINAL AND SUBJECT TO VERIFICATION

SPECIFICATIONS/DATA

13" x 24" PC Style (Stackable) Assembly

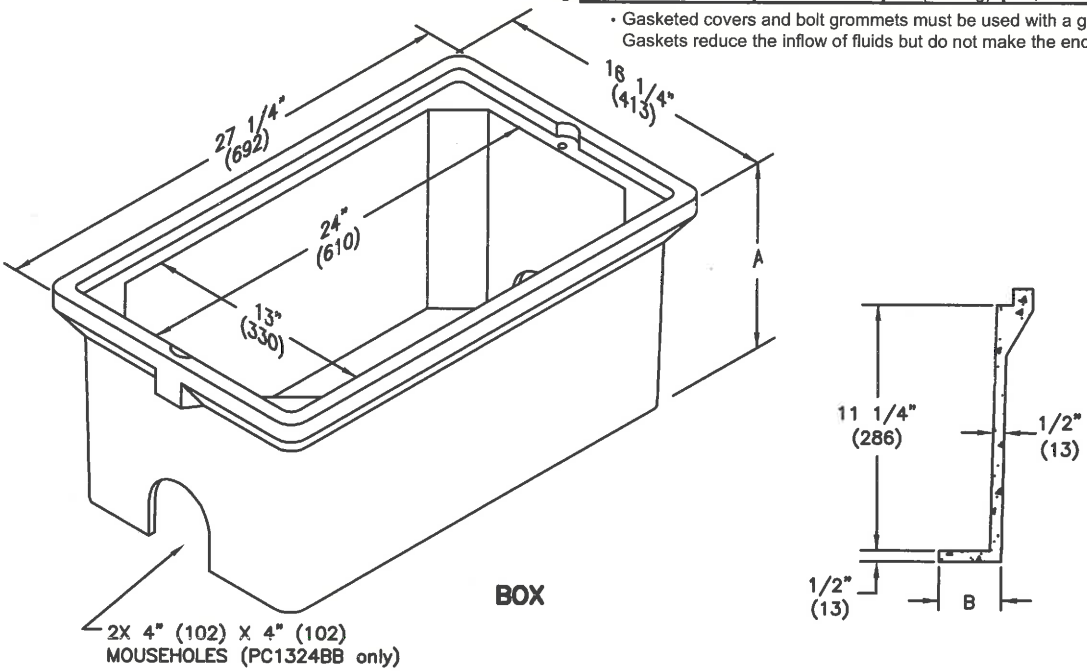


COVER

Covers (Blank unless logo is specified)

	DESCRIPTION	PART NO.	WEIGHT #	DESIGN/ TEST LOAD #	ANSI TIER*
UL	W/2 Bolts	PC1324CA00	23 (10.4 kg)	5,000 / 7,500	5
UL	Gasketed w/2 Bolts	PC1324CG00	23 (10.4 kg)	5,000 / 7,500	5
UL	No Bolts	PC1324WA00	23 (10.4 kg)	5,000 / 7,500	5

• Gasketed covers and bolt grommets must be used with a gasketed box. Gaskets reduce the inflow of fluids but do not make the enclosure water tight.



BOX

Boxes (Stackable with self-aligning, replaceable EZ-Nut)

	DESCRIPTION	PART NO.	WEIGHT #	DIMENSION A	DIMENSION B	DESIGN/TEST LOAD #	ANSI TIER*
UL	Open Bottom	PC1324BA12	50 (22.7 kg)	12" (305 mm)	N/A	5,000 / 7,500	5
UL	Open Bottom w/Gasket	PC1324BG12	50 (22.7 kg)	12" (305 mm)	N/A	5,000 / 7,500	5
UL	Open Bottom w/2 Mouseholes	PC1324BB12	50 (22.7 kg)	12" (305 mm)	N/A	5,000 / 7,500	5
UL	Solid Bottom	PC1324DA12	60 (27.2 kg)	12 1/2" (318 mm)	N/A	5,000 / 7,500	5
UL	Solid Bottom w/Gasket	PC1324DG12	60 (27.2 kg)	12 1/2" (318 mm)	N/A	5,000 / 7,500	5
UL	Footed Box	PC1324JA12	57 (25.9 kg)	12 1/2" (318 mm)	2 7/8" (73 mm)	5,000 / 7,500	5

Dimensions & weights in parentheses are metric equivalent.
* Loadings comply with ANSI/SCTE 77 (see page 9).

Most commonly used cover logos are shown below.
Custom Logos are available. Contact your Quazite/Hubbell Representative.

QUAZITE® COVER OPTIONS

POLYMER CONCRETE STYLE LOGOS	FRP & CORRUGATED STYLE LOGOS	DESCRIPTION
09	009	BLANK
10	010	CATV
12	012	COMMUNICATIONS
14	014	CONTROLS
17	017	ELECTRIC
21	021	FIBER OPTICS
22	022	FIRE ALARM
23	023	GAS
24	024	GROUND
26	026	HIGH VOLTAGE
29	029	LIGHTING
36	036	SECURITY
38	038	SIGNAL
40	040	STATE TRAFFIC SIGNAL
41	041	STREET LIGHTING
42	042	TELECOM
43	043	TELEPHONE
44	044	TRAFFIC
45	045	TRAFFIC CONTROL
46	046	TRAFFIC SIGNAL
48	048	TV
50	050	WATER
57	057	EMERGENCY
65	065	ILLUMINATION
81	081	DANGER HIGH VOLTAGE
84	084	POWER
92	092	TELECOMMUNICTIONS
3A	03A	DOT
6B	06B	INSTRUMENTATION
ZA	0ZA	IRRIGATION
K91	K91	RECLAIMED WATER
KH1	KH1	FIBEROPTIC

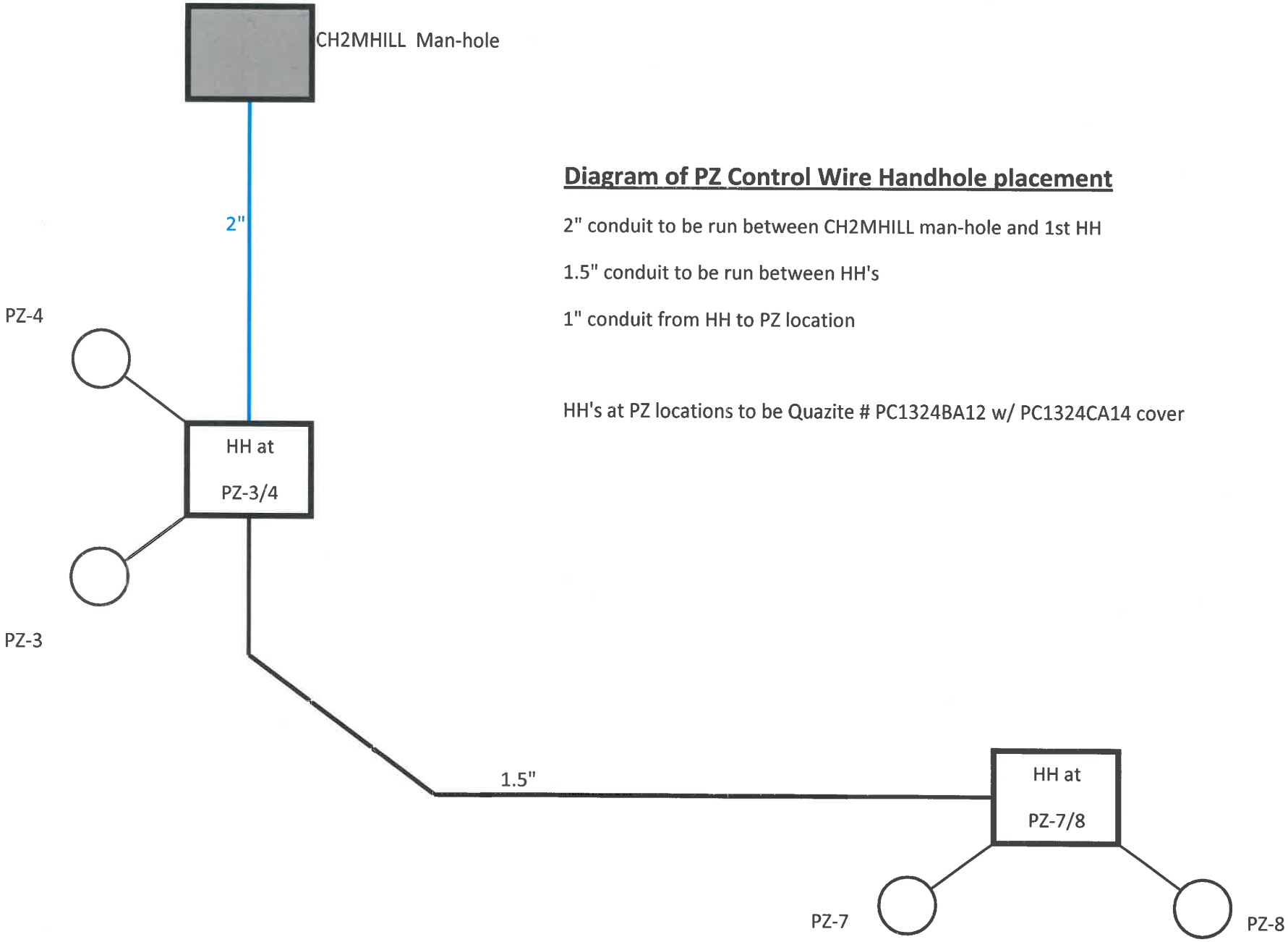


Diagram of PZ Control Wire Handhole placement

2" conduit to be run between CH2MHILL man-hole and 1st HH

1.5" conduit to be run between HH's

1" conduit from HH to PZ location

HH's at PZ locations to be Quazite # PC1324BA12 w/ PC1324CA14 cover

Rigid PVC Conduit & Fittings

- Commercial, Industrial and Utility Usage
- Corrosion Resistant
- Non-Magnetic and non-galvanic
- Self Extinguishing
- Impact Resistant

FEATURES & SPECIFICATIONS

Allied Tube & Conduit offers a complete line of rigid PVC conduit and fittings and PVC utility duct. For commercial, industrial and utility usage, Allied PVC conduit and duct is proven durable and effective for years of maintenance-free performance in underground, encased and exposed applications in accordance with the National Electrical Code.

Corrosion Proof:
Resistant to most chemicals, PVC is typically not affected by corrosive soils or salts.
Non-Magnetic and Non-Galvanic:
Properties of Allied PVC Conduit provide good insulation and no power loss or conductor heating.
Self Extinguishing:
Properties make PVC fire resistant.
Impact Resistant:
Tough, durable, with high tensile strength, yet easy to handle and install right on the jobsite.

Schedule 40 & 80 rigid PVC conduit systems are sunlight resistant and are used exposed, encased in concrete, concealed in walls and in direct burial applications including systems for:

- Utilities
- Cable, data and communication lines
- Institutional, commercial, industrial buildings
- Residential applications, & service entrances
- Street and highway underground feeds
- Transportation systems - subways, bridges,tunnels, airports
- Water and wastewater treatment plants
- Marinas
- Mines and mills

Type DB-60 and DB-120 utility duct are designed for direct burial applications. **Type EB-20 and EB-35** are designed for burial encased in concrete.

Project Information

Company Name: _____
Address: _____
City: _____
State & Zip: _____
Phone: _____
Project Name: _____
City: _____
State: _____

Codes And Standards Compliance

Allied Schedule 40 and Schedule 80 rigid conduits are listed to UL 651 and are allowed for use with 90° C conductors, in accordance with the National Electrical Code. They are manufactured in accordance with NEMA TC2.

Allied Type DB and EB ducts are manufactured in accordance with NEMA TC 6&8 and are allowed for use with 90° C conductors.

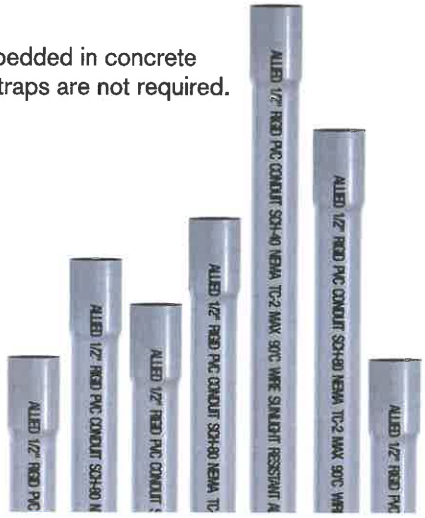
Allied PVC fittings are manufactured in accordance with NEMA TC3. The UL standard for PVC fittings is UL 651; for boxes UL 514C, for cover plates UL 514D and for enclosures UL 50. See product pages for UL listing information.

Specification

All wiring shall be installed in Allied Tube & Conduit rigid PVC conduit and secured by means of proper fittings. All fittings shall be offered by Allied Tube & Conduit. All outlets, pull boxes and junction points shall be fitted with Allied outlet boxes, fittings and junction boxes.

Exposed conduit shall be securely attached and supported by means of straps. The straps shall be installed at the recommended spacing as specified in the National Electrical Code (NEC). The straps must allow for linear expansion and contraction of the conduit due to temperature change. If the variance in temperature exceeds 25°F, expansion joints shall be installed according to the manufacturer's recommendations.

If rigid PVC conduit is embedded in concrete or direct buried, support straps are not required.



PVC Conduit & Fittings are not available in all markets.

Please contact your Allied representative or distributor for details.

NOTE: Special orders are non-cancelable, non-returnable and non-refundable.

www.alliedeg.com

Rigid PVC Conduit - Schedule 40

allied TUBE & CONDUIT®
A PART OF atkore INTERNATIONAL

Schedule-40 PVC Rigid Conduit
Rated for 90° C Wiring

Allied Schedule-40 is sunlight resistant. Meets or exceeds the requirements of NEMA TC-2 and UL-651 for Schedule 40 Conduit.

Schedule 40 PVC Conduit Weight and Dimensions (10' lengths with belled ends)

Trade Size	Metric Designator	Average Outside Dia (in)	Minimum Average I.D. (in)	Min. Wall Thickness (in)	Weight Per Foot	Feet Per Pallet	Nominal Bell (Socket) Depth/Inches
1/2	16	.840 ±0.004	.578	.109	.164	6000	1.8
3/4	21	1.050 ±0.004	.780	.113	.218	4400	1.8
1	27	1.315 ±0.005	1.004	.133	.321	3600	2
1-1/4	35	1.660 ±0.005	1.335	.140	.434	3300	2.5
1-1/2	41	1.900 ±0.006	1.564	.145	.518	2250	2.5
2	53	2.375 ±0.006	2.021	.154	.695	1400	4.5
2-1/2	63	2.875 ±0.007	2.414	.203	1.096	930	4.5
3	78	3.500 ±0.008	3.008	.216	1.435	880	4.5
3-1/2	91	4.000 ±0.008	3.486	.226	1.729	630	4.5
4	103	4.500 ±0.009	3.961	.237	2.043	570	5
5	129	5.563 ±0.010	4.975	.258	2.776	380	6
6	155	6.625 ±0.011	5.986	.280	3.600	260	6

SPECIAL INFORMATION
1. 20' lengths available on special request.
2. Minimum shipment: full pallet quantity per size.

New Trade Size 8 Coming in Summer of 2012

PVC Conduit & Fittings are not available in all markets.
Please contact your Allied representative or distributor for details.
NOTE: Special orders are non-cancelable, non-returnable and non-refundable.

16100 S. Lathrop Ave. Harvey, IL 60426
PHONE 708-339-1610 • TOLL-FREE 800-882-5543

www.alliedeg.com

KELSO-BURNETT Co.

1378 Saint Paul Ave · Gurnee, IL 60031 · 847 / 746-2300 · Fax 847 / 746-2340 · Cell 847 / 997-9304

Electrical Submittals

TO: The Denovo Group
1884 E. Fabyan Pkwy
Batavia, IL 60510
Attn: Ben O'Connor

July 25, 2013

SUBJECT: Outboard Marine Project – Waukegan: Electrical Submittals (Cable Only)

Kelso-Burnett is submitting the following electrical items for approval:

1) Cable for ODC-EW-1 and ODC-EW-2:
   Service Wire Company: ASDPTC8/3 with 3#10 grd.
   Service Wire Company: ASDPTC6/3 with 3#10 grd.
   See attached

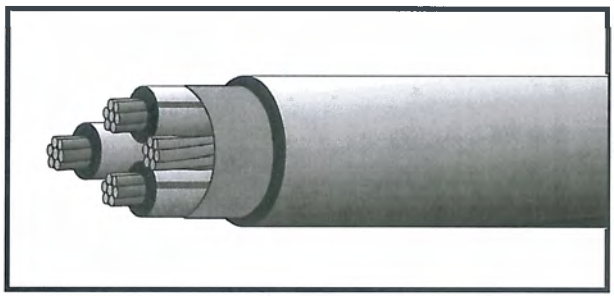
Sincerely,

Kris Murray

Kris Murray
Project Manager/Estimator

As an employee owned company, we endeavor to be the best electrical and communications company in Northern Illinois; striving for the benefit of employees, customers, vendors and shareholders.

Service Wire Co.
Manufacturing quality. Delivering service.



ServiceDrive® ASD/VFD Shielded Tray Drive Cable

PVC Jacket Overall
Patented

Description:
3 conductors, stranded, insulated with heat and moisture resistant cross-linked polyethylene, phase identified, cabled together with suitable fillers and 3 symmetrical bare copper ground conductors. Cable core covered with 5-mil helical copper tape shield, and overall flame and sunlight resistant black PVC jacket. Surface printed. Jacket available in colors.

Features:
Suitable for use in NEC Hazardous Locations:
Class I - Div 2, Class II - Div 2, and Class III, Div 1 and 2
For use in ASD / VFD applications

Standards:
UL 1277
Flame Rated: IEEE 383 (70,000 BTU),
ICEA T-29-520 (210,000 BTU) on 1/0 and larger
IEEE 1202 / CSA FT-4
Two-hour Firewall rated, (2/0 AWG and smaller)
Sunlight Resistant, for CT Use; Direct Burial
Oil Resistant II Jacket
Code: Black and Numbered
Temperature Rating: 90°C Wet / Dry
ICEA S-95-658 / NEMA WC-70
Exposed runs rated #4 and larger
600 Volt Tray Cable

	Part Number	Size AWG or MCM	Strand (no.)	Insulation Thickness (mils)	Copper Grounding Conductor(s) (AWG)	PVC Jacket Thickness (mils)	Approx. Diameter Overall (inch)	Approx. Net Wt. per 1000 ft. (lbs.)	Ampacity* (30°C Ambient Wet/Dry)
THREE CONDUCTOR	ASDPTC14/3	14	7	45	3-#10	45	.470	239	25+
	ASDPTC12/3	12	7	45	3-#10	45	.520	270	30+
	ASDPTC10/3	10	7	45	3-#10	60	.600	338	40+
	ASDPTC8/3	8	7	45	3-#10	60	.644	415	55
	ASDPTC6/3	6	7	45	3-#10	60	.725	538	75
	ASDPTC4/3	4	7	45	3-#10	80	.869	757	95
	ASDPTC3/3	3	7	45	3-#10	80	.929	886	110
	ASDPTC2/3	2	7	45	3-#8	80	.998	1,100	130
	ASDPTC1/3	1	19	55	3-#8	80	1.104	1,326	150
	ASDPTC1/03	1/0	19	55	3-#6	80	1.188	1,658	170
	ASDPTC2/03	2/0	19	55	3-#6	80	1.289	1,970	195
	ASDPTC3/03	3/0	19	55	3-#4	80	1.390	2,486	225
	ASDPTC4/03	4/0	19	55	3-#4	80	1.511	2,965	260
	ASDPTC250/3	250	37	65	3-#4	110	1.754	3,554	290
	ASDPTC350/3	350	37	65	3-#2	110	1.983	4,867	350
	ASDPTC500/3	500	37	65	3-#1	110	2.271	6,641	430
	ASDPTC600/3	600	61	80	3-1/0	110	2.504	8,009	475
	ASDPTC750/3	750	61	80	3-2/0	140	2.790	10,007	535

*Per NEC Table 310-16. + The overcurrent protection for items marked with an obelisk (+) shall not exceed 15 amps for 14 AWG , 20 amps for 12 AWG, and 30 amps for 10 AWG per NEC 310-16 footnote.
Note: The data shown is approximate and subject to standard industry tolerances.

2009

www.servicewire.com

Made in the USA

Phoenix, AZ 877-623-9473
Culloden, WV 800-624-3572
Houston, TX 800-231-9473
Pittsburgh, PA 800-778-9473

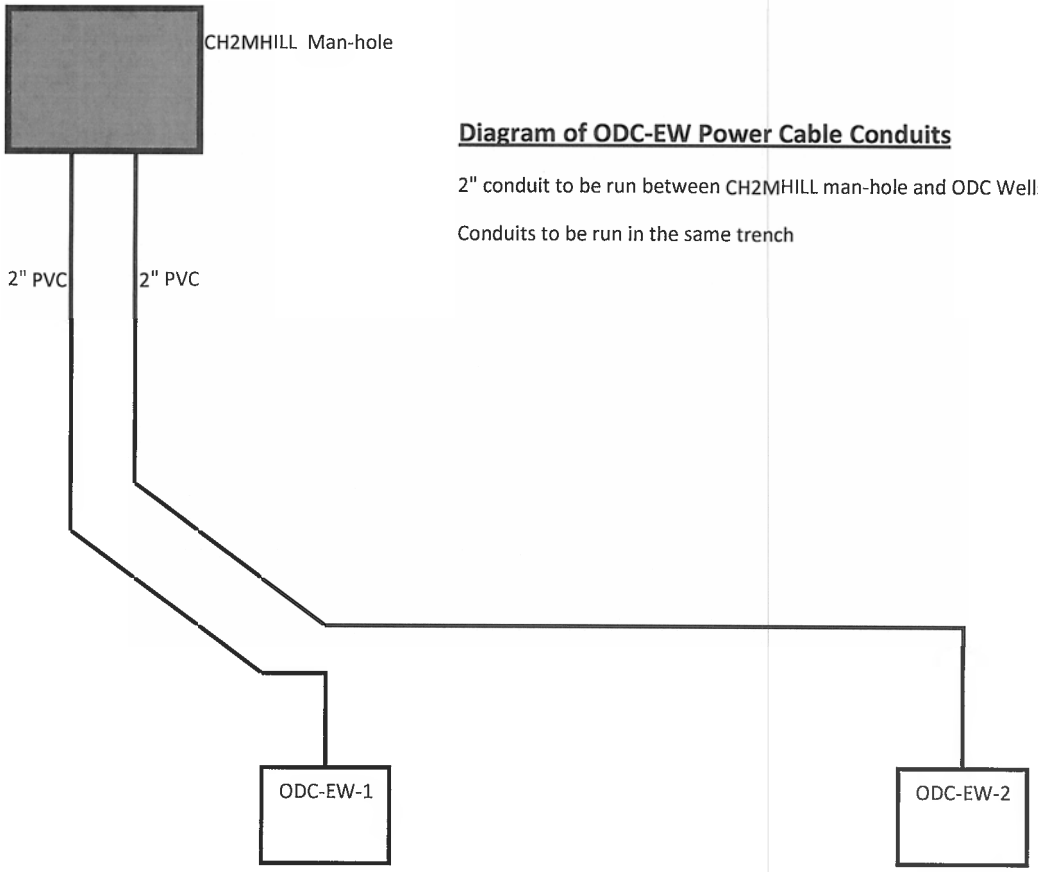


Diagram of ODC-EW Power Cable Conduits

2" conduit to be run between CH2MHILL man-hole and ODC Wells

Conduits to be run in the same trench

529 Thomas Drive, Bensenville, IL 60106 | TF: 888.518.8086 | FX: 630.860.5944 | www.lakecable.com

Specification Sheet

Lake Cable Part #: TX162S

Description: 16 AWG 2 conductors 7 strand bare copper wire, XLPE insulation, shielded, with an overall flame retardant PVC jacket, (UL) PLTC, ITC.

1. **Conductor**
   - 1.1. AWG Size & Stranding: 16 AWG 7 Strands Class B
   - 1.2. Material: Annealed Bare Copper
   - 1.3. **Conductor** Count: 2 Conductors

2. **Insulation**
   - 2.1. Material: Cross Linked Polyethylene
   - 2.2. Wall Thickness: 0.015"
   - 2.3. Color Code: Black, White

3. **Assembly**
   - 3.1. Nominal Lay Length: 2.75" LHL 4.36 Tw/Ft)
   - 3.2. Binder: N/A
   - 3.3. Shield: Aluminum mylar - 100% coverage
   - 3.4. Drain Wire: 18AWG 7 Strand Tinned Copper

4. **Jacket**
   - 4.1. Material: Polyvinylchloride (PVC)
   - 4.2. Wall thickness: 0.035"
   - 4.3. Diameter: 0.251"
   - 4.4. Color: Black
   - 4.5. Ripcord: Yes
   - 4.6. Weight: 43 Lbs/Mft

5. **Markings**
   - 5.1. Type: Cable shall be permanently identified via surface inkjet print
   - 5.2. Legend: LAKE CABLE E171202 16AWG 2C SHLD (UL) PLTC OR (UL) ITC XLPE 90'C DRY/WET PVC JACKET SUN RES DIR BUR FT-4 'ROHS"
   - 5.3. Footage Markers: Yes

6. **Standards**
   - 6.1. Cable suitable for installations under NEC (NFPA 70) article 725 guidelines
   - 6.1. Cable suitable for use in Class I Division II hazardous locations
   - 6.2. UL listed as Type PLTC per UL Standard 13 and ITC Type per (UL) Standard 2250
   - 6.3. UL approved for Sunlight Resistant & Direct Burial applications
   - 6.4. Meets IEEE 1202 flame test
   - 6.5. All materials used in the manufacture of this cable are RoHS compliant
   - 6.6. Recommended Operating Voltage: 300V
   - 6.7. Made in the USA

Your signature constitutes that you have read and agreed to this specification sheet and upon confirmation of your order; this item may be non-cancelable and non-returnable.

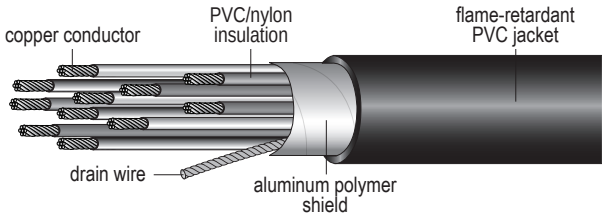
Signature

Company

ALL SPECIFIED PARAMETERS ARE NOMINAL AND SUBJECT TO VERIFICATION

TRAY CABLE - SHIELDED CONTROL CABLE

600 Volt UL Type TC-ER*, 90°C
TFN Insulation
PVC Jacket
Copper Conductors



Catalog Number	Size AWG	Number of Conductors	Number of Strands	Insulation Thickness Mils	Nylon Jacket Thickness Mils	Overall Jacket Thickness Mils	Overall Diameter Inches	Net Weight Lbs/Mft
HW152 01802	18	2	7	15	4	45	0.27	34
HW152 01803	18	3	7	15	4	45	0.28	43
HW152 01804	18	4	7	15	4	45	0.31	52
HW152 01805	18	5	7	15	4	45	0.33	62
HW152 01806	18	6	7	15	4	45	0.36	72
HW152 01807	18	7	7	15	4	45	0.36	79
HW152 01808	18	8	7	15	4	45	0.38	89
HW152 01812	18	12	7	15	4	45	0.46	127
HW152 01819	18	19	7	15	4	60	0.57	202
HW152 01837	18	37	7	15	4	60	0.74	360

APPLICATION:
General purpose cable for use where shielding from electro-static interference is required in power, control and lighting circuits in a broad range of commercial and industrial applications. Approved for continuous operation at 90°C in dry locations, installation indoors or outdoors, aerially, in conduits, ducts, cable trays or direct burial in circuits not exceeding 600 volts. May be used in NEC Class I and II, Division 2 hazardous locations. Exposed Run (ER) rating available upon request.

CONDUCTORS:
Soft bare annealed copper per ASTM B-3, Class B stranding per ASTM B-8

INSULATION:
Flame-retardant PVC per UL Standard 62 for Type TFN wire

INSULATION JACKET:
Clear nylon per UL Standard 62 for Type TFN wire

OVERALL SHIELD:
Aluminum-polymer tape providing 100% coverage with a flexible 7-strand tinned copper drain wire

JACKET:
Sunlight-resistant PVC per UL Standard 1277

FLAME TESTS:
- IEEE 383 (70,000 BTU/hr) Flame Test
- ICEA (210,000 BTU/hr) Flame Test

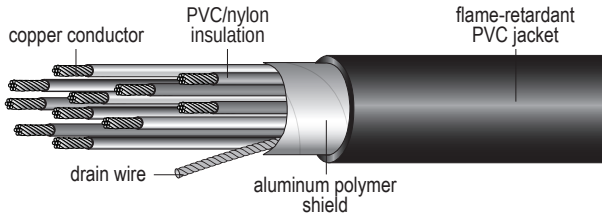
COLOR CODE:
ICEA Method 1, Table E-2

ADDITIONAL STANDARDS:
- UL Type TC per Article 336 of the NEC
- Approved for Class 1 remote-control and signaling circuits per Article 725 of the NEC

**TC-ER rating applies to cables with 3 or more insulated conductors*

TRAY CABLE - SHIELDED CONTROL CABLE

600 Volt UL Type TC-ER*, 90°C
TFN Insulation
PVC Jacket
Copper Conductors



Catalog Number	Size AWG	Number of Conductors	Number of Strands	Insulation Thickness Mils	Nylon Jacket Thickness Mils	Overall Jacket Thickness Mils	Overall Diameter Inches	Net Weight Lbs/Mft
HW152 01602	16	2	7	15	4	45	0.29	43
HW152 01603	16	3	7	15	4	45	0.31	55
HW152 01604	16	4	7	15	4	45	0.34	69
HW152 01605	16	5	7	15	4	45	0.36	83
HW152 01606	16	6	7	15	4	45	0.39	96
HW152 01607	16	7	7	15	4	45	0.41	106
HW152 01608	16	8	7	15	4	45	0.43	122
HW152 01609	16	9	7	15	4	45	0.46	138
HW152 01610	16	10	7	15	4	45	0.49	149
HW152 01612	16	12	7	15	4	45	0.51	174
HW152 01619	16	19	7	15	4	60	0.63	275
HW152 01625	16	25	7	15	4	60	0.72	355
HW152 01637	16	37	7	15	4	80	0.82	498

APPLICATION:
General purpose cable for use where shielding from electrostatic interference is required in power, control and lighting circuits in a broad range of commercial and industrial applications. Approved for continuous operation at 90°C in dry locations, installation indoors or outdoors, aerially, in conduits, ducts, cable trays or direct burial in circuits not exceeding 600 volts. May be used in NEC Class I and II, Division 2 hazardous locations.

CONDUCTORS:
Soft bare annealed copper per ASTM B-3, Class B stranding per ASTM B-8

INSULATION:
Flame-retardant PVC per UL Standard 62 for Type TFN wire

INSULATION JACKET:
Clear nylon per UL Standard 62 for Type TFN wire

OVERALL SHIELD:
Aluminum-polymer tape providing 100% coverage with a flexible 7-strand tinned copper drain wire

JACKET:
Sunlight-resistant PVC per UL Standard 1277

FLAME TESTS:
- IEEE 383 (70,000 BTU/hr) Flame Test
- ICEA (210,000 BTU/hr) Flame Test

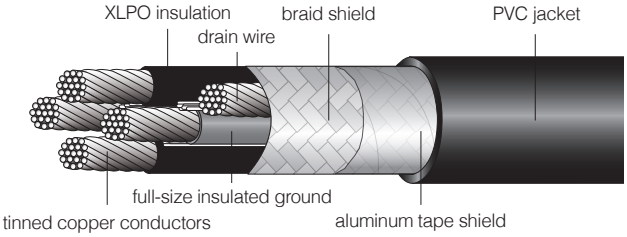
COLOR CODE:
ICEA Method 1, Table E-2

ADDITIONAL STANDARDS:
- UL Type TC per Article 336 of the NEC
- Approved for Class 1 remote-control and signaling circuits per Article 725 of the NEC

**TC-ER rating applies to cables with 3 or more insulated conductors*

VFD POWER CABLE

600/1000V UL Type TC-ER, 90°C
Braid/Foil Shield with Drain Wire
XLPO Insulation, PVC Jacket
Tinned Copper Conductors
Full-size Insulated Ground



Catalog Number	Size (AWG/kcmil)	Number of Conductors	Conductor Stranding	Insulation Thickness (inches)	Ground Wire Size (AWG)	Ground Wire Stranding	Drain Wire Size (AWG)	Drain Wire Stranding	Jacket Thickness (inches)	Overall Dia. (inches)	Weight (lbs/Mft.)
HW190A 01603	16	3	19	0.030	16	19	16	19	0.060	0.461	144
HW190A 01403	14	3	19	0.030	14	19	14	19	0.060	0.497	182
HW190A 01203	12	3	19	0.030	12	19	12	19	0.060	0.567	248
HW190A 01003	10	3	37	0.030	10	37	10	37	0.060	0.631	326
HW190A 00803	8	3	37	0.045	8	37	14 (4X)	19	0.060	0.750	505
HW190A 00603	6	3	61	0.045	6	61	12 (4X)	19	0.080	0.890	745
HW190A 00403	4	3	133	0.045	4	133	10 (4X)	37	0.080	1.088	1130
HW190A 00203	2	3	133	0.045	2	133	8 (4X)	37	0.080	1.252	1614

Catalog Number	Size (AWG/kcmil)	Non-Exp Proof Gland	Exp Proof Gland with Compound Seal	Exp Proof RapidEx Gland (Must include appropriate sized RapidEx Liquid Resin)	RapidEx Liquid Resin
HW190A 01603	16	20SC2KX1RA531	20SPX2KX1RA531	20SPX2KXREX1RA531	RE30
HW190A 01403	14	20SC2KX1RA531	20SPX2KX1RA531	20SPX2KXREX1RA531	RE30
HW190A 01203	12	20C2KX1RA531	20PX2KX1RA531	20PX2KXREX1RA531	RE30
HW190A 01003	10	20C2KX1RA531	20PX2KX1RA531	20PX2KXREX1RA531	RE30
HW190A 00803	8	25SC2KX1RA532	25SPX2KX1RA532	25SPX2KXREX1RA532	RE30
HW190A 00603	6	25C2KX1RA532	25PX2KX1RA532	25PX2KXREX1RA532	RE30
HW190A 00403	4	32C2KX1RA533	32PX2KX1RA533	32PX2KXREX1RA533	RE30
HW190A 00203	2	40C2KX1RA34	40PX2KX1RA534	40PX2KXREX1RA534	RE80

APPLICATIONS:
A flexible, shielded power cable specifically engineered for use in variable frequency AC motor drive (VFD) applications.

CONDUCTOR:
Stranded tinned copper circuit conductors

INSULATION:
Crossed-linked polyolefin (XLPO), flexible and low dielectric

COLOR CODE:
Black with number surface printed in contrasting ink

GROUNDING CONDUCTOR:
One full-size tinned copper conductor with solid green cross-linked polyolefin (XLPO) insulation

DRAIN WIRE:
Tinned copper wires

OVERALL SHIELD:
Braid of tinned copper wires and a poly aluminum tape, helically applied and lapped

JACKET:
Black sunlight resistant polyvinyl chloride (PVC)

RATINGS & APPROVALS:
- UL Listed as Type TC-ER 600V
- UL Listed as 1kV Flexible Motor Supply Cable (up to 4/0 AWG)
- 90°C Temperature Rating
- FT-4 and IEEE 1202 Flame Ratings
- Sunlight Resistant
- Oil Resistant (Oil Res I)
- Direct Burial
- Meets crush and impact requirements for Type MC cable
- Permitted for Exposed Run (“ER”) use in accordance with the NEC
- Permitted for use in Class 1, Division 2 and Zone 2 industrial hazardous locations per the NEC

OTHER:
- Specially engineered cable design produces a longer cable life in VFD applications
- Overall shield provides 100% coverage containing VFD EMI emissions
- High strand count design is much more flexible, easier to install and more resistant to vibration than Type MC cable
- Specially formulated insulation material with a lower dielectric constant (standard XLPE and EPR insulation materials have higher dielectric constants) withstands reflected voltages, allowing for longer output cable distances and minimizes the effect of high frequency noise induced into the plant ground system
- Gas and vapor tight - impervious to water and air
- Reduced installation time and cost compared to Type MC
- Glands for this product cost up to 50% less than those for Type MC
- Bend Radius is 8 x O.D.

** Cable diameters shown as nominal are subject to a ±5% manufacturing tolerance.*

ODC CAP LINER MATERIALS

PRODUCT DATA SHEET

GSE FabriNet 200 mil Geocomposite

GSE FabriNet geocomposite consists of a 200 mil thick GSE HyperNet geonet heat-laminated on one or both sides with a GSE nonwoven needle-punched geotextile. The geotextile is available in mass per unit area range of 6 oz/yd² to 16 oz/yd². The geocomposite is designed and formulated to perform drainage function under a range of anticipated site loads, gradients and boundary conditions.

AT THE CORE:
A 200 mil thick HyperNet geonet heat-laminated on one or both sides with a nonwoven needlepunched geotextile.

Product Specifications

Tested Property	Test Method	Frequency	Minimum Average Roll Value[1]		
Geocomposite			6 oz/yd²	8 oz/yd²	10 oz/yd²
Transmissivity[2], gal/min/ft, (m²/sec) Double-Sided Composite Single-Sided Composite	ASTM D 4716	1/540,000 ft²	 0.5 ($1x10^{-4}$) 4.8 ($1x10^{-3}$)	 0.5 ($1x10^{-4}$) 4.8 ($1x10^{-3}$)	 0.4 ($9x10^{-5}$) 4.3 ($9x10^{-4}$)
Ply Adhesion, lb/in	ASTM D 7005	1/50,000 ft²	1.0	1.0	1.0
Geonet Core[1,3] – GSE HyperNet					
Geonet Core Thickness, mil	ASTM D 5199	1/50,000 ft²	200	200	200
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		9.6 (2×10^{-3})	9.6 (2×10^{-3})	9.6 (2×10^{-3})
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in	ASTM D 7179	1/50,000 ft²	45	45	45
Carbon Black Content, %	ASTM D 4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile[1,3]					
Mass per Unit Area, oz/yd²	ASTM D 5261	1/90,000 ft²	6	8	10
Grab Tensile Strength, lb	ASTM D 4632	1/90,000 ft²	160	220	260
Grab Elongation	ASTM D 4632	1/90,000 ft²	50%	50%	50%
CBR Puncture Strength, lb	ASTM D 6241	1/540,000 ft²	435	575	725
Trapezoidal Tear Strength, lb	ASTM D 4533	1/90,000 ft²	65	90	100
AOS, US sieve[1], (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, sec⁻¹	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Water Flow Rate, gpm/ft²	ASTM D 4491	1/540,000 ft²	110	95	75
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	per formulation	70	70	70
NOMINAL ROLL DIMENSIONS[4]					
Roll Width, ft			14.75	14.75	14.75
Roll Length, ft	Double-Sided Composite Single-Sided Composite		270 300	260 300	230 290
Roll Area, ft²	Double-Sided Composite Single-Sided Composite		3,982 4,425	3,835 4,425	3,392 4,277

NOTES:

- [1] All geotextile properties are minimum average roll values except AOS which is maximum average roll value and UV resistance is typical value. Geonet core thickness is nominal value.
- [2] Gradient of 0.1, normal load of 10,000 psf, water at 70°F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [3] Component properties prior to lamination.
- [4] Roll widths and lengths have a tolerance of ±1%.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

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PRODUCT DATA SHEET

GSE BentoLiner NSL Geosynthetic Clay Liner

GSE BentoLiner "NSL" is a needle-punched reinforced composite geosynthetic clay liner (GCL) comprised of a uniform layer of granular sodium bentonite encapsulated between a woven and a nonwoven geotextile. The product is intended for moderate to steep slopes and moderate to high load applications where increased internal shear strength is required.

[*]

AT THE CORE:
This composite clay liner is intended for moderate to steep slopes and moderate to high load applications where increased internal shear strength is required.

Product Specifications

Tested Property	Test Method	Frequency	Value
Geotextile Property			
Cap Nonwoven, Mass/Unit Area	ASTM D 5261	1/200,000 ft²	6.0 oz/yd² MARV(1)
Carrier Woven, Mass/Unit Area	ASTM D 5261	1/200,000 ft²	3.1 oz/yd² MARV
Bentonite Property			
Swell Index	ASTM D 5890	1/100,000 lb	24 ml/2 g min
Moisture Content	ASTM D 4643	1/100,000 lb	12% max
Fluid Loss	ASTM D 5891	1/100,000 lb	18 ml max
Finished GCL Property			
Bentonite, Mass/Unit Area(2)	ASTM D 5993	1/40,000 ft²	0.75 lb/ft² MARV
Tensile Strength(3)	ASTM D 6768	1/40,000 ft²	30 lb/in MARV
Peel Strength	ASTM D 6496 ASTM D 4632(4)	1/40,000 ft²	3.5 lb/in MARV 21 lb MARV
Hydraulic Conductivity(5)	ASTM D 5887	1/Week	5×10^{-9} cm/sec max
Index Flux(5)	ASTM D 5887	1/Week	1×10^{-8} m³/m²/sec max
Internal Shear Strength(6)	ASTM D 6243	Periodically	500 psf Typical
TYPICAL ROLL DIMENSIONS			
Width x Length(7)	Typical	Every Roll	15.5 ft x 150 ft
Area per Roll	Typical	Every Roll	2,325 ft²
Packaged Weight	Typical	Every Roll	2,600 lb

NOTES:
- (1) Minimum Average Roll Value.
- (2) At 0% moisture content.
- (3) Tested in machine direction.
- (4) Modified ASTM D 4632 to use a 4 in wide grip. The maximum peak of five specimens averaged in machine direction.
- (5) Dealred, deionized water @ 5 psi maximum effective confining stress and 2 psi head pressure.
- (6) Typical peak value for specimen hydrated for 24 hours and sheared under a 200 psf normal stress.
- (7) Roll widths and lengths have a tolerance of ±1%.

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Appendix A: Minimum Testing Frequencies for GSE Raw Materials

Property	Test Method[1]	Natural Resin
Density	ASTM D 1505	once per resin lot
Melt Flow Index	ASTM D 1238 (190/2.16)	once per resin lot
Carbon Black Content	ASTM D 1603*/4218	N/A
Carbon Black Dispersion	ASTM D 5596	N/A

Notes:

- GSE utilizes test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.
- Refer to GSE's ISO 9000 quality manual for raw material requirements for individual products.
- *Modified.

PRODUCT DATA SHEET

GSE UltraFlex Smooth Geomembrane

GSE UltraFlex is a smooth linear low density polyethylene (LLDPE) geomembrane manufactured with the highest quality resin specifically formulated for flexible geomembranes. This product is used in applications that require increased flexibility and elongation properties where differential or localized subgrade settlements may occur such as in a landfill closure application.

[*]

AT THE CORE:
An LLDPE geomembrane that is used in applications requiring increased flexibility and elongation properties, such as landfill closures and mining applications.

Product Specifications

These product specifications meet GRI GM17

Tested Property	Test Method	Frequency	Minimum Average Value			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm³ (max.)	ASTM D 1505	200,000 lb	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lb	 152 800	 228 800	 304 800	 380 800
Tear Resistance, lb	ASTM D 1004	45,000 lb	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lb	56	84	112	140
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)	Note(1)
Oxidative Induction Time, mins	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>100	>100	>100	>100
TYPICAL ROLL DIMENSIONS						
Roll Length(2), ft			870	560	430	340
Roll Width(2), ft			22.5	22.5	22.5	22.5
Roll Area, ft²			19,575	12,600	9,675	7,650

NOTES:
- (1)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)Roll lengths and widths have a tolerance of ±1 %.
- GSE UltraFlex is available in rolls weighing approximately 3,900 lb.
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

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ATTACHMENT 3:
PROJECT SPECIFICATIONS

TECHNICAL SPECIFICATIONS
CONTENTS

DIVISION 00 PROCUREMENT AND CONTRACTING REQUIREMENTS

INTRODUCTORY INFORMATION

Section 00 11 16 Invitation to Bid

Section 00 21 13 Instructions to Bidders

Section 00 41 00 Bid Form

Section 00 43 13 Bid Bond

Section 00 43 36 Proposed Subcontractors Form

Section 00 43 39 Minority and Small Disadvantaged Business Enterprise Utilization Certification

Section 00 43 43 Health and Safety Questionnaire

Section 00 45 16 Contractor's Compliance Statement and Certification

Section 00 45 19 Non-Collusion Affidavit

Section 00 45 33 Certification of Non-segregated Facilities

CONTRACTING REQUIREMENTS

Section 00 52 00 Agreement Form

Section 00 52 01 Notice of Award

Section 00 55 00 Notice to Proceed

Section 00 61 13.13 Performance Bond Form

Section 00 61 13.16 Payment Bond Form

Section 00 62 16 Certificate of Insurance Form

Section 00 62 99 Contractor's Notification of Subcontractors and Suppliers to be Utilized

Section 00 72 00 General Conditions of the Contract

Section 00 73 01 Federal Acquisition Regulations

Section 00 73 46 Davis-Bacon Prevailing Wage Rate Determination

DIVISION 01 GENERAL REQUIREMENTS

Section 01 11 00 Summary of Work

Section 01 20 00 Application for Payment

Section 01 31 00 Project Management and Coordination

Section 01 32 00 Construction Progress Documentation

Section 01 33 00 Submittal Procedures

Section 01 34 90 System Testing and Quality Control

Section 01 35 30 Health and Safety Requirements

Section 01 41 00 Regulatory Requirements
Section 01 45 00 Quality Control
Section 01 50 00 Temporary Facilities and Controls
Section 01 57 20 Environmental Protection
Section 01 60 00 Product Requirements
Section 01 70 00 Project Closeout
Section 01 74 00 Cleaning and Waste Management
Erosion and Sediment Control Plan

DIVISION 02 EXISTING CONDITIONS

Section 02 21 00 Surveying
Section 02 81 00 Transportation and Disposal of Nonhazardous and Hazardous Materials

DIVISION 03 CONCRETE

Section 03 00 00 General Concrete Requirements

DIVISIONS 04 THROUGH 21 NOT USED

DIVISION 22 NONPOTABLE WATER PIPING, VALVES, AND ACCESSORIES

Section 22 10 00 Piping and Valves

DIVISIONS 23 THROUGH 25 NOT USED

DIVISION 26 ELECTRICAL

Section 26 05 00 Basic Electrical Materials and Methods
Section 26 60 00 Measurement and Control Instrumentation
Section 26 60 05 Control Narratives

DIVISIONS 27 THROUGH 30 NOT USED

DIVISION 31 EARTHWORK

Section 31 00 00 Earthwork
Section 31 11 00 Clearing and Grubbing
Section 31 55 00 Soil Bentonite Cutoff Wall
Section 31 55 01 Soil Bentonite cutoff Wall, Trenchless Construction

Geotechnical Tests
Soil Physical Tests
Hydraulic Conductivity Tests

DIVISION 32 EXTERIOR IMPROVEMENTS

Section 32 12 16 Asphalt Caps

Section 32 30 00 Site Restoration

DIVISION 33 UTILITIES

Section 33 23 00 Extraction Wells, Monitoring Wells, and Piezometers

Section 33 29 00 Well Abandonment

Well Construction Completion Drawings

DIVISIONS 34 THROUGH 42 NOT USED

DIVISION 01 GENERAL REQUIREMENTS

SECTION 01 11 00

SUMMARY OF WORK

1. GENERAL

1.1 SECTION CONTENTS

1.1.1 Work covered by contract documents

1.1.2 Contractor's Duties

1.1.3 Construction sequence

1.1.4 Contractor's use of premises and other private property

1.1.5 Existing facilities

1.1.6 Work on OMC and other private property

1.1.7 Abbreviations

1.2 WORK COVERED BY CONTRACT DOCUMENTS

The work area is at the OMC Plant 2 Superfund Site at 90 East Seahorse Drive, Waukegan, Illinois. The work to be performed is shown on the drawings. In general the project will include (1) relocating a sanitary force main, (2) construction of a containment cell to include a vertical barrier, dewatering system and cap and (3) installation of utility corridor asphalt caps.

Other remedial actions will be ongoing at the site during this work. Safe work practices, coordination and cooperation with other consultants and contractors on site is imperative.

1.3 CONTRACTOR'S DUTIES

1.3.1 Except as specifically noted, provide and pay for

1.3.1.1 Labor, materials, and equipment for:

- Surveying
- Installing erosion controls
- Abandoning and reinstalling sanitary force main
- Installing vertical barrier around the Old Die Cast (ODC) containment cell
- Removing concrete from former slabs and processing
- Transporting and disposing of soil
- Installing 811 cap on the ODC containment cell

- Installing groundwater extraction system including extraction wells and conveyance system
- Installing piezometers and monitoring wells
- Startup and shakedown of groundwater extraction system
- Installing the asphalt cap on the North Utility Corridor (NUC)
- Installing the asphalt cap on the West Utility Corridor (WUC)
- Quality Assurance/Quality Control testing of slurry and soil bentonite
- Waste disposal characterization samples, shipping costs, and tests
- Restoration of work areas

1.3.1.2 Necessary utilities, such as potable water, telephones, roads, and sanitary facilities, including maintenance thereof

1.3.1.3 Contractor office and other facilities and services as necessary for proper execution and completion of the Work

1.3.1.4 Office with electrical power for Engineer.

1.3.2 Perform all the work described in these contract documents except where specifically indicated to be done by others.

1.3.3 Pay legally required sales, consumer, and use taxes.

1.3.4 Secure and pay for legally required permits, licenses, and government fees.

1.3.5 Give required notices.

1.3.6 Employ workmen and foremen with sufficient knowledge, skill, and experience to perform the work assigned to them.

1.3.7 Comply with the codes, laws, ordinances, rules, regulations, orders, and other legal requirements of public authorities bearing on the conduct of the work.

1.3.8 Submit written notice to Engineer of observed variance of Contract Documents from legal requirements. Any necessary changes will be adjusted as provided in the Contract for changes in the Work.

1.3.9 Enforce discipline and good order among contractor and subcontractor employees. Any person employed by contractor or subcontractors who does not perform his work in a skillful manner, is incompetent, or acts in a disorderly or intemperate manner shall, at the written request of Engineer, be removed from the project immediately and shall not be employed again in any portion of the Work without the approval of Engineer.

1.3.10 Provide at all times facilities for access and inspection of the Work by representatives of Owner and of official governmental agencies designated by Owner as having the right to inspect the work.

1.3.11 Contact J.U.L.I.E., Inc. at 1-800-892-0123 prior to starting any underground activities.

1.4 CONSTRUCTION SEQUENCE

1.4.1 Contractor shall submit a work sequence so that the entire project can be properly coordinated.

1.4.2 Contractor shall arrange with the Engineer a sequence of procedures, means of access, space for storage of materials and equipment, and use of approaches prior to work startup.

1.4.3 The work sequence to be submitted shall include a Work Plan that provides details on how the following operations will be performed.

1.4.3.1 Site preparation

1.4.3.2 Repair, replacement, and extension of existing silt fence as needed.

1.4.3.3 Concrete removal, processing, and placement

1.4.3.4 Clearing and grubbing.

1.4.3.5 Sanitary force main abandonment and installation of replacement force main.

1.4.3.6 Steel sheet piling installation for utility line protection, if needed.

1.4.3.7 Vertical barrier installation and QA/QC testing.

1.4.3.8 Stockpiling of excavation or installation spoils and testing for waste characterization.

1.4.3.9 Loading, transportation and proper disposal of TSCA characteristic soil (PCB>50 milligrams per kilogram).

1.4.3.10 Loading, transportation and proper disposal of RCRA Hazardous waste (TCLP TCE > 0.5 milligrams per liter).

1.4.3.11 Extraction well installation.

1.4.3.12 Dewatering system installation to include conduit, trenching, pumps and all controls.

1.4.3.13 Dewatering system shakedown and startup.

1.4.3.14 Temporary storage of extracted groundwater, testing for PCB, VOC and TSS.

1.4.3.15 Monitoring well installation

1.4.3.16 Piezometer installation

1.4.3.17 Title 35 IAC Part 811 Cap installation on ODC to include GCL, geomembrane, geotextile and soil materials.

1.4.3.18 Topsoil and seeding of ODC cap.

1.4.3.19 Installation of asphalt caps on north and west utility corridors.

1.4.3.20 Restoration and seeding for site stabilization.

1.5 CONTRACTOR'S USE OF PREMISES AND OTHER PRIVATE PROPERTY

1.5.1 Confine operations at site to areas permitted by access agreements, law, ordinances, permits, and the contract documents.

1.5.2 Do not load or permit any part of a structure to be subjected to any force that will endanger its safety.

1.5.3 Assume responsibility for protection and safekeeping of products stored on site.

1.5.4 Do not discharge smoke, dust, or other contaminants into the atmosphere, or fluids or materials into any waterway as will violate regulations of any legally constituted authority.

1.5.5 Move stored products which interfere with the operations of other contractors.

1.5.6 Obtain and pay for additional storage or work areas needed for operations.

1.5.7 Do not turn on any hydrants unless permission is obtained. If potable water is desired, make arrangements with the water utility, obtain water meter from utility and pay for water at the established rate.

1.6 EXISTING FACILITIES

1.6.1 The existing North Shore Sanitary District water discharge facilities, sanitary sewer force mains, water service lines, water mains and North Shore Gas Natural Gas Pipeline shall remain in continuous operation during the construction period.

1.6.2 A short shut-down period for the sanitary sewer force main to be relocated must be arranged in advance with the City of Waukegan.

1.6.3 Pipelines and appurtenances associated with the Harbor sediment removal project are to remain in continuous operation during the construction period.

1.6.4 Access to the containment facility or to other facilities used for sediment management are restricted during the Work.

1.6.5 Access thru the east gate is prohibited during the Work.

1.6.6 Plan and conduct construction operations to avoid disturbing existing structures, piping, equipment, and services in any manner which will interrupt or impair operations, except as approved by Engineer.

1.7 WORK ON OMC AND OTHER PRIVATE PROPERTY

1.7.1 Contractor shall comply with supplemental conditions, if applicable, prior to starting any work on private property.

1.7.2 Contractor shall notify the City of Waukegan and other private property owners not less than 72 hours prior to starting any work on this property.

1.7.3 Contractor shall submit a work sequence and layout for review and approval by Engineer, before starting any work.

1.7.4 Restoration shall commence as soon as the construction is completed.

1.7.5 Contractor shall maintain City of Waukegan and other EPA contractors access to the property at all times without any exceptions, except where it would be in violation of the approved Construction Health and Safety Plan.

1.7.6 All work on private property shall be limited to the areas approved. Any damage done by the Contractor beyond its limit shall be corrected and restored at the Contractor's expense.

1.7.7 When all restoration is completed, Engineer will request a "sign off" from the City of Waukegan and other private property owners.

1.8 ABBREVIATIONS

The following abbreviations as used in the Contract Documents have the listed meanings:

1.8.1 Standards Organizations

AA.....	Aluminum Association
AASHTO ...	American Association of State Highway and Transportation Officials
ACI.....	American Concrete Institute
ADC	Air Diffusion Council
AGA.....	American Gas Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ARI.....	Air Conditioning and Refrigeration Institute
ASHRAE ...	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS.....	American Welding Society
AWWA	American Water Works Association

CRSI..... Concrete Reinforcing Steel Institute

FIA ..... Factory Insurance Association
FM..... Factory Mutual
FS ..... Federal Specifications

GRI..... Geosynthetic Research Institute

IEEE..... Institute of Electrical and Electronic Engineers

MS..... Military Specifications

NBBPVI..... National Board of Boiler and Pressure Vessel Inspectors
NBS..... National Bureau of Standards
NEC ..... National Electrical Code
NEMA..... National Electrical Manufacturers Association
NFPA ..... National Fire Protection Association

ODC …….. Old Die Cast
OSHA..... Occupational Safety and Health Administration

TSCA ..... Toxic Substances Control Act

UL ..... Underwriters Laboratory

1.8.2 Units of Weight and Measure

A ..... ampere

btu ..... British thermal unit

C..... degrees Celsius
cc..... cubic centimeter
cf ..... cubic foot
cfm ..... cubic feet per minute
cfs..... . cubic feet per second
cy..... cubic yard

dB..... decibel

F ..... degrees Fahrenheit
fpm..... feet per minute
fps..... feet per second
ft..... feet

g ..... gram
ga..... gauge
gal..... gallon
gpm ..... gallons per minute

hp ..... horsepower
h ..... hour
Hz..... hertz

in ..... inches

kV..... kilovolts
kVA..... kilovolt-amperes
kW..... kilowatts
kWh..... kilowatt hours

L..... liter
lb ..... pound
lbs..... pounds

mA ..... milliamperes
mg/L..... milligrams per liter
mgd ..... million gallons per day
mL..... milliliter
mm ..... millimeter
mph ..... miles per hour
MVA ..... megavolt-ampere

ppb ..... . parts per billion
ppm ..... parts per million
psf..... pounds per square foot
psi..... pounds per square inch gauge

rpm..... revolutions per minute

scfm..... standard cubic feet per minute
sf..... square feet
sy..... square yard

V ..... volt
VA..... volt-ampere

1.8.3 Other Abbreviations

AC..... alternating current
AHU..... air handling unit

Bil..... basic impulse insulation level
BOD..... biochemical oxygen demand

Co..... company
conc..... concrete
Corp ..... corporation
cu..... cubic

DC..... direct current
dpdt ..... double pole, double throw

H-O-A ..... hand-off-automatic

Inc ..... Incorporated

LPG..... liquid petroleum gas

max..... maximum
min ..... minimum

N.C..... normally closed
N.O..... normally open
No..... number

pvc..... polyvinyl chloride

Rms ..... root mean square
RTRP ..... reinforced thermosetting resin pipe

scr..... silicon controlled rectifier
SDR..... standard dimension ratio
spdt..... single pole, double throw
sq..... square
std..... square transmission coefficient

U.S. ..... United States

2. PRODUCTS - (NOT USED)

3. EXECUTION - (NOT USED)

End of Section 01 11 00

SECTION 01 20 00

APPLICATION FOR PAYMENT

1. GENERAL

1.1 SECTION CONTENTS

Procedure for the preparation and the submittal of the applications for Partial Payment.

1.2 RELATED SECTIONS AND DOCUMENTS

1.2.1 Agreement

1.2.2 General Conditions

1.2.3 Section 01 33 00 - Submittals - submittal procedures

1.2.4 Section 01 70 00 - Project Closeout - final payment

1.3 FORMAT

1.3.1 Use the Monthly Estimate for Partial Payment form included in this document.

1.4 PREPARATION OF APPLICATIONS

1.4.1 Include a transmittal letter with each application for payment.

1.4.2 Present the required information in typewritten form or on electronic media printout for approval by the Engineer.

1.4.3 Payment items shall conform to those provided in Section 00 41 00 Bid Form.

1.4.4 Quantify the amount of work performed for which payment is sought. The quantities shall be presented in the units provided in Section 00 41 00 Bid Form. Attach documentation for measurement of quantities. Stated quantities shall have been measured using methods stipulated in Sections covering that work.

1.4.5 Include an updated construction schedule with each payment request.

1.4.6 Execute certification by signature of authorized officer.

1.4.7 Provide dollar value in each column for each line item for portion of work performed.

1.4.8 List each authorized change order as an extension on continuation sheet, listing change order number and dollar amount as for an original item of work.

1.4.9 For final payment, in addition to the requirements above, indicate previous payments and sum remaining due. Include all waivers along with final application for payment.

1.5 SUBMITTALS

Submit the following in compliance with Section 01 33 00 Submittals:

1.5.1 Three copies of Application for Payment. Submit at intervals stipulated in the contract.

1.6 SUBSTANTIATING DATA

1.6.1 Provide copies of trucking hauling tickets and landfill weigh tickets, as required, to the Engineer to substantiate costs.

1.6.2 When required by Engineer, submit other substantiating information, data to justify dollar amounts in question.

1.6.3 Provide one copy of data with cover letter for each copy of submittal. Indicate application number and date, and line item by number and description.

2. PRODUCTS - (NOT USED)

3. EXECUTION - (NOT USED)

End of Section 01 20 00

_____ **OWNER**

MONTHLY ESTIMATE FOR PARTIAL PAYMENT NO. CONTRACT NO.

PROJECT: SULTRAC PROJECT NO.

FOR THE PERIOD: TO , INCLUSIVE

SUBCONTRACTOR'S NAME AND ADDRESS;

CONTRACT PRICE (LUMP SUM), $ ESTIMATED COST (UNIT PRICE): $

ITEM NO. (1)	DESCRIPTION OF ITEM (2)	SUBCONTRACTOR=S SCHEDULE OF VALUES			WORK COMPLETED TO DATE		
		UNIT PRICE (3)	QUANTITY (4)	AMOUNT (5)	QUANTITY (6)	AMOUNT EARNED TO DATE (7)	% COMPLETE (8)

_____ **OWNER**

MONTHLY ESTIMATE FOR PARTIAL PAYMENT NO. CONTRACT NO.

PROJECT: SULTRAC PROJECT NO.

FOR THE PERIOD: TO , INCLUSIVE

SUBCONTRACTOR'S NAME AND ADDRESS;

CONTRACT PRICE (LUMP SUM), $ ESTIMATED COST (UNIT PRICE): $

ITEM NO. (1)	DESCRIPTION OF ITEM (2)	SUBCONTRACTOR=S SCHEDULE OF VALUES			WORK COMPLETED TO DATE		
		UNIT PRICE (3)	QUANTITY (4)	AMOUNT (5)	QUANTITY (6)	AMOUNT EARNED TO DATE (7)	% COMPLETE (8)
TOTAL (ORIGINAL CONTRACT)				$		$	
	CHANGE ORDER NO. 1						
	CHANGE ORDER NO. 2						
	Materials Stored On-Site (For detailed breakdown, see attached supplements)						
	TOTALS			$		$	

*SUPPLEMENT TO MONTHLY ESTIMATE FORM

PROJECT AND LOCATION	CONTRACT NO.	SULTRAC PROJECT NO.
PARTIAL PAYMENT NO.	SUBCONTRACTOR	

DETAIL OF MATERIALS STORED ON SITE

DESCRIPTION OF ITEM	NO. OF UNITS	COST PER UNIT	AMOUNT
TOTAL			$

* NOTE: This form must be filled out and securely attached to the Monthly Estimate Form whenever credit is taken for materials stored on site. Submit copies of certified invoices and proof of payment for all materials stored on site and claimed on this form.

CERTIFICATE OF SUBCONTRACTOR OR HIS DULY AUTHORIZED REPRESENTATIVE

To the best of my knowledge and belief, I certify that all items, units, quantities, and prices of work and material shown on the face of Sheet(s) of this Estimate are correct and that all work has been performed and materials supplied in full accordance with the terms and conditions of the corresponding construction contract documents between the undersigned as Subcontractor and _____as Owner, dated,_____ and all authorized changes thereto; that the following is a true and correct statement of the contract account up to and including the last day of the period covered by this estimate and that no part of the Total Amount Due has been received:

(a) Total amount earned (col. 7)
(b) Retained percentage (10%) up to 50% of Contract
(c) Total earned less retained percentage
(d) Total previously certified [Line (c) from previous estimate No. ----]
(e) Total Amount Due This Estimate
(f) Total billed to Sullivan International Group, Inc.
(g) Total billed to Tetra Tech EM Inc.

I further certify that all claims outstanding as of this date against the undersigned as Subcontractor for labor, materials, and expendable equipment employed in the performance of said contract up to this date have been paid in full in accordance with the requirements of said contract.

SUBCONTRACTOR: _____ Date: _____

By: _____ Title: _____

CERTIFICATE OF OWNER'S CONSULTING ENGINEER

I certify that I have verified this Monthly Estimate, and that to the best of my knowledge and belief it is a true and correct statement of work performed and materials supplied under the Contract, and that the Subcontractor's certified statement of his account and the amount due him is correct and just, and that all work and material included in this Estimate have been performed in full accordance with the terms and conditions of this corresponding construction contract documents and authorized changes thereto.

SulTRAC

By: Resident Engineer

Date:

Payment of the above amount due this estimate is approved.

SulTRAC

By:

Title:

Date:

SECTION 01 31 00

PROJECT MANAGEMENT AND COORDINATION

1. GENERAL

1.1 SECTION CONTENTS

1.1.1 Coordination

1.1.2 Field Engineering

1.1.3 Truck Traffic Control

1.1.4 Cutting and Patching

1.1.5 Preconstruction Conference

1.1.6 Progress Meetings

1.1.7 On-Site Meetings

1.2 RELATED SECTIONS

1.2.1 Section 01 11 00 - Summary of Work

1.2.2 Section 01 33 00 - Submittals

1.2.3 Section 01 70 00 - Project Closeout

1.3 COORDINATION

1.3.1 Coordinate scheduling, submittals, and work of the various sections of specifications to ensure efficient and orderly sequence of installation of interdependent construction elements.

1.3.2 After inspection of work, coordinate access to site for correction of defective work and work not in accordance with contract documents, to minimize disruption of property owner's activities.

1.4 FIELD ENGINEERING

1.4.1 Employ a Land Surveyor registered in the State of Illinois and acceptable to the Engineer.

1.4.2 Contractor shall locate and protect survey control and reference points.

1.4.3 Control datum for survey is that shown on drawings.

1.4.4 Provide drawings and certification signed by the land surveyor that the elevations and locations of the excavations are in conformance with the contract documents

1.4.5 Submit three copies of registered site drawing and certificate signed by the land surveyor that the elevations and locations of the work are in conformance with the contract documents.

1.5 TRUCK TRAFFIC CONTROL

1.5.1 Provide on-site trucking manager at gates being used under this work during import and export of materials.

1.5.2 Trucking manager must direct traffic at west gate and northwest gate during material import or export.

1.5.3 Trucking manager is to ensure materials and trucks are delivered to the correct location at the site.

1.6 CUTTING AND PATCHING

1.6.1 Employ skilled and experienced installer to perform cutting and patching.

1.6.2 Submit written request in advance of cutting or altering elements which affects:

1.6.2.1 Structural integrity of element

1.6.2.2 Efficiency, maintenance, or safety of element

1.6.2.3 Visual qualities of sight-exposed elements

1.6.2.4 Work of owner or separate subcontractor

1.6.3 Identify any hazardous substance or condition exposed during the work to the engineer for decision or remedy.

1.7 PRECONSTRUCTION CONFERENCE

1.7.1 Engineer will schedule a conference after notice of award.

1.7.2 Attendance required: owner, engineer, and contractor.

1.7.3 Agenda

1.7.3.1 Review of Contract Agreement.

1.7.3.2 Submission of executed bonds and insurance certificates.

1.7.3.3 Distribution of contract documents.

1.7.3.4 Submission of list of subcontractors, list of products, schedule of values, and progress schedule.

1.7.3.5 Designation of personnel representing the parties in contract, owner, and the engineer.

1.7.3.6 Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal requests, change orders, and contract closeout procedures.

1.7.3.7 Scheduling and meetings

1.8 PROGRESS MEETINGS

1.8.1 Schedule and administer meetings throughout progress of the work at maximum weekly intervals.

1.8.2 Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within two days to engineer, owner, participants, and those affected by decisions made.

1.8.3 Attendance required: Contractor superintendent, major subcontractors, engineer, as appropriate to agenda topics for each meeting.

1.8.4 Agenda.

1.8.4.1 Review minutes of previous meetings.

1.8.4.2 Review of work progress.

1.8.4.3 Field observations, problems, and decisions.

1.8.4.4 Identification of problems which impede planned progress.

1.8.4.5 Review of submittals, schedule and status of submittals.

1.8.4.6 Review of off-site fabrication and delivery schedules.

1.8.4.7 Maintenance of progress schedule.

1.8.4.8 Corrective measures to regain projected schedules.

1.8.4.9 Planned progress during succeeding work period.

1.8.4.10 Coordination of projected progress.

1.8.4.11 Maintenance of quality and work standards.

1.8.4.12 Effect of proposed changes on progress schedule and coordination.

1.8.4.13 Other business relating to work.

1.9 ON-SITE MEETINGS

1.9.1 Contractor superintendent, major subcontractors, as appropriate are to attend on-site meetings with Engineer and other Consultant and Contractors as needed to discuss coordination of site resources and access points.

1.9.2 Maintain at job site, one copy each of the following:

1.9.2.1 Contract drawings

1.9.2.2 Specifications

1.9.2.3 Addenda

1.9.2.4 Reviewed submittals
1.9.2.5 List of outstanding submittals
1.9.2.6 Change orders
1.9.2.7 Other modifications to Contract
1.9.2.8 Field test reports
1.9.2.9 Copy of approved work schedule
1.9.2.10 Health and Safety Plan and other safety-related documents
1.9.2.11 Manufacturers' installation and application instructions
1.9.2.12 Labor conditions and wage schedules
1.9.2.13 Other documents as specified

2. PRODUCTS - (NOT USED)

3. EXECUTION - (NOT USED)

End of Section 01 31 00

SECTION 01 32 00

CONSTRUCTION PROGRESS DOCUMENTATION

1. GENERAL

1.1 REFERENCES

Not used.

1.2 DEFINITIONS

Not used.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 Submittals:

1.3.1 Construction Schedule

Prior to start of work, within 14 days of notice to proceed, submit a Construction Schedule as described in this section. Allow sufficient time for cycles of review, comment and resubmission so that the final version is delivered to the Engineer before start of construction activities.

1.3.2 Weekly Reports

The Contractor will provide weekly reports on construction progress. These reports should include qualitative descriptions of work performed and provide forward guidance on upcoming scheduled activities; also include weekly summaries of quantities to the extent practicable.

The reports will summarize the work performed, the equipment used, and the results of any QC inspections, tests, or other monitoring activities. The reports will also document any noncompliant conditions, communicate these conditions to the Engineer, and describe correction actions taken to attain compliance. Weekly summaries on the progress of excavation and capping should be included in the weekly construction QC reports. These reports will include tabulated summaries of volumes removed or placed, shipping receipts and material volumes for import materials delivered to the site, and quantities and appropriate documentation for all wastes shipped from the site.

1.4 CONSTRUCTION SCHEDULE SUBMITTAL PROCEDURES

Submit all network analysis and updates in hard copy and on electronic media that is acceptable to the Engineer. The project schedule will also be posted in the format specified as an Adobe PDF file. For hard copy submittals, a condensed critical path method schedule is preferred but another practicable form of presentation will be acceptable as approved by the Engineer.

1.5 SCHEDULING

The Contractor shall use the critical path method (CPM) to schedule and control construction activities. Schedules shall include start and stop dates, durations for tasks and subtasks.

The scheduling software that will be utilized on this project is MS Project or similar.

1.5.1 Construction Schedule

Prepare a detailed schedule in graphic form (Gantt Chart) showing proposed dates of starting and completing each major division of the Work. Develop the Project Schedule to an appropriate level of detail. Failure to develop the Project Schedule to an appropriate level of detail, as determined by the Engineer, will result in its disapproval. Subdivide tasks so that less than 2 percent of all non-procurement activities have Original Durations (OD) greater than 20 work days or 30 calendar days.

The schedule shall identify as a minimum:

- Contractor mobilization to site
- Critical submittals (including submission and approval dates)
- Site set up including installation of temporary facilities and controls
- Material delivery schedule
- Installation of new sanitary force main
- Installation of steel sheet piling for utility protection
- Installation of vertical barrier
- TSCA characteristic soil transportation and disposal
- Installation of dewatering system
- Installation of conveyance piping, electrical wiring and controls
- Startup and shakedown of dewatering system
- Installation of monitoring wells and piezometers
- Installation of 811 cap over ODC
- Installation of North utility corridor cap
- Installation of West utility corridor cap
- Site restoration/seeding/stabilization and cleanup
- Demobilization

1.5.2 Construction Progress Schedule

The network analysis system shall be kept current, with changes made to reflect the actual progress and status of the construction. Update the construction schedule at monthly intervals or when the schedule has been revised. Reflect any changes occurring since the last update. The schedule should show the progress of work compared to the original project schedule. Application for progress payments will not be processed until the progress schedule is delivered to Engineer.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

End of Section 01 32 00

SECTION 01 33 00

SUBMITTALS

1. GENERAL

1.1 SECTION CONTENTS

1.1.1 Submittal Procedures

1.1.2 Construction Progress Schedule

1.1.3 Proposed Product List

1.1.4 Shop Drawings

1.1.5 Product Data

1.1.6 Breakdown of Contract Amount

1.1.7 Health and Safety Requirements

1.1.8 As-Constructed Drawings

1.2 RELATED SECTIONS

1.2.1 Section 01 45 00 - Quality Control

1.2.2 Section 01 70 00 - Project Closeout

1.3 SUBMITTAL PROCEDURES

1.3.1 Transmit each submittal with an engineer accepted form.

1.3.2 Sequentially number the transmittal forms. Resubmittals shall have original number with an alphabetic suffix.

1.3.3 Identify Project, Contractor, subcontractor, or Supplier; pertinent Drawing sheet and detail numbers, and Specification Section number.

1.3.4 Apply Contractor's stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.

1.3.5 Schedule submittals to expedite the project, and deliver to Engineer at business address. Coordinate submission of related items.

1.3.6 Identify variations, deviations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed work.

1.3.7 Provide adequate space for Contractor and Engineer review stamps, if required.

1.3.8 Revise and resubmit submittals as required, identify all changes made since previous submittal.

1.3.9 Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with the provisions of the contract documents.

1.4 CONSTRUCTION PROGRESS SCHEDULE

1.4.1 Submit three copies of the initial construction progress schedule within 14 days after date of Notice to Proceed.

1.4.2 Prepare a detailed progress schedule in graphic form showing proposed dates of starting and completing each major division of the Work.

1.4.3 The schedule shall be consistent with the time and order of work requirements of the Specifications, and shall be the basis of Subcontractor's operations.

1.4.4 The schedule shall be prepared utilizing the critical path method.

1.4.4.1 Level of Detail Required

Develop the Project Schedule to an appropriate level of detail. Failure to develop the Project Schedule to an appropriate level of detail, as determined by the Engineer, will result in its disapproval. The Engineer will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail:

1.4.4.2 Activity Durations

Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods. Less than 2 percent of all non-procurement activities shall have Original Durations (OD) greater than 20 work days or 30 calendar days. Procurement activities are defined herein.

1.4.4.3 Procurement Activities

The schedule must include activities associated with the submittal, approval, procurement, fabrication, and delivery of long lead materials, equipment, fabricated assemblies and supplies. Long lead procurement activities are those with an anticipated procurement sequence of over 90 calendar days. A typical procurement sequence includes the string of activities: submit, approve, procure, fabricate, and deliver.

1.4.5 A condensed critical path method schedule is preferred but another practicable form of presentation will be acceptable.

1.4.6 At the end of each month, Contractor shall submit a revised schedule showing the current status of the Work as compared to the projected status. The current application for a progress payment will not be processed until the revised schedule is delivered to Engineer.

1.5 PROPOSED PRODUCT LIST

1.5.1 Within 10 days after execution of the Contract, submit to Engineer a complete list of products and equipment which are intended to be furnished.

1.6 SHOP DRAWINGS

1.6.1 Shop drawings are original drawings prepared by Contractor, subcontractors, suppliers, or distributors, illustrating some portion of the work and showing fabrication, layout, setting, or erection details of equipment, materials, and components.

1.6.2 Unless otherwise instructed, Contractor shall submit to Engineer for review and approval three prints of each plan or two prints and one reproducible. Engineer will return with review comments on one print or one reproducible.

1.6.3 Shop drawings shall be 8-1/2 x 11 or 8-1/2 x 14 inch or standard size, or as directed by Engineer. Drawings shall be clearly identified as to location of the equipment, materials, and apparatus in the Work. Submittals shall show the name, address, and telephone number of the company that prepared them.

1.6.4 Fold drawings to an approximate size of 8-1/2 x 11 inch in such a manner that the title block will be located in the lower right hand corner of the exposed surface. Roll, do not fold, reproducible copies of drawings.

1.6.5 Shop Drawings Showing Deviations from Contract Drawings

1.6.5.1 Submit detailed drawings of modifications to or deviations from the contract drawings, as required to accommodate equipment, facilities, or processes included in the awarded Contract.

1.6.5.2 Submittal procedures shall be the same as for shop drawings.

1.6.6 Subcontractor Responsibilities

1.6.6.1 Review and approve shop drawings, project data, and samples before submitting them.

1.6.6.2 Verify field measurements, field construction criteria, catalog numbers, and similar data.

1.6.6.3 Coordinate each submittal with the requirements of the Contract Documents.

1.6.6.4 For each major equipment item, submit all shop drawings in one complete package to permit checking complete installation details.

1.6.6.5 In a clear space above the title block of the shop drawings, or on the back, hand stamp the following, and enter the required information:

EPA
OMC Plant 2 Superfund Site –Remedial Action-ODC and Utility Corridors
Date.....
Project No.
Identification ....
Contract Drawing No. ...
Specification Section.....

This document has been checked for accuracy of content and for compliance with the Contract Documents and is hereby approved. The information contained herein has been coordinated with all involved Contractors.

Contractor _____

Signed . _____

1.6.6.6 Contractor's responsibility for errors, omissions, and deviations from requirements of the Contract Documents in submittals is not relieved by Engineer's review.

1.6.6.7 At time of submittal, notify Engineer in writing of deviations in submittals from requirements of the Contract Documents.

1.6.6.8 Do not install materials or equipment which require submittals until the submittals are returned with Engineer's stamp and initials or signature indicating approval.

1.6.6.9 Revise returned shop drawings as required and resubmit until final approval is obtained. Indicate on the drawings any changes which have been made other than those requested by Engineer.

1.6.6.10 Submit new project data and samples when the initial submittal is returned disapproved.

1.6.6.11 No claim will be allowed for damages or extension of time because of delays in the work resulting from rejection of material or from revision and resubmittal of shop drawings, project data, or samples.

1.6.7 Engineer's Duties

1.6.7.1 Engineer will review submittals for compliance with the Contract Documents and with the design concept of the project within 14 days of receipt of submittals.

1.6.7.2 Review of a separate item does not constitute acceptance of an assembly in which the item functions.

1.6.7.3 Engineer will affix a stamp to the returned copy of each submittal. The stamp will be marked to indicate whether the submittal is "Approved," "Approved as Noted," "Revise and Resubmit," "Not Approved," or "Information" and an explanation will be given if the submittal is unsatisfactory. The stamp will be initialed or signed certifying the submittal review.

1.7 PRODUCT DATA

Submit the number of copies which Contractor requires, plus two copies which will be retained by the Engineer.

1.7.1 Product data are standard schematic drawings, catalog sheets, brochures, diagrams, schedules, performance charts, illustrations, and other standard descriptive data. Product data shall be submitted on all materials with a purchase price of $1000 or more.

1.7.2 Mark each copy of printed material to identify applicable products, models, options, and other data.

1.7.3 Project data shall show the name, mailing address, and telephone number of the manufacturer and supplier.

1.8 BREAKDOWN OF CONTRACT AMOUNT

1.8.1 Submit a typewritten breakdown of contract amount on for use in computing and checking periodic payment estimates.

1.8.2 No payment will be made until the breakdown has been submitted and accepted by Engineer.

1.8.3 The breakdown may be as detailed as desired for partial payment application.

1.9 HEALTH AND SAFETY REQUIREMENTS

1.9.1 Prepare a Construction Health and Safety Plan. Submit three copies to Engineer and Owner for review in accordance with Section 01 35 00 no later than 10 days after Notice to Proceed and prior to the start of any field work.

1.10 AS-CONSTRUCTED DRAWINGS

1.10.1 Provide to Engineer at closeout, one set of as- constructed record documents; including all revision, modifications, additions, and changes to the Work as required in Section 01 70 00 Project Closeout.

2. PRODUCTS/MATERIALS (NOT USED)

3. EXECUTION (NOT USED)

End of Section 01 33 00

SECTION 01 34 90
SYSTEM TESTING AND QUALITY CONTROL

1. GENERAL

1.1 SUBMITTALS

Submit the following in accordance with Section 01 33 00 Submittal Procedures.

1.1.1 SD-06 Test Reports

a. Functional Test Result. Submit completed functional test plan form included at end of this specification.
b. 24-hour run test in Extraction Well Drawdown Setpoint Control Scheme.
c. 24-hour run test in Paired Piezometer Gradient Control Scheme.

2. PRODUCTS

Not Used

3. EXECUTION

3.1 FUNCTIONAL TESTING

After internal startup/shakedown of extraction well system is complete, conduct functional testing in presence of Engineer to demonstrate that system functions as intended. Functional testing shall be conducted in its entirety in a single event—piecemeal completion of the test will not be accepted. Functional test checklist is included at the end of this section.

Additional tests to demonstrate that the system functions in accordance with the drawings and specifications may be required.

3.2 24-HOUR RUN TESTS

Conduct two 24-hour run tests to demonstrate proper operation of extraction well system under the two well control schemes. Extracted groundwater shall be either discharged to CH2MHill system (when it becomes operational) or containerized in portable, closed tanks until CH2MHill system becomes operational.

a. Operate both extraction wells concurrently for 24-hours in the Extraction Well Drawdown Setpoint Control Scheme. Provide water level elevation data from ODC-EW-1 and ODC-PZ-3/4 and ODC-EW-2 and ODC-PZ-7/8 in tabular and graphical form to demonstrate proper operation of control scheme.

b. Operate both extraction wells concurrently for 24-hours in the Paired Piezometer Gradient Control Scheme. Provide water level elevation data from ODC-EW-1 and ODC-PZ-3/4 and ODC-EW-2 and ODC-PZ-7/8 in tabular and graphical form to demonstrate proper operation of control scheme.

ODC Extraction Well System Functional Test Checklist

Date:	**Test Conducted by:**	
Test Item	**Pass/Fail and Comments**	**Write down alarm text displayed on HMI terminal**
Pressure Transducer Calibration		
-Measure depth to water in ODC-PZ-3 -Calculate groundwater level in ODC-PZ-3 from manual measurement -Compare to pressure transducer display of groundwater level in ODC-PZ-3 -Calculate difference between manual measurement and pressure transducer display, confirm less than 0.04 feet difference	_____ft below TOC _____ft AMSL _____ft AMSL PASS / FAIL	
-Measure depth to water in ODC-PZ-4 -Calculate groundwater level in ODC-PZ-4 from manual measurement -Compare to pressure transducer display of groundwater level in ODC-PZ-4 -Calculate difference between manual measurement and pressure transducer display, confirm less than 0.04 feet difference	_____ft below TOC _____ft AMSL _____ft AMSL PASS / FAIL	
-Measure depth to water in ODC-PZ-7 -Calculate groundwater level in ODC-PZ-7 from manual measurement -Compare to pressure transducer display of groundwater level in ODC-PZ-7 -Calculate difference between manual measurement and pressure transducer display, confirm less than 0.04 feet difference	_____ft below TOC _____ft AMSL _____ft AMSL PASS / FAIL	
-Measure depth to water in ODC-PZ-8 -Calculate groundwater level in ODC-PZ-8 from manual measurement -Compare to pressure transducer display of groundwater level in ODC-PZ-8 -Calculate difference between manual measurement and pressure transducer display, confirm less than 0.04 feet difference	_____ft below TOC _____ft AMSL _____ft AMSL PASS / FAIL	
-Measure depth to water in ODC-EW-1 -Calculate groundwater level in ODC-EW-1 from manual measurement -Compare to pressure transducer display of groundwater level in ODC-EW-1 -Calculate difference between manual measurement and pressure transducer display, confirm less than 0.04 feet difference	_____ft below TOC _____ft AMSL _____ft AMSL PASS / FAIL	

Date:	**Test Conducted by:**	
Test Item	**Pass/Fail and Comments**	**Write down alarm text displayed on HMI terminal**
-Measure depth to water in ODC-EW-2 -Calculate groundwater level in ODC-EW-2 from manual measurement -Compare to pressure transducer display of groundwater level in ODC-EW-2 -Calculate difference between manual measurement and pressure transducer display, confirm less than 0.04 feet difference	_____ft below TOC _____ft AMSL _____ft AMSL PASS / FAIL	
ODC-EW-1		
Confirm red pump off light status	PASS / FAIL	
Turn pump to "HAND", confirm green run status light is on, confirm that pump is on	PASS / FAIL	
Turn pump to "AUTO" confirm green run status light is on, confirm that pump is on	PASS / FAIL	
Confirm Proper operation of Flowmeter	PASS / FAIL	
Confirm proper operation of Pressure Gauge	PASS / FAIL	
Adjust VFD, confirm corresponding increase/decrease in flow rate	PASS / FAIL	
With VFD at 60 Hz, measure full load amperage of extraction well pump	_____A	
Decrease VFD speed to low flow shutoff setting, -confirm that pump shuts off -confirm that amber alarm lamp is lit -confirm correction notation in alarm history	 PASS / FAIL PASS / FAIL PASS / FAIL	
Raise extraction well pressure transducer to artificially simulate low level alarm condition, -confirm that pump shuts off -confirm that amber alarm lamp is lit -confirm correction notation in alarm history	 PASS / FAIL PASS / FAIL PASS / FAIL	
Activate overload fault, -confirm that pump shuts off -confirm that amber alarm lamp is lit -confirm correction notation in alarm history	 PASS / FAIL PASS / FAIL PASS / FAIL	
ODC-EW-2		
Confirm red pump off light status	PASS / FAIL	
Turn pump to "HAND", confirm green run status light is on, confirm that pump is on	PASS / FAIL	
Turn pump to "AUTO" confirm green run status light is on, confirm that pump is on	PASS / FAIL	
Confirm Proper operation of Flowmeter	PASS / FAIL	
Confirm proper operation of Pressure Gauge	PASS / FAIL	
Adjust VFD, confirm corresponding increase/decrease in flow rate	PASS / FAIL	

Date:	**Test Conducted by:**	
Test Item	**Pass/Fail and Comments**	**Write down alarm text displayed on HMI terminal**
With VFD at 60 Hz, measure full load amperage of extraction well pump	_____A	
Decrease VFD speed to low flow shutoff setting, -confirm that pump shuts off -confirm that amber alarm lamp is lit -confirm correction notation in alarm history	 PASS / FAIL PASS / FAIL PASS / FAIL	
Raise extraction well pressure transducer to artificially simulate low level alarm condition, -confirm that pump shuts off -confirm that amber alarm lamp is lit -confirm correction notation in alarm history	 PASS / FAIL PASS / FAIL PASS / FAIL	
Activate overload fault, -confirm that pump shuts off -confirm that amber alarm lamp is lit -confirm correction notation in alarm history	 PASS / FAIL PASS / FAIL PASS / FAIL	
COMMUNICATION WITH CH2MHILL SYSTEM		
With ODC Extraction system running, shut down CH2MHill System, confirm that both extraction wells shut down.	PASS / FAIL	
Confirm that shutdown alarm is correctly noted on alarm history	PASS / FAIL	
Resume CH2MHill System operation, confirm that both ODC extraction wells re-start	PASS / FAIL	
Confirm that system restart time is noted on PLC history	PASS / FAIL	

End of Section 01 34 90

SECTION 01 35 30

HEALTH AND SAFETY REQUIREMENTS

1. GENERAL

1.1 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES within 10 days of Notice to Proceed:
Submit three copies of the site-specific Construction Health and Safety Plan (HASP).

1.1.2 Submit three copies of the site Health and Safety Officer's qualification and certificates.

1.1.3 Submit three copies of current OSHA training certificates for all site personnel.

1.1.4 Submit three copies of medical monitoring reports for all site personnel.

1.1.5 Submit three copies of the Contractor's corporate health and safety program.

1.2 DESCRIPTION OF WORK

This section requires the Contractor to implement practices and procedures for working safely and in compliance with OSHA regulations while performing work under this contract.

Note that other remedial actions conducted by other contractors will be ongoing at the site.

1.3 REGULATORY REQUIREMENTS

Comply with OSHA requirements in 29 CFR 1910 and 29 CFR 1926 with work performed under this contract and state specific OSHA requirements where applicable. Submit to the Engineer for resolution matters of interpretation of standards before starting work. The most stringent requirements apply where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary.

1.4 HEALTH AND SAFETY

This section outlines the health and safety requirements to be followed by Contractor during the performance of the work.

1.4.1 Address all occupational safety and health hazards (traditional construction as well as contaminant-related hazards associated with cleanup operations.

1.4.2 These requirements do not supersede, but are in addition to any federal, OSHA, state, or local regulations. If a conflict occurs between these requirements and current regulations, the more stringent shall apply.

1.4.3 Contractor's Responsibilities

Contractor is solely responsible for the health, safety, and protection of all on-site personnel during the performance of the work. Contractor shall perform the work specified in these contract documents in accordance with the health and safety requirements specified herein. It shall be the responsibility of Contractor to be familiar with the required health and safety regulations in the performance of this work.

Contractor shall provide an experienced Health and Safety Officer to implement, monitor, and enforce the Construction HASP.

The Health and Safety Officer shall have a sound working knowledge of federal and state occupational safety and health regulations.

Contractor can assume Level D protection is required for bidding purposes. Contractor shall be prepared to upgrade in accordance with its Construction HASP.

Should any unforeseen or site-specific safety related factor, hazard, or condition become evident during the performance of the work, Subcontractor shall take immediate action to establish and maintain safe working conditions and to safeguard site personnel, the public, and the environment. Subcontractor shall also immediately inform Engineer of such a condition.

1.4.4 Training Requirements. Contractor's training program for workers performing cleanup operations and who will be exposed to contaminants shall meet the following requirements.

1.4.4.1 General Hazardous Waste Operations Training

The Construction HASP will define which personnel will be performing duties with potential for exposure to on-site contaminants that must meet and maintain the following 29 CFR 1910.120 and 29 CFR 1926.65 (e) training requirements:

a. Onsite supervisor shall have 40 hours of off-site hazardous waste instruction.

b. Superintendent shall have 3 days actual field experience under the direct supervision of a trained, experienced supervisor.

c. Onsite supervisor 8 hours refresher training annually.

d. Onsite supervisors must meet these requirements and have an additional 8 hours management and supervisor training specified in 29 CFR 1910.120.

e. Construction workers with potential for exposure to site contaminants shall be OSHA 40-hour HAZWOPER trained with current 8-hour refresher certification.

1.4.4.2 Pre-entry Briefing

Prior to commencement of on-site field activities, all site employees, must attend a site-specific health and safety training session. This session will be conducted by the Site Health and Safety Officer (SHSO) to ensure that all personnel are familiar with requirements and responsibilities for maintaining a safe and healthful work environment. Thoroughly discuss procedures and contents of the accepted HASP. Each employee must sign a training log to acknowledge attendance and understanding of the training. Notify the Engineer at least 5 days prior to the initial site-specific training session. SHSO shall conduct a site-specific training session for new personnel, visitors, and suppliers. Each new employee must sign a training log to acknowledge attendance and understanding of the training.

1.4.4.3 Periodic Sessions

Conduct periodic on-site training at least weekly for personnel assigned to work at the site

1.5 SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

1.5.1 Project/Site Conditions

The Engineer's Health and Safety Plan is available for information on the site description and contamination characterization. Maximum concentrations for contaminants of concern at OMC Plant 2 are provided in Table 1 at the end of this specification.

1.6 CONSTRUCTION HEALTH AND SAFETY PLAN

Prepare a site-specific Construction HASP. Submit three copies to Engineer for review no later than 10 days after Notice to Proceed and prior to the start of any field work. The Engineer's Health and Safety plan is available for reference only. Contractor should note that the Engineer's plan is not considered adequate for the work contemplated. The Construction HASP shall comply with OSHA standards and at a minimum include:

1.6.1 Organization and persons responsible for health and safety

1.6.2 Identification of anticipated work hazards

1.6.3 Engineering controls used to mitigate work hazards

1.6.4 Safe work practices

1.6.5 List of personal protective equipment

1.6.6 Hazard communication and notification procedures

1.6.7 Hazard monitoring and record keeping

1.6.8 Incident reporting procedures

1.6.9 Emergency response procedures including responsibilities and hospital route

1.7 DAILY TAILGATE MEETINGS

Conduct daily tailgate meetings for all site personnel. Discuss anticipated work hazards, environmental hazards and safe work practices specific to work being performed that day.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

TABLE 1
MAXIMUM CONTAMINANT CONCENTRATIONS IN SOIL AND GROUNDWATER

	Contaminant	Maximum Concentration	Depth (feet below grade)
VOCs in Groundwater	TCE	75 mg/L	20 feet
PCBs in Groundwater	PCBs	0.41 mg/L	20 feet
VOCs in Soil	TCE	520 mg/kg	21 feet
PCBs in Soil	Total PCBs	54,000 mg/kg	22 feet

End of Section 01 35 30

SECTION 01 41 00

REGULATORY REQUIREMENTS

1. GENERAL

1.1 APPLICABLE CODES

The Contractor shall comply with all federal, state, and local rules, ordinances, and regulations relating to buildings, employment, the preservation of public health and safety, and so forth. All necessary permits (other than those already obtained by the Engineer) or certificates of inspection shall be paid for and obtained by the Contractor.

1.2 APPLICABLE REGULATIONS

All applicable federal, state, and local laws, ordinances, rules, and regulations are deemed to be included herein the same as though written in full. The Contractor shall comply with all authorities having jurisdiction over the work. The following list of regulations does not necessarily include all regulations which may be applicable to site activities and off-site transportation and disposal.

1.2.1 Federal Regulations

1.2.1.1 Disposal of wastes including land disposal restricted wastes at treatment and disposal facilities that are appropriately permitted. Prior to shipment of wastes to any facility, provide evidence to the owner that the facility is in compliance as required.

1.2.1.2 Transport wastes in accordance with all applicable U.S. Department of Transportation and U.S. EPA rules and regulations.

1.2.1.3 Conduct all site work in accordance with the Construction Health and Safety Plan and applicable federal regulations including U.S. Department of Labor Occupational Safety and Health Standards (29 CFR 1910).

1.2.2 State Regulations

1.2.2.1 Environmental Quality regulations

- Illinois Compiled Laws shall govern all activities of the Contractor and subcontractor(s) within the state boundaries as applicable.
- Transportation of wastes within the State of Illinois shall be in compliance with applicable laws. Waste haulers shall possess a valid license for transporting waste issued by the Department of Transportation.
- Disposal of non-hazardous wastes in Type II facilities must comply with all inter-county waste management plans.
- Disposal of TSCA wastes must comply with TSCA regulations.

1.2.2.2 Transportation of wastes through states other than Illinois shall be in compliance with all applicable requirements of those states. Waste haulers shall possess a valid license for transporting waste issued by the Department of Transportation.

1.2.2.3 Treatment and disposal facilities shall be in compliance with all requirements of the state in which they are operated.

1.2.3 Local Requirements

1.2.3.1 Ascertain and comply with all applicable county and municipal ordinances, codes, rules, and regulations and obtain all required permits including seasonal load limits which may be imposed to cover transportation on certain roads.

1.2.3.2 Comply with OMC offsite discharge requirements for treated water discharged to waterways. Table 014100 summarizes the offsite discharge limits.

TABLE 01 41 00
OFF-SITE DISCHARGE LIMITS

Parameter	Effluent Limits	
	Not to Exceed at Any Time	30-Day Average Limit
Ammonia Nitrogen, Total (Apr to Oct)	2.9 mg/L	0.6 mg/L
Ammonia Nitrogen, Total (Nov to Mar)	4.1 mg/L	0.8 mg/L
Chlordane	0.01 µg/L	0.01 µg/L
DDT and Metabolites	0.01 µg/L	0.01 µg/L
Dieldrin	0.01 µg/L	0.01 µg/L
Endrin	0.086 µg/L	0.036 µg/L
Lindane	0.95 µg/L	0.5 µg/L
PCBs (Total)	0.1 µg/L	0.1 µg/L
Total Suspended Solids (TSS)	15 mg/L	NA
Arsenic (Total)	340 µg/L	148 µg/L
Cadmium (Total)	6.6 µg/L	3.2 µg/L
Chromium (Total Trivalent)	2375 µg/L	113.5 µg/L
Copper (Total)	19.2 µg/L	12.4 µg/L
Lead (Total)	187.9 µg/L	9.9 µg/L
Mercury (Total)	1,700 ng/L	1.3 ng/L
Nickel (Total)	623.7 µg/L	69.3 µg/L
Zinc (Total)	159.3 µg/L	159.3 µg/L

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

End of Section 01 41 00

SECTION 01 45 00
QUALITY CONTROL

1. GENERAL

1.1 SECTION CONTENTS

1.1.1 Quality assurance and quality control at installation

1.1.2 References

1.1.3 Inspection and Testing Services

1.1.4 Submittals

1.1.5 Inspecting Company and Testing Laboratory Responsibility

1.1.6 Inspecting Company and Testing Laboratory Reports

1.1.7 Contractor's Responsibilities

1.2 RELATED SECTIONS

1.2.1 Section 01 33 00 - Submittals

1.3 QUALITY ASSURANCE/QUALITY CONTROL AT INSTALLATION

1.3.1 Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship to produce work of specified quality.

1.3.2 Comply fully with manufacturer's instructions, including each step in sequence.

1.3.3 Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

1.3.4 Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

1.3.5 Perform work by persons qualified to produce workmanship of specified quality.

1.3.6 Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.4 REFERENCES

1.4.1 Conform to reference standard by date of issue current on date for receiving bids.

1.4.2 Obtain copies of standards when required by Contract Documents.

1.4.3 Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.4.4 The Contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.5 INSPECTION AND TESTING SERVICES

1.5.1 Contractor shall employ and pay for services of an independent inspecting company and testing laboratory to perform inspecting and testing services as specified in individual Sections

1.5.2 Employment of inspecting company and testing laboratory and services performed by such inspecting company and testing laboratory in no way relieves Contractor of obligation to perform the Work in accordance with requirements of the Contract Documents.

1.5.3 Quality Assurance

1.5.3.1 Comply with applicable requirements of the American Society for Testing and Materials (ASTM) and the quality assurance project plan included as an attachment to the specifications.

1.5.3.2 The testing laboratory shall be authorized to operate in the State of Illinois.

1.5.3.3 Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to either the National Institute of Standards and Technology or accepted values of natural physical constants.

1.5.3.4 The inspection service shall have a full-time registered engineer on staff or available for reviews.

1.5.4 Collect field samples at the site as required by individual specification sections.

1.5.5 Collect acceptable samples that represent a quality level for the work.

1.6 SUBMITTALS

1.6.1 Prior to start of the Work, submit a Construction Quality Control Plan to include all testing and frequency of testing to be performed. Include test methods and criteria required for project.

1.6.2 Prior to start of the Work, submit independent inspecting company and testing laboratory name(s), address, and telephone number, and names of full-time registered Engineer and responsible officer to the Engineer.

1.6.3 Submit copy of report of inspecting company and testing laboratory facilities inspection made by authorized agency during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.

1.7 INSPECTING COMPANY AND TESTING LABORATORY RESPONSIBILITIES

1.7.1 Test samples of materials submitted by Contractor

1.7.2 Provide qualified personnel. Cooperate with Engineer and Contractor in performance of services.

1.7.3 Perform specified inspecting, sampling, and testing of products and methods of construction in accordance with specified standards.

1.7.4 Ascertain compliance of materials with requirements of the Contract Documents.

1.7.5 Promptly notify Engineer and Contractor of observed irregularities, deficiencies, or non-conformance of the Work or products.

1.7.6 Perform additional inspection and tests required by Engineer and as directed by Contractor.

1.8 INSPECTING COMPANY AND TESTING LABORATORY REPORTS

1.8.1 After each inspection and test promptly submit 2 copies of reports to Engineer and to Contractor.

1.8.2 At a minimum, reports shall include:

1.8.2.1 Date issued.

1.8.2.2 Project title and number.

1.8.2.3 Name and address of inspecting and testing laboratory.

1.8.2.4 Name of inspector.

1.8.2.5 Date and time of sampling or inspection.

1.8.2.6 Identification of product and related specification Section.

1.8.2.7 Location in the Project.

1.8.2.8 Record of temperature and weather.

1.8.2.9 Type of inspection or test.

1.8.2.10 Date of test.

1.8.2.11 Results of tests and observations.

1.8.2.12 Conformance with the Contract Documents.

1.8.3 Limits on Inspecting Company and Testing Laboratory Authority:

1.8.3.1 Inspecting company and testing laboratory may not release, revoke, alter, or enlarge on requirements of the Contract Documents.

1.8.3.2 Inspecting company and testing laboratory may not approve or accept any portion of the Work.

1.8.3.3 Inspecting company and testing laboratory may not assume or perform any duties of Contractor.

1.8.3.4 Inspecting company and testing laboratory has no authority to stop the Work.

1.9 CONTRACTOR'S RESPONSIBILITIES

1.9.1 Deliver to inspecting company and testing laboratory at designated location, adequate samples of materials proposed to be used which require testing.

1.9.2 Cooperate with personnel of independent inspecting company and testing laboratory, and provide safe access to the site.

1.9.3 Provide incidental labor and facilities:

1.9.3.1 To provide access to the Work to be tested.

1.9.3.2 To obtain and handle samples at the Site or at source of products to be tested.

1.9.3.3 To facilitate tests and inspections.

1.9.3.4 For inspecting company and testing laboratory's exclusive use for storage and curing of test samples.

1.9.4 Furnish copies of product test reports.

1.9.5 Promptly notify Engineer of all observed irregularities or non-conformances.

1.9.6 Retesting required because of Contractor negligence or non-conformance to specified requirements shall be performed by the same inspecting and testing laboratory at Contractor's expense and at no additional cost to Owner.

2. PRODUCTS - (NOT USED)

3. EXECUTION - (NOT USED

End of Section 01 45 00

SECTION 01 50 00

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

1. GENERAL

1.1 SECTION CONTENTS

1.1.1 Temporary controls: barriers, protection of the work, water and dust/pollution control.

1.1.2 Construction facilities: roads, parking, offices, progress cleaning, project signage.

1.2 RELATED SECTIONS

1.2.1 Section 01 33 00 - Submittals

1.2.2 Section 01 70 00 - Project Closeout

1.3 TEMPORARY ELECTRICITY

1.3.1 There will be no onsite power supply provided by the owner or Engineer. If temporary electricity is provided by Contractor, then the use must conform to these specifications.

1.3.2 Provide power outlets for construction operations. All outlets must be GFI protected without exception. Provide flexible power cords as necessary. All flexible power cords must be for outdoor use, UL-listed, and in good condition.

1.3.3 Permanent convenience receptacles may not be used during construction.

1.3.4 Provide adequate distribution equipment, wiring, and outlets to provide single-phase branch circuits for power and lighting.

1.4 TEMPORARY LIGHTING

1.4.1 Provide and maintain lighting for construction operations to achieve a minimum lighting level of 2 watt per square foot, if work will be conducted during non-daylight hours.

1.4.2 Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.

1.4.3 Maintain lighting and provide routine repairs.

1.5 BARRIERS

1.5.1 Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

1.5.2 Provide barricades and cover walkways as required by governing authorities for public rights-of-way.

1.5.3 Provide protection for plant life designated to remain.

1.5.4 Protect vehicular traffic, stored materials, site, and structures from damage.

1.6 FENCING

1.6.1 Construction: Access to the construction areas must be restricted. Except where required on drawings, additional fencing is at Contractor's option. Submit details of fencing for Engineer's review 30 days after Notice to Proceed.

1.7 WATER CONTROL

1.7.1 Provide Storm Water Pollution Prevention Controls in accordance with the EPA-approved "Erosion and Sediment Control Plan" provided as an Attachment to these Specifications.

1.7.2 Grade site to drain.

1.7.3 Provide water barriers as required to protect site from soil erosion.

1.7.4 Provide necessary silt fences, ditches, culverts, etc. to control runoff.

1.7.5 Dispose of contaminated water in accordance with these specifications and applicable site, state and federal permits.

1.7.6 Provide protection to hoses or piping conveyances that cross access roads from loaded dump trucks.

1.7.7 Coordinate use of City water supply with other Consultant and contractors working on-site.

1.7.8 Meter all use of City water supply and minimize water waste.

1.8 DUST AND PARTICULATE CONTROL

1.8.1 Minimize raising dust from construction operations. Employ engineering controls and administrative controls to control emission of fugitive dust from the Work Area.

1.8.2 Implement and maintain dust and particulate control measures immediately during construction.

1.8.3 Provide positive means to prevent airborne dust from dispersing into atmosphere. Use potable water for dust and particulate control.

1.8.4 Administrative means of dust control may include limiting equipment speeds, limiting traffic volume to that which is essential, limiting the height at which materials are unloaded, and minimizing dust-generating activities during periods of high wind.

1.8.5 As a minimum, use appropriate covers on trucks hauling fine or dusty material and use watertight vehicles to haul wet materials.

1.8.6 Prevent dust from becoming a nuisance to adjacent property owners or occupants.

1.8.7 Apply water to support roads, traveled surfaces, and stockpiles using a system consisting of a storage tank, spray bar, and gauge-equipped pump. Water to be used shall be clear and free from salts, oils, and other injurious materials.

1.8.8 Engineer may stop work at any time when Contractor's control of dusts and particulates is inadequate for the wind conditions present at the Site.

1.8.9 In the event that Contractor's dust and particulate control is not sufficient for controlling dusts and particulates into the atmosphere, work shall be discontinued and a meeting held between Engineer and Contractor to discuss the procedures that Contractor proposes to resolve the problem.

1.9 POLLUTION CONTROL

Comply with Section 01 57 20 Environmental Protection.

1.10 PROTECTION OF INSTALLED WORK

1.10.1 Protect installed work and provide special protection where specified in individual sections.

1.10.2 Provide temporary and removable protection for installed products. Control activity in immediate work areas to minimize damage.

1.10.3 Prohibit traffic from landscaped areas.

1.11 ACCESS ROADS

1.11.1 Existing Roads: Reasonable use of existing on-site roads for construction traffic is permitted subject to the following conditions:

a. Do not interrupt or interfere with traffic on roads at any time except where specified on the Drawings and proper notice regarding open-trench crossings has been given to Engineer.

b. Comply with weight and load size restrictions where applicable.

c. Tracked vehicles are not allowed on off-site paved areas.

d. Provide a traffic flow plan for review by Engineer for site operations.

1.11.2 Temporary Roads:

a. Locate roads as approved by Engineer. Obtain Engineer's prior approval for location and extent of temporary roads.

b. Construct temporary access roads from public thoroughfares to serve construction area of a width and load bearing capacity to provide unimpeded traffic for construction purposes as Contractor requires for performance of the Work.

c. Preparation: Clear areas, provide surface and storm drainage of road and adjacent areas.

d. Do not interfere or obstruct site traffic associated with other site remedial actions.

1.11.3 Maintenance and Use:

a. Maintain temporary access roads in a sound condition, properly graded, and free of ruts, washboard, potholes, ponding, ice, snow, mud, soft material, excavated material, construction equipment, and products.

b. Maintain existing paved areas used for construction; promptly remove standing water and repair breaks, potholes, low areas, and other deficiencies, to maintain paving and drainage in original or specified condition.

c. Remove mud from vehicle wheels before entering public roads.

d. Prevent contamination of access roads. Immediately scrape up debris or material on access roads which is suspected to be contaminated as determined by Engineer; transport and place into designated area approved by Engineer. Clean access roads at least once per shift.

1.11.4 Removal and Repair:

a. Remove temporary materials and construction at Completion at Contractor's sole expense.

b. Repair existing facilities damaged by use to Engineer's satisfaction.

1.12 SECURITY

No security will be provided by the Owner or Engineer. It is anticipated that site access and entry will be controlled by CH2M Hill, contractor to USEPA for ongoing Harbor remediation. Contractor shall:

1.12.1 Maintain a site log. Log entry and exit of persons including name, time stamp, and affiliation. Provide a copy of the site log to the Engineer upon request.

1.12.2 Provide CH2M Hill security advance notice of site visitors including name and affiliation, 24 hours prior to site entry. Ensure that any visitors comply with site Health and Safety requirements and work only in defined remediation work areas.

1.13 PARKING

1.13.1 Arrange for temporary surface parking areas to accommodate construction personnel and Engineer.

1.13.2 When site space is not adequate, provide additional off-site parking.

1.13.3 Do not allow vehicle parking on existing off-site roads.

1.14 CLEANING

Comply with Section 01 74 00 Cleaning and Waste Management.

1.15 TEMPORARY SANITARY FACILITIES

1.15.1 Contractor shall furnish and maintain a chemical toilet for all personnel on the project.

1.16 FIELD OFFICE FOR ENGINEER

1.16.1 Office: Provide one trailer that is weathertight, insulated, heated, and air conditioned. Trailer shall have lighting and electrical outlets and locking doors.

1.16.2 Provide desks and swivel chairs.

1.16.3 Provide electrical service. Pay all costs for supplying and maintaining service.

1.16.4 Provide and pay for maintenance and cleaning of the Engineer's office during construction period.

1.17 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

1.17.1 Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to substantial completion inspection.

1.17.2 Clean and repair damage caused by installation or use of temporary work.

1.17.3 Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

2. PRODUCTS - (NOT USED)

3. EXECUTION - (NOT USED)

End of Section 01 50 00

SECTION 01 57 20
ENVIRONMENTAL PROTECTION

1. GENERAL

1.1 DEFINITIONS

1.1.1 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

1.1.2 Environmental Protection

Environmental protection is the prevention or control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2 GENERAL REQUIREMENTS

Minimize environmental pollution and damage that may occur as the result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work must be protected during the entire duration of this contract. Comply with all applicable environmental Federal, State, and local laws and regulations. Any delays resulting from failure to comply with environmental laws and regulations will be the Contractor's responsibility.

1.3 CONTRACTORS

Ensure compliance with this section by subcontractors.

1.4 JOINT CONDITION SURVEY

Prior to start of any on-site construction activities, the Contractor and the Engineer will make a joint condition survey. Immediately following the survey, the Contractor will prepare a brief report including a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the Contractor's assigned area and access route(s), as applicable. This survey report will be signed by both the Contractor and the Engineer upon mutual agreement as to its accuracy and completeness. The Contractor must protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference which their preservation may cause to the work under the contract.

Comply with any special environmental requirements listed in this section.

1.5 NOTIFICATION

The Engineer will notify the Contractor in writing of any observed noncompliance with Federal, State, or local environmental laws or regulations, permits, and other elements of the Contractor's Environmental Protection plan. After receipt of such notice, the Contractor will inform the Engineer of the proposed corrective action and take such action when approved by the Engineer. The Engineer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or equitable adjustments allowed for any such suspensions. This is in addition to any other actions the Engineer may take under the contract, or in accordance with Federal Acquisition Regulations or Federal Law.

1.6 PAYMENT

No separate payment will be made for work covered under this section. Payment of fees associated with environmental permits, application, and/or notices obtained by the Contractor, and payment of all fines/fees for violation or non-compliance with Federal, State, Regional, and local laws and regulations are the Contractor's responsibility. All costs associated with this section must be included in the contract price.

1.7 ENVIRONMENTAL PROTECTION PLAN

Within two weeks after Notice to Proceed, submit an Environmental Protection Plan for review and approval by the Engineer. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental issues which the Contractor must address during construction. Issues of concern must be defined within the Environmental Protection Plan as outlined in this section. Address each topic at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but are considered necessary, must be identified and discussed after those items formally identified in this section. Prior to submittal of the Environmental Protection Plan, meet with the Engineer for the purpose of discussing the implementation of the initial Environmental Protection Plan; possible subsequent additions and revisions to the plan including any reporting requirements; and methods for administration of the Contractor's Environmental Protection Plan. The Environmental Protection Plan must be current and maintained on site by the Contractor.

1.7.1 Compliance

No requirement in this Section will relieve the Contractor of any applicable Federal, State, and local environmental protection laws and regulations. During construction, the Contractor will be responsible for identifying, implementing, and submitting for approval any additional requirements to be included in the Environmental Protection Plan.

1.7.2 Contents

Include in the Environmental Protection Plan, but not limit it to, the following:

1.7.2.1 Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan.

1.7.2.2 Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.

1.7.2.3 Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

1.7.2.4 Description of the Contractor's environmental protection personnel training program.

1.7.2.5 Name(s) and qualifications of person(s) responsible for ensuring adherence to the Erosion and Sediment Control Plan.

1.7.2.6 Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on the site.

1.7.2.7 Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan shall include measures to minimize the amount of mud and sand transported onto paved public roads by vehicles or runoff.

1.7.2.8 Decontamination plan including description of facilities and procedures for decontamination of trucks, construction equipment and rented facilities (such as road mats) before they leave the site. The plan shall also include methods for containment and management of wastes resulting from these activities.

1.7.2.9 Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.

1.7.2.10 Spill Control plan including procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance regulated by 40 CFR 68, 40 CFR 302, 40 CFR 355, and/or regulated under State or Local laws and regulations. Include in this plan, as a minimum:

(a) The name of the individual who will report any spills or hazardous substance releases and who will follow up with complete documentation. This individual will immediately notify the Engineer and the local Fire Department in addition to the legally required Federal, State, and local reporting channels

(including the National Response Center 1-800-424-8802) if a reportable quantity is released to the environment. Include in the plan a list of the required reporting channels and telephone numbers.

(b) The name and qualifications of the individual who will be responsible for implementing and supervising the containment and cleanup.

(c) Training requirements for Contractor personnel and methods of accomplishing the training.

(d) A list of materials and equipment to be immediately available at the job site, tailored to cleanup work of the potential hazard(s) identified.

(e) The names and locations of suppliers of containment materials and locations of additional fuel oil recovery, cleanup, restoration, and material-placement equipment available in case of an unforeseen spill emergency.

(f) The methods and procedures to be used for expeditious contaminant cleanup.

1.7.2.11 A non-hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris and schedules for disposal.

1.7.2.12 An air pollution control plan detailing provisions to ensure that dust, debris, materials, trash, etc., do not become airborne and travel off the project site.

1.7.2.13 A contaminant prevention plan that identifies potentially hazardous substances to be used on the job site; identifies the intended actions to prevent introduction of such materials into the air, water, or ground; and details provisions for compliance with Federal, State, and local laws and regulations for storage and handling of these materials.

1.7.2.14 A wastewater management plan that identifies the methods and procedures for management and/or discharge of wastewaters which are directly derived from construction activities. For disposal to a waterway, the plan must include documentation that the water will meet discharge criteria. (It is anticipated that the Contractor will not conduct activities that result in offsite discharge of water)

1.7.3 Appendix

Attach to the Environmental Protection Plan, as an appendix, copies of all environmental permits, permit application packages, approvals to construct, notifications, certifications, reports, and termination documents.

1.8 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS

Any deviations from the drawings, plans and specifications, requested by the Contractor and which may have an environmental impact, will be subject to approval by the Engineer and may require an extended review, processing, and approval time. The Engineer reserves the right to disapprove alternate methods, even if they are more cost effective, if the Engineer determines that the proposed alternate method will have an adverse environmental impact.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 ENVIRONMENTAL PROTECTION PLAN

3.1.1 Contractor shall implement provisions of the Environmental Protection Plan during the period of performance.

3.2 ENVIRONMENTAL PERMITS AND COMMITMENTS

Contractor shall abide by specific permit requirements included in these specifications.

3.3 ENDANGERED SPECIES

3.3.1 Possible threatened or endangered species identified during site survey activities include:

Blanding's Turtle
Piping Plover
St. John's Wart
Beach Maram Grass

3.3.2 Confine all activities to areas defined by the drawings and specifications.

3.3.3 Do not remove, destroy, injure or disturb endangered species.

3.3.4 If endangered species are observed in work area, stop work and immediately notify Engineer.

3.3.5 Engineer will mark areas of known habitats of endangered species prior to commencement of site work.

3.3.6 Additional areas will be marked by the Engineer if other habitats of endangered species become known during site activities.

3.4 LAND RESOURCES

Confine all activities to areas defined by the drawings and specifications. Identify any land resources to be preserved within the work area prior to the beginning of any construction. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without approval, except in areas indicated on the drawings or specified to be cleared.

3.4.1 Work Area Limits

Mark the areas that need not be disturbed under this contract prior to commencing construction activities. Mark or fence isolated areas within the general work area which are not to be disturbed. Protect monuments and markers before construction operations commence.

3.4.2 Erosion and Sediment Controls

Providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations is the Contractor's responsibility. The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of construction activities.

3.4.3 Contractor Facilities and Work Areas

Place field offices, staging areas, stockpile storage, and temporary buildings in areas designated on the drawings or as directed by the Engineer. Temporary movement or relocation of Contractor facilities will be made only when approved. Erosion and sediment controls must be provided for any on-site borrow and spoil areas to prevent sediment from entering the waterways.

3.4.4 Fuel and Lubricants

Storage, fueling, and lubrication of equipment and motor vehicles must be conducted in a manner that affords the maximum protection against spill and evaporation. Manage and store fuel, lubricants, and oil in accordance with all Federal, State, Regional, and local laws and regulations.

3.4.5 Landscape

Trees, shrubs, vines, grasses, land forms, and other landscape features indicated and defined on the drawings to be preserved must be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques. Restore landscape features damaged or destroyed during construction operations outside the limits of the approved work area as specified in Section 32 30 00 – Site Restoration.

3.5 WATER RESOURCES

Monitor all water areas affected by construction activities to prevent pollution of surface and ground waters. Do not apply toxic or hazardous chemicals to soil or vegetation unless otherwise indicated. For construction activities immediately adjacent to impaired surface waters, the Contractor must be capable of quantifying sediment or pollutant loading to that surface water when required by State or Federal-issued Clean Water Act permits.

3.5.1 Water Quality Monitoring

Contractor must test filtered water prior to onsite release; no other monitoring will be conducted. If discharges to offsite waterways occur, they must comply with discharge limitations in Table 01 41 00.

3.5.2 City Water Use

A City water source is available at the site. Use of this water requires permission and obtaining a meter from the City of Waukegan. The water must be metered and use of the source must be coordinated with the other Consultant and Contractors at the site. Any hoses or piping to be used for conveyance must be protected from loaded truck traffic at access road crossings at the site. Minimize waste and do not allow release of excess water at the site.

3.6 AIR RESOURCES

Equipment operation, activities, or processes will be in accordance with all Federal and State air emission and performance laws and standards.

3.6.1 Dust Control

Dust particles must be controlled at all times. Maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. Provide sufficient, competent equipment available to accomplish these tasks.

Odors from construction activities must be controlled at all times. The odors must be in compliance with State regulations and/or local ordinances and may not constitute a health hazard.

3.6.2 Sound Intrusions

Keep construction activities under surveillance and control to minimize noise. Comply with the provisions of the State of Illinois and City of Waukegan rules and local noise ordinances.

3.6.3 Burning

Burning will not be allowed on the project site unless specified in other sections or authorized in writing by the Engineer. The specific time, location, and manner of burning will be subject to approval.

3.7 MAINTENANCE OF POLLUTION CONTROL FACILITIES

Maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.8 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel must be trained in all phases of environmental protection and pollution control. Conduct environmental protection/pollution control meetings for all personnel prior to commencing construction activities. Additional meetings must be conducted for new personnel and when site conditions change.

3.9 WASTE MANAGEMENT

Manage waste in compliance with Section 01 74 00 Cleaning and Waste Management.

End of Section 01 57 20

SECTION 01 60 00

PRODUCT REQUIREMENTS

1. GENERAL

1.1 SECTION CONTENTS

1.1.1 Products

1.1.2 Transportation and handling

1.1.3 Storage and protection

1.1.4 Product options

1.1.5 Substitutions

1.2 RELATED SECTIONS

1.2.1 Section 00 21 13 - Instructions to Bidders: Material Substitutions

1.2.2 Section 01 33 00 - Submittals

1.2.3 Section 01 45 00 - Quality Control

1.3 PRODUCTS

1.3.1 Products include materials, equipment, components, fixtures, systems, and assemblies forming the work. It does not include machinery and equipment used for preparation, fabrication, conveying, and installation of the work. Products may also include existing materials or components required for reuse.

1.3.2 Do not use materials removed from existing premises, except as specifically permitted by the Contract Documents.

1.4 TRANSPORTATION AND HANDLING

1.4.1 Transport and handle products in accordance with manufacturer's instructions.

1.4.2 Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products delivered are undamaged.

1.4.3 Provide proper equipment and skilled personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.5 STORAGE AND PROTECTION

1.5.1 Store and protect products in accordance with manufacturer's instructions, with all seals and labels intact and legible.

1.5.2 Store products in temperature controlled environments when necessary to prevent freezing. Comply with manufacturers' instructions regarding temperature at which products should be stored.

1.5.3 Store products in moisture-tight enclosures when moisture can detrimentally affect the quality of the product.

1.5.4 For exterior storage of fabricated products, place on sloped supports, above ground.

1.5.5 Cover products subject to deterioration with impervious sheet covering. Provide proper ventilation to prevent condensation.

1.5.6 Arrange storage of products to permit access for inspection. Periodically inspect to ensure products are undamaged and maintained under specified conditions.

1.5.7 Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

1.5.8 All material installed but not in operation shall be considered in storage and shall be protected accordingly.

1.6 PRODUCT OPTIONS

1.6.1 Products specified by reference standards or by description only: any products meeting those standards or description.

1.6.2 Products specified by naming one or more manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.

1.6.3 Products specified by naming one or more manufacturers with a provision for substitution (or equal): submit a written request for substitution for any manufacturer not named.

1.7 SUBSTITUTIONS

1.7.1 Engineer will consider requests for substitution only within 15 days after date established in Notice to Proceed.

1.7.2 Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

1.7.3 Document each request with complete data substantiating compliance of proposed substitution with Contract Document requirements.

1.7.4 A request constitutes a representation that the Contractor:

1.7.4.1 Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product.

1.7.4.2 Will provide the same warranty for the substitution as for the specified product.

1.7.4.3 Has investigated proposed product and determined that it meets or exceeds the performance criteria specified and intended for originally specified products.

1.7.4.4 Will coordinate installation and make changes to other work which may be required for the work to be complete and operational with no additional cost to Owner.

1.7.4.5 Will waive claims for additional costs and time extension which may subsequently become apparent.

1.7.4.6 Will reimburse Owner for review or redesign services associated with acceptance of the substitute product.

1.7.5 Substitutions will not be considered when they are indicated or implied on shop drawings or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

1.7.6 Substitution Submittal Procedure:

1.7.6.1 Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.

1.7.6.2 Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. See Section 01 33 00 for submittal requirements.

1.7.6.3 Engineer will notify Contractor, in writing, of decision to accept or reject requests.

2. PRODUCTS - (NOT USED)

3. EXECUTION - (NOT USED)

End of Section 01 60 00

SECTION 01 70 00
PROJECT CLOSEOUT

1. GENERAL

1.1 SECTION CONTENTS

1.1.1 Pre-Final Inspection

1.1.2 Final Inspection

1.1.3 Final Cleaning

1.1.4 Project Record Documents

1.1.5 Final Payment

1.1.6 Closeout Submittals

1.2 RELATED SECTIONS

1.2.1 Section 01 33 00 - Submittals

1.2.2 Section 01 50 00 – Construction Facilities and Temporary Controls

1.2.3 Section 01 74 00 – Cleaning and Waste Management

1.3 PRE-FINAL INSPECTION

1.3.1 Notify Engineer in writing when project is substantially complete.

1.3.2 Engineer will make an inspection of the completed work and will prepare and submit to Contractor a list of items to be completed or corrected.

1.3.3 After the Engineer and the appropriate agencies have inspected the completed work, the Construction Contractor will assist the Engineer in preparing consolidated list of items (the pre-final punch list) to be completed or corrected after the inspection. The Construction Contractor may assist the Engineer in preparing the pre-final and final inspection reports.

1.3.4 Take immediate steps to remedy the listed deficiencies and notify Engineer in writing that the project is complete and ready for final inspection.

1.4 FINAL INSPECTION

1.4.1 Notify Engineer in writing when project is substantially complete and pre-final inspection punch list has been addressed.

1.4.2 Engineer will make an inspection of the completed work and will prepare and submit to Contractor a list of items to be completed or corrected.

1.4.3 Take immediate steps to remedy the listed deficiencies and notify Engineer in writing that the project is complete and ready for final inspection.

1.4.4 Engineer and Owner will make a final inspection.

1.5 FINAL CLEANING

1.5.1 Execute cleaning requirements in Section 01 74 00 Cleaning and Waste Management

1.6 PROJECT RECORD DOCUMENTS

1.6.1 Provide to Engineer at closeout, one set of the following record documents; including all revision, modifications, additions, and changes to the Work:

1.6.1.1 Contract drawings

1.6.1.2 Specifications

1.6.1.3 Addenda

1.6.1.4 Change orders and all other modifications to the Contract.

1.6.1.5 Reviewed and approved shop drawings, product data, and samples

1.6.2 Record documents are separate from documents used for construction.

1.6.3 Record all information concurrent with construction progress.

1.6.4 Specifications: Legibly mark and record at each Product section a description of actual products installed including the following:

1.6.4.1 Manufacturer’s name and product model and number

1.6.4.2 Product substitution or alternates used

1.6.4.3 Changes made by Addenda and modifications

1.6.5 Record (As-Built) Drawings and Shop Drawings: Legibly mark each item to record actual construction, including:

1.6.5.1 Actual dimensions and elevations

1.6.5.2 Actual horizontal and vertical locations of underground utilities and appurtenance referenced to buildings, bench marks, and local data.

1.6.5.3 Actual locations of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of work.

1.6.5.4 All field changes of dimensions, details, and elevations.

1.6.5.5 All details not shown on the original drawings.

1.6.5.6 Provide a pre-excavation survey and a final survey with final grades and elevations.

1.6.6 Submit all documents required in General Conditions to Engineer with Application for Final Payment.

1.7 FINAL PAYMENT

Submit application for final payment identifying previous payments, and sum remaining due. Prepare application as stipulated in Section 01 20 00 Application for Payment.

1.8 CLOSEOUT SUBMITTALS

Prior to final payment, submit the following:

1.8.1. Guarantees and bonds

1.8.2. Duplicate notarized copies of any legally required permit inspections

1.8.3. Contractor's waiver of lien

1.8.4. Separate waivers of lien for subcontractors, suppliers, and others with lien rights against the Owner

2. PRODUCTS - (NOT USED)

3. EXECUTION - (NOT USED)

End of Section 01 70 00

SECTION 01 74 00

CLEANING AND WASTE MANAGEMENT

1. GENERAL

1.1 GENERAL REQUIREMENTS

1.1.1 Keep the site clean while construction is in progress.

1.1.2 Prevent remediation-derived wastes from polluting the environment.

1.1.3 Manage wastes on site such that they are not a hazard to on-site personnel.

1.1.4 When work is complete, leave project site clean and ready for occupancy.

1.2 DESCRIPTION OF WORK

Keep site clean. Prevent remediation-derived wastes from polluting the environment. Manage wastes safely so that they are not a hazard to workers handling the waste. Comply with regulations pertaining to management of waste.

1.3 SUBMITTALS

1.3.1 Waste Management Plan

Submit a Waste Management Plan within 14 days of notice to proceed. The plan shall describe management of waste resulting from remedial activities. The plan shall include:

a. Names of individuals responsible for implementation of the plan

b. A list of the types of solid wastes that will be generated during remediation and their sources

c. A list of the types of liquid wastes that will be generated during remediation and their sources

d. Method of storage of each type of waste

e. Marking and labeling of waste storage containers

f. Methods of characterizing each waste to determine waste class for disposal

g. Method of collection of representative samples for waste characterization

h. Laboratories to be used for characterization of waste

i. Frequency of characterization

j. Method of disposal of each type of waste including but not limited to soil, dredge material, wastewater, process residuals (such as spent media, nonaqueous-phase liquid, and sludge), personal protective equipment, unused chemicals, construction debris, used oil, plant-based waste, and general refuse.

k. List of off-site disposal facilities to be used. Include name, location, phone number, and copy of permit or license.

l. Waste acceptance criteria for each off-site disposal facility to be used

m. List of recyclable or salvageable materials

n. List of facilities that recyclable or salvageable materials will be sent to. Include name, location, phone number, and copy of permit or license.

Revise and resubmit the Waste Management Plan as required by the Engineer. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations. Distribute copies of the Waste Management Plan to each subcontractor.

1.3.2 Forms

Submit draft waste manifests to be used for transportation and disposal of each type of waste.

1.3.3 Records

Submit waste manifests, weight tickets, receipts, and invoices specifically identifying the project and waste material. Payment will not be made without these records.

1.3.4 Reports

Submit monthly reports and a final report. Monthly and final reports shall include project name, quantity of waste generated during that period, and cumulative totals for the project. Each report shall include supporting documentation such as manifests, weight tickets, receipts, and invoices specifically identifying the project and waste material. Include timber harvest and demolition information, if any.

1.3.5 Products

Submit manufacturer’s literature for products related to waste storage.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 CLEANING DURING CONSTRUCTION

3.1.1 Perform cleaning operations daily so that structures, grounds, and public property are free from accumulations of waste materials and rubbish.

3.1.2 Sprinkle dry materials with water to prevent blowing dust.

3.1.3 Clean site and public properties weekly or more frequently as needed, and dispose of waste materials, debris, and rubbish.

3.2 WASTE MANAGEMENT

3.2.1 General

3.2.1.1 Perform all work in compliance with the Contractor's approved Waste Management Plan. Approval of the plan does not preclude the Contractor from compliance with applicable Federal, State, and local regulations.

3.2.1.2 Control accumulation of waste materials and trash. Recycle or dispose of collected materials off-site at regular intervals. Do not allow accumulations of wastes that create hazardous conditions.

3.2.1.3 Do not burn or bury rubbish and waste materials on project site.

3.2.2 Records

3.2.2.1 Records shall be maintained to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed. Quantities may be measured by weight or by volume, but must be consistent throughout. List each type of waste separately noting the disposal or diversion date. Identify the facility receiving the waste.

3.2.3 Storage

3.2.3.1 Use appropriate temporary storage to isolate waste from the environment.

3.2.3.2 Use storage units that are in good condition and constructed of materials that are compatible with the material to be stored. If multiple storage units are required, label each unit with an identification number and the type of waste to be stored. A water-proof cover shall be placed over the units to prevent precipitation from contacting the stored material. Secure covers suitably to protect from wind.

3.2.3.3 Stockpiles may be used for storage of material. If stockpiles are used:

a. Protect the stockpiles from weather and implement controls to prevent freezing

b. If stockpile areas are paved, clean and seal cracks in existing pavement before stockpiling material.

c. If stockpiles areas are unpaved, install a minimum 40 mil thick geomembrane over a graded and compacted subgrade. The ground surface on which the geomembrane is to be placed shall be free of rocks greater than 0.5 inches in diameter and any other object which could damage the membrane.

d. Provide a water-proof cover free of holes or other damage to prevent precipitation from entering the stockpile. Secure covers suitably to protect from wind.

e. Install berms surrounding the stockpile area, a minimum of 12 inches in height. Vehicle access points shall also be bermed.

f. Slope the liner system to allow collection of leachate. Remove and store liquids in accordance with the Contractor's approved Waste Management Plan.

3.2.3.4 Aqueous phase liquids may be stored in a holding tank as long as they do not prevent adequate treatment to the required pre-treatment criteria before discharge to the site.

3.2.3.5 Store volatile wastes in covered metal containers and remove from premises daily.

3.2.4 Recycling (if performed)

3.2.4.1 Separate, store, protect, and handle at the site identified recyclable and salvageable waste products in a manner that maximizes recyclability and salvagability of identified materials. Recyclable materials shall be placed into a single container and then transported to a recycling facility where the recyclable materials are sorted and processed.

3.2.4.2 Provide the necessary containers, bins, and storage areas to facilitate effective waste management and clearly and appropriately identify them.

3.2.4.3 Provide materials for barriers and enclosures around recyclable material storage areas which are nonhazardous and recyclable or reusable. Locate out of the way of construction traffic. Provide adequate space for pick-up and delivery and convenience to subcontractors. Recycling and waste bin areas are to be kept neat and clean.

3.2.4.4 Recyclable materials shall be handled to prevent contamination of materials from incompatible products and materials. Clean contaminated materials prior to placing in collection containers. Use cleaning materials that are nonhazardous and biodegradable.

3.2.5 Hazardous Waste

Hazardous wastes as defined in 40 CFR 261, or as defined by applicable State and local regulations shall be managed and stored in compliance with 40 CFR 262. Take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing. Segregate hazardous waste from other materials and wastes; protect it from the weather by placing it in a safe covered location, and take precautionary measures against accidental spillage.

3.2.6 Transportation and Disposal of Waste

Transport and dispose of waste in compliance with Section 02 81 00 - Transportation and Disposal of Nonhazardous and Hazardous Waste.

3.2.7 On-Site Disposal of Aqueous-Phase Wastes

On-site disposal of liquid wastes must not result in any off-site releases of water during the project. Any off-site releases must comply with Table 01 41 00.

3.3 FINAL CLEANING

3.3.1 Excavate and dispose of soil impacted by remediation activities.

3.3.1 Remove debris directly or indirectly resulting from construction activities.

3.3.2 Clean paved surfaces and rake clean landscaped areas.

End of Section 01 74 00

DIVISION 02 EXISTING CONDITIONS

SECTION 02 21 00

SURVEY AND GRADE CONTROL

1. GENERAL

1.1 REFERENCES

Not used.

1.2 DEFINITIONS

BM—Benchmark
CAD—Computer-aided drafting
NAD 83—North American Datum of 1983
NAVD 88— North American Vertical Datum of 1988

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 Submittals:

1.3.1 Preconstruction Submittals

Submit the following within 14 days after notice to proceed:

1.3.1.1 Submit resumes for survey personnel and photocopy of Illinois State license of crew chief.

1.3.1.2 Certifications as required by the Construction Health and Safety Plan.

1.3.2 Survey Data

Submit survey data in hard copy and electronic format (MS Excel or compatible). Submit survey drawings in hard copy and electronically in Microstation® format or compatible versions of AutoCAD and a triangular irregular network (TIN) layer of the surveyed surface as approved by the Engineer. Provide drawing legend with all submittals. Survey files shall be provided no later than one week after field data are gathered and drawings shall be provided within 14 days. Interim hard copy drawings will be 11x17 size drawings.

1.3.2.1 Pre-Earthwork Record Survey

Submit pre-earthwork record survey hard copy and electronic data within one week of completing the pre-earthwork survey and prior to conducting any site earthwork. Hard copy will consist of three ANSI D drawing packages, each set with original Illinois Licensed Surveyor stamp.

1.3.2.2 Cap Layers As-Built Topographic Surveys

Submit cap layers as-built topographic surveys hard copy and electronic data within one week of completing the final post installation surveys. Each cap layer must be surveyed. Hard copy will consist of three ANSI D drawing packages, each set with original Illinois Licensed Surveyor stamp.

1.3.2.3 Final Post-Construction Record Survey

Submit post-construction record survey for areas that were excavated, graded, stabilized and backfilled and all cap areas. Submit as hard copy and electronic data within one week of completing the final post-construction surveys. Hard copy will consist of three ANSI D drawing packages, each set with original Illinois Licensed Surveyor stamp.

1.3.2.4 Close-out Submittals

Copies of all field books, notes, and other data developed in performing surveying shall be turned in to the Engineer upon request.

1.4 DESCRIPTION OF WORK

Verify existing (pre-earthwork) grades, post grading/stabilization/backfilling and post-construction grades for each cap layer for all work areas. Provide professional surveying services to document existing conditions, document attainment of design grades, vertical barrier layout and depth and facilitate earthwork in compliance with the contract documents. Include in survey permanent site features in work area, such as manholes, fenceline, water way, utilities, pavement, and wells associated with this work. Some areas to be surveyed may be under1 to 4 feet of water.

The survey crew shall be supervised by a professional surveyor licensed in the State of Illinois. The surveyor shall be present on site with a frequency to maintain project quality and schedule. The surveyor shall keep neat and legible notes of measurement and calculations made concerning field activities. Work under this section shall include:

1.4.1 Delineation of work areas. Survey and stake out areas where work is to be performed as shown on the drawings.

1.4.2 Survey and stake out underground utility protection corridors to protect sanitary mains, natural gas lines, and storm lines.

1.4.3 Survey and stake vertical barrier layout and survey elevation.

1.4.4 Survey vertical barrier post-installation layout, elevation and depth.

1.4.5 Verification of extent and grades. Verify extent of work completed and obtainment of design grades.

1.4.6 Survey layout and elevations of dewatering system conveyance.

1.4.7 Survey locations and elevations of extraction wells, monitoring wells and piezometers.

1.4.8 Progress surveys will be submitted quality control/quality assurance purposes.

1.4.9 Record drawings survey. After completion of the project perform an "as-built" survey.

1.4.10 Locate and tie-in temporary benchmarks shown on drawings and establish survey lines and additional temporary benchmarks as necessary.

1.4.11 This work always requires reporting of northings, eastings, and elevations and other data as requested in specific sections, at all surveyed points. All data shall be presented in the coordinate system used on drawings.

1.5 MEASUREMENT AND PAYMENT

Payment for survey work will be under the cost items for the respective bid item on the Bid Form.

2. PRODUCTS

2.1 EQUIPMENT

2.1.1 The Contractor shall use state-of-the-art survey equipment capable of performing the work specified herein. Horizontal and vertical measurements shall be accurate to 0.1 foot.

2.1.2 The Contractor shall furnish all equipment, tools, material, and labor needed to perform this work.

2.1.3 At All survey points, measure northing, easting and elevation.

2.2 PERSONNEL

2.2.1 The survey crew chief shall be a professional surveyor licensed in the State of Illinois.

3. EXECUTION

3.1 GENERAL

3.1.1 The survey crew shall perform all work in compliance with the approved Construction Health and Safety Plan.

3.1.2 The Contractor shall be responsible for decontamination of survey equipment.

3.1.3 For topographic surveys, at a minimum survey points shall be on a 10-foot by 10-foot grid. Survey additional points at suitable intervals along grade breaks to define the surface.

3.2 REFERENCE SYSTEM

3.2.1 Reference all horizontal measurements to Illinois State Plane Coordinate System referenced to NAD 83.

3.2.2 Reference all vertical measurements to NAVD 88.

3.3 SURVEYING

3.3.1 Upland topographic surveys of disturbed laydown and staging areas shall be conducted with sufficient grid density to generate 1-foot contour interval maps.

3.3.2 Run a level loop on proposed control points to establish vertical control if necessary.

3.3.3 Conduct a pre-excavation topographic survey of earthwork areas. The survey should extend to a minimum of 50 feet beyond the limits of earthwork shown on the drawings. If the limits of earthwork are altered in the field, alter the limits of the survey accordingly.

3.3.4 Conduct a pre-and post-installation survey of vertical barrier layout and elevations.

3.3.5 Conduct a topographic survey of each cover layers, including compacted top of foundation layer (lower lifts), top of geotextile layers, top of freeze-thaw layer, and top of topsoil layer.

3.3.6 Conduct a topographic survey of NUC and WUC cap areas. Survey the horizontal extent and material boundaries.

3.3.7 Survey all utilities within the work area, to include manholes.

3.3.8 Provide ongoing surveying services for grade control and utility documentation as needed.

3.3.9 Conduct a post-construction/restoration topographic survey to demonstrate final site conditions.

3.4 SCHEDULE

3.4.1 The Contractor shall complete the surveying specified herein according to the Contractor's approved construction schedule.

End of Section 02 21 00

SECTION 02 81 00
TRANSPORTATION AND DISPOSAL OF NONHAZARDOUS AND HAZARDOUS MATERIALS

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

DOT 4500.9R	Defense Transportation Regulation, Part 2, Cargo Movement, Chapter 204, Hazardous Material

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packages
49 CFR 178	Specifications for Packages

1.2 DEFINITIONS

1.2.1 Hazardous Material

A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated pursuant to the Hazardous Materials Transportation Act, 49 U.S.C. Appendix Section 1801 et seq. The term includes materials designated as hazardous

materials under the provisions in 49 CFR 173. EPA designated hazardous wastes are also hazardous materials.

1.2.2 Hazardous Waste

A waste which meets criteria established in RCRA or specified by the EPA in 40 CFR 261 or which has been designated as hazardous by a RCRA authorized state program.

1.2.3 TSCA Waste

A waste that meets the description of Toxic Substances Control Act (TSCA) waste as a result of total polychlorinated biphenyl (PCB) content of 50 milligrams per kilogram or higher.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 Submittals:

1.3.1 Product Data

Notices of non-compliance or notices of violation, as specified.

1.3.2 Test Reports

Information necessary to file state annual or EPA biennial reports for all hazardous waste transported, treated, stored, or disposed of under this contract. The Contractor shall not forward these data directly to the regulatory agency but to the Engineer at the specified time. The submittal shall contain all the information necessary for filing of the formal reports in the form and format required by the governing Federal or state regulatory agency. A cover letter shall accompany the data to include the contract number, Contractor name, and project location.

1.3.3 Spill Response

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), or pollutant or contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), the Contractor shall notify the Engineer immediately. If the spill exceeds a reporting threshold, the Contractor shall follow the pre-established procedures for immediate reporting to the Engineer.

1.3.4 Certificates

a. Transportation and Disposal Coordinator

If hazardous wastes are transported, provide Transportation and Disposal Coordinator qualifications including proof of at least one year specialized experience in management and transportation of hazardous wastes; and proof of current Department of Transportation Hazardous Materials Training Certification.

b. Training

If hazardous wastes are transported, provide documentation that employees preparing or transporting hazardous materials have been trained, tested, and certified per 49 CFR 172, Subpart H, including general security awareness requirements and where applicable, site-specific security plan requirements.

c. Certificates of Disposal

If hazardous or TSCA wastes are transported, provide certificates documenting the ultimate disposal, destruction or placement of wastes within 21 days of initial shipment. Receipt of these certificates will be required for final payment.

d. Shipping Documents and Packaging Certification

Submit to the Engineer all transportation-related shipping documents including draft waste manifests, draft land disposal restriction notifications, draft bill of ladings, lists of corresponding proposed labels, packages, marks, and placards to be used for shipment, waste profiles, supporting waste analysis documents, for review a minimum of 14 days prior to anticipated pickup. Packaging assurances shall be furnished prior to transporting hazardous material; "generator copies" of hazardous waste manifests, land disposal restriction notifications, used oil invoices/shipment records, bill of ladings, supporting waste analysis documents shall be furnished when shipments are originated; and "receipt copies" of waste manifests at the designated disposal facility shall be furnished not later than 35 days after acceptance of the shipment.

1.4 DESCRIPTION OF WORK

This section covers transport of hazardous, TSCA and nonhazardous materials (including waste), and waste disposal.

1.4.1 Transport any materials deemed to be hazardous in accordance with this section.

1.4.2 Transport and dispose of all waste generated on site at a facility or facilities licensed to accept such waste.

1.4.3 Comply with all Federal, State, and local regulations pertaining to transportation and disposal.

1.5 RELATED WORK DESCRIBED ELSEWHERE

Not used.

1.6 QUALIFICATIONS

1.6.1 Transportation and Disposal Coordinator

The Contractor shall designate, by position and title, one person to act as the Transportation and Disposal Coordinator (TDC) for this contract. The TDC shall serve as the single point of contact for all environmental regulatory matters and shall have overall responsibility for total environmental compliance at the site including, but not limited to, accurate identification and classification of waste; determination of proper shipping names; identification of marking, labeling, packaging and placarding requirements; completion of waste profiles, hazardous waste manifests, bill of ladings, exception and discrepancy reports; and all other environmental documentation.

1.6.2 Training

The Contractor's waste-handling employees shall be trained, tested, and certified to safely and effectively carry out their assigned duties in accordance with the Construction Health and Safety Plan.

1.6.3 Certification

The Contractor and/or subcontractors transporting waste shall possess a current certificate of registration issued by the U.S. Department of Transportation.

1.7 LAWS AND REGULATIONS REQUIREMENTS

Work shall meet or exceed the minimum requirements established by Federal, State, and local laws and regulations which are applicable. These requirements are amended frequently and the Contractor shall be responsible for complying with amendments as they become effective. In the event that compliance exceeds the scope of work or conflicts with specific requirements of the contract, the Contractor shall notify the Engineer immediately.

1.8 MEASUREMENT AND PAYMENT

The Contractor will be paid for transportation and disposal of the TSCA and nonhazardous excavation waste as part of the transportation and disposal of excavation materials. Disposal of other trash and debris will be incident to the demobilization cost and will be paid for under that bid item.

2. PRODUCTS

2.1 MATERIALS

The Contractor shall provide all of the materials required for the packaging, labeling, marking, placarding, and transportation of hazardous wastes and hazardous materials and TSCA materials in conformance with Department of Transportation standards. Details in this specification shall not be construed as establishing the limits of the Contractor's responsibility.

2.1.1 Packaging

The Contractor shall provide bulk and non-bulk containers for packaging materials/wastes according to their classification.

If hazardous, packaging shall be consistent with the authorizations referenced in the Hazardous Materials Table in 49 CFR 172, Section .101, Column 8. Bulk and non-bulk packaging shall meet the corresponding specifications in 49 CFR 173 referenced in the Hazardous Materials Table, 49 CFR 172, Section .101. Each packaging shall conform to the general packaging requirements of Subpart B of 49 CFR 173, to the requirements of 49 CFR 178 at the specified packing group performance level, to the requirements of special provisions of column 7 of the Hazardous Materials Table in 49 CFR 172, Section.101, and shall be compatible with the material to be packaged as required by 40 CFR 262.

The Contractor shall also provide other packaging related materials such as materials used to cushion or fill voids in overpacked containers, etc. Sorbent materials shall not be capable of reacting dangerously with, being decomposed by, or being ignited by the hazardous materials being packaged. Additionally, sorbents used to treat free liquids to be disposed of in landfills shall be non-biodegradable as specified in 40 CFR 264, Section .314.

2.1.2 Markings

The Contractor shall provide appropriate markings for each material/waste package, freight container, and transport vehicle consistent with the requirements of 49 CFR 173. Markings shall be capable of withstanding, without deterioration or substantial color change, a 180 day exposure to conditions reasonably expected to be encountered during container storage and transportation.

2.1.3 Labeling

If hazardous wastes are transported, the Contractor shall provide primary and subsidiary labels for materials/wastes consistent with the requirements in the Hazardous Materials Table in 49 CFR 172, Section .101, Column 6. Labels shall meet design specifications required by 49 CFR 172, Subpart E

2.1.4 Placards

For each off-site shipment of hazardous material/waste or TSCA material, the Contractor shall provide primary and subsidiary placards consistent with the requirements of 49 CFR 172, Subpart F. Placards shall be provided for each side and each end of bulk packaging, freight containers, transport vehicles, and rail cars requiring such placarding.

2.1.5 Spill Response Materials

The Contractor shall provide spill response materials including, but not limited to, containers, adsorbent, shovels, and personal protective equipment. Spill response materials shall be available at all times in which hazardous materials/wastes are being handled or transported. Spill response materials shall be compatible with the type of material being handled.

2.2 EQUIPMENT AND TOOLS

The Contractor shall provide miscellaneous equipment and tools necessary to handle hazardous materials and hazardous wastes in a safe and environmentally sound manner.

3. EXECUTION

3.1 GENERAL

3.1.1 Treatment, Storage, and/or Disposal Facility

The Contractor shall select a facility or facilities that are licensed to receive the classes of waste to be disposed of. The Contractor shall provide the Engineer with EPA or state ID numbers, names, locations, and telephone numbers of the facilities.

3.1.2 Transporter

The Contractor shall select a transporter or transporters that are licensed to transport the classes of waste to be disposed of. The Contractor shall provide the Engineer with DOT license numbers, names, locations, and telephone numbers of the transporters.

3.1.3 Truck Route

The Contractor shall comply with Federal, State, and local requirements in selecting truck routes. The Contractor shall show truck routes on a map and submit this map along with maps of approved truck routes from the appropriate authorities. The truck route must be approved by the Engineer.

Loaded trucks may not leave the site from the Northwest Gate and may not use Pershing Road.

3.1.4 Waste Characterization

The Contractor, shall evaluate, prior to shipment of any material off-site, whether the material is regulated as a hazardous waste in addition to being regulated as a hazardous material; this shall be done for the purpose of determining proper shipping descriptions, marking requirements, etc.

The Contractor shall obtain waste acceptance criteria from each facility and work with the facility to design a waste sampling and analysis plan. The Contractor shall sample and characterize waste at a frequency agreed to by the facility and use methods approved by the facility to characterize the material. Comply with the Contractor's approved Waste Management Plan.

3.1.5 Decontamination

Tires of vehicles leaving the site shall be decontaminated to prevent tracking of mud or sand on public roads. Tires shall be decontaminated via pressure washing or other method subject to approval by the Engineer. Surfactants shall not be used.

3.1.6 Shipping Documents and Packaging Certification

Prior to shipment of any material off-site, the Contractor's TDC shall provide written certification to the Engineer that materials have been properly packaged, labeled, and marked in accordance with Department of Transportation and EPA requirements.

3.1.7 Waste Minimization

The Contractor shall minimize the generation of hazardous waste to the maximum extent practicable. The Contractor shall take all necessary precautions to avoid mixing clean materials and contaminated wastes. The Contractor shall identify and evaluate recycling and reclamation options as alternatives to land disposal.

3.1.8 Record Keeping

The Contractor shall be responsible for maintaining adequate records to support information provided to the Engineer regarding waste transportation and disposal. The Contractor shall be responsible for maintaining shipment records for a minimum of 3 years from the date of shipment or any longer period required by any applicable law or regulation or any other provision of this contract.

3.1.9 Spill Response

The Contractor shall clean-up any spills of materials or waste which are in the custody or care of the Contractor regardless of whether the spill occurs on or off site. Any direction from the Engineer concerning a spill or release shall not be considered a change under the contract. The Contractor shall comply with all

applicable requirements of Federal, state, or local laws or regulations regarding any spill incident.

3.1.10 Truck Traffic Coordinator

Install a truck traffic coordinator at all gates used to ensure the trucks and materials are directed to the correct site location. Other remedial actions will be on going at the site. Truck traffic coordinator will be responsible for truck entry and egress from the site and will ensure smooth and safe transit on SeaHorse Drive.

3.1.11 Waste Management Plan

Comply with the Contractor's approved Waste Management Plan.

3.2 TRANSPORTATION AND DISPOSAL OF EXCAVATION MATERIAL

Based on remedial actions performed in 2010, 2011, and 2012, excavation material is expected to be TSCA material (PCBs > 50 mg/kg) or SubTitle D soil (PCBs < 50 mg/kg). In addition, excavation material may be characterized as RCRA hazardous for trichloroethylene (TCE).

3.2.1 Containers

Containers used to transport excavation material off site shall be suited to that type of waste. They shall be in good condition and free of leaks. Use liners and covers or other means approved by the Engineer to prevent dripping and spills during transportation. The Engineer may disallow use of containers that do not meet the requirements of this section.

3.2.2 Pre-Approval Certification

Obtain pre-approval certification from the designated disposal facility prior to transporting any waste to that facility. Submit pre-approval certificates to the Engineer.

3.2.3 Measurement

Obtain a weight ticket from the facility showing the weight of waste disposed of.

3.3 TRANSPORTATION AND DISPOSAL OF HAZARDOUS WASTE

3.3.1 Waste Classification

The Contractor shall identify waste codes based on requirements in 40 CFR 261 or any applicable state or local law or regulation. The Contractor shall also identify all applicable treatment standards in 40 CFR 268 and state land disposal restrictions and shall make a determination as to whether the waste meets or exceeds the standards. Waste profiles, analyses, classification, and treatment standards information shall be submitted to Engineer for review and approval.

3.3.2 Status of the Facility

Facilities receiving hazardous waste must be permitted in accordance with 40 CFR 270 or operating under interim status in accordance with 40 CFR 265 requirements, or must be permitted by a state authorized by the Environmental Protection Agency to administer the RCRA permit program.

3.3.3 Transportation

The Contractor shall use manifests for transporting hazardous wastes as required by 40 CFR 263 or any applicable state or local law or regulation. Transportation shall comply with all requirements in the Department of Transportation referenced regulations in the 49 CFR series. The Contractor shall prepare hazardous waste manifests for each shipment of hazardous waste shipped off-site. Manifests shall be completed using instructions in 40 CFR 262, Subpart B and any applicable state or local law or regulation. Manifests and waste profiles shall be submitted to Engineer for review and approval. The Contractor shall prepare land disposal restriction notifications as required by 40 CFR 268 or any applicable state or local law or regulation for each shipment of hazardous waste. Notifications shall be submitted with the manifest to the Engineer for review and approval.

3.3.4 Treatment and Disposal of Hazardous Wastes

If hazardous waste is found, the hazardous waste shall be transported to an approved hazardous waste treatment, storage, or disposal facility within 90 days of the accumulation start date on each container. The Contractor shall ship hazardous wastes only to facilities which are properly permitted to accept the hazardous waste or operating under interim status.
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End of Section 02 81 00

DIVISION 03 CONCRETE

SECTION 03 30 00
GENERAL CONCRETE REQUIREMENTS

1. GENERAL

This specification covers concrete used for installation and construction of concrete pads for extraction wells, monitoring wells, and piezometers. In addition, this specification covers concrete used for installation of manhole risers.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest version of each publication is to be used.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Standard Specification for Structural Concrete
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 308	Curing Concrete
ACI 315	ACI Detailing Manual
ACI 318	Building Code Requirements for Reinforced Concrete

AMERICAN WELDING SOCIETY (AWS)

D1.4	Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 185	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 675	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM C 33	Specification for Concrete Aggregates
ASTM C 94	Specification for Ready-Mixed Concrete

ASTM C 143 Test Method for Slump of Hydraulic Cement Concrete

ASTM C 150 Specification for Portland Cement

ASTM C 920 Standard Specification for Elastomeric Joint Sealants

ASTM C 1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

ASTM D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)

CONCRETE REINFORCING STEEL INSTITUTE

CRSI Placing Reinforcing Bars (9th Ed.)

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 Submittal Procedures.

1.2.1 SD-05 Design Data
a. Concrete Mix Design for 3,000 pounds per square inch (psi);

1.2.2 SD-07 Certificates
a. Cement
b. Aggregate
c. Admixtures

1.3 CONCRETE DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until ready for concrete placement. Store concrete aggregates to prevent contamination or segregation. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Provide for accurate identification after bundles are broken and tags removed.

1.4 REINFORCEMENT DELIVERY, STORAGE, AND HANDLING

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

1.5 MEASUREMENT AND PAYMENT

Payment for concrete work is incidental to well installation activities.

2. PRODUCTS

2.1 CONCRETE

2.1.1 Contractor Mix Design

ACI 301, except as modified herein. Concrete shall have a minimum of 28-day compressive strength of 3,000 psi. Slump shall be between 4 and 6 inches in accordance with ASTM C 143. Provide ASTM C 33 aggregate Size No. 57 or 67.

2.1.1.1 Cement

ASTM C 150, Type I.

2.1.1.2 Aggregates

ASTM C 33. Obtain aggregates for exposed concrete surfaces from one source. Aggregates shall not contain any substance that may be deleteriously reactive with the alkalis in the cement.

2.1.1.3 Water

Water shall be free from injurious amounts of oil, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.1.1.4 Admixtures

Provide only when approved by Contracting Officer. Calcium chloride shall not be used as an admixture.

2.1.2 Ready-Mixed Concrete

ASTM C 94, except as modified herein. Ready-mixed concrete is defined in this specification as concrete produced regularly by a commercial establishment and delivered to the purchaser in the plastic state.

2.2 NON-SHRINKING CEMENT GROUT

ASTM C 1107.

3. EXECUTION

3.1 SURFACE PREPARATION

Bring to grade and compact in 6-inch lifts to 88 percent of maximum dry density as determined by ASTM D 1557. Predampen prior to placement. Do not place concrete or shotcrete on frozen surfaces.

3.2 FORMS

Provide and install forms for concrete pads for extraction wells, monitoring wells, and piezometers. Provide and install forms for manhole risers, as needed. Forms shall withstand pressures encountered during placement and maintain specified tolerances for formed surfaces. Forms shall prevent mortar leakage but permit escape of air and rebound. Construct forms to allow removal without damage to cured concrete.

3.3 COATING

Do not use mineral oil to coat forms.

3.4 MEASURING, MIXING, TRANSPORTING, AND PLACING CONCRETE

Conform to ACI 304R, except as modified herein. ASTM C 94; machine mix concrete and provide mandatory batch ticket information for each load of ready-mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 85 degrees F. Reduce mixing time to 60 minutes if the air temperature is greater than 85 degrees F. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded.

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water prior to placing concrete. Remove dirt, construction debris, water, snow, and ice from within forms.

3.5 CONCRETE SURFACE FINISHES

ACI 315 for repair and finish, unless otherwise specified.

3.5.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 1 square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb (including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects) that affects the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete shall not vary more than the allowable tolerances of ACI 301. Exposed surfaces shall be uniform in appearance and finished to a smooth form finish, unless otherwise specified.

3.6.2 Finish

All concrete work shall have a broomed finish. Tool edges to ¾-inch radius.

3.7 CURING AND PROTECTION

Cure concrete in accordance with ACI 308, except as modified. Throughout curing process, maintain in moist condition and at a minimum temperature of 40 degrees F.

3.7.1 Curing

Continuously moisten concrete for at least 24 hours after placement. Use one of the following methods:

a. Absorptive mat or fabric, sand, or other covering kept continuously wet.

b. Curing compound: Use only on the finish coat. Do not use on surfaces to be bonded. Double the normal application rate on natural gun finishes. When a layer of shotcrete is to be covered by a succeeding layer of shotcrete, or other cementitious finishing materials are to be bonded, remove the curing compound completely by sandblasting prior to application of additional materials.

3.8 FINISH EARTHWORK

After final curing is completed, backfill voids left by formwork and site preparation to match surrounding grades. Compact with pneumatic tamper.

End of Section 03 30 00

DIVISION 22 NONPOTABLE WATER PIPING, VALVES, AND ACCESSORIES

SECTION 22 10 00
PIPING AND VALVES

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest version of each publication is to be used.

ASTM International

ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
ASTM D2466	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2855	Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene Plastic Pipe Based on Outside Diameter

American National Standards Institute (ANSI)

ANSI B1.20.1	Standard Tapered Pipe Threads, General Purpose

1.2 SUBMITTALS

1.2.1 SD-03, Manufacturer's Catalog Data

Provide catalog cut sheets, clearly denoting the size(s), material(s), and model numbers as appropriate to demonstrate that the selected product meets the specifications and drawings for the following items:

a. PVC pipe and fittings
b. HDPE pipe and fittings, groundwater extraction service
c. HDPE pipe and fittings, sanitary sewer force main re-route service
d. Transition coupling from threaded to HPDE extraction well service
e. Transition coupling for cement asbestos cement/HDPE coupling
f. Mechanical joint restraint for asbestos cement/HDPE transition
g. Stainless steel extraction well drop pipe
h. Pitless adapters
i. Non-shrink cement grout
j. Rubber modular seal

1.2.2 SD-06, Field Test Reports

a) Hydrostatic test of extraction well piping and water conveyance
b) Hydrostatic test of sanitary sewer force main

1.2.3 SD-07, Certificates

a) Provide training certificates for personnel conducting HDPE thermal fusion of HDPE piping
b) Provide training certificates for personnel conducting HDPE electrofusion joining of HDPE piping

1.3 MEASUREMENT AND PAYMENT

Payment for work under this specification is included in the bid items on the bid form 00 41 00.

2. PRODUCTS

2.1 HDPE PIPE AND FITTINGS, GROUNDWATER EXTRACTION SERVICE

HDPE Pipe shall be manufactured from a PE 4710 resin listed with the Plastic Pipe Institute (PPI). Pipe shall have a manufacturing standard of ASTM F 714. Pipe shall be DR 11 with a working pressure rating of 125 psi. Pipe and fittings shall be rated for full vacuum.

2.2 HDPE PIPE AND FITTINGS, SANITARY SEWER FORCE MAIN RE-ROUTE SERVICE

8-inch nominal diameter IPS HDPE Pipe shall be manufactured from a PE 4710 resin listed with the Plastic Pipe Institute (PPI). Pipe shall be manufactured in accordance with ASTM F 714. Pipe shall be DR 17 with a working pressure rating of 125 psi. Pipe and fittings shall be rated for full vacuum.

HDPE elbows (both 45 and 90 degrees) shall be molded (not fabricated) long radius, with a radius at least 3 times the nominal pipe diameter.

Electrofusion couplings with pressure ratings of at least 125 psi may be used to join sections of HDPE pipe or connect HDPE pipe to HDPE fittings. Electrofusion fittings shall be PE 4710.

2.3 TRANSITION COUPLING THREADED TO HDPE

1.5-inch by 1.5-inch nominal diameter, 304 or 316 stainless steel threaded NPT ANSI B1.20.1 by 3408 or 4710 HDPE. Pressure rating shall not be less than 125 psi.

2.4 TRANSITION COUPLING AND MECHANICAL JOINT RESTRAINT FOR SANITARY SEWER FORCE MAIN RE-ROUTE

Field verify existing pipe size and material. Provide and install transition coupling sized to match existing pipe and compatible with its material of construction. Other side of coupling shall be sized and constructed to mate to 8-inch IPS HDPE pipe and include a stainless steel

reinforcement sleeve. Transition coupling shall have a pressure rating of not less than 125 psi. Gasket materials shall be compatible with sewer service.

Provide and install mechanical joint restraint sized and compatible with both field-verified existing pipe and new 8-inch diameter HDPE pipe.

2.5 STAINLESS STEEL PIPE FOR EXTRACTION WELL DROP PIPE

304 stainless steel, schedule 40.

2.6 PITLESS ADAPTERS

Brass or stainless steel with PTFE or viton elastomers. Sized for 4-inch diameter nominal (4.5-inch OD) well casing and 1 ¼-inch drop pipe. Maass 4JC1 ¼ or approved equal.

2.7 NON-SHRINK CEMENT GROUT FOR GROUT PLUGS IN ABANDONED PIPE AND CONDUIT

ASTM C 1107.

2.8 RUBBER MODULAR SEAL FOR SANITARY SEWER FORCE MAIN CONNECTION TO MANHOLE

Thunderline Link-Seal or equal. Sized to fit hole in the manhole sidewall and 8-inch HDPE pipe. All modular seal materials shall be compatible with sanitary sewer service.

3.0 EXECUTION

3.1 PIPE PREPARATION

Ream pipe ends. Remove burrs. Remove scale and dirt on inside and outside before installation. Remove oil and grease from piping ends

3.2 INSTALLATION

3.2.1 Piping shall form complete connected systems, including connections to valves and equipment supplied under other Sections of the specifications. Piping work shall be performed by skilled workmen.

3.2.2 Information on pipe sizes, pressure classes, operating pressures, types of joints, types of valves, and other pertinent data is contained in schedules, or shown on the Drawings.

3.2.3 The Drawings indicate the required pipe sizes and general arrangement and location for piping, valves, manholes, and equipment. Locations shall be verified in the field. If it is necessary to change the location of any of the work due to the treatment building construction or site-specific issues, consult with the Engineer before making changes. Do not change sizes indicated without prior written approval of the Engineer.

PVC socket joints shall be made in accordance with ASTM D2855. Connections between PVC pipe and threaded fittings shall be made with socket x threaded adapters. PVC pipe shall not be threaded.

3.2.4 HDPE Joints

HDPE Joints shall be (1) heat-butt fused using equipment and methods consistent with pipe and fittings manufacturer's recommendations or (2) joined using electro-fusion couplings in conjunction with equipment and methods consistent with manufacturer's recommendations.

3.2.5 HDPE to Asbestos Cement Pipe Joining

Install HDPE to asbestos cement transition coupling according to manufacturer's instructions.

3.2.6 Temporary Stub Ups, Extraction Well Service

At stub-up location shown on the drawings, install 90 degree elbow to stub-up both 1.5-inch HDPE pipes to ground surface. Install HDPE flange adapter, back-up ring and blind flange.

3.2.7 Concrete Coring for Sanitary Sewer Force Main Connection to Manhole

Core hole in concrete sidewall of existing manhole at same elevation as existing. Hole shall be sufficiently smooth to form watertight seal around pipe using rubber modular seal in paragraph 2.8 of this specification system.

3.3 HYDROSTATIC TESTING, EXTRACTION WELL PIPING

Hydrostatically test both extraction well pipeline after all piping and instrumentation has been installed. Fill pipelines with water and vent air by pumping from extraction wells to water collection tank. Pressurize entire extraction well piping system to 40 psi for a 4-hour pressure/temperature equilibration period. After 4 hours, pressurize pipe to 40 psi and begin test. Monitor pressure every 5 minutes. Piping system pressure shall not decrease by more than 2 psi during the 2-hour test or demonstrate a decreasing pressure for the last hour of test. If necessary, repair leaks and retest until piping system passes test.

Test results shall include date, time and pipeline pressure recorded at 5-minute intervals. Locations of leaks and subsequent repairs shall also be documented, if applicable.

Dispose of collected well water in accordance with Paragraph 3.11 of Section 33 23 00 "Extraction Wells, Monitoring Wells, and Piezometers."

3.4 HYDROSTATIC TESING, SANITARY SEWER FORCE MAIN

Install test plug on end of 8-inch HDPE pipe in manhole. Install safety gag on test plug. Fill pipeline with water and vent air. Locate and close nearest upstream valve. Pressurize pipe to 10 psi for 4 hours to allow pipe and water to thermally equilibrate.

After equilibration period, begin test at 10 psi. Monitor pressure every 5 minutes. Piping system pressure shall not decrease by more than 2 psi during the 2-hour test or demonstrate a continuous decrease in pipe pressure. If necessary, repair leaks and retest until piping system passes test.

Test results shall include date, time and pipeline pressure recorded at 5-minute intervals. Locations of leaks and subsequent repairs shall also be documented, if applicable.

End of Section 22 10 00

DIVISION 26 ELECTRICAL

SECTION 26 05 00
BASIC ELECTRICAL MATERIALS AND METHODS

1. GENERAL

1.1 SECTION INCLUDES

A. Basic electrical requirements for materials and methods applicable to electrical equipment specified under this Section and other related sections

B. Conduit

C. Boxes

D. Wire and Cable

E. Grounding Materials

1.2 REFERENCES

A. ANSI C2—National Electrical Safety Code

B. ANSI/NEMA FB 1—Fittings and Supports for Conduit and Cable Assemblies

C. ANSI/NEMA OS 1—Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports

D. ANSI/NEMA OS 2—Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

E. IEEE—All applicable standards

F. IPCEA—All applicable standards

G. NEMA—All applicable standards

H. NEMA 250—Enclosures for Electrical Equipment (1,000 Volts Maximum)

I. NFPA 70—National Electrical Code

J. UL—All applicable standards

1.3 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of installation

1.4 REGULATORY REQUIREMENTS

A. Electrical: Conform to NFPA70, National Electrical Code and applicable local codes

1.5 FIELD MEASUREMENTS

A. Verify that field measurements are as shown on Drawings

B. Verify routing and termination locations of conduit

1.6 MAINTENANCE MATERIALS

A. Spare Parts:
1. 10 percent replacement lamps for pilot lights
2. 100 percent replacement fuses
3. 2 spare lamp lenses of each type specified

2. PRODUCTS

2.1 CONDUIT

A. Minimum Size:
1. General: 3/4 inch minimum unless otherwise specified

B. Exposed, locations: Use rigid galvanized steel conduit

C. Underground Installations: Schedule 40 PVC unless otherwise indicated

D. Outdoor Locations, Above Grade: Use PVC coated rigid steel conduit

E. Flexible Connections:
1. Conduit:
   a. Vinyl jacketed, liquid-tight, flexible steel
   b. Anaconda Type UA, Electroflex Type LA, or approved equal
2. Connectors:
   a. Watertight
   b. Appleton Type ST or STB, Crouse-Hinds Type LT or LTC, or approved equal

2.2 CONDUIT SUPPORT

A. General: Galvanized steel framing channel

B. Unistrut, Powerstrut, or approved equal

2.3 PULL AND JUNCTION BOXES

A. Outdoor, above ground:
1. Surface-Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface-mounted junction box:
   a. Material: Galvanized cast iron
   b. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws

c. Crouse-Hinds WCB or approved equal

B. Outdoor, in ground:
a. Precast concrete handhole
b. 24” x 36” x 36”
c. Galvanized steel traffic cover, marked “Electric”

2.4 DEFLECTION FITTINGS

A. Locations:
1. Underground conduit runs
2. Runs between concrete sections subject to relative movement
Material:
3. Ferroalloy hubs
4. Neoprene outer jacket
5. Stainless steel jacket clamps
6. Molded plastic inner sleeve
7. Tinned copper braid grounding strap

B. Model XD as Manufactured by Crouse-Hinds

2.5 FLEXIBLE SEALING COMPOUND

A. “Duxseal” as Manufactured by Johns-Manville, or approved equal

B. “Permagum” as Manufactured by Inmount, or approved equal

2.6 WIRE AND CABLE

A. Power Circuits, 600 V and Below
1. General Use:
a. Conductors: Single, copper, 12 AWG minimum
b. Stranded where larger than 10 AWG, solid or stranded for 10 AWG and 12 AWG
c. Insulation: 600 V thermoplastic, UL Type THWN/THHNJacket: Nylon
d. Suitability: Wet or dry locations at 75C copper temp
e. Or as specified for service entrances
2. VFD Cable:
a. Multi-conductor cable with full sized ground
b. Belden 255xx or approved equal
3. Terminations: Lugs, cup washers or pressure type; do not use wire nuts on stranded cable or wrap stranded cable around screw type terminals

B. Control Circuits, 600 V and below:
1. Conductors: Single, copper, 12 AWG
2. Stranded
3. Insulation: 600 V thermoplastic, UL Type THWN/THHN
4. Jacket: Nylon
5. Suitability: Wet or dry location at 75C copper temp

C. Multi-conductor Instrument Signal Cable:

1. Conductors:

a. Pair: stranded copper, number of pairs as indicated on drawings

2. Insulation: 15 mils, minimum, 90C PVC or cross-linked polyethylene
3. Shield: Mylar aluminum tape with 18 AWG copper drain wire, fully covering conductors
4. Jacket: 20 mils, minimum, 80C PVC
5. Suitability: Wet or dry steel conduit

D. Network and Data Communications Cable:

1. Ethernet:

a. 100baseT, Category 5e

b. Provide with all required taps, hubs, terminating resistors, transceivers and accessories for complete Ethernet network

2. Fiber Optic:

a. Outdoor long distance fiber cable:

1. Up to 3.2 kilometers
2. 9/125 micron
3. Attenuation at 1300 nm: 0.4 dB/km
4. Loose tube
5. Fiber Optic Cable Placing - Duct
6. 6 fibers per cable
7. Phoenix Digital FOC-EXP or approved equal

E. Arc-Proofing Tape: Irvington "77 Arc-Proofing Tape," Slipknot No. 50 or Slipknot No. 3, or approved equal

2.7 GROUNDING AND BONDING

A. Provide grounding and bonding in accordance with NFPA 70

B. Ground rods: Copper-clad steel; ¾ inch by 10 feet

3. EXECUTION

3.1 INSTALLATION

A. General:

1. Install all equipment level and plumb
2. Separate sheet metal junction boxes, equipment enclosures, sheet metal raceways, etc., mounted on water or earth-bearing walls or wall-mounted outdoors 1/4 inch from wall by corrosion resistant spacers
3. Screen or seal with flexible sealing compound all openings into outdoor equipment to prevent the entrance of rodents, wasps, and mud-daubers

B. Raceways:

1. General:

a. Metal conduit connections and terminations to be reamed, de-burred, threaded and provided with bushings
b. Securely fasten conduit connections to sheet metal enclosures with locknuts inside and out
c. Provide deflection fittings across structural joints where structural movement is allowed
d. Keep conduit clear of structural openings and indicated future openings
e. Neatly grout conduit into any opening cut into structure
f. Cap or plug conduits during construction to prevent entrance of trash, dirt and water
g. Provide flexible conduit where flexible connections are necessary, including each motor without flexible cord:
   1) Length kept to a minimum, 6 feet max
   2) No sharp bends

2. Underground:

a. Two feet minimum bend radius at vertical risers, 3 feet elsewhere
b. Install underground conduit so that it does not drain to cable pulling access in buildings; where necessary, provide a handhole or manhole near or adjacent to building
c. Provide 2.5 feet minimum earth cover
d. Install detectable warning tape 12 inches above conduit

3. Junction boxes and wiring gutters:

a. Install electrical boxes as shown on drawings and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements
b. Install pull boxes and junction boxes to maintain headroom and to present neat mechanical appearance
c. Install level and plumb
d. At least code size including space for full size continuation of any conduit not originally continued
e. Arrange conduit for maximum space for future conduits
f. Support boxes independently of conduit,

C. Wire and Cable:

1. General:

a. Protect the cable and avoid kinking conductors, cutting or puncturing jackets, contaminating by oil or grease or damaging in any manner
b. Terminate stranded cable with lugs, cup washers, or pressure type connectors; do not wrap stranded cable around screw type terminals
c. Splice stranded cable with pressure type connectors; do not use wire nut type connectors on stranded cable
d. Splice cables only at readily accessible locations
e. Do not pull cable tight against bushings or press heavily against enclosures
f. Use cable pulling lubricants as recommended by the cable manufacturer
g. Use swab to clean conduits before pulling cables
h. Install cable and accessories in accordance with manufacturer's instructions

i. Coil and tape spare cable ends
j. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet
k. Pull all conductors into raceway at same time
l. Use suitable wire pulling lubricant for building wire 4 AWG and larger
m. Protect exposed cable from damage
n. Use suitable cable fittings and connectors
o. Neatly train and lace wiring inside boxes, equipment, and panelboards
p. Clean conductor surfaces before installing lugs and connectors
q. Make splices, taps, and terminations to carry full ampacity of conductors

2. Conductor identification:

a. Color code all service, feeder, and branch circuit conductors, 120/208/240 V ac as follows:
   1) Phase A: Red
   2) Phase B: Black
   3) Phase C: Blue
   4) Neutral: White
   5) Ground: Bare or Green
b. Identify single control conductors by color coding orange and by labeling each end conductor with adhesive labels, Brady "Quicklabel" or approved equal
c. Identify multi-conductor instrumentation and control cables with adhesive labels, Brady "Quicklabel", or approved equal
d. Contractor shall establish a control and instrumentation conductor and cable identification system acceptable to Engineer

D. Grounding Materials:

1. Provide bonding to meet Regulatory Requirements
2. All branch circuit and feeder circuits to include a copper ground conductor in addition to the conduit ground connection
3. Connect ground conductors to equipment by ground lugs or clamps:

a. If no ground bus or terminal is provided and enclosure is not explosion-proof or submersible provide a clamp type lug under a permanent assembly bolt or by grounding locknuts or bushings
b. Do not make ground connections to anchor bolts; against gaskets, paint or varnish; or to bolts holding removable access covers

End of Section 26 05 00

SECTION 26 60 00
MEASUREMENT AND CONTROL INSTRUMENTATION

1. GENERAL

1.1 SECTION INCLUDES

A. The work of this section consists of furnishing and installing field mounted instruments and devices.

B. Coordination of entire instrumentation installation

1.2 REFERENCES

A. ISA S5.1—Instrumentation symbols

B. ISA S5.4—Instrument Loop Diagrams

C. IEEE—All applicable standards

D. NEMA ICS1—General Standards for Industrial Controls and Systems

E. NEMA 2—Industrial Control Devices, Controllers and Assemblies

F. NEMA 3—Industrial Systems

G. NEMA ICS6—Enclosures for Industrial Control and Systems

H. NEMA 250—Enclosures for Electrical Equipment

I. UL—All applicable sections

J. NFPA 70—National Electrical Code

1.3 SYSTEM INTERFACE COORDINATION

A. Provide all buffers, isolators, signal converters and amplifiers for interfacing with existing equipment, equipment furnished under another section and between items of equipment furnished hereunder, whether or not such interfacing is indicated on the Drawings or detailed specification

1.4 DESIGN REQUIREMENTS

A. Equipment Interfacing:
   1. Analog signals to equipment by others or under other Section: 4 to 20 milliamperes direct current (DC), negative ground for a total loop impedance of 0 to 500 ohms
   2. Analog signals from equipment by others or under other Section: 4 to 20 milliamperes DC, negative ground, suitable for 100 to 500 ohms loop impedance
   3. Provide all required buffers, isolators, signal converters, and amplifiers for coordination with existing equipment, equipment furnished under another Section, and between items

of equipment furnished hereunder, whether or not indicated on the Drawings or detailed Specifications

1.5 PROJECT RECORD DOCUMENTS

A. As-calibrated instrument calibration sheets

B. As-built vendor drawings:
   1. Hard-copy
   2. AutoCAD® drawing files or more recent release

C. As-built Contract Documents

1.6 OPERATION AND MAINTENANCE

A. Operation Data: Complete and detailed instruction manual

B. Maintenance Data:
   1. Recommended spare parts list
   2. Preventative maintenance schedule
   3. Calibration schedule and detailed calibration instructions

1.7 REGULATORY REQUIREMENTS

A. Underwriters Laboratories

B. National Fire Protection Association

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept products on site in factory containers and verify condition of product

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install instruments until spaces are suitably protected from weather, moisture, and damage from other trades

B. Maintain protection of instruments during and after installation

C. Any items damaged during construction will be repaired or replaced at the Project Engineer's discretion

1.10 WARRANTY

A. Work shall be performed under the Contractor's warranty or the correction period shall be done by employees of the instrument supplier, or of an authorized agency

1.11 MAINTENANCE MATERIALS

A. Provide spare parts:

1. 25 percent replacement bulbs for indicator pilot lamps
2. 100 percent replacement fuses
3. 10 percent replacement pilot light lenses

2. PRODUCTS

2.1 FIELD MOUNTED LEVEL INSTRUMENTS

A. Gauge Pressure Transducer:
1. Submersible transducer for liquid level measurement.
2. Pressure range shall be 0 to 15 psi
3. 4-20mA output
4. Cable length as required for measurement depth
5. Vent line in cable to allow for barometric compensation of level measurement, with desiccant
6. All wetted materials shall be 316 stainless steel
7. Cable shall be Tefzel
8. Geotech or approved equal

2.2 QUALITY CONTROL AND TESTS

A. Provide shop inspection and testing of all instrument panel devices

B. Notify the Project Engineer two weeks prior to shipment of panel

3. EXECUTION

3.1 EXAMINATION

A. Verify all equipment in control loop or system is available and on-site prior to taking an existing loop out of service

B. Review the requirements of the installation to ensure that the changeover can be performed within the project constraints

3.2 INSTALLATION

A. Install all products per Manufacturer's recommendations and the Drawings:

B. Provide signal converters and boosters as required

C. Calibration of Instruments:
1. Perform calibration exactly as outlined in Manufacturer's printed instructions
2. Check calibration at several points along instrument range
3. Complete data entry on Instrument Calibration Record Sheet immediately after each step of calibration and obtain the Project Engineer's initials for each sheet
4. Completed Instrument Calibration Record Sheets and Instrument Loop Record Sheets must be submitted prior to substantial completion

3.3 FIELD QUALITY CONTROL

A. Prior to start-up:
   1. Check, calibrate, and place equipment in operation
   2. Advise Contractor of necessary corrections for start-up

B. Start-up:
   1. Pressure transducer readings shall be in feet above mean sea level and shall match manual groundwater level measurements +/- 0.035 feet.

3.4 INSTRUMENT CALIBRATION RECORD

A. Attached

INSTRUMENT CALIBRATION RECORD

CALIBRATION DATE: _____ CALIBRATOR: _____

INSTRUMENT TAG NO: _____ LOOP NAME: _____

CALIBRATED RANGE: _____ MANUFACTURER: _____

INPUT POWER SUPPLY: _____ MODEL NO: _____

UNITS: _____ VOLTSAC____ DC___

INPUT SIGNAL	EXPECTED DISPLAY	EXPECTED OUTPUT	ACTUAL DISPLAY	ACTUAL OUTPUT

REMARKS:

WITNESS/APPROVED:

_____ DATE: _____

_____ DATE: _____

TT: _____ DATE: _____

SECTION 26 60 05
CONTROL NARRATIVES

1. GENERAL

1.1 DESCRIPTION

A. This Section is provided for information only and includes programming and control logic for new control systems. The programming will be provided by Others as part of the Treatment Building project.

1.2 RELATED SECTIONS

A. Section 26 60 00—Measurement And Control Instrumentation

B. Section 33 23 00 – Groundwater Extraction Wells, Monitoring Wells, and Piezometers

2. PRODUCTS

Not Used

3. EXECUTION

3.1 CONTROL NARRATIVE FORMAT

A. Control Narratives are presented in the following format:

1. Equipment Identification: Describes the equipment to be controlled and the associated equipment tag numbers
2. P&ID: Identifies the associated Process and Instrumentation Drawing
3. General: Provides a general overview of the function of the equipment within the process
4. Signals: Lists all signals related to control of the equipment. The list includes the following:
   a. Tagname: This is the tagname entered into the SCADA database
   b. Type: Identifies how the tagname is linked to the SCADA system:
      1) AI: Hardwired analog input to the PLC
      2) DI: Hardwired digital input to the PLC
      3) AO: Hardwired analog output from the PLC
      4) DO: Hardwired digital output from the PLC
5. Automatic Control: Defines the control functions when the equipment or associated process is placed in SCADA Automatic
6. Manual Control: Defines the control functions when the equipment or associated process is placed in SCADA Manual
7. Interlocks and Alarms: Defines interlock conditions which affect equipment operation. For example, Level Alarm Low will typically cause the control system to shut down the associated pump. This section also identifies additional alarm conditions which will not affect equipment operation but will trigger a SCADA alarm.

3.2 CONTROL NARRATIVES

A Extraction Well System

1. Extraction Well Pumps (OCD-EW-1, ODC-EW-2)
2. P&ID: Drawing No. I-1
3. General:
4. The extraction wells are each provided with a control panel with a variable frequency controller to modulate flow rate. The pumps pump water to the treatment building where flow is monitored from each well individually. A PLC Control Panel, located in the Treatment Building will provide overall remote and automatic control of the system.
5. Signals:

Tagname	Type	Description	Display	Alarm	Historize	Totalize
FIT-1	AI	ODC-EW-1 Flowrate	Yes	No	Yes	Yes
FIT-2	AI	ODC-EW-2 Flowrate	Yes	No	Yes	Yes
LI-1	AI	ODC-EW-1 Well Level	Yes	No	Yes	No
LI-3	AI	Piezometer ODC-PZ-3 Level	Yes	No	Yes	No
LI-4	AI	Piezometer ODC-PZ-4 Level	Yes	Yes	Yes	No
HS-1	DO	ODC-EW-1 Pump Start/Stop	Yes	No	Yes	No
YL-1	DI	ODC-EW-1 Pump Running	Yes	No	Yes	No
UA-1	DI	ODC-EW-1 VFD Fault	Yes	Yes	Yes	No
SC-1	AO	ODC-EW-1 Pump Speed Ctl	Yes	No	Yes	No
LI-2	AI	ODC-EW-2 Well Level	Yes	No	Yes	No
LI-7	AI	Piezometer ODC-PZ-7 Level	Yes	No	Yes	No
LI-8	AI	Piezometer ODC-PZ-8 Level	Yes	Yes	Yes	No
HS-2	DO	ODC-EW-2 Pump Start/Stop	Yes	No	Yes	No
YL-2	DI	ODC-EW-2 Pump Running	Yes	No	Yes	No
UA-2	DI	ODC-EW-2 VFD Fault	Yes	Yes	Yes	No
SC-2	AO	ODC-EW-2 Pump Speed Ctl	Yes	No	Yes	No

6. Automatic Control:

   a. When a permissive signal is received (that is, a signal that the treatment system (by others) is operating normally and able to treat extracted groundwater), the PLC will turn on both ODC extraction well pumps. Conversely, when a treatment system shutdown occurs, the PLC will shut down both ODC extraction wells pumps. The flow rates of the extraction wells will be controlled by the PLC in either of the following two user-selectable methods (1) user-selectable extraction well drawdown, or (2) maintain a user-selectable groundwater elevation difference at paired piezometers.

   b. <u>User-Selectable Extraction Well Drawdown Control Scheme.</u>
   The user-selectable extraction well drawdown control scheme consists of using the groundwater elevation data from both extraction well pressure transducers. O&M personnel will then select the desired drawdown and corresponding groundwater elevation for each extraction well. The PLC will modulate the pump speed based on the monitored groundwater elevation in

the extraction well. When the groundwater level is below the drawdown setpoint, the PLC will slow the extraction well pump speed. If the flow rate decreases to below the minimum pumping rate for the selected pump/motor, the VFD will shut off the pump until the groundwater level recharges to the user-adjustable elevation and the pump will restart automatically. If the groundwater level is above the drawdown setpoint, the PLC will increase the extraction well pump speed. If the water level in the well decreases to 2 feet above the pump, the PLC will shut off the pump, until the groundwater level recharges to the user-adjustable pump re-start elevation and the pump will restart automatically.

c. User-Selectable Groundwater Elevation Difference at Paired Piezometer Control Scheme.
The paired piezometer gradient control scheme will consist of pressure transducers located in two pairs of piezometers (ODC-PZ-3/ODC-PZ-4 and ODC-PZ-7/ODC-PZ-8) located on the inside and outside of the ODC slurry wall. The flow rate of extraction well ODC-EW1 will be electronically linked to the groundwater elevation differential at piezometer pair ODC-PZ-3 and ODC-PZ-4. O&M personnel will be able to set the desired groundwater elevation difference between these pairs via the PLC user interface. When the groundwater elevation difference between piezometer pair ODC-PZ-3 and ODC-PZ-4 is below the setpoint, the PLC will increase the flow rate from extraction well ODC-EW1. When the groundwater level difference is above the setpoint, the PLC will decrease or shut off the extraction well, as needed. If the flow rate decreases to below the minimum pumping rate for the selected pump/motor, the VFD will shut off the pump until the groundwater level recharges to the user-adjustable elevation and the pump will restart automatically. If the water level in the well decreases to 2 feet above the pump, the PLC will shut off the pump, until the groundwater level recharges to the user-adjustable pump re-start elevation and the pump will restart automatically.

7. Manual Control:

Each pump will be provided with local HOA (Hand-Off-Auto) controls at the local well pump control panel. Manual speed control will be available via the local VFD interface pad.

8. Interlocks and Alarms:

Low level in the well (2 feet above the well pump) will shut down the well pump. VFD fault will shut down the well pump and initiate a PLC alarm.

End of Section 26 60 05

DIVISION 31 EARTHWORK

SECTION 31 00 00
EARTHWORK

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest version of each publication is to be used.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M147	Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses

ASTM INTERNATIONAL (ASTM)

ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 140	Sampling and Testing Concrete Masonry Units
ASTM D 1556	Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)
ASTM D 2216	Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2434	Standard Test Method for Permeability of Granular Soils
ASTM D 2487	Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4355	Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus

ASTM D 4491	Water Permeability of Geotextiles by Permittivity
ASTM D 4595	Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4751	Determining Apparent Opening Size of a Geotextile
ASTM D 4873	Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D4884	Strength of Sewn or Thermally Bonded Seams of Geotextiles

1.2 DEFINITIONS

1.2.1 Solid Waste

Rubbish, debris, garbage, and other discarded solid non-inert materials resulting from industrial, commercial, and agricultural operations and from community activities.

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 Submittal Procedures.

1.3.1 SD-01, Preconstruction Submittals

A. Geosynthetic Clay Liner Installer Qualifications. Provide certificate demonstrating that installer has installed the proposed geosynthetic liner on at least 5 similar projects with a total minimum area of a least 1 million square feet. Provide names, locations, and references for each project.
B. Geomembrane Installer Qualifications. Provide certificate demonstrating that installer has installed the proposed geomembrane (or similar LDPE geomembrane) on at least 5 similar projects with a total minimum area of at least 1 million square feet. Provide names, locations, and references for each project.

1.3.2 SD-02, Shop Drawings

A. Standard Penetration Details. Provide drawings showing proposed extraction well/monitoring well/piezometer and conduit penetrations through the cap materials. Penetration seals shall be designed and installed in accordance with geosynthetic clay liner and geomembrane manufacturer's instructions to minimize the potential for leaks.

1.3.3 SD-03, Product Data

A. Sand Freeze/Thaw Protection Layer Soil
B. Sand Foundation Layer Soil
C. Geosynthetic Clay Liner
D. Geomembrane
E. Geocomposite Drainage Layer
F. Topsoil

G. Erosion Control Mat
H. Pipe bedding Material, including typical gradation
I. Detectable Warning Tape
J. Controlled Low Strength Material
K. Perforated Corrugated PE Pipe
L. Nonperforated Corrugated PE Pipe
M. Nonwoven geotextile
N. Drain rock, including typical gradation

1.3.4 SD-05, Samples, submit material sample, 3 inches by 3 inches or larger along with SD-03 Product data
A. Geosynthetic Clay Liner
B. Geomembrane
C. Geocomposite Drainage Layer
D. Erosion Control Mat
E. Detectable warning tape (submit sample large enough to show custom lettering)

1.3.5 SD-06, Test Reports

A. Chemical Analytical Tests for Imported Soil

Provide to Engineer the analytical results of two samples for each source of imported material before bringing imported material onsite. Analyses shall include the following:

a. Volatile organic compounds (VOC) by USEPA SW-846 Methods 5035 and 8260B
b. Semivolatile organic compounds (SVOC) by USEPA SW-846 Method 8270C
c. Total priority pollutant (TPP) metals by USEPA SW-846 Methods 6010B/6020, 7060A/7061A/7062, 7421, 7470A/7471A 7740A/7741A/7742, 7841, 9012A as applicable
d. Polychlorinated biphenyls (PCB) by USEPA SW-846 Method 8082
e. Pesticides by USEPA SW-846 Method 8081A
f. Herbicides by USEPA SW-846 Method 8321A

All chemical constituents shall meet the Title 35 of the Illinois Administrative Code Part 742 “Tiered Approach to Corrective Action Objectives” (TACO) Tier 1 remediation objectives for residential properties and for soil migration to the groundwater ingestion exposure route for Class I groundwater.

B. Chemical Analytical Tests for Native Soil
Provide to Engineer the analytical results of two samples for each source of imported material before bringing imported material onsite. Analyses shall include the following:

a. Volatile organic compounds (VOC) by USEPA SW-846 Methods 5035 and 8260B
b. Semivolatile organic compounds (SVOC) by USEPA SW-846 Method 8270C

c. Total priority pollutant (TPP) metals by USEPA SW-846 Methods 6010B/6020, 7060A/7061A/7062, 7421, 7470A/7471A 7740A/7741A/7742, 7841, 9012A as applicable
d. Polychlorinated biphenyls (PCB) by USEPA SW-846 Method 8082
e. Pesticides by USEPA SW-846 Method 8081A
f. Herbicides by USEPA SW-846 Method 8321A

All chemical constituents shall meet the Title 35 of the Illinois Administrative Code Part 742 "Tiered Approach to Corrective Action Objectives" (TACO) Tier 1 remediation objectives for residential properties and for soil migration to the groundwater ingestion exposure route for Class I groundwater.

C. Compaction Tests. Provide modified proctor test (ASTM D1557) and soil classification ASTM D2487 for each of the following:

a. Each subgrade soil area to be compacted (ODC cap, and utility trench bottoms)
b. Sand Foundation Layer
c. Sand Freeze/Thaw Protection Layer
d. Utility trench backfill

Provide nuclear gauge density and moisture test results (ASTM D2922 and D3017), sand cone density test results (ASTM D1556), moisture (ASTM D 2216) at the frequency shown in Section 3.11 of this section.

1.3.6 SD-07 Certificates

A. Geosynthetic Clay Liner
B. Geomembrane
C. Geocomposite

1.3.7 SD-08, Manufacturer's Instructions. Provide preprinted manufacturer's instructions for the following items. Each Manufacturer instruction shall be accompanied by a cover letter from the Contractor Quality Control Supervisor stating that the material will be installed in accordance with these instructions.

A. Geosynthetic Clay Liner
B. Geomembrane
C. Triaxial Geocomposite
D. Erosion Control Mat

1.3.8 SD-09, Manufacturer's Test Reports

A. Sand Freeze/Thaw Protection Layer Soil, the results of the Manufacturer's/ Supplier's sieve analysis per ASTM C136
B. Sand Freeze/Thaw Protection Layer Soil hydraulic conductivity per ASTM D2434
C. Sand Foundation Layer Soil, the results of the supplier's sieve analysis and soil classification per ASTM C136 and ASTM 2487.
D. Topsoil

1.3.9 SD-11, Closeout Submittals

A. As-built report including quantities of all construction materials used

1.4 DELIVERY, STORAGE, AND HANDLING

Perform in a manner to prevent contamination or segregation of blended materials.

Geosynthetic clay liner, geomembrane, traixial geocomposite, and erosion control mat shall be delivered, stored, and handled in a manner consistent with their manufacturer's published instructions.

Temporary storage at the project site shall be on a level surface, free of sharp objects where water cannot accumulate. The geomembrane shall be protected from puncture, abrasion, excessive heat or cold, material degradation, or other damaging circumstances. Storage shall not result in crushing the core of roll goods or flattening of the rolls. Rolls shall not be stored more than two high. Palleted materials shall be stored on level surfaces and shall not be stacked on top of one another. Ultraviolet sensitive materials (i.e., LDPE, GCL, and geocomposite) shall be covered with a sacrificial opaque and waterproof covering or placed in a temporary shelter. Damaged materials shall be removed from the site and replaced with materials that meets the specified requirements.

Rolls/panels shall not be dragged, lifted by one end, or dropped. A pipe or solid bar, of sufficient strength to support the full weight of a roll without significant bending, shall be used for all handling activities. The diameter of the pipe or solid bar shall be small enough to be easily inserted through the core of the roll. Chains shall be used to link the ends of the pipe or bar to the ends of a spreader bar. The spreader bar shall be wide enough to prevent the chains from rubbing against the ends of the roll. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. The stinger bar shall be at least three-fourths the length of the core and also must be capable of supporting the full weight of the roll without significant bending. If recommended by the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

1.5 INSTALLER'S QUALIFICATIONS

The Contractor or it's installer shall have successfully installed geotextile at a minimum of 5 projects of comparable scope and complexity totaling a minimum of 1,000,000 square feet or must provide to the Engineer satisfactory evidence through similar experience in the installation of other types of geosynthetics that the geotextile for pavement will be installed in a competent and professional manner.

2. PRODUCTS

2.1 SAND FREEZE/THAW PROTECTION LAYER SOIL

Soil meeting the following requirements:

A. Be excavated from a site with no history of environmental contamination. Native sand qualified for use as bedding material shall be sample, analyzed, and deemed acceptable for on-site use in accordance with Section 1.3.4 (d) Chemical Tests for Native Soil.

B. Be free of debris, roots, wood, scrap metal, vegetation, refuse, soft unsound particles, and deleterious or objectionable materials.

C. Meet gradation requirements below

Sieve Size	Percent Passing
3/8 inch	100
No. 40	>99
No. 80	>93
No. 200	>35

D. Have hydraulic conductivity less than 1x10-4 cm/sec after compaction when tested by ASTM D2434.

2.2 SAND FOUNDATION LAYER SOIL

Soil meeting the following requirements:

A. Be excavated from a site with no history of environmental contamination. Native sand qualified for use as bedding material shall be sample, analyzed, and deemed acceptable for on-site use in accordance with Section 1.3.4 (d) Chemical Tests for Native Soil.

B. Be free of debris, roots, wood, scrap metal, vegetation, refuse, soft unsound particles, and deleterious or objectionable materials.

C. Maximum particle size shall be less than ¾ inch

D. Soil shall be classified as SW, SP, SM, SC in accordance with ASTM D2487.

2.3 GEOSYNTHETIC CLAY LINER

Needlepunched geosynthetic clay liner (GCL), consisting of a layer of sodium bentonite between woven or nonwoven geotextiles, which shall be needlepunched together. GCL shall have a hydraulic conductivity less than 5x10-9 cm/sec when tested by ASTM D5887. The GCL shall contain at least 0.75 pounds of bentonite per square foot of GCL when tested by ASTMI D 5993.

2.4 GEOMEMBRANE

40-mil thick geomembrane liner constructed from low-density polyurethane. Geomembrane shall be free of holes, bubbles, blisters, nicks and cuts. Edges shall be free of nicks and cuts.

Property	Test Method	Test Frequency	Minimum Average Value
Thickness, mil Lowest individual measurement	ASTM D5199	Every roll	40 36
Density (g/cm^3)	ASTM D1505	200,000 lbs	0.94
Tear Resistance	ASTM D 1004	50,000 lbs	28
Puncture Resistance	ASTM D4833	50,000 lbs	72
Carbon Black Content	ASTM D4218	50,000 lbs	2 -3 percent
Notch Constant Tensile Load, hr	ASTM D5397	200,000 lbs	300
Oxidative Induction Time, min	ASTM D 3895, 200 deg C; 1 atm	200,000 lbs	>100

Geomembrane shall be warranted, on a pro-rata basis against Manufacturer's defects for 5 years from the date of installation.

2.4.1 Geomembrane Equipment

Equipment used in joining geomembrane shall be in accordance with the geomembrane manufacturer's recommendations and shall be maintained in satisfactory working condition.

2.5 GEOCOMPOSITE DRAINAGE LAYER

Geocomposite drainage layer shall consist of a drainage layer sandwiched between two heat-bonded nonwoven geotextiles. Geocomposite shall have a transmissivity of at least 5 x 10^{-3} m^2/sec.

2.6 TOPSOIL

Topsoil shall be loamy soil with an organic content between 1 and 10 percent according to AASHTO T 194. Topsoil shall be relatively free from large roots, sticks, weeds, brush, or stones larger than 1 inch in diameter. At least 90 percent of topsoil shall pass the No. 10 sieve according to AASHTO T 27, and the pH shall be between 5.0 and 8.0 according to ASTM D 4972. Topsoil shall meet all requirements of Illinois Department of Transportation Specification 1081.05 "Topsoil and Compost".

2.7 EROSION CONTROL MAT

Knitted straw mat shall be a machine-assembled blanket whose primary component is clean, weed-free straw from agricultural crops. Straw mat shall meet the requirements of Illinois Department of Transportation Specification 1081.10(b) "Knitted Straw Mat".

2.8 PIPE BEDDING MATERIAL

Pipeline bedding material shall be porous, free-flowing and free-draining granular sand. Imported bedding material shall have a gradation that meets the following requirements:

Sieve Size	Percent Passing
3/8 inch	100
No. 4	20-84
No. 16	0-10
No. 200	0-2

Native sand qualified for use as bedding material shall be classified as SM or SW in accordance with ASTM D2488, shall have a liquid limit less than 25 and a plasticity index less than 10, with a maximum particle size of ¾-inch. Native sand qualified for use as bedding material shall be sample, analyzed, and deemed acceptable for on-site use in accordance with Section 1.3.4 (d) Chemical Tests for Native Soil.

2.9 WARNING TAPE

Warning tape in utility trenches shall be a solid core foil tape that is detectable by both standard inductive or conductive underground utility detection techniques and equipment. Thickness shall be 6-mil minimum, with a 0.3-mil minimum thick foil core. Width shall be 3 inches minimum.

Color of tape shall be yellow and be printed with permanent black text “contaminated water pipeline”.

2.10 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

Shall be in accordance with Illinois Department of Transportation Standard Specification Section 1019 “Controlled Low-Strength Material.”

2.11 PERFORATED CORRUGATED PE DRAIN PIPE

Shall be in accordance with Illinois Department of Transportation Standard Specification Section 1040.04(a) “Perforated Corrugated PE Pipe”, for use as underdrain.

2.12 NONPERFORATED CORRUGATED PE DRAIN PIPE

Shall be in accordance with Illinois Department of Transportation Standard Specification Section 1040.04(a) “Corrugated PE Pipe,” for use as underdrain.

2.13 NONWOVEN GEOTEXTILE

Shall be in accordance with Illinois Department of Transportation Standard Specification Section 1080.05 “Geotechnical Fabric for French Drains” for nonwoven geotextiles.

2.14 DRAIN ROCK

Shall be in accordance with Illinois Department of Transportation Standard Specification Section 1004.01 “Coarse Aggregates.” Shall be angular material meeting CA 7 gradation requirements.

3. EXECUTION

3.1 SCHEDULE

Contractor shall schedule earthwork with other activities to maintain construction schedule.

3.2 PROTECTION

Contractor is responsible for maintaining completed work and environmental controls at all times, including during gaps in construction activity. Prevent stormwater run-on into disturbed areas that may be contaminated. Prevent stormwater runoff from disturbed areas that may be contaminated.

Maintain earthwork areas free of water at all times. Water may be allowed to infiltrate. Provide for the collection and disposal of surface water that does not infiltrate.
In areas where clean fill has been placed, grade the construction area to provide positive surface water runoff away from the construction activity or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils.

3.3 FOUNDATION LAYER PREPARATION

The foundation layer shall be prepared by grading and compacting existing material, excavated trench spoils that contain less than 50 ppb PCBs, and crushed concrete from Western Utility Corridor. Subgrade materials shall be spread evenly throughout the ODC area and compacted into the existing soil as needed to provide a stable base for the ODC cap. Trench spoils shall be dewatered as necessary to meet the required moisture/density. Compact subgrade material to 95 percent Modified Proctor density. Where cutting is necessary to attain the design grades, mechanically compact the final cut surface to attain 95 percent Modified Proctor density to a depth of 6 inches or more.

Where filling is necessary to attain design grades, back and grade in maximum 6-inch loose lifts and mechanically compact to 95 percent Modified Proctor density. Fine grade the foundation layer such that the surface is within 0.1 feet of the design grades shown on the Drawings.

A 6-inch layer of imported sand foundation soil shall be placed on top of the subgrade and compacted to 95 percent of Modified Proctor Density.

Entire foundation layer shall be inspect for the presence of rocks, concrete, or brick larger than 3 inches in diameter, sticks larger than 1 inch in diameter, debris, metal, or any other material that could puncture the overlying geosynthetic clay liner or geomembrane. Any such deleterious material shall be removed.

3.4 GEOSYNTHETIC CLAY LINER

Geosynthetic clay liner shall be installed according to all manufacturer's instructions.

3.4.2 Placement

A. Contractor shall deploy the geotextile carefully such that it and underlying materials are not damaged. All faulty or damaged geotextile shall be replaced or repaired.
B. The geotextile shall be unrolled downslope keeping the net in slight tension to minimize wrinkles and folds.
C. The geotextile shall be maintained free of dirt, mud, or any other foreign materials at all times during construction. Rolls which are contaminated with these material shall be cleaned or replaced by Contractor at no additional cost to Government.
D. Adequate loading (e.g. sandbags) shall be placed to prevent uplift by wind.
E. Adjacent rolls shall be overlapped a minimum of 12 inches or as directed by the manufacturer, whichever is greater, as a function of subgrade strength (CBR).
F. In the corners of side slopes, where overlaps between rolls of geotextile are staggered, an extra layer of geotextile shall be installed from the top to the bottom of the slope.

3.4.3 Repairs

Holes or tears in the GLC shall be removed and repaired in accordance with manufacturer's written instructions.

3.4.4 Penetrations

GCL penetration details shall be installed as recommended by the geotextile manufacturer and as approved by the Engineer.

3.5 GEOMEMBRANE INSTALLATION

3.5.1 Placement.

Assign each panel a simple and logical identifying code. The coding system shall be subject to approval and shall be determined at the job site. Visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas. Unroll geomembrane using methods that will not damage geomembrane and will protect underlying surface from damage (spreader bar, protected equipment bucket). Place ballast (commonly sandbags) on geomembrane which will not damage geomembrane to prevent wind uplift. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking shall not be permitted on the geomembrane. Do not allow heavy vehicular traffic directly on geomembrane. Rubber-tired ATV's and trucks are acceptable if wheel contact is less than 8 psi. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material.

3.5.2 Field Seaming.

LDPE seams shall be made by thermal fusion methods using techniques and equipment consistent with manufacturer's instructions. To the maximum extent possible, orient seams parallel to line of slope, i.e., down and not across slope. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners. Slope seams (panels) shall extend a minimum of five-feet beyond the grade break into the flat area.

Align seam overlaps consistent with the requirements of the welding equipment being used.

3.5.3 Trial Seams.

Trial seams shall be made under field conditions on strips of excess geomembrane. Trial seams shall be made each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment and at least once every four hours, by each seamer and each piece of seaming equipment used that day. Trial seam samples shall be collected and tested in accordance with ASTM D6392. One sample shall be obtained from each trial seam.

Ten random specimens 1 inch wide shall be cut from the sample. Five seam specimens shall be field tested for shear strength and 5 seam specimens shall be field tested for peel adhesion using an approved quantitative tensiometer. To be acceptable, 4 out of 5 replicate test specimens shall meet seam strength requirements specified below:

Property	Test Method	Minimum Value (pounds per inch)
Peel Strength (fusion)	ASTM D 6392	48
Peel Strength (extrusion)	ASTM D 6392	50
Shear Strength	ASTM D 6392	60

If the field tests fail to meet these requirements, the entire operation shall be repeated. If the additional trial seam fails, the seaming apparatus or seamer shall not be used until the deficiencies are corrected by the installer and 2 consecutive successful trial seams are achieved.

3.5.4 Ambient Conditions.

Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the installation or are not consistent with manufacturer's installation instructions.

3.5.5 Non-Destructive Field Seam Continuity Testing

Field seams shall be non-destructively tested for continuity over their full length after completion of entire geomembrane installation and immediately before geocomposite layer installation. Non-destructive testing shall be either:

a. Vacuum testing in accordance with ASTM D5641, or
b. Air Pressure Testing in accordance with ASTM D5820

Failed seams shall be reconstructed between the two passed test locations in accordance with manufacturer's instructions. Repaired failed seams shall be re-tested, and repaired if necessary, until passing.

3.5.6 Penetrations

Geomembrane penetration details shall be provided and installed as recommended by the geomembrane manufacturer. Factory fabricated boots shall be used wherever possible. Field seams for penetrations shall be non-destructively tested in accordance with the installer's approved QC manual. Seams that fail non-destructive testing shall be repaired in accordance with the installer's approved QC manual and non-destructively tested prior to acceptance.

3.5.7 Repair Procedures

Tears, holes, blisters and other defects shall be repaired with patches. Patches shall have rounded corners, be made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects or in accordance with manufacturer's instructions. Minor localized flaws shall be repaired by spot welding or seaming as determined by the QC officer and in accordance with manufacturer's instructions. All repairs shall be non-destructively tested and confirmed to be competent by the QC officer.

3.6 GEOCOMPOSITE DRAINAGE LAYER INSTALLATION

Geocomposite liner shall be installed in accordance with manufacturer's instructions at the locations shown on the drawings. Geocomposite layer installation shall commence within 2 days of geomembrane liner completion. Installation of geocomposite liner shall be conducted in a manner to not damage or puncture the geomembrane liner.

3.7 SAND FREEZE/THAW PROTECTION LAYER INSTALLATION

Cover soil shall not be dropped onto the geocomposite drainage layer from a height greater than 3 feet. The soil shall be pushed out over geocomposite layer in an upward tumbling motion. Soil shall be placed from the bottom of the slope upward. The initial loose soil lift thickness shall be 8 inches. Equipment with ground pressures less than 10 psi shall be used to place the first lift over the geocomposite. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

Sand freeze/thaw protection layer shall be compacted to 95 percent maximum dry density in accordance with ASTM D1557.

3.8 TOPSOIL INSTALLATION AND FINISHING

Place topsoil on top of the sand freeze/thaw protection layer. The surface of the topsoil shall be free from clods, stones, sticks, and debris, and shall be placed according to the grade lines and minimum thickness shown on the Drawings.

Grade smooth final surface of backfilled material and blend into surrounding grade. Repair or re-establish damaged grades, elevations, or slopes.

3.9 TRENCH EXCAVATION

Excavate trenches to the depths shown on drawings. Compact subgrade of utility trenches. Do not compact bottom of drainage trench around ODC perimeter.

3.10 MANAGEMENT OF EXCAVATED SPOILS

All spoils generated from earthwork activities shall be assumed to be contaminated until proven otherwise.

3.10.1 Storage of Spoils

Stockpile spoils in an area approved by the Engineer. Each stockpile shall be 100 cubic yards or smaller, and shall be assigned a unique label so that it can be tracked. All stockpiles shall be placed on plastic liners suitable for such use. Stockpiles shall be protected against wind and water erosion. Cover the stockpiles with properly secured waterproof fabric when not in use. Use dust suppression techniques (chemicals not allowed) to minimize wind erosion when stockpiles are not covered. Install diversion berms around stockpiles to prevent stormwater run-on.

3.10.2 Testing of Spoils

Produce one composite sample from each stockpile. The composite sample shall be produced as follows:

A. Collect one grab sample from every 100 cubic yards of material removed.
B. Thoroughly blend grab samples using hand tools and transfer the resulting composite sample into a sample jar. Fill the container to the brim and store it at 4 degrees Centigrade in a sample cooler or refrigerator. Label the container indicating stockpile ID, time and date of collection, and initials of person collecting the sample.
C. Ship the sample to an approved laboratory for analysis of chemicals/contaminants listed in Table 1. Submit results of chemical analysis within 24 hours.

3.10.3 Classification of Spoils

Stockpiles that are tested and found to comply with the Title 35 of the Illinois Administrative Code Part 742 “Tiered Approach to Corrective Action Objectives” (TACO) Tier 1 remediation objectives for residential properties and for soil migration to the groundwater ingestion exposure route for Class I groundwater may be used. All other stockpiles shall be characterized for waste disposal and disposed of at a licensed off-site facility in accordance with Section 02 81 00, Transportation and Disposal of Nonhazardous and Hazardous Materials.

3.10.4 Backfilling and Spreading of Clean Spoils

Excavated spoils that meet the standards listed above in Section 3.10.3 may be used as foundation layer material for the ODC cap.

Backfilling shall proceed by uniformly spreading the material in 8-inch loose lifts, then mechanically compacting the lift to 95 percent of maximum dry density according to ASTM D1557.

3.11 FIELD QUALITY CONTROL

3.11.1 Sampling

Collect the number and size of samples required to perform the specified tests of source materials.

3.11.2 Source Testing

Determine laboratory compaction characteristics and soil classification for each material used. Provide additional tests for every source change.

Sample all imported materials for the soil layers once per source. Collect samples according to laboratory instruction.

3.11.3 Field Density Tests

See following table. If a test location fails, the surrounding area shall be reworked up to at least half the distance to all nearby test locations that passed. Then, a new location within 10 feet of the previous test location shall be retested. Repeat until test location area passes.

Nuclear gauge results (ASTM D 2922 and D 3017) shall be compared with and calibrated to oven-dried water content (ASTM D 2216) and sand cone (ASTM D 1556) tests according to the larger of the frequencies of the oven-dried water content and sand cone tests.

FOUNDATION LAYER TESTING
REQUIREMENTS AND FREQUENCY

Test	ASTM Method	Frequency	Required Minimum Criteria
Density & Moisture	Nuclear gauge D2922 and D3017	One per 2,500 s.f.	See Layer Compaction Table
Density	Sand Cone D1556	One per 50,000 s.f. (minimum one per week)	See Layer Compaction Table
Moisture	Oven D2216 (with cor. to Nuclear gauge D2922)	One per 50,000 s.f. (minimum one per week)	Based on compaction curves
Compaction Curves	Mod. Proctor D1557	One per change in material	n/a
Identification of Soils	D 2487	One per change in material	n/a

LAYER COMPACTION

Fill Type	Maximum Loose Lift Thickness[1] (in.)	Moisture Content	Percentage of Maximum Dry Density	Method of Test
Subgrade soils	6	± 3% of optimum	95% min	ASTM D1557
Sand Foundation Layer	6	± 3% of optimum	95% min	ASTM D1557
Sand Freeze/Thaw Protection Layer	8	± 3% of optimum	95% min	ASTM D1557
Utility Trenches	6	± 3% of optimum	95% min	ASTM D1557

[1]Thinner lifts may be required to obtain adequate compaction.

End of Section 31 00 00

SECTION 31 11 00

CLEARING AND GRUBBING

1. GENERAL

1.1 REFERENCES

Not used.

1.2 DEFINITIONS

Not used.

1.3 SUBMITTALS

Not used.

1.4 DESCRIPTION OF WORK

Clear and grub vegetation within the cap construction footprint as shown on the drawings, as needed. Avoid tree cutting to the extent practicable.

1.5 RELATED WORK DESCRIBED ELSEWHERE

Not used.

1.6 PROJECT CONDITIONS

1.6.1 Trees, Vegetation to Remain

Vegetation outside clearing and grubbing areas indicated on the drawings shall remain. However, limbs overhanging the work areas may be trimmed as necessary for access and completion of the work. Trees in staging areas and temporary access roads shown on the drawings shall not be removed without written authorization by the Engineer. Temporary access roads shall be rerouted to preserve trees to the extent possible.

1.6.2 Prevent Damage to Improvements

Take all necessary measures to prevent damage to utilities and structures on site and on properties adjacent to the project. A high pressure gas main, storm sewer lines, a fragile water transmission main and a sanitary force main are present near the work area. Prevent damage to East and West Containment Cells to include the existing slurry walls and monitoring wells.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver materials to store at the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

1.8 MEASUREMENT AND PAYMENT

Payment for clearing and grubbing will be paid per acre as shown on the bid form 00 41 00.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 PROTECTION

3.1.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

3.1.2 Trees, Shrubs, and Existing Facilities

Trees and vegetation to be left standing shall be protected from damage incident to clearing and grubbing by the erection of barriers or other means as the circumstances require.

3.1.3 Utility Lines

Locate utilities and sediment conveyance systems before commencing clearing and grubbing operations. Protect existing utility and sediment conveyance system lines from damage. Notify the Engineer immediately of damage to or an encounter with an unknown existing utility line and sediment conveyance system. The Contractor shall be responsible for the repairs of damage to existing utility lines and sediment conveyance systems. When utility lines and sediment conveyance systems are encountered within the area of operations, notify the Engineer in ample time to minimize interruption of the service.

3.1.4 Endangered Species

3.1.4.1 Possible threatened or endangered species include:
Blanding's Turtle
Piping Plover
St. John's Wart
Beach Maram Grass

3.1.4.2 Confine all activities to areas defined by the drawings and specifications. Do not remove, destroy, injure or disturb endangered species. If endangered species are observed in work area, stop work and immediately notify Engineer. Engineer will mark areas of known

habitats of endangered species prior to commencement of site work. Additional areas will be marked by the Engineer as other habitats of endangered species become known during site activities.

3.2 SITE CLEARING

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber (trees, limbs, and branches), snags, brush, and debris occurring within the areas to be cleared. Trees, stumps, roots, brush, and other vegetation in areas to be cleared as delineated in the design drawings shall be cut off flush with or below the original ground surface. Trees and vegetation outside of the delineated clear and grub area shall be left standing. Trees outside the cleared area that may inhibit construction and remediation processes may be trimmed of dead branches 1-1/2 inches or more in diameter. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1-1/2 inches in diameter shall be painted with an approved tree-wound paint.

3.2.1 Removal of Trees, Stumps, and Vegetation

Where indicated or directed, trees, stumps that are designated as trees, and vegetation shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph 3.3 (GRUBBING). Trees, stumps, and vegetation shall be disposed of as specified in the paragraph 3.4 (DISPOSAL OF WASTE MATERIALS).

3.2.2 Debris Removal

Debris includes general garbage, tires, scrap metal, concrete, and other building material rubble. The work areas shall be cleared of all debris from staging areas and temporary access roads shown on the drawings. Contractor shall note all required debris removal during pre-bid site visit.

3.3 GRUBBING

Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas or as required to complete the work. Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be cleared and grubbed and in areas indicated as construction areas under this contract, such as the excavation footprint and areas for temporary facilities.

3.4 DISPOSAL OF WASTE MATERIALS

3.4.1 Timber and Other Vegetation

All timber and other vegetation on the project site noted for clearing and grubbing shall become the property of the Contractor, and shall be removed from the site and disposed of in compliance with all Federal, State, and local

regulations. Soil generated during grubbing will be sampled and characterized prior to disposal.

3.4.2 Concrete and Other Debris

All concrete and other debris including metal scrap, slag, and refuse shall be characterized and disposed of in accordance with Federal, State, and local regulations.

End of Section 31 11 00

SECTION 31 55 00
SOIL-BENTONITE CUT-OFF WALL, SLURRY WALL CONSTRUCTION

1. GENERAL

1.1 DESCRIPTION OF WORK

This specification is for construction of the cut-off wall using traditional bentonite slurry wall construction techniques.

A low-permeability soil-bentonite cutoff wall shall be constructed at the horizontal location shown on the drawings. The soil-bentonite cutoff wall shall be constructed to a depth of 3-feet below the top of the clay layer. The cutoff wall shall be essentially vertical with a minimum width of 27 inches.

1.2 REFERENCES

American Petroleum Institute (API)

API Spec 13A API Specification for Oil-Well Drilling-Fluid Materials

API RP13B API Recommended Procedure for Field Testing Drilling Fluids

ASTM International (ASTM)

ASTM C143 Standard Test Method for Slump of Hydraulic Cement Concrete

ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

ASTM D 5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

1.3 SUBMITTALS

1.3.1 SD-01, preconstruction submittals. The following preconstruction submittals shall be provided for approval at least 30 days before construction.

A. Contractor Qualifications. The contractor shall have a minimum of five years of experience successfully installing soil bentonite cutoff walls. The Contractor shall provide a list of 3 similar completed soil-bentonite cutoff wall projects with contact information for references.
B. Personnel Qualifications. The Contractor shall provide resumes demonstrating experience on 3 similar soil-bentonite cutoff wall projects for the construction manager, construction quality control officer, and site superintendent.

C. Construction Work Plan. The Contractor shall provide a work plan describing the sequencing of work necessary to construct the soil-bentonite cutoff wall. The work plan shall contain the following elements, at a minimum:

1. List of major equipment to be used.
2. Site layout showing locations of equipment, slurry mixing areas, soil-bentonite backfill mixing areas, access and haul roads, field office trailers, and excavated spoils containment areas
3. Procedures for bentonite slurry mixing, pumping and recirculation
4. Sequence and schedule for any shoring/existing utility protection, temporary work surfaces, haul roads
5. Procedures for trench excavation, slurry placement, backfill mixing, and backfill placement

D. Soil-Bentonite Backfill Mix Design. Include test results demonstrating compliance with specifications.

E. Existing Utility Protection Plan. Prior to construction, the Contractor shall provide a utility protection plan that will detail the materials, equipment, and construction methods to be used to ensure that construction of the soil-bentonite cutoff wall will not undermine, damage, or reduce the structural integrity of any existing on-site or off-site utilities and railroad tracks. These existing utilities include, but are not limited to, the storm drain located on the northwest corner of the ODC cell, the sanitary sewer line adjacent to the western side of the ODC cell, the gas line along the southern and western sides of the ODC cell, the sanitary sewer force main manhole, the slurry wall containment cell north of the ODC cell, the 24-inch water transmission line in Seahorse Drive, the railroad tracks along the western edge of the site, monitoring wells, piezometers, and fences along the western and southern portions of the site.

The existing utility protection plan shall be prepared and sealed by an Illinois-licensed geotechnical engineer experienced in cutoff wall construction.

F. Excavated Soil Stockpile Plan. Contractor shall prepare design of lined, secondarily-contained potentially-contaminated soil staging areas.

G. Field Sampling Plan. Contractor shall prepare a field sampling plan to describe the soil characterization sampling and import material sampling for chemical analysis. In addition, the plan should include the water sampling for waste characterization or pre-treatment system characterization. The plan must include sample collection, handling, and analytical methods at a minimum.

1.3.2 SD-03 Product Data.

A. Bentonite
B. Soil(s) for soil-bentonite backfill, including: (1) gradation curves (ASTM D422), (2) soil classification ASTM D2487, and (3) chemical tests for each soil source

C. Slurry admixtures
D. Soil bentonite admixtures, including chemical and permeability test results

1.3.3 SD-06 Field Test Reports

A. Clay layer key confirmation sample, every 20 linear feet, i.e. for STA 0+00, STA 0+20 through end of cutoff wall
B. Top of clay layer elevation, every 20 linear feet, i.e. for STA 0+00, STA 0+20 through end of cutoff wall
C. Bottom of trench elevation, every 20 linear feet, i.e. for STA 0+00, STA 0+20 through end of cutoff wall
D. Daily trench profiles
E. Excavated Spoils Laboratory Reports for PCBs and TCLP VOCs
F. Permeability test laboratory reports.
G. Chemical analytical test results for imported soil for backfill

1.3.4 SD-11 Closeout Report. Provide Record Drawings, including all native CAD files, of cutoff wall, showing horizontal extent of wall, including locations of any lead-in/lead-out trenches, elevation of top of cutoff wall and actual depth of cutoff wall. Record Drawings shall be sealed by an Illinois-registered Professional Engineer

1.4 GEOTECHNICAL SITE CONDITIONS

1.4.1 Exploratory Borings

Some subsurface exploratory borings have been obtained by EPA to determine the character of materials to be excavated. Locations of the borings are shown on the drawings and the logs of those borings, which fall within the area of this contract, are included in on the Drawings for the convenience of the Contractor. Additional geotechnical data from the site is included in the attachment at the end of this section.

EPA assumes no responsibility for interpretation or deductions made from the logs and borings. Local minor variations may exist in the subsurface materials between boring locations and, if encountered, will not be considered as being materially different within the purview of this contract. Soils classifications shown on the logs are the result of field visual classifications classifications] in accordance with the Unified Soil Classification System.

Contractor may conduct additional soil borings and laboratory analyses as needed prior to construction.

2. PRODUCTS

2.1 BENTONITE

Bentonite used in slurry and soil-bentonite backfill shall meet the requirements of API Spec 13A.

2.2 SOIL-BENTONITE BACKFILL

Prior to construction, the Contractor shall provide a mix design detailing the relative amounts of bentonite, water, fines, sands, and any other materials that will be used for the soil-bentonite backfill that will comprise the cutoff wall. If any admixtures, other than soil, water, or bentonite, are to be used in the soil-bentonite backfill, the Contractor shall provide MSDS sheets or analytical laboratory reports for all admixtures demonstrating that no CERCLA-listed chemicals will be used.

Soil from the OMC site, including excavated trench spoils, shall not be used in the preparation of the soil-bentonite backfill unless sampled and analyzed in accordance with Section 3.2 of this specification. Excavated trench spoils containing less than 1ppm PCBs and less than 0.005 mg/L TCLP TCE can be used in soil-bentonite backfill for the slurry wall.

The soil-bentonite mix design shall include the sources of each material to be used. The Contractor shall prepare a minimum of three representative samples of the proposed soil-bentonite backfill, using representative samples from the actual borrow source. If borrow sources change, new tests of three representative sample shall be conducted. These samples shall be tested and demonstrated to have permeability less than $1x10^{-7}$ cm/sec according to ASTM D 5084.

All soil-backfill prepared and emplaced in the cutoff wall shall have a permeability less than $1x10^{-7}$ cm/sec according to ASTM D 5084.

2.3 OFFSITE SOIL USED IN SOIL-BENTONITE BACKFILL

Offsite soils used in soil-bentonite backfill shall consist of sand, silt, or clay from an off-site borrow source. Soil shall be excavated from a site with no history of environmental contamination. Soil shall be free of debris, roots, wood, scrap metal, slag, vegetation, refuse, and any other deleterious or objectionable materials.

2.3.1 Chemical Analytical Tests for Imported Soil

Provide to Engineer the analytical results of two samples for each source of imported material before bringing imported material onsite. Analyses shall include the following:

A. Volatile organic compounds (VOC) by USEPA SW-846 Methods 5035 and 8260B
B. Semivolatile organic compounds (SVOC) by USEPA SW-846 Method 8270C
C. Total priority pollutant (TPP) metals by USEPA SW-846 Methods 6010B/6020, 7060A/7061A/7062, 7421, 7470A/7471A 7740A/7741A/7742, 7841, 9012A as applicable
D. Polychlorinated biphenyls (PCB) by USEPA SW-846 Method 8082
E. Pesticides by USEPA SW-846 Method 8081A
F. Herbicides by USEPA SW-846 Method 8321A

All chemical constituents shall meet the Title 35 of the Illinois Administrative Code Part 742 “Tiered Approach to Corrective Action Objectives” (TACO) Tier 1 remediation objectives for residential properties and for soil migration to the groundwater ingestion exposure route for Class I groundwater.

2.4 WATER

Water used for preparation of slurry and soil-bentonite backfill, dust control, and soil moisture adjustments shall be potable water. No site groundwater shall be used. Potable water may be obtained from the existing building on the central portion of the site. Metering of the water may be required.

2.5 ADMIXTURES

Any chemical admixtures used in either the trench slurry or in the soil-bentonite backfill must be submitted for review with the manufacturer's safety data sheet (MSDS) and approved by the contracting officer before being used.

Provide to Engineer the analytical results of two samples for each admixture per source before bringing admixture material onsite. Analyses shall include the following:

A. Volatile organic compounds (VOC) by USEPA SW-846 Methods 5035 and 8260B
B. Semivolatile organic compounds (SVOC) by USEPA SW-846 Method 8270C
C. Total priority pollutant (TPP) metals by USEPA SW-846 Methods 6010B/6020, 7060A/7061A/7062, 7421, 7470A/7471A 7740A/7741A/7742, 7841, 9012A as applicable
D. Polychlorinated biphenyls (PCB) by USEPA SW-846 Method 8082
E. Pesticides by USEPA SW-846 Method 8081A
F. Herbicides by USEPA SW-846 Method 8321A

All chemical constituents shall meet the TACO Tier 1 remediation objectives for residential properties and for soil migration to the groundwater ingestion exposure route for Class I groundwater.

3. EXECUTION

3.1 CUT-OFF WALL DIMENSIONS

The cut-off wall shall be constructed to the lines and cross-sections shown on the Drawings.

Depths shown on the Drawings are approximate. Actual depths of cut-off wall shall be determined as follows: At 20 linear foot intervals, Contractor shall field-verify the elevation of the top of the clay layer by retrieving soil sample from the bottom of the trench using a drive tube sampler, collecting a sample from the excavated bucket, or other approved method. The soil sample shall be field classified by a Contractor-provided geologist in accordance with ASTM D2488. The bottom of the cut-off wall shall be constructed to a depth of 3 feet below the field verified depth of the top of the clay layer.

3.2 EXCAVATION

Excavation of the trench shall not precede the toe of the soil-bentonite backfill slope by less than 30 feet or more than 100 feet.

If the trench excavation overlaps into previously emplaced soil-bentonite backfill, the excavation shall extend fully to the original trench bottom.

All excavated trench spoils shall be stockpiled within the perimeter of the ODC area for soil characterization. If additional area is required, Contractor may prepare lined and covered stockpiles for temporary staging outside the ODC perimeter.

Excavated spoils from STA 0+00 to 2+75 and STA 9+00 to STA 20+20 shall be screened for PCB or TCE contamination by visual inspection for staining, odors, or elevated PID readings (> 10 ppmv). Soils exhibiting no staining, odors, or elevated PID readings shall be placed within the perimeter of the ODC area and used as foundation fill for the ODC cap or be sampled and analyzed and used for soil-bentonite backfill as applicable. Excavated spoils with field indications of PCB or TCE contamination based on odor, visual staining, or PID readings shall be stockpiled for sampling and analysis for waste characterization for PCBs and VOCs TCLP.

Excavated spoils from STA 2+75 to STA 9+00 shall be stockpiled for sampling and analysis for waste characterization for PCBs and TCE TCLP. Stockpiles for waste characterization must be placed on plastic and covered with same. Stockpiles must be constructed with berms to control runoff and run on.

Excavated spoils that contain less than 50 mg/kg PCBs (USEPA SW-846 Method 8082) or exceed RCRA hazardous waste characteristics based on TCLP VOC (USEPA SW-846 Methods 5035 and 8260B) test results shall be disposed of off site in accordance with Section 02 81 00 "Transportation and Disposal of Nonhazardous and Hazardous Materials".

Excavated spoils that contain PCBs and VOCs below these threshold concentrations shall be stockpiled within the ODC area and may be used as ODC cap foundation fill.

Excavated spoils that contain less than 1 mg/kg PCBs and TCLP TCE concentrations less than 0.005 mg/L may be used as soil-bentonite backfill.

3.3 IN-TRENCH SLURRY

Introduce slurry into the trench at the time excavation begins. The level of the slurry in open trenches shall be maintained a minimum of 2 feet below the top of the working surface until the placement of soil-bentonite backfill is complete. Conditioning of the slurry may require recirculation through a shaker screen or the addition of approved additives. Provide sufficient personnel, equipment, slurry storage areas, and prepared slurry materials ready to raise the slurry level at any time in the excavated trench, weekends and holidays included.

3.3.1 Slurry Testing

The bentonite slurry in the trench shall be sampled a minimum of 2 times each day (near the beginning and end of day).

SLURRY QUALITY CONTROL TESTING

Test Parameter	Test Method	Specification	Frequency
Unit weight or mud balance	API Std 13B	1.1 to 1.36 gm/cm^3	Twice per shift
Viscosity	API Code RP13B Marsh Funnel	>40 seconds @68°F	Twice per shift
Slurry elevation	Measuring tape from top of trench	Within 2 feet of top of trench	At the end and beginning of each work day; hourly during construction

In-trench slurry that does not meet these requirements shall be modified as necessary and re-tested until it meeting these requirements.

3.4 TRENCH STABILITY

The Contractor is responsible for ensuring and maintaining the stability of the excavated trench at all times, for its full length and depth, and for maintaining slurry densities and levels within specified limits. Control surcharges from all excavation and backfilling equipment, waste, berm construction, backfill stockpiles, and any other loading situations that may affect trench stability. It is the Contractor's sole responsibility to ensure that the mixing of soil-bentonite backfill and any stockpiles do not affect the open trench stability. In the event of failure of the trench walls prior to completion of backfilling, re-excavate the trench, remove all material displaced into the trench, and take corrective action to prevent further deterioration, at the Contractor's expense.

Contractor shall also comply with all recommendations and requirements of the Existing Utility Protection Plan throughout construction. Damage to existing utilities shall be reported immediately to utility owner and Engineer and repaired at Contractor’s expense.

3.5 TRENCH BOTTOM MAINTENANCE

At a minimum, unless otherwise approved, the trench bottom shall be cleaned at the start of day shift. The trench bottom shall be probed for any deposits or sloughed materials prior to cleaning. The trench bottom shall be cleaned by using an excavator bucket, air lift pump or other approved equipment to ensure removal of sand, gravel, sediment, and other material left in the trench during excavation or which has settled out of the slurry. Cleaning equipment shall not remove material from the walls of the trench. After the trench bottom has been cleaned, sample the trench bottom with a sampler approved by the Engineer. After examining the samples, the Engineer will either approve the excavation at the points checked or require additional cleaning. If additional cleaning is required, then additional post-cleaning samples shall be furnished as specified above.

3.6 SOIL-BENTONITE BACKFILL MIXING AND PLACEMENT

3.6.1 Soil-Bentonite Backfill Mixing and Testing

The soil-bentonite backfill shall be thoroughly mixed via disking, harrowing, bulldozing, blading, or other approved methods into a homogeneous mass, free from large lumps or clods of soil or pockets of fines, sand, or gravel. Occasional lumps of up to 3 inches in their largest dimension will be permitted. All particles shall be coated with slurry. The soil-bentonite backfill may be sluiced with slurry during the mixing operations. Sluicing with water is not permitted. The soil-bentonite backfill shall be mixed in locations consistent with the Construction Work Plan. Excess slurry may be allowed to flow back into the trench.

Mixed soil-bentonite backfill shall be sampled and analyzed in accordance with the following table:

SOIL-BENTONITE BACKFILL QUALITY CONTROL TESTING

Test Parameter	Test Method	Specification	Frequency
Backfill slump	Slump via ASTM C143	3 to 6 inches	Twice per shift
Backfill unit weight	API Std 13B	$\geq$ 15 lb/ft^3 greater than slurry	Twice per shift
Backfill permeability	Permeability via ASTM D 5084	$\leq 1 \times 10^{-7}$ cm/sec.	One sample per 400 cubic yards

Soil-bentonite backfill that does not meet the criteria shall not be placed. Emplaced soil-bentonite backfill that fails to meet the permeability requirement shall be excavated and replaced with new, compliant soil-bentonite backfill at Contractor's expense.

3.6.2 Soil-Bentonite Backfill Placement

Soil-bentonite backfill placement operations shall proceed in such a manner that the slope of the initially placed soil-bentonite backfill is maintained. Free dropping of soil-bentonite backfill through the slurry is not permitted. The soil-bentonite backfill shall be placed so that it will slide down the forward face of the soil-bentonite backfill slope. The soil-bentonite backfill shall be placed in the excavated trench so that no pockets of slurry are trapped and that a constant slope is maintained. Placement shall be continuous from the beginning of the trench in the direction of the excavation to the end of the trench.

3.6.3 Soil-Bentonite Mixing and Placing During Cold Weather

No mixing or placing of the soil-bentonite backfill shall be performed when the air temperature is below 20 degrees F. Frozen soil-bentonite backfill shall not be placed in the trench and backfill material containing frozen lumps shall not be used to mix soil-bentonite backfill.

3.6.4 Emplaced Soil-Bentonite Backfill Testing

Additional samples for permeability testing shall be collected every 500 linear feet of wall. Samples shall be collected from between 3 and 5 feet bgs. Samples shall be tested for permeability according to ASTM D5084.

3.7 SOUNDINGS

Take excavation and soil-bentonite backfill soundings every 20 feet along the trench centerline using a weighted tape, cable, surveyor's rod, or other approved device. Submit a record of soundings and measurements taken during construction of the slurry trench. Soundings shall be measured to the nearest 0.1 ft. The soundings shall measure the following:

A. Elevation of Top of Confining Stratum
B. The top of the confining stratum shall be determined based on examination of samples taken as described under Section 3.1. This elevation shall be subject to approval.
C. Elevation of Trench Bottom Prior to Backfilling. Determine the elevation of the trench bottom after the trench has been cleaned and approved as described under paragraph Trench

Cleaning. This sounding shall not precede the toe of the soil-bentonite backfill slope more than 30 feet. This elevation is subject to approval by the Contracting Officer.

D. Profile of soil-bentonite backfill slope and trench bottom. The soil-bentonite backfill slope and trench bottom shall be sounded at the beginning and end of each shift at intervals of 20 feet.

3.8 AS-BUILT CUT-OFF WALL PROFILE

An as-built profile of the trench bottom and soil-bentonite backfill slopes, including descriptions of materials encountered in the trench bottom, shall be continuously maintained. This profile shall indicate extent of excavation and the soil-bentonite backfill profile at the end of each work day. The soil-bentonite backfill batch numbers shall appear on the profile with the limits of each batch of material delineated as placed. Submit a scale drawing providing a log of the subsurface materials excavated from the trench, and a profile of the completed slurry trench.

3.9 CLEAN-UP

Excavation spoils that meet the PCB and TCLP TCE criteria for on-site use and unused soil-bentonite backfill shall be spread evenly throughout the ODC cap area and used for ODC cap fill material. Excess slurry shall be disposed of off-site.

End of Section 31 55 00

SECTION 31 55 01
SOIL-BENTONITE CUT-OFF WALL, TRENCHLESS CONSTRUCTION

1. GENERAL

1.1 DESCRIPTION OF WORK

This specification is for construction of the cut-off wall using continuous trenching construction techniques and shall only be applicable if the cut-off is not constructed by conventional slurry wall construction techniques.

A low-permeability soil-bentonite cutoff wall shall be constructed at the horizontal location shown on the drawings. The soil-bentonite cutoff wall shall be constructed to a depth of 5 feet below the top of the clay layer as determined by soil borings. The cutoff wall shall be essentially vertical with a minimum width of 27 inches.

1.2 REFERENCES

American Petroleum Institute (API)

API Spec 13A API Specification for Oil-Well Drilling-Fluid Materials

API RP13B API Recommended Procedure for Field Testing Drilling Fluids

ASTM International (ASTM)

ASTM C143 Standard Test Method for Slump of Hydraulic Cement Concrete

ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

ASTM D 5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

1.3 SUBMITTALS

1.3.1 SD-01, preconstruction submittals. The following preconstruction submittals shall be provided for approval at least 30 days before construction.

A. Contractor Qualifications. The Contractor shall provide a list of 3 similar completed soil-bentonite cutoff wall projects with contact information for references.
B. Personnel Qualifications. The Contractor shall provide resumes demonstrating experience on 3 similar soil-bentonite cutoff wall projects for the construction manager, construction quality control officer, and site superintendent.

C. Construction Work Plan. The Contractor shall provide a work plan describing the sequencing of work necessary to construct the soil-bentonite cutoff wall. The work plan shall contain the following elements, at a minimum:

1. List of major equipment to be used.
2. Site layout showing locations of equipment, slurry mixing areas, soil-bentonite backfill mixing areas, access and haul roads, field office trailers, and excavated spoils containment areas
3. Procedures for bentonite slurry mixing, pumping and recirculation
4. Sequence and schedule for any shoring/existing utility protection, temporary work surfaces, haul roads
5. Procedures for trench excavation, slurry placement, backfill mixing, and backfill placement

D. Soil-Bentonite Backfill Mix Design. Include test results demonstrating compliance with specifications.

E. Existing Utility Protection Plan. Prior to construction, the Contractor shall provide an existing utility protection plan that will detail the materials, equipment, and construction methods to be used to ensure that construction of the soil-bentonite cutoff wall will not undermine, damage, or reduce the structural integrity of any existing utilities and railroad tracks, both on-site and off-site. These existing utilities include, but are not limited to, the 51-inch storm drain located on the northwest corner of the ODC cell, the sanitary sewer line adjacent to the western side of the ODC cell, the gas line along the southern and western sides of the ODC cell, the sanitary sewer force main manhole, the slurry wall containment cell north of the ODC cell, the 24-inch water transmission line in Seahorse Drive, the railroad tracks along the western edge of the site, and fences along the western and southern portions of the site.

The existing utility protection plan shall be prepared and sealed by an Illinois-licensed geotechnical engineer experienced in cutoff wall construction.

F. Excavated Soil Stockpile Plan. If deemed necessary, Contractor shall prepare design of lined, secondarily-contained potentially-contaminated soil staging areas.

G. Cut-off Wall Profile. Updated Drawings C-5 and C-6, showing top of clay layer (based on previous soil borings and new preconstruction borings).

H. Field Sampling Plan. Contractor shall prepare a field sampling plan to describe the soil characterization sampling and import material sampling for chemical analysis. In addition, the plan should include the water sampling for waste characterization or pre-treatment system characterization. The plan must include sample collection, handling, and analytical methods at a minimum.

1.3.2 SD-03 Product Data

A. Bentonite
B. Soil(s) for soil-bentonite backfill, including: (1) gradation curves (ASTM D422), (2) soil classification ASTM D2487, and (3) chemical tests for each soil source
C. Slurry admixtures
D. Soil bentonite admixtures, including chemical test results

1.3.3 SD-06 Field Test Reports

A. Exploratory Borings
B. Daily trench profiles
C. Excavated Spoils Laboratory Reports for PCBs and TCLP VOCs.

1.3.4 SD-11 Closeout Report.

A. Provide Record Drawings, including all native CAD files, of cutoff wall, showing horizontal extent of wall, including locations of any lead-in/lead-out trenches, and actual depth of cutoff wall.
B. Record Drawings shall be sealed by an Illinois-registered Professional Engineer

1.4 GEOTECHNICAL SITE CONDITIONS

1.4.1 Existing Exploratory Borings

Some subsurface exploratory borings have been obtained by EPA to determine the character of materials to be excavated. Locations of the borings are shown on the drawings and the logs of those borings, which fall within the area of this contract, are included in on the Drawings for the convenience of the Contractor. Additional geotechnical data from the site is included in the attachment at the end of this section.

EPA assumes no responsibility for interpretation or deductions made from the logs and borings. Local minor variations may exist in the subsurface materials between boring locations and, if encountered, will not be considered as being materially different within the purview of this contract. Soils classifications shown on the logs are the result of field visual classifications classifications] in accordance with the Unified Soil Classification System.

Contractor shall conduct additional soil borings and laboratory analyses prior to construction in accordance with Sections 2.2 and 3.1 of this section.

1.5 MEASUREMENT AND PAYMENT

Payment for soil-bentonite cutoff wall installation will be paid per square foot as shown on the bid form 00 41 00.

2. PRODUCTS

2.1 BENTONITE

Bentonite used in slurry and soil-bentonite backfill shall meet the requirements of API Spec 13A.

2.2 SOIL-BENTONITE BACKFILL

Prior to construction, the Contractor shall provide a mix design detailing the relative amounts of bentonite, water, fines, on-soil soil, off-site soils, and any other materials that will be used for the soil-bentonite backfill that will comprise the cutoff wall.

If any admixtures, other than soil, water, or bentonite, are to be used in the soil-bentonite backfill, the Contractor shall provide MSDS sheets or analytical laboratory reports for all admixtures demonstrating that no CERCLA-listed chemicals will be used.

The soil-bentonite mix design shall include the source locations of each material to be used. The Contractor shall prepare a minimum of three representative samples of the proposed soil-bentonite backfill. These samples shall be tested and each shall have a permeability less than $1x10^{-7}$ cm/sec according to ASTM D 5084.

All soil-backfill prepared and emplaced in the cutoff wall shall have a permeability less than $1x10^{-7}$ cm/sec according to ASTM D 5084.

2.3 IMPORTED SOIL USED IN SOIL-BENTONITE BACKFILL

If soil from an off-site borrow source is used in soil-bentonite backfill, it shall consist of sand, silt, or clay. Soil shall be excavated from a site with no history of environmental contamination. Soil shall be free of debris, roots, wood, scrap metal, slag, vegetation, refuse, and any other deleterious or objectionable materials.

2.3.1 Chemical Analytical Tests for Imported Soil

Provide to Engineer the analytical results of two samples for each source of imported material before bringing imported material onsite. Analyses shall include the following:

A. Volatile organic compounds (VOC) by USEPA SW-846 Methods 5035 and 8260B
B. Semivolatile organic compounds (SVOC) by USEPA SW-846 Method 8270C
C. Total priority pollutant (TPP) metals by USEPA SW-846 Methods 6010B/6020, 7060A/7061A/7062, 7421, 7470A/7471A 7740A/7741A/7742, 7841, 9012A as applicable
D. Polychlorinated biphenyls (PCB) by USEPA SW-846 Method 8082
E. Pesticides by USEPA SW-846 Method 8081A
F. Herbicides by USEPA SW-846 Method 8321A

All chemical constituents shall meet the Title 35 of the Illinois Administrative Code Part 742 “Tiered Approach to Corrective Action Objectives” (TACO) Tier 1 remediation objectives for residential properties and for soil migration to the groundwater ingestion exposure route for Class I groundwater.

2.4 WATER

Water used for preparation of slurry and soil-bentonite backfill, dust control, and soil moisture adjustments shall be potable water. No site groundwater shall be used.

2.5 ADMIXTURES

Any chemical admixtures used in either the trench slurry or in the soil-bentonite backfill must be submitted for review with the manufacturer's safety data sheet (MSDS) and approved by the contracting officer before being used.

Provide to Engineer the analytical results of two samples for each admixture per source before bringing admixture material onsite. Analyses shall include the following:

A. Volatile organic compounds (VOC) by USEPA SW-846 Methods 5035 and 8260B
B. Semivolatile organic compounds (SVOC) by USEPA SW-846 Method 8270C
C. Total priority pollutant (TPP) metals by USEPA SW-846 Methods 6010B/6020, 7060A/7061A/7062, 7421, 7470A/7471A 7740A/7741A/7742, 7841, 9012A as applicable
D. Polychlorinated biphenyls (PCB) by USEPA SW-846 Method 8082
E. Pesticides by USEPA SW-846 Method 8081A
F. Herbicides by USEPA SW-846 Method 8321A

All chemical constituents shall meet the TACO Tier 1 remediation objectives for residential properties and for soil migration to the groundwater ingestion exposure route for Class I groundwater.

3. EXECUTION

3.1 CUT-OFF WALL DIMENSIONS

The cut-off wall shall be constructed to the lines and cross-sections shown on the Drawings.

Depths shown on the Drawings are approximate. Actual depths of cut-off wall shall be determined as follows: Prior to construction, Contractor shall advance soil borings at approximately100-linear foot intervals, except between STA 3+00 and 9+00 (STA 0+00, 1+00, 2+10, 3+00, 9+00, 9+90,11+00, 11+80, 13+00, 14+28, 15+00, 16+00, 17+00, 18+00 and 19+00). Contractor shall field-verify the elevation of the top of the clay layer. The soil sample shall be field classified by a Contractor-provided geologist in accordance with ASTM D2488. The bottom of the cut-off wall shall be constructed to a depth of 5 feet below the field verified depth of the top of the clay layer. Using these soil borings and previous soil borings shown on Drawings C-5 and C-6, Contractor shall submit an updated cut-off wall profile for approval.

3.2 EXCAVATION

Excavation of site soil and mixing/emplacement of soil-bentonite backfill shall be conducted using a single-pass trenching machine.

3.3 CUT-OFF WALL STABILITY

The Contractor is responsible for ensuring and maintaining the stability of the excavated trench at all times, for its full length and depth, and for soil-bentonite backfill and levels within specified limits. Control surcharges from all excavation and backfilling equipment, waste, berm construction, backfill stockpiles, and any other loading situations that may affect trench stability.

It is the Contractor's sole responsibility to ensure that the mixing of soil-bentonite backfill and any stockpiles do not affect the open trench stability. In the event of failure of the trench walls prior to completion of backfilling, re-excavate the trench, remove all material displaced into the trench, and take corrective action to prevent further deterioration, at the Contractor's expense.

Contractor shall also comply with all recommendations and requirements of the Existing Utility Protection Plan throughout construction. Damage to existing utilities shall be reported immediately to utility owner and Engineer and repaired at Contractor’s expense.

3.4 SOIL-BENTONITE BACKFILL MIXING AND PLACEMENT

3.4.1 Soil-Bentonite Backfill Mixing and Testing

The soil-bentonite backfill shall be thoroughly mixed in-situ with the continuous trenching equipment. Soil-bentonite backfill shall be free from large lumps or clods of soil or pockets of fines, sand, or gravel. Occasional lumps of up to 3 inches in their largest dimension will be permitted. All particles shall be coated with slurry.

Mixed soil-bentonite backfill shall be sampled and analyzed in accordance with the following table:

SOIL-BENTONITE BACKFILL QUALITY CONTROL TESTING

Test Parameter	Test Method	Specification	Frequency
Backfill slump	Slump via ASTM C143	4 to 7 inches	75 Linear Feet
Backfill unit weight	ASTM C138	For File	75 Linear Feet
Backfill permeability	Permeability via ASTM D 5084	$\leq 1 \times 10^{-7}$ cm/sec.	One sample per 150 Linear Feet

Soil-bentonite backfill that does not meet the criteria shall not be placed. Emplaced soil-bentonite backfill that fails to meet the permeability requirement shall be re-mixed until it meets the above-listed requirements at Contractor’s expense.

3.4.2 Soil-Bentonite Backfill Placement

Soil-bentonite backfill mixing and placement operations shall proceed in such a manner that results in a monolithic soil-bentonite panel of low permeability that will retard the migration of contaminated groundwater within the barrier.

3.4.3 Soil-Bentonite Mixing and Placing During Cold Weather

No mixing or placing of the soil-bentonite backfill shall be performed when the air temperature is below 20 degrees F. Frozen soil-bentonite backfill shall not be placed in the trench and backfill material containing frozen lumps shall not be used to mix soil-bentonite backfill.

3.4.4 Emplaced Soil-Bentonite Backfill Testing

Additional samples for permeability testing shall be collected every 500 linear feet of wall. At every 500 feet, two samples shall be collected, one from between 3 and 5 feet bgs and one from 21 to 24 feet bgs. Samples shall be tested for permeability according to ASTM D5084.

3.5 AS-BUILT CUT-OFF WALL PROFILE

An as-built profile of the trench bottom shall be continuously maintained. This profile shall indicate extent of excavation and the soil-bentonite backfill profile at the end of each work day. Submit a scale drawing providing a profile of the completed slurry trench.

3.6 CLEAN-UP

Any excess excavation spoils or bentonite that meet the PCB and TCLP TCE criteria for on-site use and unused soil-bentonite backfill shall be spread evenly throughout the ODC cap area. Excess slurry (if applicable) shall disposed of off-site.

End of Section 31 55 01

STAT Analysis Corporation
2242 West Harrison St., Suite 200, Chicago, IL 60612-3766
Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com
Accreditation Numbers: IEPA ELAP 100445; ORELAP IL300001; AIHA 101160; NVLAP LabCode 101202-

Date Reported: January 13, 2014
Date Printed: January 13, 2014

Client: Tetra Tech EM Inc.
Lab Order: 13120652
Project: 103G1852181.04, OMC, Waukegan, IL
Lab ID: 13120652-001

Client Sample ID: OU4-ODC-S-SB7-5
Collection Date: 12/11/2013 9:15:00 AM
Matrix: Soil

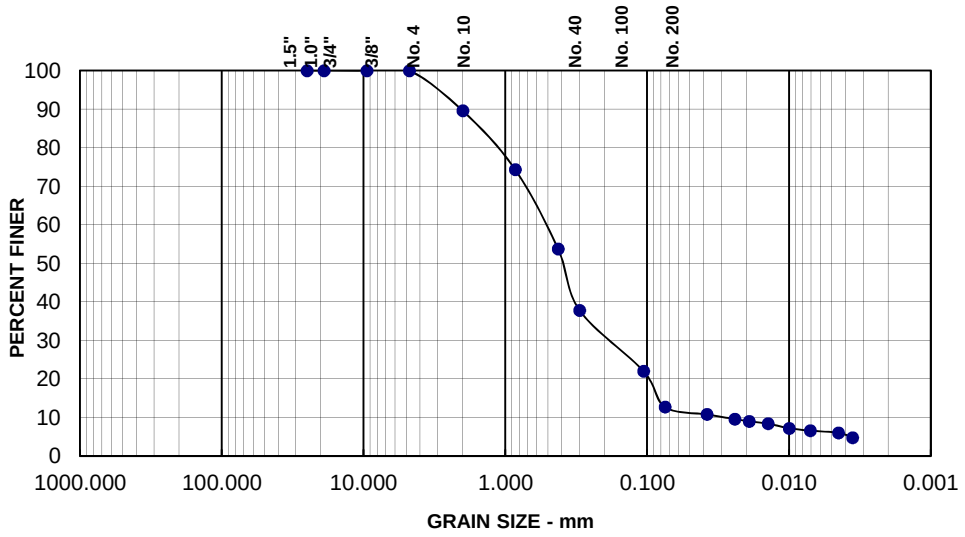
Analyses	Result	RL	Qualifier	Units	Date Analyzed
Atterberg Limits	**D4318**				Analyst: **SUB**
LL	28		*		1/10/2014
PI	8		*		1/10/2014
PL	20		*		1/10/2014
USCS Classification	**D2487**				Analyst: **SUB**
USCS Classification	SC		*		1/10/2014
Grain Size	**D422**				Analyst: **SUB**
Clay	6.5		*	%	1/10/2014
Gravel	0.1		*	%	1/10/2014
Sand	87.2		*	%	1/10/2014
Silt	6.2		*	%	1/10/2014

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

GRAIN SIZE ANALYSIS (ASTM D422)

SAMPLE ID: OU4-ODC-S-SB7 5



% + 3"	% Gravel	% Sand	% Silt	% Clay
0.0	0.1	87.2	6.2	6.5

Sieve Size	Percent Passing
1"	100.0
3/4"	100.0
3/8"	100.0
#4	99.9
#10	89.6
#20	74.3
#40	53.7
#60	37.8
#140	22.0
#200	12.7

D60 (mm)	**D30** (mm)	**D10** (mm)	**Cu**	**Cc**
0.5	0.17	0.0300	16.70	1.93

Visual Soil Description:	Gray coarse to fine sand, little fines, trace fine gravel, moist
Soil Classification:	SC
System:	USCS

STAT Analysis Corporation
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Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com
Accreditation Numbers: IEPA ELAP 100445; ORELAP IL300001; AIHA 101160; NVLAP LabCode 101202-

Date Reported: January 13, 2014
Date Printed: January 13, 2014

Client: Tetra Tech EM Inc.
Lab Order: 13120652
Project: 103G1852181.04, OMC, Waukegan, IL
Lab ID: 13120652-002

Client Sample ID: OU4-ODC-S-SB7-10
Collection Date: 12/11/2013 9:20:00 AM
Matrix: Soil

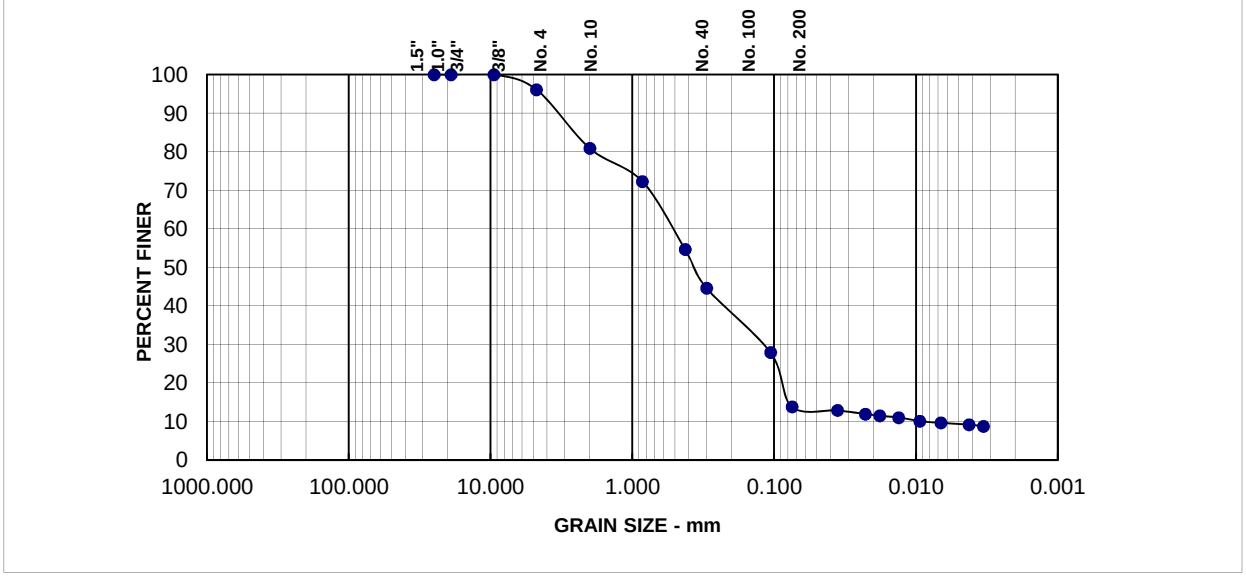
Analyses	Result	RL	Qualifier	Units	Date Analyzed
Atterberg Limits	**D4318**				Analyst: **SUB**
LL	26		*		1/10/2014
PI	3		*		1/10/2014
PL	23		*		1/10/2014
USCS Classification	**D2487**				Analyst: **SUB**
USCS Classification	SM		*		1/10/2014
Grain Size	**D422**				Analyst: **SUB**
Clay	9.3		*	%	1/10/2014
Gravel	3.9		*	%	1/10/2014
Sand	82.3		*	%	1/10/2014
Silt	4.5		*	%	1/10/2014

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

GRAIN SIZE ANALYSIS (ASTM D422)

SAMPLE ID: OU4-ODC-S-SB7 10



% + 3"	% Gravel	% Sand	% Silt	% Clay
0.0	3.9	82.3	4.5	9.3

Sieve Size	Percent Passing
1"	100.0
3/4"	100.0
3/8"	100.0
#4	96.1
#10	80.9
#20	72.3
#40	54.7
#60	44.6
#140	27.9
#200	13.8

D60 (mm)	**D30** (mm)	**D10** (mm)	**Cu**	**Cc**
0.38	0.12	0.0120	31.60	3.16

Visual Soil Description:	Gray coarse to fine sand, little fines, trace fine gravel, moist
Soil Classification:	SM
System:	USCS

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Date Reported: January 13, 2014
Date Printed: January 13, 2014

Client: Tetra Tech EM Inc.
Lab Order: 13120652
Project: 103G1852181.04, OMC, Waukegan, IL
Lab ID: 13120652-003

Client Sample ID: OU4-ODC-S-SB7-20
Collection Date: 12/11/2013 9:30:00 AM
Matrix: Soil

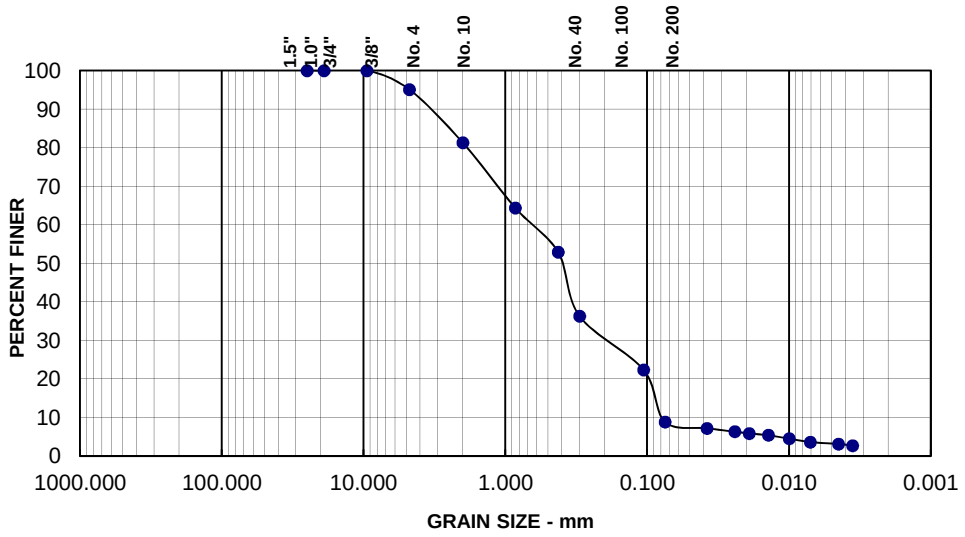
Analyses	Result	RL	Qualifier	Units	Date Analyzed
Atterberg Limits	**D4318**				Analyst: **SUB**
LL	31		*		1/10/2014
PI	5		*		1/10/2014
PL	26		*		1/10/2014
USCS Classification	**D2487**				Analyst: **SUB**
USCS Classification	SP-SM		*		1/10/2014
Grain Size	**D422**				Analyst: **SUB**
Clay	3.2		*	%	1/10/2014
Gravel	5.0		*	%	1/10/2014
Sand	86.2		*	%	1/10/2014
Silt	5.7		*	%	1/10/2014

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

GRAIN SIZE ANALYSIS (ASTM D422)

SAMPLE ID: OU4-ODC-S-SB7 20



% + 3"	% Gravel	% Sand	% Silt	% Clay
0.0	5.0	86.2	5.7	3.2

Sieve Size	Percent Passing
1"	100.0
3/4"	100.0
3/8"	100.0
#4	95.0
#10	81.3
#20	64.4
#40	52.9
#60	36.3
#140	22.4
#200	8.9

D60 (mm)	**D30** (mm)	**D10** (mm)	**Cu**	**Cc**
0.67	0.2	0.0800	8.40	0.75

Visual Soil Description:	Gray coarse to fine sand, trace fines, trace fine gravel, poorly graded, moist
Soil Classification:	SP-SM
System:	USCS

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Date Reported: January 13, 2014
Date Printed: January 13, 2014

Client: Tetra Tech EM Inc.
Lab Order: 13120652
Project: 103G1852181.04, OMC, Waukegan, IL
Lab ID: 13120652-005

Client Sample ID: OU4-ODC-S-SB8-5
Collection Date: 12/26/2013 10:00:00 AM
Matrix: Soil

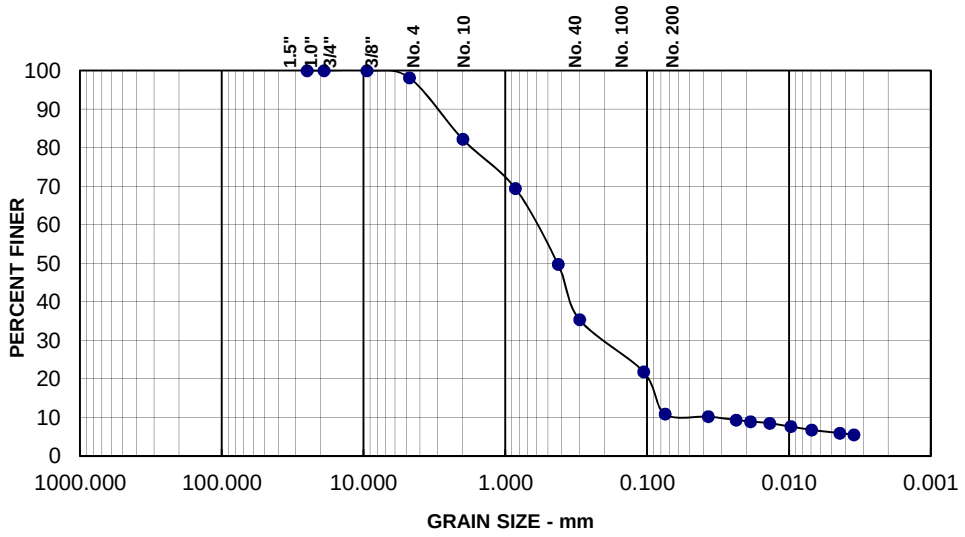
Analyses	Result	RL	Qualifier	Units	Date Analyzed
Atterberg Limits	**D4318**				Analyst: **SUB**
LL	23		*		1/10/2014
PI	4		*		1/10/2014
PL	19		*		1/10/2014
USCS Classification	**D2487**				Analyst: **SUB**
USCS Classification	SP-SC		*		1/10/2014
Grain Size	**D422**				Analyst: **SUB**
Clay	6.2		*	%	1/10/2014
Gravel	1.9		*	%	1/10/2014
Sand	87.2		*	%	1/10/2014
Silt	4.7		*	%	1/10/2014

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

GRAIN SIZE ANALYSIS (ASTM D422)

SAMPLE ID: OU4-ODC-S-SB8 5



% + 3"	% Gravel	% Sand	% Silt	% Clay
0.0	1.9	87.2	4.7	6.2

Sieve Size	Percent Passing
1"	100.0
3/4"	100.0
3/8"	100.0
#4	98.1
#10	82.2
#20	69.4
#40	49.7
#60	35.4
#140	21.8
#200	10.9

D60 (mm)	**D30** (mm)	**D10** (mm)	**Cu**	**Cc**
0.6	0.2	0.0800	7.50	0.83

Visual Soil Description:	Gray coarse to fine sand, little fines, trace fine gravel, poorly graded, moist
Soil Classification:	SP-SC
System:	USCS

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Date Reported: January 13, 2014
Date Printed: January 13, 2014

Client: Tetra Tech EM Inc.
Lab Order: 13120652
Project: 103G1852181.04, OMC, Waukegan, IL
Lab ID: 13120652-006

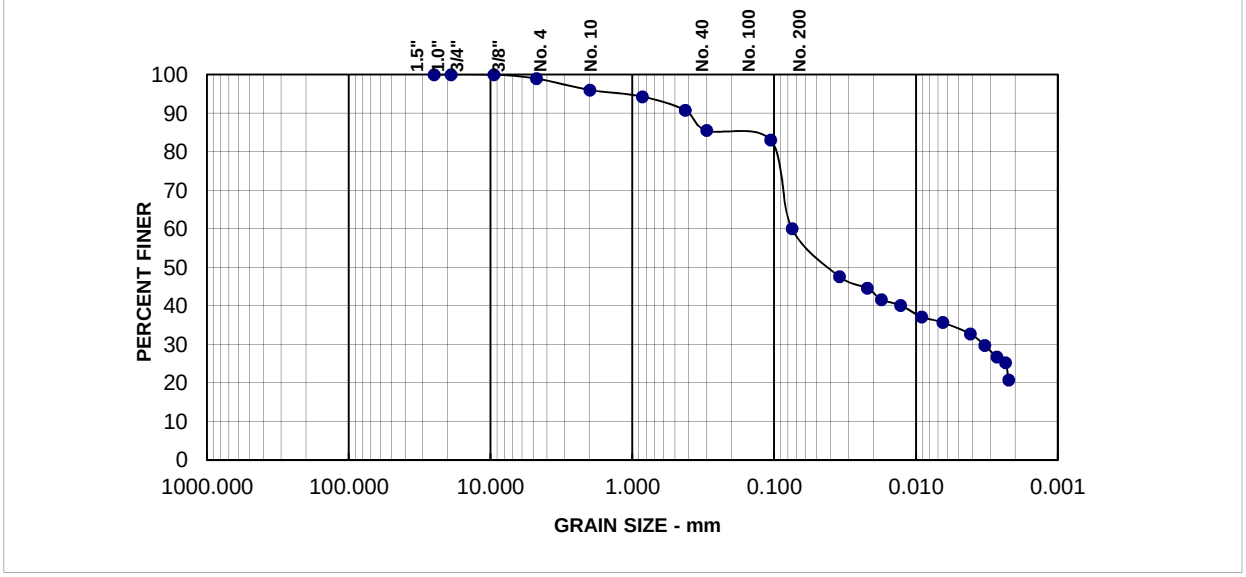
Client Sample ID: OU4-ODC-S-SB8-10
Collection Date: 12/26/2013 10:04:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	Date Analyzed
Atterberg Limits	**D4318**				Analyst: **SUB**
LL	46		*		1/10/2014
PI	24		*		1/10/2014
PL	22		*		1/10/2014
USCS Classification	**D2487**				Analyst: **SUB**
USCS Classification	CL		*		1/10/2014
Grain Size	**D422**				Analyst: **SUB**
Clay	33.2		*	%	1/10/2014
Gravel	1.1		*	%	1/10/2014
Sand	38.9		*	%	1/10/2014
Silt	26.9		*	%	1/10/2014

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

GRAIN SIZE ANALYSIS (ASTM D422)

SAMPLE ID: OU4-ODC-S-SB8 10



% + 3"	% Gravel	% Sand	% Silt	% Clay
0.0	1.1	38.9	26.9	33.2

Sieve Size	Percent Passing
1"	100.0
3/4"	100.0
3/8"	100.0
#4	98.9
#10	96.0
#20	94.3
#40	90.7
#60	85.5
#140	83.0
#200	60.1

D60 (mm)	**D30** (mm)	**D10** (mm)	**Cu**	**Cc**
0.8	0.0032			

Visual Soil Description:	Gray silty clay, and coarse to fine sand, trace fine gravel, moist
Soil Classification:	CL
System:	USCS

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Date Reported: January 13, 2014
Date Printed: January 13, 2014

Client: Tetra Tech EM Inc.
Lab Order: 13120652
Project: 103G1852181.04, OMC, Waukegan, IL
Lab ID: 13120652-007

Client Sample ID: OU4-ODC-S-SB8-20
Collection Date: 12/26/2013 10:08:00 AM
Matrix: Soil

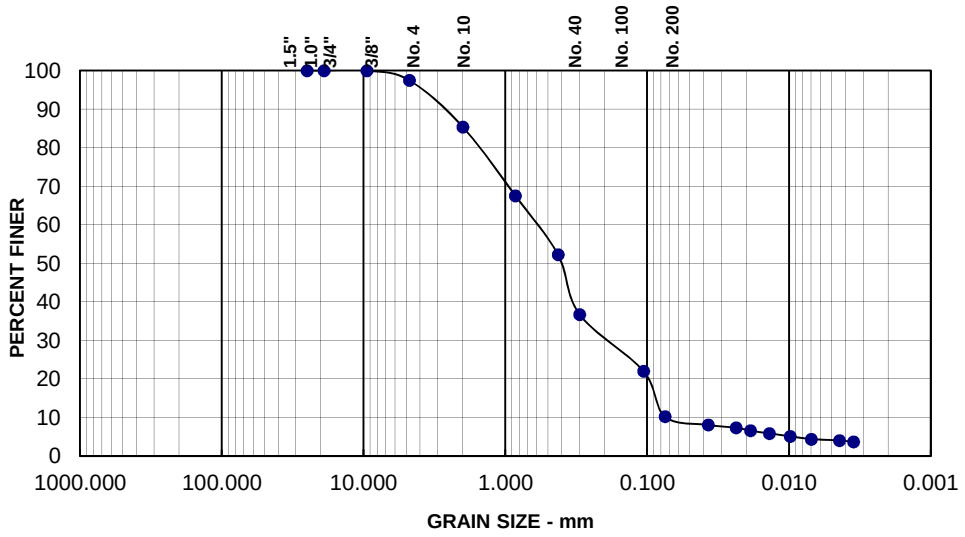
Analyses	Result	RL	Qualifier	Units	Date Analyzed
Atterberg Limits	**D4318**				Analyst: **SUB**
LL	31		*		1/10/2014
PI	8		*		1/10/2014
PL	23		*		1/10/2014
USCS Classification	**D2487**				Analyst: **SUB**
USCS Classification	SP-SM		*		1/10/2014
Grain Size	**D422**				Analyst: **SUB**
Clay	4.2		*	%	1/10/2014
Gravel	2.5		*	%	1/10/2014
Sand	87.2		*	%	1/10/2014
Silt	6.0		*	%	1/10/2014

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

GRAIN SIZE ANALYSIS (ASTM D422)

SAMPLE ID: OU4-ODC-S-SB8 20



% + 3"	% Gravel	% Sand	% Silt	% Clay
0.0	2.5	87.2	6.0	4.2

Sieve Size	Percent Passing
1"	100.0
3/4"	100.0
3/8"	100.0
#4	97.5
#10	85.4
#20	67.5
#40	52.3
#60	36.8
#140	22.0
#200	10.2

D60 (mm)	**D30** (mm)	**D10** (mm)	**Cu**	**Cc**
0.6	0.2	0.0800	7.50	0.83

Visual Soil Description:	Gray coarse to fine sand, little fines, trace fine gravel, poorly graded, moist
Soil Classification:	SP-SM
System:	USCS

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Date Reported: January 13, 2014
Date Printed: January 13, 2014

Client: Tetra Tech EM Inc.
Lab Order: 13120652
Project: 103G1852181.04, OMC, Waukegan, IL
Lab ID: 13120652-021

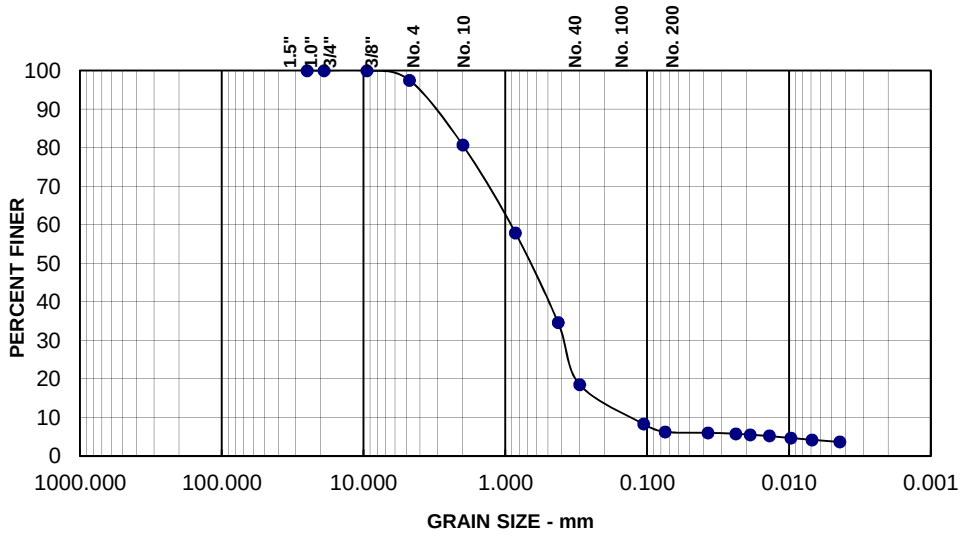
Client Sample ID: OU4-ODC-S-S16 5
Collection Date: 12/27/2013 10:30:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	Date Analyzed
Atterberg Limits	**D4318**				Analyst: **SUB**
LL	29		*		1/10/2014
PI	6		*		1/10/2014
PL	23		*		1/10/2014
USCS Classification	**D2487**				Analyst: **SUB**
USCS Classification	SP-SM		*		1/10/2014
Grain Size	**D422**				Analyst: **SUB**
Clay	3.9		*	%	1/10/2014
Gravel	2.5		*	%	1/10/2014
Sand	91.2		*	%	1/10/2014
Silt	2.4		*	%	1/10/2014

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

GRAIN SIZE ANALYSIS (ASTM D422)

SAMPLE ID: OU4-ODC-S-SB16 5



% + 3"	% Gravel	% Sand	% Silt	% Clay
0.0	2.5	91.2	2.4	3.9

Sieve Size	Percent Passing
1"	100.0
3/4"	100.0
3/8"	100.0
#4	97.5
#10	80.7
#20	57.9
#40	34.7
#60	18.6
#140	8.3
#200	6.3

D60 (mm)	**D30** (mm)	**D10** (mm)	**Cu**	**Cc**
0.89	0.38	0.1500	5.90	1.00

Visual Soil Description:	Gray Coarse to fine sand, trace fines, trace fine gravel, poorly graded, wet
Soil Classification:	SP-SM
System:	USCS

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Date Reported: January 13, 2014
Date Printed: January 13, 2014

Client: Tetra Tech EM Inc.
Lab Order: 13120652
Project: 103G1852181.04, OMC, Waukegan, IL
Lab ID: 13120652-022

Client Sample ID: OU4-ODC-S-SB16 10
Collection Date: 12/27/2013 10:35:00 AM
Matrix: Soil

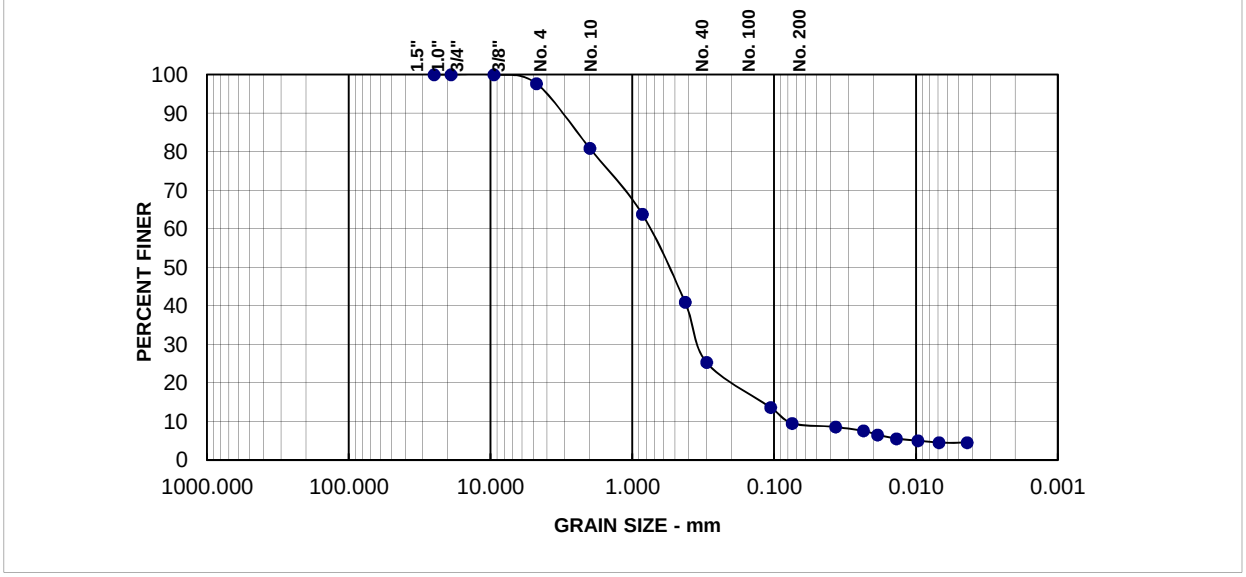
Analyses	Result	RL	Qualifier	Units	Date Analyzed
Atterberg Limits	**D4318**				Analyst: **SUB**
LL	26		*		1/10/2014
PI	5		*		1/10/2014
PL	21		*		1/10/2014
USCS Classification	**D2487**				Analyst: **SUB**
USCS Classification	SW-SC		*		1/10/2014
Grain Size	**D422**				Analyst: **SUB**
Clay	4.5		*	%	1/10/2014
Gravel	2.4		*	%	1/10/2014
Sand	88.1		*	%	1/10/2014
Silt	5.0		*	%	1/10/2014

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

GRAIN SIZE ANALYSIS (ASTM D422)

SAMPLE ID: OU4-ODC-S-SB16 10



% + 3"	% Gravel	% Sand	% Silt	% Clay
0.0	2.4	88.1	5.0	4.5

Sieve Size	Percent Passing
1"	100.0
3/4"	100.0
3/8"	100.0
#4	97.6
#10	80.9
#20	63.8
#40	41.0
#60	25.4
#140	13.7
#200	9.5

D60 (mm)	**D30** (mm)	**D10** (mm)	**Cu**	**Cc**
0.65	0.33	0.0760	8.60	2.20

Visual Soil Description:	Gray Coarse to fine sand, trace fines, trace fine gravel, well graded, wet
Soil Classification:	SW-SC
System:	USCS

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Date Reported: January 13, 2014
Date Printed: January 13, 2014

Client: Tetra Tech EM Inc.
Lab Order: 13120652
Project: 103G1852181.04, OMC, Waukegan, IL
Lab ID: 13120652-023

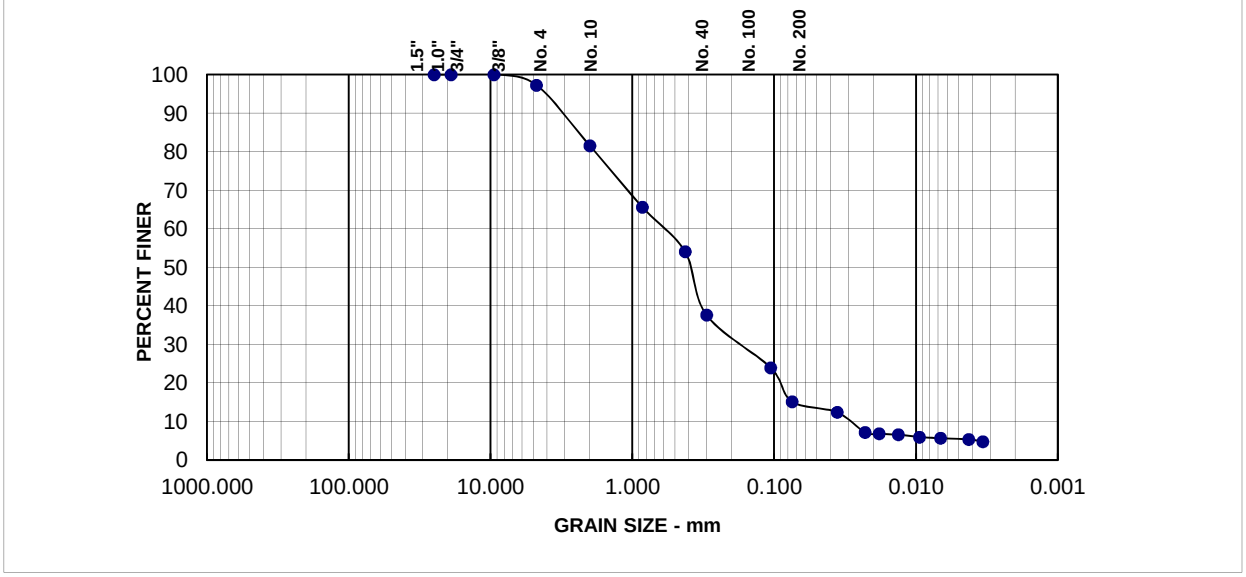
Client Sample ID: OU4-ODC-S-SB16 20
Collection Date: 12/27/2013 10:40:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	Date Analyzed
Atterberg Limits	**D4318**				Analyst: **SUB**
LL	28		*		1/10/2014
PI	4		*		1/10/2014
PL	24		*		1/10/2014
USCS Classification	**D2487**				Analyst: **SUB**
USCS Classification	SM		*		1/10/2014
Grain Size	**D422**				Analyst: **SUB**
Clay	5.5		*	%	1/10/2014
Gravel	2.7		*	%	1/10/2014
Sand	82.1		*	%	1/10/2014
Silt	9.7		*	%	1/10/2014

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

GRAIN SIZE ANALYSIS (ASTM D422)

SAMPLE ID: OU4-ODC-S-SB16 20



% + 3"	% Gravel	% Sand	% Silt	% Clay
0.0	2.7	82.1	9.7	5.5

Sieve Size	Percent Passing
1"	100.0
3/4"	100.0
3/8"	100.0
#4	97.3
#10	81.6
#20	65.6
#40	54.1
#60	37.6
#140	24.0
#200	15.2

D60 (mm)	**D30** (mm)	**D10** (mm)	**Cu**	**Cc**
0.6	0.17	0.0030	20.00	16.00

Visual Soil Description:	Gray coarse to fine sand, little fines, trace fine gravel, wet
Soil Classification:	SM
System:	USCS

Table 2-6
Appendix C
OMC Soil
Geotechnical

	Station:	SO-061	SO-061	SO-061	SO-062	SO-063	SO-063	SO-063	SO-065
	Sample:	05CK14-13	05CK14-17	05CK14-46	05CK14-18	05CK14-22	05CK14-23	05CK14-24	05CK14-31
	Interval:	4 - 6	24.5 - 26.5	1.3 - 2.3	20.5 - 22	20.5 - 22	6.5 - 7.5	1.5 - 2.5	0.9 - 1.9
	Matrix:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
	Date:	3/14/2005	3/15/2005	3/14/2005	3/15/2005	3/15/2005	3/15/2005	3/15/2005	3/16/2005
Geotechnical and Wet Chemistry									
BULK DENSITY OF SOILS	g/cc	1.61	1.84	1.3	1.35	1.34	1.32	1.44	1.3
SIEVE NO. 10, PERCENT PASSING	percent	82.92	78.61	94.39	95.28	100	98.13	84.02	98.98
SIEVE NO. 200, PERCENT PASSING	percent	2.73	7.52	2.17	14.02	4.42	1	1.88	3.44
SIEVE NO. 4, PERCENT PASSING	percent	94.85	97.45	97.07	96.88	100	99.62	90.01	99.97
SIEVE NO. 40, PERCENT PASSING	percent	61.56	31.1	77.97	94.25	99.75	91.84	68.78	90.72
SIEVE NO. 80, PERCENT PASSING	percent	5.64	18.14	5.17	89.69	93.15	5.18	19.67	36.56
SIEVE, NO. 100, PERCENT PASSING	percent	4.6	15.9	3.9	82.95	60.35	2.72	14.86	27.89
SIEVE, NO. 20, PERCENT PASSING	percent	75.57	47.45	91.83	94.81	99.88	96.8	76.98	94.59
SIEVE, NO. 60, PERCENT PASSING	percent	17.57	22.71	20.88	92.67	99.48	31.91	38.34	67.49
VOID RATIO OF SOILS	percent	52.6	20.6	55.8	41	33.6	42.9	44.3	46.5

Qualifier Key: " " - detected; "J" - detected, estimated; "Ja" - detected, estimated; "R" - rejected; "U" - Not Detected

Table 2-6
Appendix C
OMC Soil
Geotechnical

	Station:	SO-065	SO-065	SO-066	SO-066	SO-066	SO-067	SO-067	SO-067
	Sample:	05CK14-32	05CK14-33	05CK14-36	05CK14-37	05CK14-39	05CK14-43	05CK14-44	05CK14-45
	Interval:	6.4 - 7.4	20 - 21	1 - 2	5 - 6.5	29 - 30	5 - 6	6.5 - 7.5	28 - 28.8
	Matrix:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
	Date:	3/16/2005	3/16/2005	3/16/2005	3/16/2005	3/16/2005	3/17/2005	3/17/2005	3/17/2005
Geotechnical and Wet Chemistry									
BULK DENSITY OF SOILS	g/cc	1.68	1.32	1.62	1.38	1.19	1.51	1.5	1.27
SIEVE NO. 10, PERCENT PASSING	percent	35.4	99.93	84.25	99.77	85.94	88.72	61.2	85.6
SIEVE NO. 200, PERCENT PASSING	percent	1.22	4.22	2.33	1.13	18.2	3.96	1.24	12.31
SIEVE NO. 4, PERCENT PASSING	percent	59.28	100	95.68	100	99.62	98.25	87.85	97.81
SIEVE NO. 40, PERCENT PASSING	percent	10.42	99.53	59.16	98.52	44.01	60.85	31.76	67.83
SIEVE NO. 80, PERCENT PASSING	percent	2.5	84.71	9.79	9.54	31.22	10.43	3.35	63.42
SIEVE, NO. 100, PERCENT PASSING	percent	2	44.28	6.34	4.45	29.37	8.54	2.19	61.58
SIEVE, NO. 20, PERCENT PASSING	percent	19.23	99.71	71.6	99.53	59.95	77.27	40.06	73.71
SIEVE, NO. 60, PERCENT PASSING	percent	5.06	98.8	31.02	55.45	35.25	21.72	15.37	65.09
VOID RATIO OF SOILS	percent	69.7	35.1	68.8	41.8	12.1	73	58.3	50.2

Qualifier Key: " " - detected; "J" - detected, estimated; "Ja" - detected, estimated; "R" - rejected; "U" - Not Detected

Table 2-6
Appendix C
OMC Soil
Geotechnical

	Station:	SO-068	SO-068	SO-069	SO-069	SO-069	SO-070	SO-070	SO-070
	Sample:	05CK14-47	05CK14-51	05CK14-53	05CK14-54	05CK14-55	05CK14-59	05CK14-60	05CK14-61
	Interval:	1 - 2.5	5.5 - 6.5	26.5 - 27.5	4 - 5.5	5.5 - 6.5	28.9 - 29.9	4.5 - 5.6	8 - 9.5
	Matrix:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
	Date:	3/21/2005	3/21/2005	3/21/2005	3/21/2005	3/21/2005	3/22/2005	3/22/2005	3/22/2005
Geotechnical and Wet Chemistry									
BULK DENSITY OF SOILS	g/cc	1.4	1.29	1.79	1.39	1.49	1.32	1.46	1.63
SIEVE NO. 10, PERCENT PASSING	percent								
SIEVE NO. 200, PERCENT PASSING	percent								
SIEVE NO. 4, PERCENT PASSING	percent	96.38	99.19		86.39	98.97		96.37	94.46
SIEVE NO. 40, PERCENT PASSING	percent								
SIEVE NO. 80, PERCENT PASSING	percent								
SIEVE, NO. 100, PERCENT PASSING	percent			9.87					
SIEVE, NO. 20, PERCENT PASSING	percent						99.6		
SIEVE, NO. 60, PERCENT PASSING	percent								
VOID RATIO OF SOILS	percent	75.1	55.8	49	90.6	47.9	32.3	63.4	60.5

Qualifier Key: " " - detected; "J" - detected, estimated; "Ja" - detected, estimated; "R" - rejected; "U" - Not Detected

Table 2-6
Appendix C
OMC Soil
Geotechnical

	Station:	SO-071	SO-071	SO-071	SO-072	SO-072	SO-072	SO-074
	Sample:	05CK14-62	05CK14-63	05CK14-71	05CK14-75	05CK14-76	05CK14-77	05CK14-81
	Interval:	2.4 - 3.4	8.3 - 9.3	24 - 25	1 - 2	5 - 6	24.4 - 25.4	0.5 - 1.5
	Matrix:	Soil	Soil	Soil	Soil	Soil	Soil	Soil
	Date:	3/22/2005	3/22/2005	3/22/2005	3/23/2005	3/23/2005	3/23/2005	3/24/2005
Geotechnical and Wet Chemistry								
BULK DENSITY OF SOILS	g/cc	1.3	1.45	1.46	1.4	1.44	1.31	1.33
SIEVE NO. 10, PERCENT PASSING	percent							
SIEVE NO. 200, PERCENT PASSING	percent							
SIEVE NO. 4, PERCENT PASSING	percent	99.29	97.66	99.31	95.09	98.9		64.03
SIEVE NO. 40, PERCENT PASSING	percent							
SIEVE NO. 80, PERCENT PASSING	percent							
SIEVE, NO. 100, PERCENT PASSING	percent							
SIEVE, NO. 20, PERCENT PASSING	percent						99.9	
SIEVE, NO. 60, PERCENT PASSING	percent							
VOID RATIO OF SOILS	percent	96.2	30.8	22.7	46.6	34.2	39.8	81.5

Qualifier Key: " " - detected; "J" - detected, estimated; "Ja" - detected, estimated; "R" - rejected; "U" - Not Detected

Table 2-6
Appendix C
OMC Soil
Geotechnical

	Station:	SO-074	SO-074	SO-075	SO-075	SO-075	SO-077	SO-077
	Sample:	05CK14-82	05CK14-83	05CK14-84	05CK14-85	05CK14-89	05CK14-90	05CK14-93
	Interval:	2.5 - 3.5	24.1 - 25.1	2.4 - 3.3	5.9 - 6.9	24 - 24.8	1.6 - 2.6	24.3 - 25.3
	Matrix:	Soil	Soil	Soil	Soil	Soil	Soil	Soil
	Date:	3/24/2005	3/24/2005	3/24/2005	3/24/2005	3/24/2005	3/28/2005	3/28/2005
Geotechnical and Wet Chemistry								
BULK DENSITY OF SOILS	g/cc	1.44	1.36	1.2	1.39	1.54	1.59	1.45
SIEVE NO. 10, PERCENT PASSING	percent							99.84
SIEVE NO. 200, PERCENT PASSING	percent							8.96
SIEVE NO. 4, PERCENT PASSING	percent	99.04		83.06	96.36	98.11	95.85	100
SIEVE NO. 40, PERCENT PASSING	percent							97.2
SIEVE NO. 80, PERCENT PASSING	percent							91.61
SIEVE, NO. 100, PERCENT PASSING	percent							85.75
SIEVE, NO. 20, PERCENT PASSING	percent		99.94					98.46
SIEVE, NO. 60, PERCENT PASSING	percent							95.08
VOID RATIO OF SOILS	percent	56.6	44.1	78.2	41.7	48.9	88.7	37.3

Qualifier Key: " " - detected; "J" - detected, estimated; "Ja" - detected, estimated; "R" - rejected; "U" - Not Detected

Table 2-6
Appendix C
OMC Soil
Geotechnical

	Station:	SO-077	SO-078	SO-078	SO-079	SO-079	SO-079	SO-080	SO-080
	Sample:	05CK14-95	05CK14-97	05CK14-98	05CK28-03	05CK28-05	05CK28-07	05CK28-08	05CK28-11
	Interval:	8.5 - 10	1.5 - 2.5	16.1 - 17.1	1.6 - 2.6	4.5 - 6	20.6 - 21.6	1 - 2.5	29 - 30.4
	Matrix:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
	Date:	3/28/2005	3/29/2005	3/29/2005	3/29/2005	3/29/2005	3/29/2005	3/30/2005	3/30/2005
Geotechnical and Wet Chemistry									
BULK DENSITY OF SOILS	g/cc	1.36	1.48	1.39	1.36	1.89	1.61	1.45	1.23
SIEVE NO. 10, PERCENT PASSING	percent	95.37	91.16	99.05	99.02	95.21	87.99	94.49	100
SIEVE NO. 200, PERCENT PASSING	percent	0.96	3.73	3.84	0.66	0.9	1.6	1.85	5.73
SIEVE NO. 4, PERCENT PASSING	percent	96.53	97.03	99.83	99.54	97.15	95.6	96.11	100
SIEVE NO. 40, PERCENT PASSING	percent	89.97	12.34	98.44	91.56	84.86	63.51	87.21	99.97
SIEVE NO. 80, PERCENT PASSING	percent	5.6	3.73	91.12	5.12	4.62	12.33	17.01	99.35
SIEVE, NO. 100, PERCENT PASSING	percent	2.68	3.73	74.39	2.81	2.99	6.47	8.75	97.3
SIEVE, NO. 20, PERCENT PASSING	percent	94.27	77.7	98.66	98.11	93.21	70.58	91.94	100
SIEVE, NO. 60, PERCENT PASSING	percent	37.01	3.85	97.88	29.83	25.32	44.88	60.01	99.83
VOID RATIO OF SOILS	percent	45.5	41.2	43.7	63.3	47.4	60.9	85.6	47.3

Qualifier Key: " " - detected; "J" - detected, estimated; "Ja" - detected, estimated; "R" - rejected; "U" - Not Detected

Table 2-6
Appendix C
OMC Soil
Geotechnical

	Station:	SO-080	SO-081	SO-081	SO-081	SO-082	SO-082	SO-082
	Sample:	05CK28-13	05CK28-14	05CK28-18	05CK28-23	05CK28-21	05CK28-22	05CK28-24
	Interval:	8 - 9.7	0.3 - 1.4	9.9 - 10.9	24 - 25	5 - 6	8.7 - 9.7	16 - 17.3
	Matrix:	Soil	Soil	Soil	Soil	Soil	Soil	Soil
	Date:	3/30/2005	3/30/2005	3/30/2005	3/31/2005	3/30/2005	3/30/2005	3/31/2005
Geotechnical and Wet Chemistry								
BULK DENSITY OF SOILS	g/cc	1.34	1.26	1.44	1.38	1.41	1.52	1.31
SIEVE NO. 10, PERCENT PASSING	percent	100	67.52	95.17	76.32	60.65	99.91	99.75
SIEVE NO. 200, PERCENT PASSING	percent	1.66	1.67	1.06	0.97	3.85	1.31	2.03
SIEVE NO. 4, PERCENT PASSING	percent	100	80.38	95.66	86.02	78.16	100	100
SIEVE NO. 40, PERCENT PASSING	percent	97.51	42.28	90.78	63.08	34.52	96.22	98.53
SIEVE NO. 80, PERCENT PASSING	percent	6.13	4.48	5.16	22.72	7.38	9.29	16.52
SIEVE, NO. 100, PERCENT PASSING	percent	3.87	3.48	2.9	7.79	6.34	4.33	7.99
SIEVE, NO. 20, PERCENT PASSING	percent	99.98	56.46	94.22	67.83	45.96	99.81	99.41
SIEVE, NO. 60, PERCENT PASSING	percent	34.54	14.47	38.52	45.52	14.71	51.26	74.19
VOID RATIO OF SOILS	percent	48.9	73.6	45.2	40.4	59.8	49.5	48

Qualifier Key: " " - detected; "J" - detected, estimated; "Ja" - detected, estimated; "R" - rejected; "U" - Not Detected

TABLE 1

Slug Test Parameters and Result Summary

OMC Plant 2

Bouwer-Rice Method Parameters						Hydrolic Conductivity (cm/sec)						
Well ID	Radius of Well Casing (feet)	Radius of Borehole (feet)	Length of Well Screen (feet)	DTW (ft btoc)	Assumed Aquifer Thickness (feet)	Falling Head Test (attempt 1)	Falling Head Test (attempt 2)	Rising Head Test (attempt 1)	Rising Head Test (attempt 2)	Falling Head Average	Rising Head Average	Total Average
MW-500D	0.08612	0.333	5.0	4.06	30	3.22E-03		3.73E-03			3.73E-03	3.47E-03
MW-500S	0.08612	0.333	5.0	3.98	30			8.98E-02	5.66E-02		7.32E-02	7.32E-02
MW-501D	0.08612	0.333	5.0	5.23	30	2.88E-03		3.03E-03			3.03E-03	2.95E-03
MW-501S	0.08612	0.333	5.0	5.23	30			2.51E-02	5.92E-03		1.55E-02	1.55E-02
MW-502D	0.08612	0.333	5.0	4.68	30	5.82E-03		4.89E-03				5.35E-03
MW-502S	0.08612	0.333	5.0	4.79	30			3.93E-03	2.38E-02		1.39E-02	1.39E-02
MW-503D	0.08612	0.333	5.0	2.36	30	4.85E-03		NA				4.85E-03
MW-503S	0.08612	0.333	5.0	2.40	30			6.36E-03	5.91E-03		6.13E-03	6.13E-03
MW-504D	0.08612	0.333	5.0	6.05	30	3.78E-03		3.89E-03			3.89E-03	3.83E-03
MW-504S	0.08612	0.333	5.0	6.12	30			3.66E-02	3.44E-02		3.55E-02	3.55E-02
MW-505D	0.08612	0.333	5.0	5.46	30	5.39E-03		5.90E-03			5.90E-03	5.64E-03
MW-505S	0.08612	0.333	5.0	5.62	30			1.73E-02	1.76E-02		1.75E-02	1.75E-02
MW-506D	0.08612	0.333	5.0	5.94	30	5.18E-03		5.35E-03			5.35E-03	5.26E-03
MW-506S	0.08612	0.333	5.0	5.93	30			4.66E-02	4.79E-02		4.73E-02	4.73E-02
MW-507D	0.08612	0.333	5.0	4.52	30	3.28E-03	3.04E-03	3.13E-03		3.16E-03	3.13E-03	3.15E-03
MW-507S	0.08612	0.333	5.0	4.49	30			1.22E-02	1.14E-02		1.18E-02	1.18E-02
MW-508D	0.08612	0.333	5.0	3.68	30	3.44E-03		3.47E-03			3.47E-03	3.46E-03
MW-508S	0.08612	0.333	5.0	3.68	30			2.21E-02	2.15E-02		2.18E-02	2.18E-02
MW-509D	0.08612	0.333	5.0	1.18	30	6.94E-03	6.48E-03	7.33E-03	6.85E-03	6.71E-03	7.09E-03	6.90E-03
MW-509S	0.08612	0.333	5.0	1.21	30			1.51E-02	1.75E-02		1.63E-02	1.63E-02
MW-510D	0.08612	0.333	5.0	5.90	30	4.71E-03		4.77E-03			4.77E-03	4.74E-03
MW-510S	0.08612	0.333	5.0	5.88	30			1.12E-02	1.03E-02		1.07E-02	1.07E-02
MW-511D	0.08612	0.333	5.0	6.49	30	6.19E-03		3.16E-03			3.16E-03	4.67E-03
MW-511S	0.08612	0.333	5.0	6.44	30			1.08E-02	4.10E-02		2.59E-02	2.59E-02
MW-512D	0.08612	0.333	5.0	3.04	30	4.18E-03		4.33E-03			4.33E-03	4.26E-03
MW-512S	0.08612	0.333	5.0	3.01	30			1.10E-02	1.20E-02		1.15E-02	1.15E-02
MW-513D	0.08612	0.333	5.0	3.58	30		5.77E-03	6.28E-03	5.93E-03		6.10E-03	5.99E-03
MW-513S	0.08612	0.333	5.0	3.51	30			9.62E-02	9.55E-02		9.59E-02	9.59E-02
MW-514D	0.08612	0.333	5.0	3.42	30		7.46E-03	8.33E-03			8.33E-03	7.89E-03
MW-514S	0.08612	0.333	5.0	3.44	30			5.44E-02	1.11E-02		3.28E-02	3.28E-02
MW-515D	0.08612	0.333	5.0	2.28	30	4.17E-03		4.53E-03			4.53E-03	4.35E-03
MW-515S	0.08612	0.333	5.0	2.41	30			1.08E-02	1.12E-02		1.10E-02	1.10E-02
MW-516D	0.08612	0.333	5.0	3.72	30	2.20E-03		3.03E-03			3.03E-03	2.61E-03
MW-516S	0.08612	0.333	5.0	3.28	30			6.94E-02	7.28E-02		7.11E-02	7.11E-02
MW-517D	0.08612	0.333	5.0	4.29	30	6.28E-03	6.20E-03	6.58E-03	6.53E-03	6.24E-03	6.56E-03	6.40E-03
MW-517S	0.08612	0.333	5.0	4.21	30			1.15E-02	1.08E-02		1.12E-02	1.12E-02

Notes:

a. ft bgs = feet below ground surface.

b. ft btoc = feet below top of casing

c. NA = not available

Geometric Mean Shall 2.16E-02

Geometric Mean Des 4.56E-03

DIVISION 32 EXTERIOR IMPROVEMENTS

SECTION 32 12 16
ASPHALT CAPS

1. GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Unless otherwise noted, the latest version of each publication is to be used.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
AASHTO M 320	(2010) Standard Specification for Performance-Graded Asphalt Binder
AASHTO M147	Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses

ASTM INTERNATIONAL (ASTM)

ASTM C131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D140/D140M	(2009) Standard Practice for Sampling Bituminous Materials
ASTM D 1556	Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)
ASTM D 2216	Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D242/D242M	(2009) Mineral Filler for Bituminous Paving Mixtures
ASTM D 2487	Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2726/D2726M	(2013) Bulk Specific Gravity and Density of Non- Absorptive Compacted Bituminous Mixtures
ASTM D2922	Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D546	(2010) Sieve Analysis of Mineral Filler for Bituminous Paving Mixtures
ASTM D692/D692M	(2009) Coarse Aggregate for Bituminous Paving Mixtures
ASTM D75/D75M	(2009) Standard Practice for Sampling Aggregates
ASTM D979/D979M	(2012) Sampling Bituminous Paving Mixtures

Illinois Department of Transportation (IDOT)

IDOT 2012	Standard Specifications for Road and Bridge Construction, Adopted January 1, 2012.

1.2 DEFINITIONS

Not used.

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 Submittal Procedures.

1.3.1 SD-01, Preconstruction Submittals

Submit 2 weeks prior to start of construction:

a. Asphalt contractor qualifications.
b. Job Mix Formula (JMF). The Contractor shall develop the mix design. The mix design shall list all materials and their proportions.
c. Asphalt cement binder grade certificate.
d. List of all equipment to be used and their specifications.
e. List of equipment operators and their level of experience.
f. Data for proposed asphalt mixing plant to be used
g. Hot-mix asphalt quality control plan, including procedures and testing that will be used to ensure uniformity between batches of product supplied by the plant as well as compliance with the project specifications.

1.3.2 SD-03, Product Data

Submit 1 week prior to use of product.

a. Aggregate Base Course material source, gradation, and supplier's data indicating material quality compliance with 2012 IDOT Standard Specifications for Road and Bridge Construction, Section 1004.01 (b).
b. HMA aggregates material sources, gradations, and supplier's data indicating material quality compliance with 2012 IDOT Standard Specifications for Road and Bridge Construction, Section 1003.01 (b).
c. Mineral filler source and gradation showing percent passing Number 30, 100 and 200 sieve.
d. Manhole riser, including any necessary ancillary items

1.3.3 SD-06, Field Test Reports

Submit within 2 working days:

a. Progress surveys, including topography of finished surface of each material layer. Submit survey data electronically in AutoCAD format and in PDF format. The PDF file shall include the surveyor's seal and signature.
b. Laboratory results
c. Field test results

1.3.4 SD-11, Closeout Submittals

a. As-built report including quantities of all construction materials used.

1.4 WORK DESCRIPTION

Install asphalt pavement to the lines and grades shown on the drawings in two areas, measuring approximately 18,000 square feet and 30,000 square feet. Contractor shall furnish all labor, equipment and materials necessary to prepare the subgrade, install base course, and install hot-mix asphalt pavement. Site location and exact dimensions are presented on the drawings.

1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.6 INSTALLER'S QUALIFICATIONS

Paving Contractor shall have minimum of 10 years of experience in paving projects of similar size and complexity.

1.7 MEASUREMENT AND PAYMENT

Payment for asphalt cap installation will be paid per square foot as shown on the bid form 00 41 00.

2. PRODUCTS

2.1 AGGREGATE BASE COURSE

Coarse Aggregate shall conform to 2012 IDOT Standard Specifications for Road and Bridge Construction, Section 1004 and may contain up to 30 percent by weight reclaimed asphalt pavement (RAP). Aggregate shall be IDOT CA-10 conforming to gradation presented below:

Sieve Size	1 in	3/4 in	1/2 in	No. 4	No. 16	No. 200
% Passing	100	95±5	80±15	50±10	30±15	9±4

2.2 AGGREGATES IN HMA

Aggregates to be used in HMA shall conform to 2012 IDOT Standard Specifications for Road and Bridge Construction, Section 1003. Gradation shall be proposed by the Contractor, subject to approval by the Engineer.

2.3 MINERAL FILLER

Mineral Filler shall conform to 2012 IDOT Standard Specifications for Road and Bridge Construction, Section 1011.

2.4 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to AASHTO M 320 Performance Grade (PG) 64-22. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Engineer. The

supplier is defined as the last source of any modification to the binder. The Engineer may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained by the Contractor in accordance with ASTM D140/D140M and in the presence of the Engineer. These samples shall be sent to a laboratory for testing which shall be paid for by the Contractor.

2.5 HOT-MIX ASPHALT (HMA)

HMA shall be prepared in accordance with the approved JMF. No HMA for payment shall be produced until the JMF has been approved by the Engineer. The JMF shall conform to IDOT Superpave N30 design mix IL-9.5L or equal as approved by the Engineer. The JMF may contain up to 30 percent by weight RAP. RAP will not be allowed if the JMF includes polymer.

2.6 PAVING EQUIPMENT

2.6.1 Spreading Equipment

Equipment shall be self-propelled electronically controlled type, unless otherwise approved by the Engineer. Equip spreading equipment of the self-propelled electronically controlled type with hoppers, tamping or vibrating devices, distributing screws, electronically adjustable screeds, and equalizing devices. Capable of spreading hot bituminous mixtures without tearing, shoving, or gouging and to produce a finished surface of specified grade and smoothness. Operate spreaders, when laying mixture, at variable speeds between 5 and 45 feet per minute. Design spreader with a quick and efficient steering device; a forward and reverse traveling speed; and automatic devices to adjust to grade and confine the edges of the mixture to true lines. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh laid mix during operations is prohibited.

2.6.2 Rolling Equipment

Equipment shall be self-propelled pneumatic-tired rollers supplemented by steel wheel rollers. The number, type and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. Rollers shall be suitable for rolling hot-mix bituminous pavements and capable of reversing without backlash. Pneumatic-tired rollers shall be capable of being operated both forward and backward without turning on the mat, and without loosening the surface being rolled. Equip rollers with suitable devices and apparatus to keep the rolling surfaces wet and prevent adherence of bituminous mixture. Vibratory rollers especially designed for bituminous concrete compaction may be used provided rollers do not impair stability of pavement structure and underlying layers. Repair depressions in pavement surfaces resulting from use of vibratory rollers. Rollers shall be self-propelled, single or dual vibrating drums, and steel drive wheels, as applicable; equipped with variable amplitude and separate controls for energy and propulsion.

2.6.3 Hand Tampers

Equipment shall have minimum weight of 25 pounds with a tamping face of not more than 50 square inches.

2.6.4 Mechanical Hand Tampers

Equipment shall be of commercial type, operated by pneumatic pressure or by internal combustion.

2.7 MANHOLE RISERS

Select and provide manhole risers to fit existing manholes. Coordinate manhole riser selection with appropriate utility. Manhole risers and any necessary appurtenances, such as new manhole covers shall meet requirements of appropriate utility. Manhole risers and any appurtenances shall be traffic-rated in accordance with AASTHO H20.

3. EXECUTION

3.1 SCHEDULE

The work shall commence within 2 weeks of notice to proceed.

3.2 PROTECTION

Contractor is responsible for maintaining completed work and environmental controls at all times, including during gaps in construction activity. Prevent stormwater run-on into disturbed areas that may be contaminated. Prevent stormwater runoff from disturbed areas that may be contaminated.

Maintain earthwork areas free of water at all times. Water may be allowed to infiltrate. Provide for the collection and disposal of surface water that does not infiltrate.

In areas where clean fill has been placed, grade the construction area to provide positive surface water runoff away from the construction activity or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils.

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F. Measure surface temperature by approved surface thermometers or other satisfactory methods.

3.3 SUBGRADE PREPARATION

3.3.1 Identify and mark the boundary of the area to be capped through professional survey in accordance with Section 02 21 00 “Surveying” and maintain the markings until construction is complete.

3.3.2 Clear and grub the area to be capped in accordance with Section 31 11 00 Clearing and Grubbing.

3.3.3 Grade and compact the area to within 0.1 feet of the lines and grades shown on the drawings. The top 6 inches of subgrade shall be compacted to 95 percent maximum dry density by Modified Proctor (ASTM D 1557) in accordance with Paragraph 3.5 of this specification section.

3.4 AGGREGATE BASE COURSE INSTALLATION

3.4.1 Contractor shall use Aggregate Base Course construct the base course. Install the base course to within 0.1 feet of the lines and grades shown on the drawings.

3.4.2 Install in maximum 3-inch loose lifts and compact each lift to 95 percent maximum dry density by Modified Proctor (ASTM D1557). Compaction testing and frequency shall be in accordance with Paragraph 3.5 of this specification section.

3.4.3 After installing the final lift, verify attainment of design grades through professional survey. Submit to the Engineer, topographic survey of the final surface.

3.5 SUBGRADE AND AGGREGATE BASE COURSE COMPACTION TESTING

3.5.1 Source Testing

Determine laboratory compaction characteristics and soil classification for each material used. Provide additional tests for every source change.
Sample all imported materials for the soil layers once per source. Collect samples according to laboratory instruction.

3.5.2 Field Density Tests

See following table. If a test location fails, the surrounding area shall be reworked up to at least half the distance to all nearby test locations that passed. Then, a new location within 10 feet of the previous test location shall be retested. Repeat until test location area passes.
Nuclear gauge results (ASTM D 2922 and D 3017) shall be compared with and calibrated to oven-dried water content (ASTM D 2216) and sand cone (ASTM D 1556) tests according to the larger of the frequencies of the oven-dried water content and sand cone tests.

FOUNDATION LAYER TESTING
REQUIREMENTS AND FREQUENCY

Test	ASTM Method	Frequency	Required Minimum Criteria
Density & Moisture	Nuclear gauge D2922 and D3017	One per 5,000 s.f.	See Compaction Requirements
Density	Sand Cone D1556	One per 50,000 s.f. (minimum one per week)	See Compaction Requirements
Moisture	Oven D2216 (with cor. to Nuclear gauge D2922)	One per 50,000 s.f. (minimum one per week)	See Compaction Requirements
Compaction Curves	Mod. Proctor D1557	One per change in material	n/a
Identification of Soils	D 2487	One per change in material	n/a

LAYER COMPACTION

Fill Type	Maximum Loose Lift Thickness[1] (in.)	Moisture Content	Percentage of Maximum Dry Density	Method of Test
Subgrade	6	± 3% of optimum	95% min	ASTM D1557
Aggregate Base Course	4	± 3% of optimum	95% min	ASTM D1557

3.6 HMA INSTALLATION

3.6.1 HMA shall be prepared off-site at a mixing plant approved by the Engineer.

3.6.2 HMA shall be mechanically placed and spread. Minimum HMA temperature prior to spreading shall be as shown in the table below.

MINIMUM SPREADING TEMPERATURES FOR 2-INCH THICK HMA

Base Course Temperature in Degrees F	Min. Spreading Temperature in Degrees F
45 – 50	285
>50 – 60	280
>60 – 70	275
>70 – 80	270
>80 – 90	265
>90	265

HMA that is at less than minimum spreading temperature when dumped into the spreader will be rejected. Adjust spreader and regulate speed so that the surface of the course is smooth and continuous without tears and pulling, and of such depth that, when compacted, the surface conforms to the cross section, grade, and contour indicated. Unless otherwise directed, begin the placing along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. Place mixture in consecutive adjacent strips having a minimum width of 10 feet, except for the edge strips which may be less than 10 feet wide. Establish lines parallel to the centerline of the area to be paved, and place string lines coinciding with the established lines for the spreading machine to follow. Provide the number and location of the lines needed to accomplish proper grade control. Place mixture as nearly continuous as possible and adjust the speed of placing as needed to permit proper rolling.

Shovelers and rakers shall follow the spreading machine. Add or remove hot mixture and rake the mixture as required to obtain a course that when completed will conform to requirements specified herein. Broadcasting or fanning of mixture over areas being compacted is prohibited. When segregation occurs in the mixture during placing, suspend spreading operation until the

cause is determined and corrected. Correct irregularities in alignment left by the spreader by trimming directly behind the machine. Immediately after trimming, compact edges of the course by tamping laterally with a metal lute or by other approved methods. Distortion of the course during tamping is prohibited.

Compact mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the edges and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least 1 foot. Alternate trips of the roller shall be of slightly different lengths. Conduct tests for conformity with the specified crown, grade and smoothness immediately after initial rolling. Before continuing rolling, correct variations by removing or adding materials as necessary. If required, subject course to diagonal rolling with the steel wheeled roller crossing the lines of the previous rolling while mixture is hot and in a compactible condition. Speed of the rollers shall be slow enough to avoid displacement of hot mixture. Correct displacement of mixture immediately by use of rakes and fresh mixture, or remove and replace mixture as directed. Continue rolling until roller marks are eliminated in accordance with ASTM D6925. During rolling, moisten wheels of the rollers enough to prevent adhesion of mixture to wheels, but excessive water is prohibited. Operation of rollers shall be by competent and experienced operators. In places not accessible to the rollers, compact mixture thoroughly with hot hand tampers. Skin patching of an area after compaction is prohibited. Remove mixture that becomes mixed with foreign materials or is defective and replace with fresh mixture compacted to the density specified herein. Roller shall pass over unprotected edge of the course only when laying of course is to be discontinued for such length of time as to permit mixture to become cold.

3.7 MANHOLE RISERS

Installation of manhole risers shall meet any requirements of appropriate utility. Install manhole risers in accordance with manufacturer's instructions. Manhole risers shall be installed 0.5-inch to 3-inches above adjacent asphalt final grade. Slope asphalt away from manhole.

3.8 QUALITY CONTROL

In the event and portion of completed work is found not to meet the requirements of the project specifications, the Contractor will be required to remove and re-install that portion of work to the satisfaction of the Engineer.

3.8.1 Sampling

3.8.1.1 Coarse and Fine Aggregates

Take a 50-pound sample from the cold feed at least once per source for sieve analyses and specific gravity tests. Additional samples may be required to perform more frequent tests when analyses show deficiencies, or unacceptable variances or deviations. Sampling shall be conducted in accordance with ASTM D75/D75M.

3.8.1.2 Mineral Filler

Collect one sample of mineral filler per source and conduct sieve testing in accordance with ASTM D546.

3.8.1.3 HMA and Pavement

Collect plant samples for the determination of mix properties, and field samples for thickness and density of the completed pavements. Furnish tools, labor and material for sample collection, and satisfactory replacement of pavement. Collect one HMA sample for every 10,000 square feet of pavement installed, and collect one pavement sample for every 10,000 square feet of pavement installed. Perform sampling in accordance with ASTM D979/D979M.

3.8.2 Testing

3.8.2.1 HMA Tests

a. Laboratory density of HMA by ASTM D6925. Samples for laboratory specimens shall be taken from trucks delivering mixture to the site; record the project areas represented by samples.

b. Field density of pavement by testing 4 inch diameter cores obtained from the pavement. Determine density in accordance with ASTM D1188 or ASTM D2726/D2726M, as applicable. Separate pavement layers by sawing or other approved means.

c. Thickness: Determine thickness of HMA course from samples taken for the field density test. The thickness shall not be less than that shown on the drawings. Where a deficiency is noted, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

d. Smoothness: Straightedge test the compacted surface of the pavement as work progresses. Apply straightedge parallel with and at right angles to the centerline after final rolling. Unevenness shall not vary more than 1/8 inch in 10 feet. Correct each portion of the pavement showing irregularities greater than the tolerance.

End of Section 32 12 16

SECTION 32 30 00

SITE RESTORATION

1. GENERAL

The work shall consist of the preparation of the seed bed and the installation and protection of two mixes of seed.

- ODC cap Area requires grass seed. ODC cap area will be sloped, contain topsoil, and no shade.
- Laydown areas require seed for sandy substrate, no shade, and may be seasonally inundated under high groundwater conditions.

The Contractor shall furnish all labor, materials, and equipment required or inferred from this section to complete the indicated work. Established performance standards shall be achieved in order for the Contractor to receive final acceptance. Seeding shall be coordinated with all other remediation and site activities.

1.1 REFERENCES

IDOT Illinois Department of Transportation

1.2 DEFINITIONS

1.2.1 Weeds

Include, but are not limited to, Phragmites, Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.2.2 Noxious Weeds

1.2.2.1 Harmful, undesirable, hard to control.

1.2.2.2 Include but are not limited to: Johnson Grass or Johnson Grass Crosses, Canadian Thistle, Quackgrass, Wild Garlic and Wild Onion, Bermuda Grass, Annual Blue Grass, Corn Cockle, Dodder, and Blindweed.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 Submittals:

1.3.1 Product Data

At least 10 days prior to seeding the Contractor shall provide for the approval of the Engineer, a written description of the two seed mixes to use for seeding. The description shall include the following information:

a. Botanical and common name, percentage by weight, germination, and weed seed for each species

b. The estimated number of seeds per pound of each kind of seeds to be furnished

c. A statement attesting to the purity and germination of the seed

d. The name and location of seed supplier.

e. The origin and date of harvest of each of the various kinds of seed

Contractor shall list the equipment to be used for seeding and demonstrate that the equipment is calibrated for the required seeding rates.

1.4 DESCRIPTION OF WORK

Provide vegetative cover to stabilize the site vegetating bare areas within the site work zone.

- ODC cap to be vegetated with grass seed.
- Laydown and disturbed areas on sandy substrate to be vegetated with appropriate mix.
- Re-grade, clean up, and re-vegetate areas disturbed during this remedial action.

1.5 QUALIFICATIONS

1.5.1 Seed vendor capable of providing adequate seed quality and quantities.

1.5.3 Planter specializing in planting and establishment of multiple acre grading and planting projects with 5 years documented experience.

1.6 REGULATORY REQUIREMENTS

Comply with regulatory agencies for fertilizer and herbicide composition.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Deliver seed mixtures in original sealed containers bearing seed Supplier's label and certificate indicating the content of species, grade, and mass. Seed in damaged packaging will be rejected. Remove from the site seed which has become wet, moldy, or otherwise damaged in transit or storage. Store seed in weatherproof enclosures.

1.7.2 Store other materials in accordance with manufacturer's instructions and in a manner to prevent damage or deterioration.

1.8 MEASUREMENT AND PAYMENT

1.8.1 Payment for site restoration shall be made on a per acre basis and will be paid under site stabilization/seeding bid item, as shown in Section 00 41 00 Bid Form.

1.8.2 Payment for ODC cap seeding will be made on a per acre basis and will paid under the ODC cap seeding bit item, as shown in Section 00 41 00 Bid Form.

1.8.3 Final payment will be made only after successful cover is in place.

1.8.4 There shall be no payment for any of the other work specified in this section.

2. PRODUCTS

2.1 SEED MIXTURE

2.1.1 Grass Seed

For the ODC cap and disturbed areas on the West Containment cell, a grass seed mixture is specified. Illinois Department of Transportation (IDOT) Class 3 Northern Illinois slope mix, which consists of the following drought resistant, heat resistant, shallow-rooted, low nutrient requiring grass species:

Canada Wild Rye (*Elymus canadensis*)	5 lbs. / acre
Perennial Ryegrass	20 lbs. / acre
Alsike Clover	5 lbs. / acre
Illinois Bundleflower (*Desmanthus illinoensis*)	2 lbs. / acre
Little Bluestem (*Andropogon scoparius*)	12 lbs. / acre
Side-Oats Grama (*Bouteloua curtipendula*)	10 lbs. / acre
Fults Salt Grass	30 lbs. / acre
Oats, Spring	50 lbs. / acre
Slender Wheat Grass	15 lbs. / acre
Buffalo Grass (Cody or Bowie)	5 lbs. / acre

2.1.2 Sandy Substrate Areas

The seed mixture for the laydown and disturbed areas on sandy substrate – outside of the cap areas, shall be submitted to the Engineer for approval prior to import to the site.

2.1.3 Weed Seed Content

Not over 0.5 percent and free of noxious weeds.

3. EXECUTION

3.1 REMOVAL OF TEMPORARY FACILITIES

Remove all temporary facilities installed by the Contractor including but not limited to:
a. Utility connections

b. Buried pipes and cables
c. Temporary site access roads, if applicable
d. Temporary structures
e. Process equipment and appurtenances
f. Pads constructed for staging, stockpiling, decontaminating or processing material
g. Temporary fences

3.2 REGRADE AREAS DISTURBED BY CONSTRUCTION ACTIVITIES

3.2.1 Regrade areas such as those on which temporary facilities including roads and pads were constructed.

3.2.2 Regrade work areas disturbed by clearing and grubbing and remediation support activities.

3.3 CLEANUP AREAS CONTAMINATED DURING REMEDIATION

3.3.1 Inspect the site for evidence of spills of potentially contaminated material along access roads, in staging areas, and other places where spills could have occurred.

3.4 VEGETATION / RE-VEGETATION

3.4.1 Areas to be vegetated or re-vegetated:

- ODC cap, and any unvegetated, unpaved areas extending to southern and western fencelines
- The contractor laydown area
- Any unpaved areas disturbed during the Northern Utility Cap and Western Utility Cap construction

In general, re-vegetate areas that previously had vegetation that was intentionally removed (such as during clearing and grubbing) or was destroyed unintentionally during remediation. Re-vegetate all excavation work areas and graded areas. Re-vegetate all disturbed areas on the West Containment Cell without impacting the construction and performance of its soil cap. Work with the Engineer to locate and identify areas to be re-vegetated.

3.4.2 No seed shall be sown during high winds, nor shall any seed be sown until a purity test has been completed for the seeds used.

3.4.3 Bare earth seeding shall be sown by use of a no-till seed drill or by broadcasting followed by light raking to incorporate the seed into the upper 0.5 inch of surface soil. If the contractor proposes to use mechanical equipment to sow the seed or rake, all equipment prior to being used shall be approved by the Engineer. Equipment shall be operated in a manner to ensure complete coverage of the entire area to be seeded and proper incorporation of the seed into the surface of the soil.

3.4.4 If seed is applied by broadcast methods, the Contractor shall mix the seed with a carrier of vermiculite, sawdust, sand, or other carrier approved by the Engineer.

The Contractor shall mix the seed with the carrier so as to uniformly distribute the seed throughout the carrier mix. Broadcasted seed shall be uniformly applied across the area to be seeded.

3.4.5 If seed is applied by mechanical methods, all equipment shall be approved for use and shall be calibrated and adjusted to sow seeds at the required seeding rate. Equipment shall be operated in a manner to ensure complete coverage of the entire area to be seeded and proper incorporation of the seed into the surface of the soil. All equipment mobilized to the site shall be washed prior to being brought on the site in order to prevent the possible spread of invasive species from other areas.

3.4.6 Start maintenance immediately after seeding until established and stable; this may include watering and other maintenance as necessary (note that there is no onsite source of water or power). Vegetative cover will be accepted if:

a. Vegetative cover is properly established over 95 percent of seeded surface within 120 days of application.

b. Turf is free of eroded, bare, or dead spots.

3.4.7 Re-seed areas which show signs of bare spots.

3.4.8 To the extent possible, the Contractor shall use paved areas to move trucks and equipment around the site. Parking or maneuvering of machinery, stockpiling of materials, or any other use will not be allowed in any unpaved areas within 10 feet of the root zone of trees or plants that will not be removed.

3.4.9 Note that the Contractor can provide alternative methods for seeding and establishing a temporary vegetative cover. The specific details of any alternate method should be provided with the bid application. Should the engineer accept an alternate approach, this specification may be modified as acceptable to both parties.

3.5 REPAIR DAMAGE TO PRE-EXISTING INFRASTRUCTURE

If the Contractor causes damage to any site infrastructure, the Contractor shall repair and restore the affected infrastructure to the satisfaction of the Engineer. There shall be no payment for this task.

3.6 GENERAL CLEANUP

Perform general cleanup in accordance with Section 01 74 00 Cleaning and Waste Management.

3.7 WASTE DISPOSAL

Dispose of all waste in compliance with Section 02 81 00 Transportation and Disposal of Nonhazardous and Hazardous Materials.

End of Section 32 30 00

SECTION 32 30 00

SITE RESTORATION

1. GENERAL

The work shall consist of the preparation of the seed bed and the installation and protection of two mixes of seed.

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c. A statement attesting to the purity and germination of the seed

d. The name and location of seed supplier.

e. The origin and date of harvest of each of the various kinds of seed

Contractor shall list the equipment to be used for seeding and demonstrate that the equipment is calibrated for the required seeding rates.

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Provide vegetative cover to stabilize the site vegetating bare areas within the site work zone.

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1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Deliver seed mixtures in original sealed containers bearing seed Supplier's label and certificate indicating the content of species, grade, and mass. Seed in damaged packaging will be rejected. Remove from the site seed which has become wet, moldy, or otherwise damaged in transit or storage. Store seed in weatherproof enclosures.

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Side-Oats Grama (*Bouteloua curtipendula*)	10 lbs. / acre
Fults Salt Grass	30 lbs. / acre
Oats, Spring	50 lbs. / acre
Slender Wheat Grass	15 lbs. / acre
Buffalo Grass (Cody or Bowie)	5 lbs. / acre

2.1.2 Sandy Substrate Areas

The seed mixture for the laydown and disturbed areas on sandy substrate – outside of the cap areas, shall be submitted to the Engineer for approval prior to import to the site.

2.1.3 Weed Seed Content

Not over 0.5 percent and free of noxious weeds.

3. EXECUTION

3.1 REMOVAL OF TEMPORARY FACILITIES

Remove all temporary facilities installed by the Contractor including but not limited to:
a. Utility connections

b. Buried pipes and cables
c. Temporary site access roads, if applicable
d. Temporary structures
e. Process equipment and appurtenances
f. Pads constructed for staging, stockpiling, decontaminating or processing material
g. Temporary fences

3.2 REGRADE AREAS DISTURBED BY CONSTRUCTION ACTIVITIES

3.2.1 Regrade areas such as those on which temporary facilities including roads and pads were constructed.

3.2.2 Regrade work areas disturbed by clearing and grubbing and remediation support activities.

3.3 CLEANUP AREAS CONTAMINATED DURING REMEDIATION

3.3.1 Inspect the site for evidence of spills of potentially contaminated material along access roads, in staging areas, and other places where spills could have occurred.

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3.4.2 No seed shall be sown during high winds, nor shall any seed be sown until a purity test has been completed for the seeds used.

3.4.3 Bare earth seeding shall be sown by use of a no-till seed drill or by broadcasting followed by light raking to incorporate the seed into the upper 0.5 inch of surface soil. If the contractor proposes to use mechanical equipment to sow the seed or rake, all equipment prior to being used shall be approved by the Engineer. Equipment shall be operated in a manner to ensure complete coverage of the entire area to be seeded and proper incorporation of the seed into the surface of the soil.

3.4.4 If seed is applied by broadcast methods, the Contractor shall mix the seed with a carrier of vermiculite, sawdust, sand, or other carrier approved by the Engineer.

The Contractor shall mix the seed with the carrier so as to uniformly distribute the seed throughout the carrier mix. Broadcasted seed shall be uniformly applied across the area to be seeded.

3.4.5 If seed is applied by mechanical methods, all equipment shall be approved for use and shall be calibrated and adjusted to sow seeds at the required seeding rate. Equipment shall be operated in a manner to ensure complete coverage of the entire area to be seeded and proper incorporation of the seed into the surface of the soil. All equipment mobilized to the site shall be washed prior to being brought on the site in order to prevent the possible spread of invasive species from other areas.

3.4.6 Start maintenance immediately after seeding until established and stable; this may include watering and other maintenance as necessary (note that there is no onsite source of water or power). Vegetative cover will be accepted if:

a. Vegetative cover is properly established over 95 percent of seeded surface within 120 days of application.

b. Turf is free of eroded, bare, or dead spots.

3.4.7 Re-seed areas which show signs of bare spots.

3.4.8 To the extent possible, the Contractor shall use paved areas to move trucks and equipment around the site. Parking or maneuvering of machinery, stockpiling of materials, or any other use will not be allowed in any unpaved areas within 10 feet of the root zone of trees or plants that will not be removed.

3.4.9 Note that the Contractor can provide alternative methods for seeding and establishing a temporary vegetative cover. The specific details of any alternate method should be provided with the bid application. Should the engineer accept an alternate approach, this specification may be modified as acceptable to both parties.

3.5 REPAIR DAMAGE TO PRE-EXISTING INFRASTRUCTURE

If the Contractor causes damage to any site infrastructure, the Contractor shall repair and restore the affected infrastructure to the satisfaction of the Engineer. There shall be no payment for this task.

3.6 GENERAL CLEANUP

Perform general cleanup in accordance with Section 01 74 00 Cleaning and Waste Management.

3.7 WASTE DISPOSAL

Dispose of all waste in compliance with Section 02 81 00 Transportation and Disposal of Nonhazardous and Hazardous Materials.

End of Section 32 30 00

DIVISION 33 UTILITIES

SECTION 33 23 00
EXTRACTION WELLS, MONITORING WELLS AND PIEZOMETERS

1. GENERAL

1.1. REFERENCES

1.1.1. 29 CFR Section 1926.650, OSHA Regulations, Excavation and Trenching Operations

1.1.2. ASTM C150 - Standard Specifications for Portland Cement

1.1.3. ASTM D422 - Standard Method for Particle Size Analysis

1.1.4. ASTM D1785 - Polyvinyl Chloride (PVC) Plastic Pipe Schedule 40, 80 and 120

1.1.5. ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

1.1.6. ASTM F480 - Standard Specifications for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimensional Ratio (SDR) Schedule 40 and 80

1.2. SUBMITTALS

1.2.1. Submit shop drawings and project data for the following items:

Drilling equipment
Extraction and monitoring well and piezometer casing
Extraction and monitoring well and piezometer screen
Protective extraction and monitoring well and piezometer casing
Well manholes and well head
Sand, bentonite, and cement

1.2.2. Submit signed copy of driller's log.

1.2.3. The well installation work shall be performed by an experienced contractor specializing in well installation and licensed in the State of Illinois.

1.3. PROJECT AND SITE CONDITIONS

1.3.1. Consult available soil data prior to drilling. Obtain additional soil data as required by this specification.

1.3.2. Following installation, all working areas shall be returned to a like new condition with new sod, fences, and plantings.

1.3.3. Well Surveying. Finished wells shall be surveyed by an Illinois licensed surveyor. Survey each extraction well, monitoring well, and piezometer. Report northing, easting, adjacent ground surface elevation, and top of casing elevation.

Use NAD 83 State plane Central coordinate system and NAVD 88 for vertical datum.

1.4. MEASUREMENT AND PAYMENT

1.4.1. General:

Payment for the extraction and monitoring well installation will be made for the actual number of units of work installed and at the contract unit price per linear foot of extraction, monitoring well, or piezometer installed. All other items such as well development, well manholes, concrete pads, well caps, pitless adapters, and all other appurtenance shall be included in the fixed unit price for the installation and development of 4-inch diameter extraction wells, 2-inch diameter monitoring wells, and 2-inch diameter piezometers.

2. MATERIALS

2.1 EQUIPMENT

2.1.1 Drilling Equipment

2.1.1.1 Extraction and monitoring wells and piezometers shall be installed by augering with a hollow stem auger or other approved method. Extraction and monitoring wells and piezometers shall be completed to the details shown on the Contract Drawings.

2.1.2 Well Developing Equipment

Furnish all submersible pumps, bailers, surge block pump hoisting equipment, piping, tanks, and all other necessary equipment for well development.

2.1.2.1 Jetting

2.1.2.1.1 One- and one-half-inch nominal diameter jetting pipe with four solid stream jet nozzles threaded at a 90-degree angle to the long axis of the jetting pipe and located at 90 degrees around the jetting pipe

2.1.2.1.2 Three-inch or larger piping to connect the jetting pipe to the water pump

2.1.2.1.3 Swivel joints or flexible connections on the piping to permit vertical and rotational movement of the jetting tool

2.1.2.1.4 A high-pressure water pump capable of delivering 100 gpm at a pressure of 250 psi and equipped with a flow meter and regulation valve.

2.1.2.1.5 A suction or airlift or submersible pump and equipment for well development. The suction pump should be capable of a

discharge at least as great as produced by the jetting equipment.

2.1.2.1.6 Miscellaneous connections and piping as required

2.1.2.2 Surging and Bailing

Furnish a solid type surge block, bailer, sand pump, and all necessary equipment for developing the well.

2.1.2.3 Storage Tanks

Furnish a temporary water storage tank for all development and startup water. Tanks shall be of sufficient capacity to provide storage until the treatment system is operational. Tanks shall be protected and covered.

2.2 MATERIAL

2.2.1 Extraction Well, Monitoring Well, and Piezometer Casing

2.2.1.1 All casing shall be manufactured of new, first quality material, and free of defects in workmanship and handling.

2.2.1.2 Extraction well casing shall be PVC Schedule 40 with flush thread joints conforming to ASTM D1785.

2.2.1.3 Monitoring well and piezometer casing shall be Schedule 40 with flush thread joints conforming to ASTM D1785.

2.2.1.4 Well bottom caps shall be same material as well casing.

2.2.1.5 Well casing diameter and length shall be as shown on the drawings.

2.2.2 Extraction Well, Monitoring Well, and Piezometer Well Screens

2.2.2.1 All extraction well screens shall be flush jointed and be made of PVC as indicated on the drawings.

2.2.2.2 All monitoring well and piezometer screens shall be flush jointed and be made of PVC Schedule 40 as indicated on the drawings. The screens shall have a slot size of 0.010-inch (10-slot).

2.2.2.3 Extraction Well Screens shall be flush jointed and be made of PVC Schedule 40. The screens shall have a slot size of 0.020-inch (20-slot) and shall be of the continuous opening type, with slots that widen inwardly to minimize clogging.

2.2.2.4 Provide all screen assembly fittings as required. All screen fittings shall be manufactured by the screen manufacturer and shall be designed for use with the particular well screen selected.

2.2.2.5 Each well shall have a sump/bottom cap below the screened interval as shown on the drawings. Bottom cap shall consist of Schedule 40 PVC with flush threaded joints.

2.2.3 Well Heads

2.2.3.1 Extraction well heads shall be SCH 40 PVC. The well head shall be capable of supporting the well pumps and its discharge riser. Well head shall be secured to the well casing with a sleeve type coupling as indicated on the Drawings or other approved method.

2.2.3.2 Top of the well head shall have a tapped 1-inch conduit fitting, a 3/4-inch tap on the opposite side for level probe conduit, and another 3/4-inch tap with a bronze plug.

2.2.4 Extraction Well, Piezometer, and Monitoring Well Vaults

2.2.4.1 Furnish and install extraction and monitoring well vaults as shown on the drawings. Vaults shall be cast iron and steel. The manhole covers shall be fitted with captive recessed access bolt system with an alignment tab. Vaults shall be fitted with Buna-N, neoprene, or EPDM gasket for watertight seal. Vaults shall be installed in concrete pads as shown on the drawings.

2.2.5 Sand Pack

2.2.5.1 Contractor shall supply all materials and equipment necessary for placing the sand pack as specified herein.

2.2.5.2 The sand for the sand pack shall be thoroughly washed, sound, durable, well rounded basalt or siliceous material, free of organic material, anhydride, gypsum, mica, or calcareous material.

2.2.5.3 The sand shall conform to the following gradation as determined by ASTM D422:

U.S. Standard Sieve Size	Grain Size (mm)	Percent Retained by Weight
12	1.70	0
16	1.18	94 +/- 5
20	0.85	22 +/- 16
30	0.60	3 +/-3

2.2.6 Cement Bentonite Grout

2.2.6.1 Portland Cement: Conforming to ASTM C150, Type I.

2.2.6.2 Bentonite. Wyoming benonite.

2.2.6.3 Water. Potable water

2.2.6.4 Cement to bentonite ratio shall be 9 to 1 by weight. Mixed grout shall contain no more than 7 gallons of water per bag (94 pounds) of cement.

2.2.7 Pitless Adapters
In accordance with Section 22 10 00 "Piping".

2.2.8 Extraction Well Pumps
Grundfos SP 16S05-5, 4-inch, with 4-inch , 230-v, 3-phase, 60 Hz, 0.5-hp motors (Grundfos 79302002 MS 402), or approved equal.

2.2.9 Extraction Well Pump Riser Pipe
In accordance with Section 22 10 00 "Piping".

3 INSTALLATION

3.1 MOBILIZATION AND CLEANUP

3.1.1 Set up well drilling equipment within the area required for well installation. Accomplish all required work in accordance with applicable portions of these Specifications.

3.1.2 Avoid contamination of the project area. Do not dump waste oil, fuels, rubbish, or other similar materials on the ground.

3.1.3 Augers and downhole equipment shall be decontaminated between locations.

3.1.4 Upon completion of well installation, remove from the site the drill rig and equipment, all debris, unused materials, and all other miscellaneous items resulting from or used in the operations.

3.2 DRILLING

3.2.1 Notify the Engineer five days prior to drilling.

3.2.2 Provide at all times a thoroughly experienced and competent driller present during all operations at the site of work.

3.2.3 Drill the hole at the location and to dimensions shown on the drawings and as approved by the Engineer.

3.2.4 The borehole shall be drilled so as to permit the installation of the casing and screen assembly in a plumb and true line.

3.2.5 Furnish the Engineer with a daily drilling log. The log shall accurately describe the geologic materials and depths encountered; the presence or absence of water; time, depth, and description of any unusual occurrences or problems during

drilling; and diameters and lengths of casing installed. Keep the log up-to-date with the progress of drilling. Keep a copy at the drill site for inspection by the Engineer.

3.2.6 Prepare and submit a final well log which shall include geologic log; borehole diameters; depth of the bottom of the casing and/or the bottom of the borehole; casing diameters and wall thicknesses; completion zones; screened interval(s); type, size, and quantity of gravel pack installed, and other information from the daily logs pertinent to the well construction.

3.3 FORMATION SAMPLES

3.3.1 Take representative formation samples for all boreholes using continuous core plastic sleeves.

3.3.2 Each sample shall be field classified in accordance with ASTM D2488.

3.4 CASING SCREEN ASSEMBLY

3.4.1 Casing lengths and screen shall be joined watertight by methods appropriate to the materials used. Joints shall have the same structural integrity as the casing.

3.4.2 Attach bottom plug or cap to the bottom of each screen.

3.4.3 All casing and screen assemblies shall be installed by an appropriate method. Install the casing and screen assembly in the hole, plumb, and true to line. Install centralizers on extraction well above and below well screen.

3.4.4 Install the screen assembly and fittings in conformance with the screen manufacturer's recommendations.

3.4.5 Casing or screen which fails, collapses, separates, or is not plumb and true to line shall be removed from the hole and repaired or replaced at Contractor's sole expense.

3.4.6 Install pitless adapter on the well casing as shown on the Drawings and in accordance with manufacturer’s instructions.

3.4.7 Cut top of casing perpendicular to ground. For extraction wells, cut all three casings (two piezometers and one extraction well) at the same elevation, perpendicular to the ground surface.

3.4.8 For extraction wells, install one piezometer on the north side of the extraction well and one piezometer on the south side of the extraction well.

3.5 SAND PACK

3.5.1 Introduce the sand into the annulus around the casing and screen assembly at a metered uniform rate in a manner that will allow even placement of the sand. Take every precaution which will ensure the proper placing of sand continuously without separation or bridging. During placement, the top of the sand shall be

continuously sounded to measure its rate of rise and to determine if bridging is occurring.

3.5.2 The sand pack shall extend at least 1 foot above the top of the screen.

3.6 BENTONITE SLURRY

3.6.1 Portion 50 pounds of bentonite to 14 gallons of fresh, clean water. The slurry will weigh about 10.2 pounds per gallon. Adjust mixture so that the slurry weighs 11.0 pounds per gallon plus or minus 0.25 pound.

3.6.2 The bentonite slurry shall be placed by forcing the grout from the bottom of the annulus. The grouting shall be done continuously and in such a manner as will ensure the filling of the entire annular space in one operation. The slurry shall be from the top of the fine sand collar to the bottom of the non-shrink grout.

3.7 NON-SHRINK GROUT

3.7.1 Non-shrink grout shall have 1/4-inch maximum size coarse aggregate. Aggregate, cement, sand and water shall be in the same proportions as Class B concrete.

3.7.2 The grouting shall be done continuously and in such a manner as will reinsure the entire filling of the annular space in one operation.

3.7.3 Non-shrink grout shall be used from 10 feet below the surface to the surface.

3.8 WELL DEVELOPMENT

3.8.1 After the casing and screen assembly has been installed and the extraction and monitoring well construction completed, develop each well by a combination of high velocity pumping and vigorous mechanical surging. Development should begin above the screen and move progressively downward to prevent the surge block from becoming sand locked in the well. The pump shall be raised and lowered throughout the screened interval to suspend and collect dislodged sediment and fully develop the well. Development shall continue until the well discharge turbidity is less than 0.5 NTU.

3.8.2 Upon completion of development, clean each well to the bottom.

3.9 COMPLIANCE WITH GOVERNMENTAL REGULATIONS

Construct wells in strict conformance with all laws, rules, regulations, and standards related to the construction of wells in the State of Illinois.

3.10 DISPOSAL OF DRILLING CUTTINGS

Fluids shall be collected in 55-gallon drums for disposal in accordance with Section 02 81 00 "Transportation and Disposal of Nonhazardous and Hazardous Materials." Drill cuttings can be managed with the excavation spoils in accordance with Sections 31 00 00 and 31 55 00 and 02 81 00.

3.11 DISPOSAL OF WATER

Development water shall be containerized in a temporary above ground storage tank and shall be sampled for PCBs, VOCs and total suspended solids (TSS). Analytical results must be provided to Engineer for review and approval. The development water can be pumped into the surge tank of the on-site treatment plant being constructed by others. The development water will be pumped to the treatment system in batches of no more than 500 gallons each. Coordinate transport and treatment with Engineer and other Consultant and Contractors.

The storage tank must be decontaminated prior to demobilization from the site.

If the on-site treatment plant is not operational, then the development water will be characterized and disposed of off site at the sole expense of the Contractor at a wastewater treatment plant Section 02 81 00 "Transportation and Disposal of Nonhazardous and Hazardous Materials".

3.12 SURVEYING

Provide top of casing elevation, northing and easting for each monitoring well and piezometer in accordance with Section 02 21 00 "Surveying." Provide elevation of well vault rim.

For each extraction well, provide top of casing elevations for the extraction well and two piezometers. Denote survey results as follows, ODC-EW-2-N (for northern piezometer), ODC-EW-2-E (for extraction well), and ODC-EW-2-S (for southern piezometer).

3.13 PUMP INSTALLATION

Install pump, drop pipe, and pitless adapters in accordance with manufacturer's instructions for leak free connections. Pump, drop pipe, and pitless adapters shall be hydrostatically tested in accordance with Section 22 10 00 "Piping and Valves"

End of Section 33 23 00

SECTION 33 29 00
WELL ABANDONMENT

1. GENERAL

1.1 DESCRIPTION OF WORK

This section describes the work involved in abandoning two existing monitoring wells that are located within the work area. The approximate locations are shown on the drawings.

1.2 DEFINITIONS

1.2.1 "Grout" means a slurry of cement or bentonite material that is used to seal a well, test hole, dry hole, or annular space.

1.2.2 "Seal" means to close or properly abandon a well, cistern or hauled water storage tank or to close a portion of a well or the annular space of a well.

1.3 REFERENCES

1.3.1 Regulations

1.3.1.1 All applicable regulations and standards for the completion of the work specified herein, as identified by Lake County Department of Public Health, Joint Committee on Administrative Rules, Administrative Code Title 77 Chapter I, Subchapter r, Part 920.120.

1.3.2 Guidance - Not used.

1.3.3 Specifications – Not used.

1.4 SUBMITTALS

1.4.1 The Contractor shall provide the following submittals prior to performing well abandonment work:

1.4.1.1 Description of equipment used to abandon the wells.
1.4.1.2 Description of materials used to abandon the wells.
1.4.1.3 Certifications, licenses, and permits in accordance with the State of Illinois
1.4.1.4 A schedule for the work.

1.4.2 The Contractor shall provide the following submittals as documentation of the well abandonment work within 30 days after the completion of the sealing of the well:

1.4.2.1 Well sealing reports using forms prescribed and prepared by the Lake County Department of Public Health, to include the following:

a. The name and the state plane coordinates or the latitude and longitude of the well;
b. The depth of the well, the size and length of its casing, and the static water level of the well;
c. The sealing procedures, including the volume and type of sealing material or materials and the method and depth of placement of each material;
d. The date on which the sealing was performed;
e. The signature of the individual who sealed the well and filed the sealing report;
f. Any other information required by the Lake County Department of Public Health, as indicated on the forms.

1.5 MEASUREMENT AND PAYMENT

The work under this section will be measured by the linear feet of wells abandoned. The cost of all work under this section shall be included in the unit price item per well abandonment. The payment shall be considered full compensation for all materials, labor, and equipment required to complete the work as specified under this Section, subject to acceptance.

2. PRODUCTS

2.1 MATERIALS

The Contractor shall use materials that comply with specifications provided by the Lake County Department of Public Health, the State of Illinois Department of Public Health, and the Illinois Environmental Protection Agency.

3. EXECUTION

3.1 EXECUTION

3.1.1 Wells should be abandoned by Illinois licensed water well drillers.

3.2 PREPARATION

3.2.1 Perform necessary equipment safety checks.
3.2.2 Ensure correct quantity of materials needed to seal the wells.

3.3 WELL SEALING/ABANDONMENT

3.3.1 Remove all associated equipment or obstructions from the well (pumps, drop pipes, etc.)
3.3.2 Remove well casing by pulling or overdrilling, or by method approved by the Engineer.
3.3.3 Seal the well by grouting from the bottom up by using neat cement grout or any bentonite product manufactured for well sealing.
3.3.2 Sealing material shall be applied to full depth of the well and shall terminate within 3-4 feet of the ground surface.
3.3.3 Well casing or liner shall be removed to at least 3-4 feet below final grade.
3.3.4 Upper 4 to 6 inches of borehole shall be restored to existing ground surface conditions.

3.4 CLEANUP

3.4.1 Remove excess materials and other debris from the work area and restore the ground surface.

End of Section 33 29 00

PROJECT NUMBER	WELL NUMBER	
425041.RI.01	MW-611D	SHEET 1 OF 1

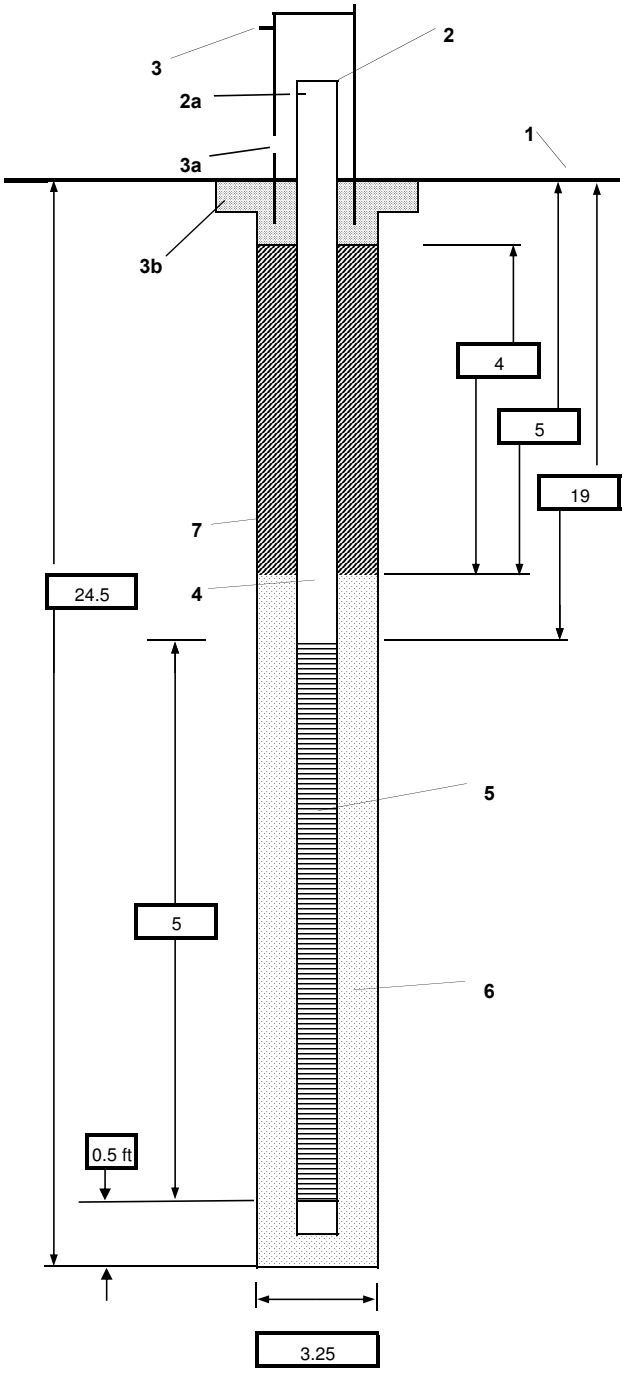
WELL COMPLETION DIAGRAM

PROJECT : OMC Plant 2 DATE: 12/13/2013

DRILLING CONTRACTOR : EFS

DRILLING METHOD AND EQUIPMENT USED : 3.25-inch I.D. DPT

WATER LEVELS : 3.8 ft bgs START: 0945 END : 1100 LOGGER : A. Kozak



1- Ground elevation at well	NA
2- Top of casing elevation	NA
a) vent hole?	No
3- Wellhead protection cover type	Stick up
a) weep hole?	No
b) concrete pad dimensions	2 ft x 2 ft x 4 inches
4- Dia./type of well casing	1.5- inch diameter schedule 40 PVC
5- Type/slot size of screen	1.5- inch diameter schedule 40 PVC 0.010 slot
6- Type screen filter	20/40 sand to 1 ft above screen.
a) Quantity used	NA
7- Type of seal	Bentonite
a) Quantity used	8 lbs
Development method	Surge and Purge
Turbidity	75.3 NTU
Estimated purge volume	25 gallons

Comments 6-inch filter pack sand placed in bottom of borehole prior to monitoring well installation.
Concrete pad to be installed in warmer temperatures.
Native sand collapsed.

PROJECT NUMBER	WELL NUMBER	
425041.RI.01	MW-611S	SHEET 1 OF 1

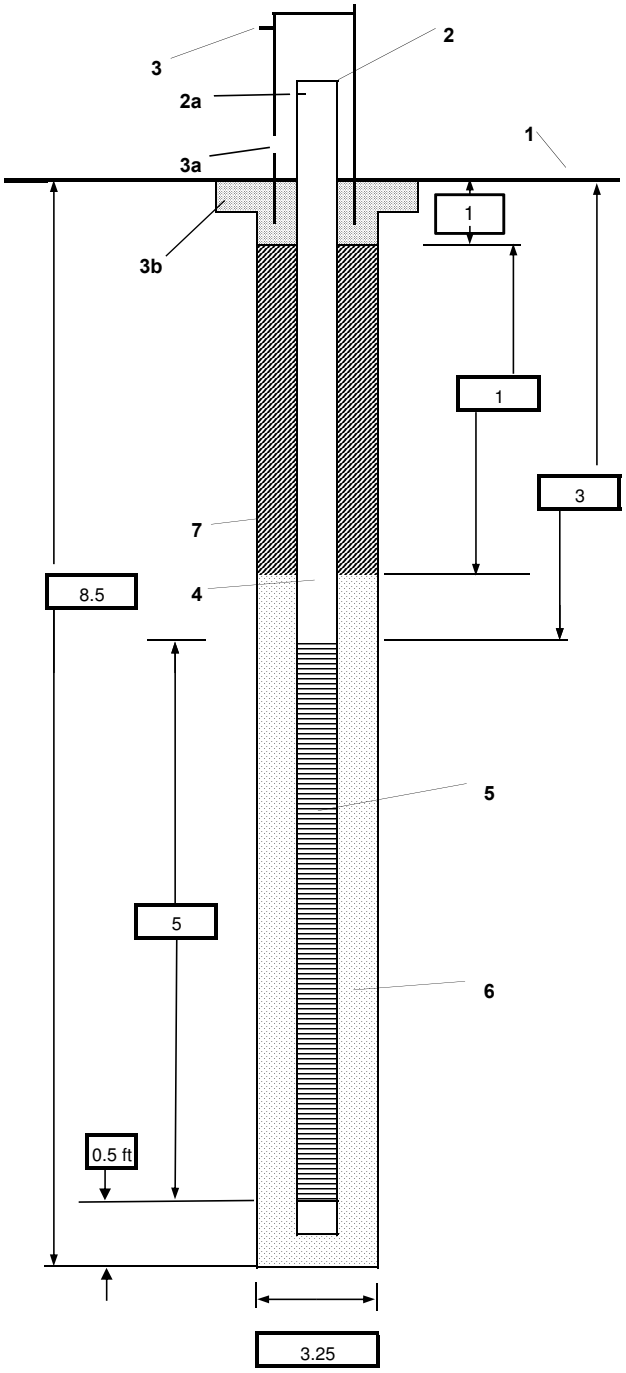
WELL COMPLETION DIAGRAM

PROJECT : OMC Plant 2 DATE: 12/13/2013

DRILLING CONTRACTOR : EFS

DRILLING METHOD AND EQUIPMENT USED : 3.25-inch I.D. DPT

WATER LEVELS : 3.5 ft bgs START: 0945 END : 1100 LOGGER : A. Kozak



1- Ground elevation at well	NA
2- Top of casing elevation	NA
a) vent hole?	No
3- Wellhead protection cover type	Stick up
a) weep hole?	No
b) concrete pad dimensions	2 ft x 2 ft x 4 inches
4- Dia./type of well casing	1.5- inch diameter schedule 40 PVC
5- Type/slot size of screen	1.5- inch diameter schedule 40 PVC 0.010 slot
6- Type screen filter	20/40 sand to 1 ft above screen.
a) Quantity used	NA
7- Type of seal	Bentonite
a) Quantity used	~3 lbs

Development method	Surge and Purge
Turbidty	14.1 NTU
Estimated purge volume	10 gallons

Comments 6-inch filter pack sand placed in bottom of borehole prior to monitoring well installation.

Well collapsed, resulting in less benotnite used.

Concrete pad to be installed in warmer temperatures.

PROJECT NUMBER	WELL NUMBER	
425041.RI.01	MW-613D	SHEET 1 OF 1

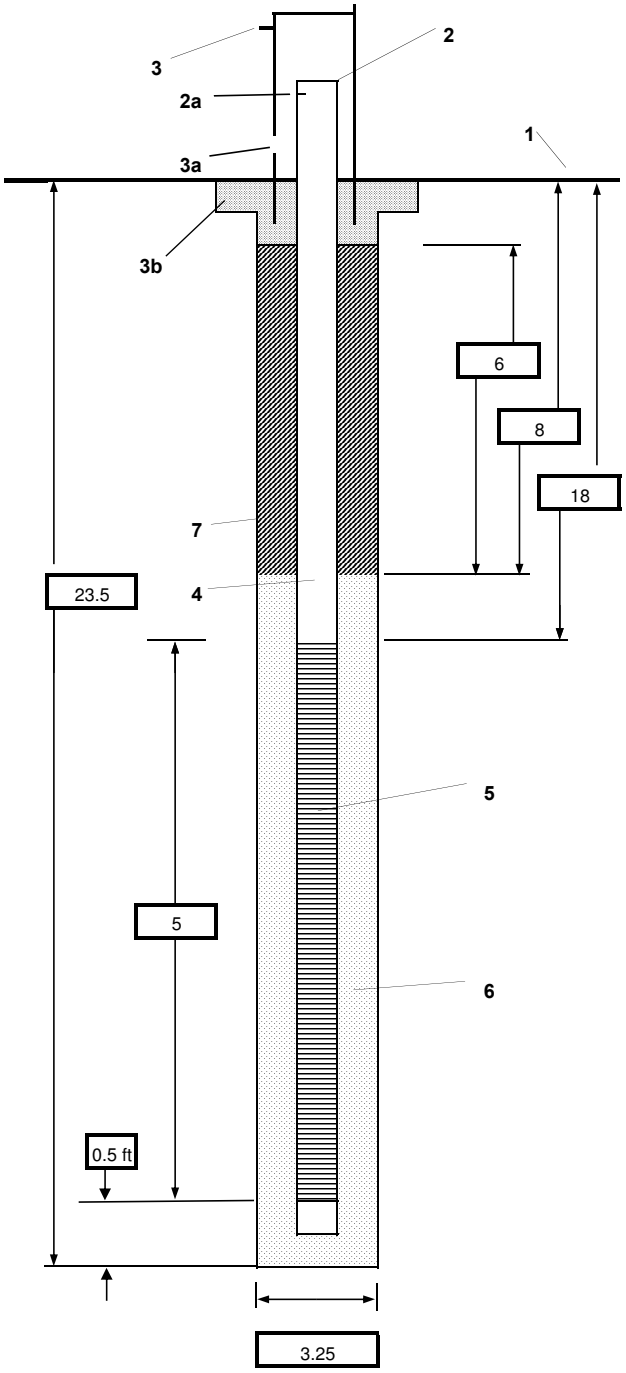
WELL COMPLETION DIAGRAM

PROJECT : OMC Plant 2 DATE: 12/13/2013

DRILLING CONTRACTOR : EFS

DRILLING METHOD AND EQUIPMENT USED : 3.25-inch I.D. DPT

WATER LEVELS : 4.0 ft bgs START: 1125 END : 1310 LOGGER : A. Kozak



1- Ground elevation at well	NA
2- Top of casing elevation	NA
a) vent hole?	No
3- Wellhead protection cover type	Stick up
a) weep hole?	No
b) concrete pad dimensions	2 ft x 2 ft x 4 inches
4- Dia./type of well casing	1.5- inch diameter schedule 40 PVC
5- Type/slot size of screen	1.5- inch diameter schedule 40 PVC 0.010 slot
6- Type screen filter	20/40 sand to 1 ft above screen.
a) Quantity used	NA
7- Type of seal	Bentonite
a) Quantity used	10 lbs
Development method	Surge and Purge
Turbidity	106 NTU
Estimated purge volume	25 gallons

Comments 6-inch filter pack sand placed in bottom of borehole prior to monitoring well installation.
Concrete pad to be installed in warmer temperatures.
Native sand collapsed.

PROJECT NUMBER	WELL NUMBER	
425041.RI.01	MW-613S	SHEET 1 OF 1

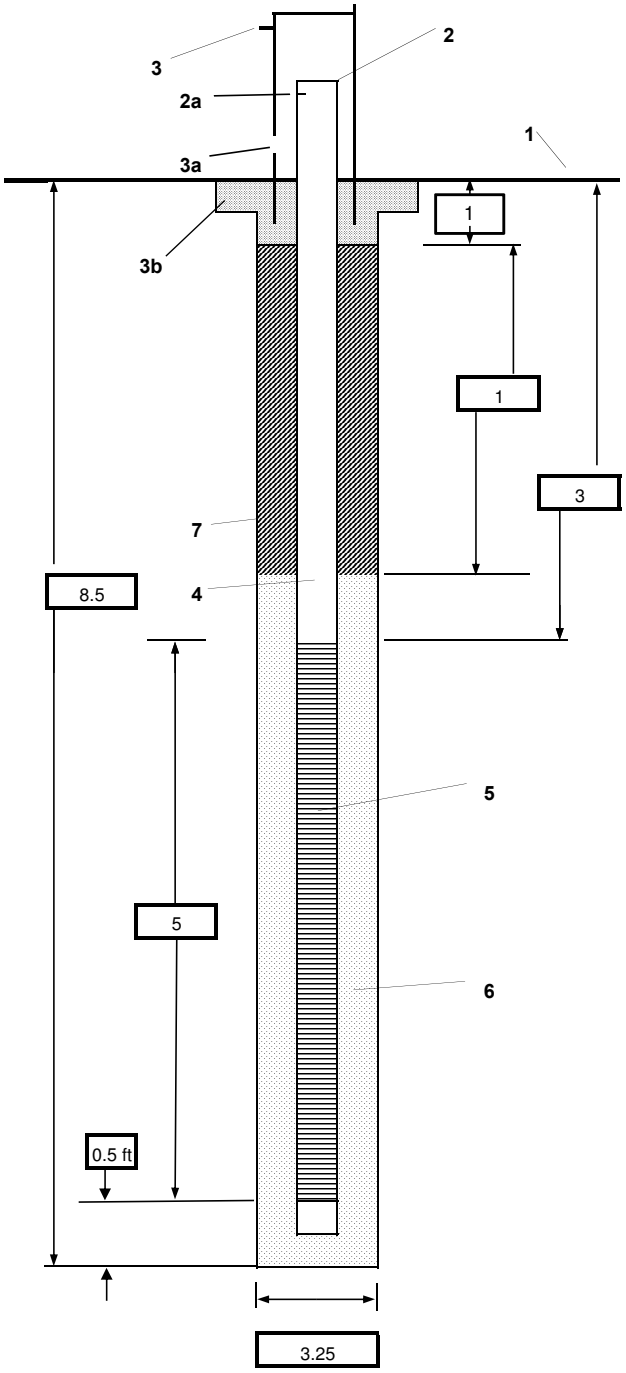
WELL COMPLETION DIAGRAM

PROJECT : OMC Plant 2 DATE: 12/13/2013

DRILLING CONTRACTOR : EFS

DRILLING METHOD AND EQUIPMENT USED : 3.25-inch I.D. DPT

WATER LEVELS : 3.4 ft bgs START: 1125 END : 1310 LOGGER : A. Kozak



1- Ground elevation at well	NA
2- Top of casing elevation	NA
a) vent hole?	No
3- Wellhead protection cover type	Stick up
a) weep hole?	No
b) concrete pad dimensions	2 ft x 2 ft x 4 inches
4- Dia./type of well casing	1.5- inch diameter schedule 40 PVC
5- Type/slot size of screen	1.5- inch diameter schedule 40 PVC 0.010 slot
6- Type screen filter	20/40 sand to 1 ft above screen.
a) Quantity used	NA
7- Type of seal	Bentonite
a) Quantity used	~4 lbs
Development method	Surge and Purge
Turbidty	49.7 NTU
Estimated purge volume	10 gallons

Comments 6-inch filter pack sand placed in bottom of borehole prior to monitoring well installation.
Well collapsed, resulting in less bentonite used.
Concrete pad to be installed in warmer temperatures.

ATTACHMENT

City Sewer Drawing Excerpt