Appendix D
Union Pump Station Preliminary Design Report

DRAFT REPORT

Long-Term Control Plan Update

Union Pump Station –Preliminary Design Report

Prepared for

Greater New Haven Water Pollution Control Authority

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ACGIH	American Conference of Governmental Industrial Hygienists
ACH	air changes per hour
ACI	American Concrete Institute
AFD	adjustable frequency drive
AISC	American Institute of Steel Construction
ANSI	American National Standard Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
ATC	automatic temperature control
Authority	Greater New Haven Water Pollution Control Authority
AWWA	American Water Works Association
BEP	best efficiency point
BFE	base flood elevation
CAIECC	Connecticut Amendments to the International Energy Conservation Code
CFD	computational fluid dynamics
cfm	cubic feet per minute
CISPI	Cast Iron Soil Pipe Institute
CMU	concrete masonry unit
CSBC	Connecticut State Building Code
CSO	combined sewer overflow
DC	direct current
DDC	direct digital control
DFE	design flood elevation
DLR	device level ring
DWF	dry weather flow
DX	direct expansion
fps	feet per second
FRP	fiberglass reinforced plastic
ft^2	square feet
ft^3	cubic feet
GNHWPCA	Greater New Haven Water Pollution Control Authority
gpm	gallon(s) per minute
H_2S	hydrogen sulfide
HI	Hydraulic Institute
HMI	human-machine interface
hp	horsepower
HSS	hollow structural sections
HVAC	heating, ventilation, and air conditioning
I&C	instrumentation and controls
I/O	input/output
IBC	International Building Code

ICRI	International Concrete Repair Institute, Inc.
IEBC	International Existing Building Code
IECC	International Energy Conservation Code
IMC	International Mechanical Code
IPC	International Plumbing Code
ksi	kilopound(s) per square inch
kVA	kilovolt-ampere(s)
LTCP	long-term control plan
MAU	make-up air unit
MCC	motor control center
mgd	million gallon(s) per day
mph	mile(s) per hour
NaOH	sodium hydroxide
NAVD 88	North American Vertical Datum of 1988
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association (NEMA)
NFPA	National Fire Protection Association
NGVD 29	National Geodetic Vertical Datum of 1929
NPV	net present value
O&M	operations and maintenance
OIT	operator interface terminal
pcf	pound(s) per cubic foot
PLC	programmable logic controller
POR	preferred operating range
ppmv	part(s) per million by volume
psf	pound(s) per square foot
psi	pound(s) per square inch
RPM	revolution(s) per minute
SLR	sea level rise
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SSPC	Structural Steel Painting Council
TDH	total dynamic head
UI	United Illuminating
UL	Underwriter's Laboratory
UPS	uninterruptable power supply
VFD	variable-frequency drive
WEF	Water Environment Federation
WPAF	water pollution abatement facility
WSE	water surface elevation
WWF	wet weather flow
WWTP	wastewater treatment plant

SECTION 1

Hydraulics

1.1 Introduction

The *Long-Term Control Plan (LTCP) Update* includes alternatives that control combined sewer overflow (CSO) discharges from all CSO outfalls to meet a 2-year, 6-hour level of CSO control (zero discharges) by 2040. The LTCP Update includes short term, intermediate term, and long term improvements to meet these stated goals. This Preliminary Design Report of the LTCP focuses on intermediate and long term improvements at the Union Street Pump Station (Union). Preliminary Design Drawings are shown in Appendix A of the report.

1.2 Basis of Design

1.2.1 Hydraulic Design Objectives

The hydraulic design objective is to upgrade the Union, East Street and Boulevard Pump Stations to convey the maximum flow to the East Shore Water Pollution Abatement Facility (ESWPAF) resulting in CSO mitigation.

Models were developed to calculate how much flow can be conveyed to the wet well of the pump station using the existing and upgraded infrastructure and to evaluate improvements to the pump station to allow the station to convey the design flows.

1.2.2 Design Flows and Pumping Strategy

The flow scenarios (Table 1-1) analyzed were developed from the 2015 Hydraulic Model. The model identified the design flows necessary for the system to meet the 2-year, 6-hour level of service. Three flow scenarios were analyzed during the LTCP Update: short-term, intermediate-term, and long term.

The short-term improvements do not impact the existing flows from the three GNH pump stations. The total flow conveyed to the East Shore WPAF from the pump stations is 60 million gallons per day (mgd) split between Boulevard and East Street with each pump station pumping 30 mgd. Union currently pumps 15 mgd to East Street.

The intermediate term improvements increase the total flow conveyed to the ESWPAF. Union will be upgraded to pump 35 MGD capacity under the intermediate improvements, but capacity will be limited to between 15 and 25 MGD. East Street will be upgraded to pump up to 65 MGD, but capacity will be limited to 40 MGD. This is an increase of 10 MGD over existing capacity. Boulevard will be increased to pump up to 45 MGD, but capacity will be limited to 30 MGD.

The long-term improvements increase the total flow conveyed to the East Shore WPAF by the three pump stations to 110 mgd. The flows from the pump stations are 35 mgd from Union (pumping to East Street), 65 mgd from East Street, and 45 mgd from Boulevard.

Table 1-1. Flow Scenarios

Pump Station	Short-Term Flows (mgd)	Intermediate-Term Flows (mgd)	Long-Term Flows (mgd)
Union (to East)	15	25	35
East	30	40	65
Boulevard	30	30	45

The design parameters and considerations in selecting pumps for the stations include;

1. Create maximum reliability, efficiency and redundancy for flows in the dry weather range since flows in the dry weather range occur 98 percent of the time during a typical year.
2. Utilize extended shaft centrifugal pumps.
3. Maintain N+1 for dry weather and wet weather pumping conditions.
4. Consider space restrictions in existing station footprints.
5. Avoid cycling of flows at the East Street and Boulevard Pump Stations since these flows go directly to the ESWPAF.
6. Select pumps to operate well within the pump manufacturers' defined allowable operating range (AOR) for both wet and dry weather conditions.
7. For high frequency flow capacities, select pumps to operate within the pump's preferred operating range (POR) as defined by the Hydraulic Institute Standards (HIS) to obtain high wire-to-water pump efficiencies for both wet and dry weather conditions. For less frequent lower flow capacities, size pumps for operation well within the candidate pump manufacturers' defined allowable operating range (AOR).
8. Maintaining impeller tip speed to prevent accumulation of rags within the volute.
9. Maintaining scouring velocities in pump discharges to prevent grit accumulation.
10. Avoiding high VFD and corresponding pump speed turndown.

1.3 Hydraulic Model

Two models were developed for each pump station to identify the improvements necessary to meet the design flows.

Improvements necessary to convey the design flows by gravity from the sanitary sewer to the wet well were identified by computing a hydraulic profile using CH2M's proprietary software, WinHydro. The hydraulic model was prepared using available mechanical, structural, and civil plan-and-profile record drawings, site visits and photos.

Improvements to the existing pump station pumping capacity and force mains were identified through incompressible pipe flow modeling using AFT Fathom version 8.0. The hydraulic model was prepared using available mechanical, structural, and civil plan-and-profile record drawings and photos.

Record drawings are in the National Geodetic Vertical Datum of 1929 (NGVD 29) and have been converted to the North American Vertical Datum of 1988 (NAVD 88) by subtracting 1.05 feet from NGVD 29. All elevations referenced in this section are in NAVD 88.

1.4 Hydraulic Analyses

1.4.1 Hydraulic Profile

The hydraulic profile from the influent sewer through the station and into the wet well at Union includes the following:

- Influent Chamber flow split between screening channels
- Screening Channel (two channels)
- Junction Chamber downstream of the screening channels
- Flow split to the divided wet well

The analysis included the following two alternatives:

- Alternative 1 – replacement of mechanical screens.
- Alternative 2 – provide a grinder in each screening channel to grind debris entering the pump station for protection of the pumps.

The alternatives were run at the proposed long-term flow of 35 mgd. At this flow rate it was assumed both screening channels would be in service.

The results of the analysis are as follows:

- **Alternative 1.** The water surface elevation (WSE) coming into the influent chamber is -6.6 feet. The sewer invert coming into the chamber is -6.8 feet. This shows at max flows there is 0.2 feet of water depth as the sewer enters the chamber. A model run was performed with a WSE at the influent chamber of -6.6 feet. The run shows that the upstream infrastructure was able to deliver 35 mgd to the pump station under this alternative.
- **Alternative 2.** The WSE coming into the influent chamber with the grinders installed is -5.3 feet. The grinders' head loss was taken from the manufacturer's literature. A model run was performed with a WSE at the influent chamber of -5.3 feet. The run shows that the upstream infrastructure was able to deliver 35 mgd to the pump station with the grinders installed.

1.4.2 Pipe Flow Modeling

A pipe flow model was created using AFT Fathom to represent the pressurized system. The model included East Street, Union, and Boulevard Pump Stations, their force mains, the harbor crossings, and force main to East Shore WPAF. The model base was built from existing conditions. Various alternatives were added to the model to identify the improvements necessary to meet the design flows at the short-term, intermediate-term, and long-term scenarios. All scenarios used an N+1 design to meet the design flow rate with the largest pump out of service.

1.4.2.1 Union Pump Station

Union Pump Station currently has four pumps with space for a fifth pump. There are three different pump sizes. There are two large pumps with capacities of 12.9 mgd, one medium pump with a capacity of 7.2 mgd and one small pump with a capacity of 3.6 mgd. The station's firm pumping capacity is 23.7 mgd and the total pumping capacity is 36.6 mgd. Pump station flows are limited to 15 mgd during peak flows to avoid overflows in the Water Street gravity system. The station pumps to a 24-inch force main over the railroad to the submergence chamber where the flow transitions to gravity. The gravity sewer flows to the East Street Pump Station

The dry weather flow rates were calculated from the 2015 Hydraulic Model. The minimum dry weather flow to the Union Pump Station is 1.5 mgd and the average dry weather flow to Union is 3.8 mgd. The maximum flows of 35 mgd occur twice a year.

The existing pumps do not have the capacity to meet the long-term pumping scenario with the largest pump out of service (N+1 redundancy criteria). Several scenarios were investigated to meet the design flows.

- **Scenario 1** (five pumps, three large and two small): This scenario utilizes the large pumps for wet weather flows and the small pumps for dry weather flows. The dry weather pumps were sized to efficiently pump the minimum flows to avoid cycling. To achieve this, the dry weather pumps were sized for 3.8 mgd and would require both pumps in service to meet the maximum dry weather flowrate. Pump redundancy would be provided by one of the wet weather pumps which would cycle at the maximum dry weather flows in the event one of the dry weather pumps was out of service.

The wet weather pumps would be sized to pump the maximum flows with one pump out of service. Each wet weather pump would be rated at 17.5 mgd.

- **Scenario 2** (five pumps, three large and two small): This scenario was similar to the previous with one exception: The dry weather pumps were sized to pump the maximum dry weather flowrate with one pump out of service. To achieve this, the pumps would cycle at the minimum dry weather flowrate. The wet weather pumps are identical to those described above.
- **Scenario 3** (five pumps, two large and three small): This scenario would require two pumps at 12.5 mgd and three pumps at 7.5 mgd. All pumps would be sized to pump together during wet weather. This closely matches existing capacities and would not require modifications to the existing suction piping. At max flow, the suction velocity in the existing 16-inch suction pipe is 7.5 feet per second (fps), below the max velocity recommendation of 8 fps in Hydraulic Institute (HI) standards.

It was determined that Scenario 2 was the best option to meet the design flows. This scenario allows for one of the dry weather pumps to meet the maximum dry weather flow with possible cycling (allowing the second dry weather pump to be the N+1 pump), does not require replacement of the existing wall pipes to meet maximum suction velocities, and allows for 480V service loads.

Table 1-2 shows the proposed pump operation under several flow regimes for the intermediate- and long-term flow scenarios.

Table 1-2. Pump Operation

		Total Flow (mgd)	Dry Weather Pump	Wet Weather Pump
Intermediate	Min. Dry Weather	1.5	1 pump	0
	Avg. Dry Weather	3.8	1 pump	0
	Max. Dry Weather	6.3	1 pump	0
	Max Wet Weather	25	0	2 Pumps
Long-Term	Min. Dry Weather	1.5	1 pump	0
	Avg. Dry Weather	3.8	1 pump	0
	Max. Dry Weather	6.3	1 pump	0
	Max Wet Weather	35	0	2 Pumps

1.4.2.2 Force Mains

The existing force main from Union is 24 inch and extends 230 feet to the submergence chamber where it discharges via gravity. Velocities within the force main average below 8 fps, and can peak at velocities around 16 fps a few times during the year. The duration of these peak flows are minimal. Design velocities are well within the acceptable range for this size force main. It is recommended to maintain a 24 inch forcemain.

SECTION 2

Process Mechanical

2.1 Introduction

This section describes the basis of the process mechanical design associated with improvements to meet the intermediate and long-term flow scenarios and improve reliability of the station.

2.2 Pump Station Existing Conditions

2.2.1 Background and Existing Conditions

The design drawings for Union are dated February 25, 1960 and it is assumed the station was constructed shortly thereafter. Union is located below the elevated roadway of State Street North to the west of the Amtrak Rail Line. The station is bounded by the rail line to the east, Water Street to the south, South State Street to the west, the Knights of Columbus Museum to the north, and State Street North above. Due to the site constraints there is limited space available for expansion.

A 42-inch reinforced-concrete pipe (RCP) sewer enters an influent junction chamber from the west. A sluice gate is installed on the sewer entering the pump station. Flow splits between two screen channels downstream of the influent junction chamber. Sluice gates are installed on the influent and effluent of the screen channels. Mechanical bar screens were installed in the screen channels but have since been removed. The screen housings above the channels are still present. Figure 2-1 shows the screen channels and housings.

Figure 2-1. Existing Screen Channels

Downstream of the screen channels, the flow combines again. The flow then splits to the two sides of the divided wet well. Sluice gates are located on the wet well influent channels and a sluice gate is located on the wet well dividing wall.

There are four pumps currently installed; two on each side of the divided wet well. A small pump and large pump are connected to the north wet well and a medium pump and large pump are connected to the south wet well. An additional suction wall pipe is located on the south wet well for installation of a fifth pump. The small pump has a 16-inch wall pipe, the large pumps have 24-inch wall pipes and the medium pump and additional suction wall pipe are 20 inches.

Each pump listed in Table 2-1 is an extended shaft centrifugal pump manufactured by Fairbanks-Morse.

Table 2-1. Existing Pumps

Pump	Make/Model	Rated Capacity	Motor Size	Speed
1	Fairbanks Morse 12”- 5710	3.6 mgd	25 HP	860 rpm
2	Fairbanks Morse 18” - E5711	12.9 mgd	75 HP	590 rpm
3	Fairbanks Morse 14”- 5710	7.2 mgd	50 HP	860 rpm
4	Fairbanks Morse 18” - E5711	12.9 mgd	75 HP	590 rpm

A gate valve is provided on the suction to each pump and a check valve and gate valve are provided on the discharge of each pump. Figure 2-2 represents the suction and discharge arrangement for Pump 2. All other pumps are typical.

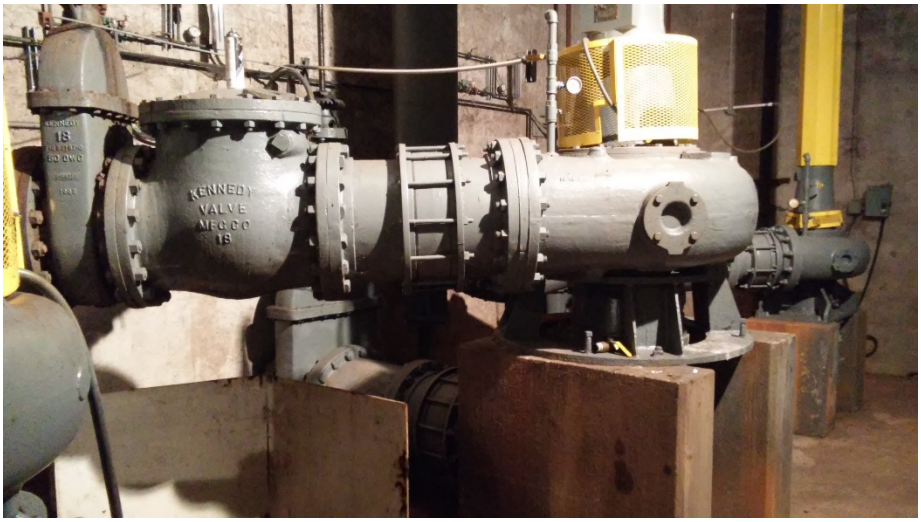

Figure 2-2. Suction and Discharge arrangement for Pump 2

A wye with a plug valve is provided on the discharge riser for each pump to allow maintenance to drain and flush the risers, which have a tendency to collect grit when the pump is not operated. Figure 2-3 depicts the wye and plug valve on the riser for Pump 4.

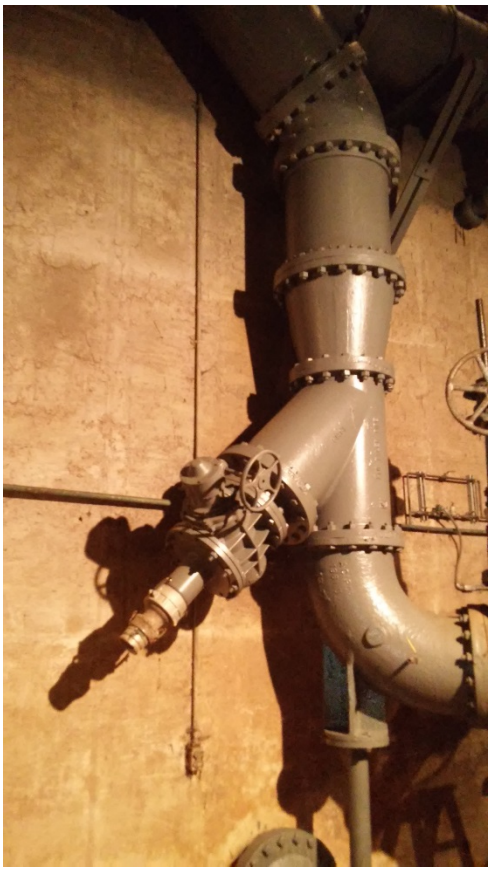

Figure 2-3. Discharge header

The wet wells are ventilated through 10-inch diameter ducts on each side of the divided wet well. A fan located in the screening room originally vented the ducts outside of the pump station. The fan has been removed and the ducts currently vent to the atmosphere inside the screening room.

The pumps discharge to a 24-inch pipe that leaves the pump station from the south. Outside the pump station, there is a flow meter before the force main crosses the rail lines to the east.

2.3 Inlet Works Facilities Design Criteria

2.3.1 General

The current pump station arrangement does not include inlet works for protection of the pump and force main. Screens were installed with the original pump station but they have since been removed/abandoned.

Grit removal was not considered for Union. The station does not have existing grit channels and there is no place to build them due to the site constraints.

Mechanical screens were discussed and explored but does not appear to be feasible due to the constraints overhead from State Street North and limited space to locate a screenings container, washer and compactor. The container would need to be located inside the station to contain odors or be installed in a new enclosure. Installation of the screen would also be problematic without space overhead but could be feasible if installed in sections. Removal and maintenance would be difficult due to the limited space overhead. For these reasons mechanical screening was not considered feasible.

Coarse manual bar racks could be installed but they would require regular cleaning to remove collected debris and could potentially cause backups into the system.

Channel grinders can be installed in the existing screen channels to protect the pumps from stringy material and large objects. Two grinders would be installed, one in each channel, that would be able to handle the long-term flow scenario. Bar racks can be installed above the grinder in the event a grinder gets jammed. Flow would be able to pass over the top of the grinder while maintaining some level of protection for the pumps. The existing channel ranges from 4 to 5 feet wide and the grinder is 54-inches wide, a stainless steel mounting frame could be provided to make up the distance on either side of the grinder. Wipes ready cutters would be provided to further reduce the size of materials preventing them from reweaving at the pump intake.

A preliminary grinder selection is provided in Table 2-2.

Table 2-2. Grinder Selection

Max Flow Rate	21.8 mgd
Width	54-inches
Height	51.878-inches
Grinder Motor	5 HP
Drum Motors (two)	1 HP
Manufacturer	JWC CDD4020-XDM

Figure 2-4 shows a typical installation with a bar rack.

Figure 2-4. Typical Grinder Installation

2.4 Pumping Systems Design

2.4.1 Pump Configuration

As stated in Section 1, the proposed configuration for Union is to have five pumps installed; two dry weather pumps rated at 6.2 mgd and three large pumps rated at 17.5 mgd. The two dry weather pumps would be installed at positions 1 and 3 on the 16-inch and 20-inch suction wall pipes, and the three wet weather pumps would be installed at positions 2, 4, and 5 on the 20-inch and 24-inch suction wall pipes.

There are two alternatives for type of pumps to be provided at Union:

- Extended shaft vertically mounted centrifugal pumps
- Dry pit submersible vertically mounted pumps

The existing pumps are extended shaft vertically mounted centrifugal pumps. These types of pumps have the pump located in the dry well and the motor located at the top floor. A shaft from the motor extends to the pump. After an alternatives analysis, GNH has elected to remain with the extended shaft vertically mounted centrifugal pumps. Preliminary pump selections for dry and wet weather are listed in Tables 2-3 and 2-4.

Table 2-3. Dry Weather Pump Selection

Design Criteria	DWF Avg	DWF Min	DWF Max
Number of pumps	2	2	2
Number of pumps operating	1	1	1
Design flow (mgd) (each pump)	3.8	1.5	6.2
Design flow (gpm) (each pump)	2,639	1,042	4,306
TDH at design flow (ft)	30	28.5	31
Efficiency at design flow	78%	--	80%
NPSHA (ft)	42	--	42
NPSH3	4.4	--	8.9
Motor (HP)	50		
Impeller (in)	22.65		
Speed	600 RPM		
Type of Pump	Extended Shaft Vertical Centrifugal		
Model	12MN24E		
Manufacturer	Flowserve		

Table 2-4. Wet Weather Pump Selections

Design Criteria	DWF Max	WWF
Number of pumps installed	3	3
Number of pumps in operation	1	2
Design flow each pump (mgd)	6.2	17.5
Design flow each pump (mgd)	4,306	12,153
TDH at design flow (ft)	31	55
Efficiency at design flow	75%	81%
NPSHA (ft)	41	39
NPSH3	7.7	
Motor (HP)	250	
Impeller (in)	21.5	
Speed	900 RPM	
Type of Pump	Extended Shaft Vertical Centrifugal	
Model	16MW25B	

Figures 2-5 and 2-6 display the selected pump system curves for the dry weather and wet weather pumps.

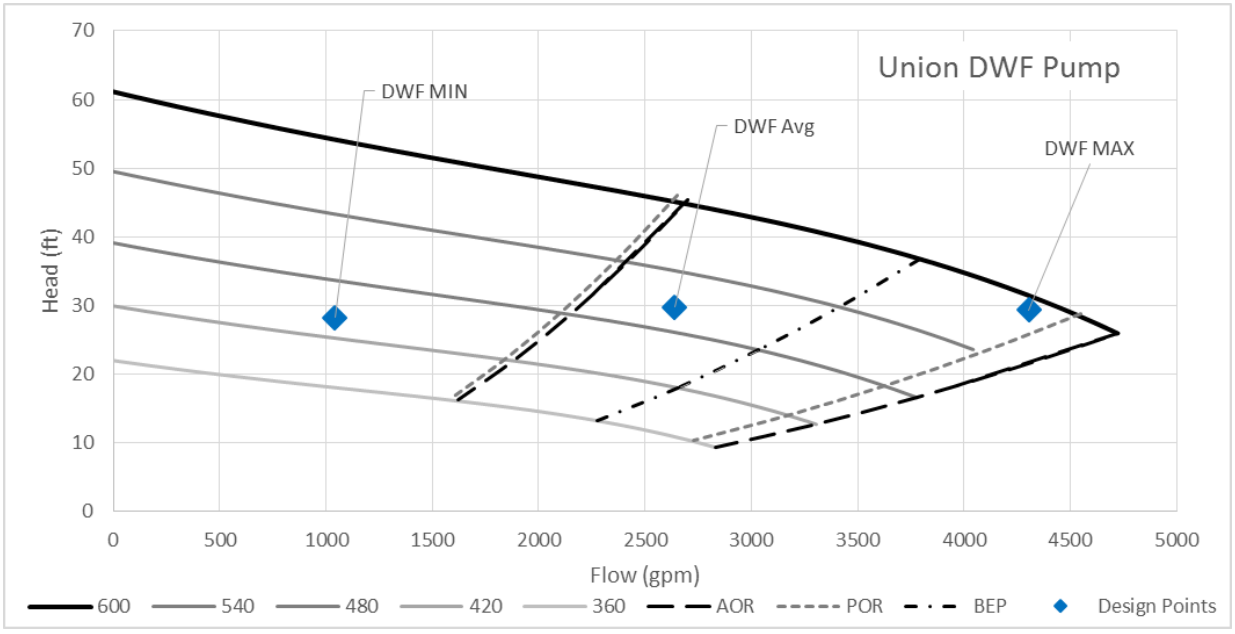

Figure 2-5: Dry Weather Pump Selections

Figure 2-5 shows the variable-frequency drive (VFD) curve for a single pump in operation. Under the minimum dry weather flow (DWF), a single pump is operating outside the allowable operating range (AOR); under this condition, the station would cycle. Under average DWF, a single pump is operating

within the preferred operating range (POR). Under maximum DWF, a single pump is operating within the POR.

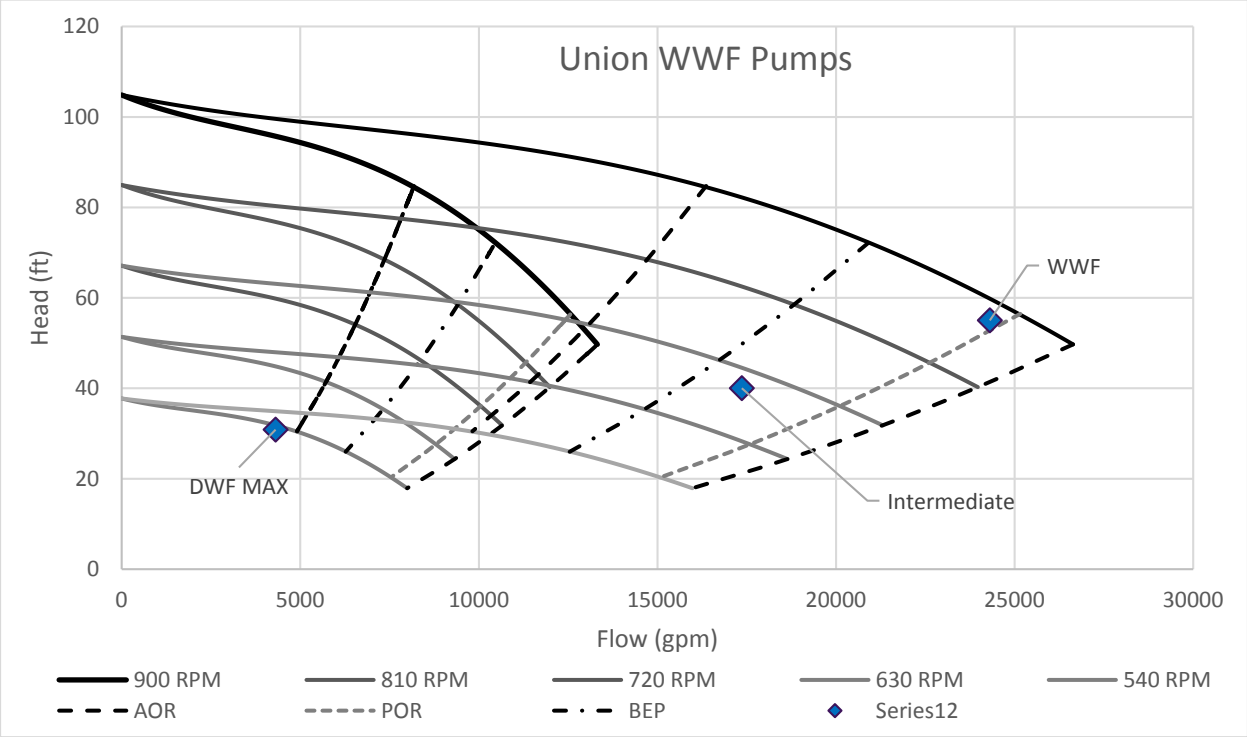

Figure 2-6. Wet Weather Pump Selections

Figure 2-6 shows the max DWF is just outside the AOR of a single wet weather pump. During the Intermediate term the WWF (25 MGD) is near the BEP for two wet weather pumps and within the POR. During the Long Term the WWF (35 MGD) is within the POR when two pumps are in operation.

The motors for extended shaft vertically mounted centrifugal pumps should be installed in a location that protects the pumps from damage during a flooding event. Dry floodproofing will be installed to safeguard the pumps from damage due to flooding.

2.4.2 Pump Operating Criteria

During dry weather, one pump is required to meet the minimum, average, and maximum flows. The pumps were sized such that one dry weather pump would be able to meet the maximum flows (using the second dry weather pump as the N+1 redundant pump). The minimum flow for the large pumps is greater than the maximum dry weather flow of 6.3 mgd. These pumps would be used solely for wet weather pumping.

2.4.3 Wet Well Intake Configuration

The existing wet well configuration does not meet HI standards in the following areas:

- Anti-rotational baffles are required for pumps larger than 3,000 gallons per minute (gpm) (4.3 mgd).
- Pumps suctions should be located in a confined wet well where each suction inlet bell is located in a confined pocket to isolate the pump from any flow disturbances that might be generated by adjacent pumps.

For retrofit designs, meeting the requirements of HI standards is often not feasible. If designs other than those required by HI standards are shown by prototype or model tests performed in accordance with HI standards the alternative designs are considered to comply with HI standards. During detailed design,

the wet wells will be evaluated using computational fluid dynamics (CFD) modeling to verify the hydraulic efficiency and further physical testing may be required to model the existing wet well to identify measures that can be taken to comply with HI standards.

HI also provides recommendations for retrofit designs of rectangular wet wells that would help improve suction conditions. Recommendations are as follows:

- Inclusion of a baffle wall to minimize air entrainment due to falling liquid
- Setting the baffle wall below the maximum wet well level to allow any floatable material to pass over the wall
- Inclusion of fillets below the pump intake
- Inclusion of baffles between the pump intakes
- Inclusion of fillets along the sides of the wet well to eliminate dead zones

2.4.4 Effluent Piping

The existing effluent piping allows for grit to accumulate in the pipe when the pump is not in operation. This occurs because each pump discharge piping enters the discharge header at the invert. In the new mechanical configuration, the isolation valve and check valve remain at the pump level. The discharge piping enters the header from the side instead of from the bottom. This prevents grit from settling out in the discharge header as a result of upstream pump flows in the manifold. Any grit generated by that specific pump will settle to the bottom of the discharge header which should get re-suspended on high flows.

The discharge piping will wye into the header. A wye has less friction loss but only allows flow to go in a single direction further limiting the deposition of grit in each individual discharge header. This discharge header/manifold configuration is consistent with the process mechanical configuration at East Street and Boulevard pump stations.

2.4.5 Valves and Flow Meters

Gate valves are recommended for isolation upstream and downstream of each pump. American Water Works Association (AWWA) C500 double disk metal seated valves are recommended for this application. Resilient seated gate valves (AWWA C509 or 515) are prone to damage from grit, double disk metal seated valves are more robust than the resilient seated valves and leak less than a solid metal seated disk.

Check valves are provided for prevention of flow reversal on all pumps.

A flow meter will be installed on each pump discharge and on the existing 24-inch force main after it leaves the pump station.

2.4.6 Equipment Access and Removal

The grinder can be installed on slide rails to facilitate removal. A jib or gantry crane would need to be provided to remove the grinder from the channel for maintenance.

The existing monorail is rated for 2 tons. This is insufficient for the new pumps and would need to be replaced.

SECTION 3

Structural

3.1 Introduction

This section is intended to assess the building structure components of the Union Pump Station and identify design criteria for the rehabilitation of the facility. It outlines proposed solutions to address structural deterioration, deficiencies, and upgrades to incorporate architectural, process mechanical, and MEP findings.

3.2 Codes and Standards

The current governing code utilized by the City of New Haven and the State of Connecticut is the 2016 Connecticut State Building Code. This code is based on the 2012 International Building Code and 2012 International Existing Building Code.

The following standards shall be used in support of the building code:

Standards

- ACI 318-11 – Building Code Requirements for Structural Concrete
- ACI 530-11 Building Code Requirements for Masonry Structures
- ASCE/SEI 7-10 - (Supp 1)—Minimum Design Loads for Buildings and Other Structures.
- ASCE 24 – 14 – Flood Resistant Design and Construction
- CH2M HILL Water Business Group Design Guide.
- International Concrete Repair Institute Technical Guidelines (ICRI)
- ICC-ES Evaluation Reports for specific products.
- Structural Steel Painting Council (SSPC)

Reinforced Concrete

- Typical Unless Noted Otherwise: ACI 318-11 Building Code Requirements for Structural Concrete.
- Liquid Containment Structures: ACI 350-06 Code Requirements for Environmental Engineering Concrete Structures.

Concrete Repair

- ICRI GS03130 Guide Specifications for Structural Concrete Repair.
- ICRI Technical Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Coatings, Sealers, and Polymer Overlays.

Steel

- AISC 360-10 Specification for Structural Steel Buildings, including Supplement No. 1 dated 2005.
- Manual of Steel Construction, Thirteenth Edition.
- AWS: D1.1, Structural Welding Code – Steel Design Loads

3.3 Structural Condition Assessment

The construction of the Union Pump Station structure was completed in the early 1960s. The structure was designed by Gneovese and Cahn Consulting Engineers of New Haven Connecticut; original design drawings available for review are dated November 30, 1959.

The Union Pump Station structure is primarily composed of conventionally reinforced cast-in-place concrete. The foundation system is a mat foundation supported by undisturbed soils with 2-foot thick

concrete foundation walls around the below-grade wet well and dry well areas. The above-grade exterior elevations of the pump station structure is clad with brick veneer with a non-structural concrete masonry unit (CMU) backup and an 8-inch CMU partition wall has been provided between the motor room and the screen room.

The cast-in-place roof over the pump station structure is integral with a vehicular roadway above. A bridge approach slab exists on the south side and is supported by the spandrel beam. A monorail crane system supported by the roof structure is provided for maintenance of the four pumps in the dry well.

3.3.1 Observations and Recommendations

The following observations and rehabilitation recommendations (in italics) are divided into the five main areas of the Union Pump Station, and the vehicular roadway above:

1. Motor Room: The motor room houses electrical control panels and pump motors and provides access to the dry well area below. Some concrete deterioration was noted in the southeast corner where two 8-inch diameter pipes penetrate the wall and slab in the stair down to the Dry Well area.
    a. The concrete floor structure in the Motor Room is in good condition; no spalling or structural distress cracking was noted.
    b. The structure above the motor room appears to be in good condition with no observed leaks or distress.
    c. The existing monorail crane beam and assembly appears to be in working order. The extents of the crane for access at the outside of the facility is a concern. *It is recommended that the existing monorail crane be replaced with structure allowing the crane to extend outside of the building on the south side. Because a monorail crane with greater capacity may be necessary for the new pumps, the existing structure will be analyzed for reserve capacity to confirm this potential upgrade.*
    d. The floor openings for access to the dry well have a 2-inch deep metal grating over four 6x10-foot openings. The grating was not flush with the floor creating a potential trip hazard. There is also concern over the capacity of the grating to resist point loads over an opening of this size. *Supplemental steel framing to support new heavy duty steel bar grating or new solid access covers shall be provided to increase load carrying capacity over each of the dry well pumps.*
2. Screen Room: The screen room provides access to influent channels below, screening equipment, and slide gate operators. All screening equipment in this room is no longer in service.
    a. The concrete structure in the screen room appears to be in good condition. From sounding of the concrete with a masons hammer, deterioration was isolated around the five access hatches. *All deteriorated concrete will be repaired when equipment and access hatches are replaced. A protective coating should be applied to all concrete floor surfaces in the screen room.*
    b. The five access hatches provided over the influent channels are significantly deteriorated and will require replacement. *All deteriorated concrete shall be replaced around existing hatches, new flush mount aluminum access hatches rated for a minimum of 150 pounds per square foot (psf) live load shall be provided throughout the screen room. All new access hatches shall include neoprene seals to work with the proposed odor control system for this facility.*
    c. The floor drain provided in the screening room is corroded, clogged and no longer functioning. *A new floor drain should be installed to aid drainage and maintenance (washdowns) within the screen room.*
3. Dry Well: The dry well is located approximately 25 feet below the Motor Room and houses the pumps for discharge from the adjacent wet well.

a. The dry well area concrete surfaces were in good condition. Minor leakage was noted through the existing concrete foundation walls.

b. Structural steel braces have been provided to provide support or the pump motor shafts which extend from the motor room above. The steel appears to be in good condition, but should be re-coated for protection.

c. The stairs leading from the motor room down to the dry well are composed of galvanized steel and in good condition. *A new CMU wall will be necessary to isolate the stair from the drywell area (see Section 4 – Architectural in this report).*

4. Influent Channels: Two influent channels are located below the Screen Room, the channels are constructed of reinforced cast-in-place concrete. Access to the influent channels was limited to visual inspection from above.

   a. The access covers could be removed to view the slide gates and concrete conditions on the north and south ends. The gates and respective supports exhibit significant deterioration and corrosion and will require concrete repair at channel walls when replaced. *Deterioration and corrosion of the channel structure outside of the slide gates was not observed, but with limited access the concrete surfaces should be further reviewed. Concrete repairs will be necessary around the gate structures. A protective coating should be applied to all channel concrete surfaces.*

5. Wet Well: The wet well is located outside of the northwest side of the Motor Room and is accessed from the exterior of the Union Pump Station Structure. There are two surface mounted aluminum access hatches provided above the wet well. Access to the wet well was limited to visual inspection from above.

   a. The two aluminum access hatches appear to be in good condition and have been replaced since original construction. The safety grating provided below each hatch was bent and did not appear to function as intended. *Replace safety grating, or provide guardrails around the access hatches*

   b. The concrete surfaces within the wet well did not exhibit deterioration in areas that could be observed, but the concrete does not appear to have a protective coating. *A protective coating should be applied to all concrete wet well surfaces.*

6. Vehicular Roadway: The Roadway located directly above the Union Pump Station is also composed of cast-in-place concrete.

   a. The roadway bridge approach on the south side of pump station is also a concrete structure, and is currently supported by steel brackets embedded into the building south elevation spandrel beam. These brackets are intended to provide an expansion joint between the structures. Leaks have developed from the roadway above allowing water infiltration into the exterior wall assemblies and onto structural elements below. Corrosion of the steel support brackets (5 locations) has occurred; leaks also expose the concrete structural elements to deicing salts which will lead to deterioration. *The extents of deterioration of the roadway approach support brackets could not be determined due to the buildup of corrosion. At a minimum the brackets should be cleaned of corrosion and protected with a coating system. The roadway expansion joint assembly above should be replaced to minimize further structure exposure to moisture and deicing salts infiltrating from above.*

3.4 Design Criteria

3.4.1 Loading

Design loading criteria is not noted on the existing drawings available for review. Prior to renovation/rehabilitation, a structural analysis should be completed to confirm expected loads during construction and during future service.

3.4.2 Resiliency Planning and Design Basis

As part of its recognition of future coastal resiliency impacts, the State of Connecticut has directed that all projects using State funding, such as the Clean Water Fund (CWF), must include features that address potential sea level rise and coastal resiliency issues within its design. Each of these stations are either within or directly adjacent to the 100-year floodplain, as determined by the Federal Emergency Management Agency (FEMA). The current Flood Insurance Rate Maps (FIRMs) for the New Haven area have recently been updated as a result of documented impacts from Hurricane Sandy, and recent regional evaluations of sea level rise trends and future projections. Due to this revision, the regulatory base flood elevations have risen by 1 foot at both East Street and Boulevard Pump Stations, but remain the same for Union Pump Station.

In accordance with the Public Act Nos. 13-15, the CWF is required to consider the necessity and feasibility of implementing measures designed to mitigate the impact of a rise in sea level over the projected life span of such a project. To further the abilities of municipalities to implement this requirement, the New England Interstate Water Pollution Control Commission (NEIWPCC) updated its Technical Release 16, Guides for the Design of Wastewater Treatment Works (TR-16) and provided guidance on selecting an appropriate protection elevation related to the criticality of each process component and the impact on the environment if that process was impacted during a storm event. The guidance document separates facilities into two types: critical and non-critical. Critical facilities are defined as those systems that are required for the conveyance of wastewater to and through a treatment facility. This includes all electrical, mechanical, and control systems within a pump station. The recommendation in TR-16 is to elevate these critical elements a minimum of 3 feet above the 100-year flood elevation.

As part of the recent Phase 1 Wet Weather Capacity Improvements and Nitrogen Reduction Project at the South Shore WPAF, an evaluation was conducted to establish the resiliency elevation for use during this construction project. This evaluation included consideration of recent regional coastal sea level rise evaluations, along with elevating equipment above the 500-year flood elevation. Combining these two elements resulted in a protection elevation for the East Shore WPAF of 2.95 feet (NAVD 88) above the established 100-year base flood elevation. As part of this Preliminary Design Report, the protection elevation is being set at 3 feet to be consistent with the TR-16 guidance.

The Union Pump Station was evaluated for the feasibility and necessity of elevating critical equipment to maintain operations during a flooding event. It was deemed not feasible or cost-effective to elevate all equipment due to existing space limitations, or overall station configuration. In addition, due to the interconnectivity of the station with existing outfalls adjacent to the stations, certain areas will be inundated without the ability to protect the interior of the facilities from rising flood waters. For this purpose, GNH has taken the approach of providing dry floodproofing where critical equipment must remain below the resiliency protection elevation, and providing wet floodproofing where appropriate to maintain structural stability and allow the facility to quickly regain full operations once the flood waters recede. In general, floodproofing methods include construction of cast-in-place structural walls around the perimeter of each area to be dry floodproofed, with implementation of removable bulkheads at roll up doors and personnel doors as needed. Wet floodproofing methods include installation of flood vents

to allow hydrostatic pressures to equalize on either side of facility walls during the flooding event allowing immediate return to service following cessation of flood waters. Specific floodproofing locations are included in the Preliminary Design Drawings included in Appendix A.

3.4.3 Design Loads

Loads shall be based on the most stringent criteria of the Building Codes and Standards listed above. In some cases, the minimum loads listed in the American Society of Civil Engineers *Minimum Design Loads for Buildings and other Structures* (ASCE 7) may be equivalent criteria and may be substituted for the loads listed below. In all cases, the minimum criteria shall conform to the minimum requirements of the International Building Code (IBC), as amended by the 2016 Connecticut State Building Code.

3.4.3.1 Floor Live Loads

In accordance with codes and standards listed above, and the following minimums:

Process Rooms	300 psf on slabs and beams and 200 psf on girders, columns
Electrical Rooms	300 psf
Storage Areas	150 psf
Mechanical/HVAC Rooms	150 psf or Equipment weight plus 50 psf Allow for rolling equipment out
Stairs, Walkways and Platforms	100 psf
Platforms Only for Access	60 psf
Vehicular Traffic	AASHTO HS 20-44

3.4.3.2 Wind Loads

Wind loads will be based on Risk Category III unless otherwise noted, with an ultimate design wind speed (Vult) of 135 mph (3-second gust), Exposure C.

3.4.3.3 Snow Loads

Some of the areas of the existing structure are exposed to potential snow loads. Existing areas requiring analysis and areas of new construction will be analyzed with the following assumptions.

Ground Snow Loads	30 psf
Importance Factor	1.1
Snow Exposure Factor	1.0

3.4.3.4 Flood Loads

Hydrostatic Loading of 63 pcf will be assumed up to the proposed Sea Level Rise Elevation (SLR). The screening room portion of the structure will be designed for Wet Flood resistance, and the pump room dry well areas will be designed for Dry Flood resistance.

The following assumptions apply to the Union Pump Station, all elevations are based on NAVD 88.

Base Flood Elevation (BFE):	+11.0’
Design Flood Elevation (DFE):	+12.0’
Sea Level Rise Elevation (SLR):	+14.0’

3.4.3.5 Liquid Loads

Refer to Drawings for design water levels and top of base slab elevations. Extreme loads during a seismic event will also be taken into account during detailed design.

Load cases that will be considered in detailed design of liquid holding basins are:

- All basins full of liquid, no backfill.
- Backfill and groundwater with empty tank
- Any tank cell empty or full in any combination.
- A fluid pressure of 62.4 pcf will be used for hydrostatic loads from ground water and flooding.
- A fluid pressure of 63 pcf will be used for process liquid in these basins, unless otherwise noted.

3.4.4 Concrete

Materials and design procedures for concrete are described below.

3.4.4.1 Materials

The following minimum requirements apply (concrete compressive strength at 28 days):

- Typical Concrete, unless otherwise noted 4,500 psi
- Concrete Fill, unless otherwise noted 3,000 psi
- Curbs and Sidewalks 3,000 psi
- Conduit Encasements and Pipe (encasements not integral with foundation) 4,500 psi
- Precast Concrete 5,000 psi

Reinforcement:

- Conventional Steel: ASTM A615, Grade 60 (f_y = 60 kilopounds per square inch [ksi])

3.4.4.2 Design Procedures

Strength design will be used for concrete in accordance with ACI 318 unless noted otherwise. Hydraulic structures will be designed in accordance with ACI350.

Design of concrete hydraulic structures will include use of environmental durability factor (Sd), for anticipated fluid and earth loads during normal operation only. Available capacity of members will be checked for loads that may occur during extreme design events.

During detailed design, existing slabs and structural elements will be checked for intended design load capacity.

3.4.4.3 Details of Steel Reinforcement

Minimum concrete cover over steel reinforcement will be as follows:

- Surfaces cast against soil 3 inches
- Typical unless otherwise noted 2 inches

3.4.5 Masonry

Materials and design procedures for masonry are described below.

3.4.5.1 Materials

The following requirements apply:

- Hollow concrete masonry units will conform to ASTM C 90 and will be normal- or medium-weight units with a net area compressive strength of 1,900 psi.
- Mortar will conform to ASTM C 270, Type S.

- Grout will conform to ASTM C 476. Minimum 28-day compressive strength will be 2,000 psi.
- Steel reinforcement will conform to ASTM A615, Grade 60.
- Horizontal joint reinforcing steel will conform to ASTM A82.

3.4.5.2 Design Procedures

Allowable stress design will be used for masonry in accordance with ACI 530. Compressive strength of masonry, f'_m, for masonry assembly will be 1,500 psi. For design, calculated tensile/compressive stress, f_s, of steel reinforcement is 24,000 psi for deformed bars and 30,000 psi for wire in joints.

3.4.5.3 Details of Steel Reinforcement

1. Limit maximum spacing of vertical steel reinforcement in bearing walls and partition walls to 4 ft. and 8 ft., respectively.
2. Provide bond beams at top of walls.
3. Use joint reinforcement at 16-in. maximum vertical spacing.

3.4.6 Structural Steel

Materials and design procedures for structural steel are described below.

3.4.6.1 Material

The material requirements for structural steel are listed in Table 3-1.

Table 3-1. Material Requirements for Structural Steel

Shape	ASTM	Grade	Fy (ksi)	Fu (ksi)
Rolled Shapes, Plates and Rods	A36	-	36	58
W-shapes & WT-shapes	A992	-	50	65
Pipes	A53	B	35	60
Round Hollow Structural Sections (HSS)	A500	B	42	58
Square and Rectangular Hollow Structural Sections (HSS)	A500	B	46	58
Bolts for Connections (1/2” to 1” diameter)	A325 or F1582	-	-	120
Anchor Rods – Dry Areas Only	F1554	36	36	58
Anchor Rods – Typical	F593	316, Cond. CW	40	80
Welding Electrode	E70XX			70

3.4.6.2 Design Procedures

Structural steel design will be in accordance with the American Institute of Steel Construction’s (AISC’s) *Steel Construction Manual*.

3.4.7 Monorail Cranes

Monorail Cranes shall meet requirements of the AISC’s *Steel Construction Manual* and ASCE 7. Unless noted otherwise, vertical impact shall be 25 percent of maximum wheel load. Lateral force on crane

runway shall be calculated as 20 percent of sum of rated capacity of crane and weight of hoist and trolley. Lateral force shall be assumed to act horizontally at traction surface of a runway beam, in either direction perpendicular to beam. Longitudinal force on crane runway beams shall be calculated as 10 percent of maximum wheel loads of crane. Longitudinal force shall be assumed to act horizontally at traction surface of a runway beam in either direction parallel to beam.

SECTION 4

Architectural

4.1 Introduction

This section assesses the architectural components of the Union Pump Station and presents the design criteria for upgrades to the facility. The architectural assessment consisted of three tasks: interviewing staff, visiting facility site, and reviewing available facility documentation. It outlines proposed solutions to deficiencies found from building and code assessment completed. These recommendations are intended to serve as preliminary guidance for the design of facility renovations.

4.2 Building Codes

The 2016 Connecticut Building Code, which is based on the 2012 International Building Code (IBC) and 2012 International Existing Building Code (IEBC) will be used as a basis of this.

4.2.1 Authorities Having Jurisdiction

The Union Pump Station is located in the City of New Haven, Connecticut. The City of New Haven Building Department enforces the Connecticut State Building Code.

4.2.2 Current Connecticut Codes

Per the State of Connecticut Department of Construction Services, the following codes have been adopted and are applicable to this project:

Building Code:	2012 International Building Code (IBC) as modified by CSBC.
Existing Building Code:	2012 International Existing Building Code (IEBC) as modified by CSBC.
Accessibility Code:	ICC/ANSI A117.1-2003 Accessible and Usable Buildings and Facilities as modified by CSBC.
Fire Code:	Connecticut State Fire Safety Code including all current Amendments to the fire code.
Energy Code:	2012 International Energy Conservation Code (IECC)
Mechanical Code:	2012 International Mechanical Code International Mechanical Code (IMC) as modified by CSBC.
Plumbing Code:	2012 International Plumbing Code (IPC) as modified by CSBC.
Electrical Code:	2014 National Electrical Code (NEC) as modified by CSBC.

4.3 Union Pump Station

4.3.1 Building Code Analysis

4.3.1.1 Enclose Stairs

Egress distance from north end of Pump Room to egress door is greater than the 75 feet allowed by code. It is important to note that rollup doors are not considered an exit from the room, so there is no exit from the south side of the building. The design will include the following components:

1. Enclose existing stair with 1-hour fire-rated CMU walls.
2. Add exterior fiberglass reinforced plastic (FRP) door in existing wall at existing window.

3. Add interior fire-rated FRP doors on both levels.
4. Relocate or remove gas piping from stair.
5. Add FRP door and opening into concrete wall on southwest corner of the space south of the pump station.

4.3.1.2 Sprinkler System

Current code requires floors with limited fire fighter access doors and openings to have a sprinkler system. The lower level Pump Room has limited fire access, so a sprinkler system is required. The design will include the addition of a sprinkler system to the lower level Pump Room.

4.3.2 Energy Conservation Code

4.3.2.1 Insulation

The walls and ceilings have no insulation, which does not meet Energy Code for conditioned spaces. The design will include the addition of a 5-inch spray-on, fire-retardant insulation to the bottom of the concrete roof slab and beams, which will provide an R-value of 19.

4.3.3 Building Condition Assessment

4.3.3.1 Brick

Exterior brick is deteriorated from water damage with face of the brick exhibiting spalling, efflorescence on surfaces, and brick ties rusted out. The brick damage is worse on the south and west elevations where water is leaking from above. The design will include the following:

1. Repair joint in road at the south end of the Union Pump Station to prevent water from getting into south wall.
2. Add coating to top and side of Union Pump Station concrete roof on east and west sides of the road. An alternate may be to add built-up roofing and aluminum fascia instead of a coating.
3. Add stainless steel flashing to top and bottom of exterior walls to direct water out of the cavity wall. Add vapor retarder on the outside face of existing CMU inside wythe.
4. Replace brick including new stainless steel wall ties, mortar nets, and weep holes.

4.3.3.2 Painting

The ground floor walls and ceilings are not painted. Equipment and piping is in need of painting. The following solutions are recommended:

1. Surface prepare and paint walls and ceilings in all the ground floor rooms with a chemical resistant epoxy paint system. If the insulation is added to the ceiling, then paint may not be necessary.
2. Epoxy paint floor of new restroom.
3. Surface prepare and paint piping, equipment, and supports in all the rooms with a chemical resistant epoxy paint system.

See below on Lintels, Windows, and Doors for more details on painting.

4.3.3.3 Lintels

The lintels above doors and windows are rusted on the south wall of the Motor Room and Screen room and the north wall of the Screen Room. The design will include the following:

1. Ventilate rooms to help remove moisture and fumes. Add new FRP louvers.
2. Seal around louvers.

3. Implement brick improvements to help prevent water infiltration.
4. Replace damaged steel lintels with galvanized steel framing painted with a chemical resistant epoxy paint system.

4.3.3.4 Windows

Existing steel windows need replacement. The design will include the following:

1. Remove windows/plywood from three Screen Room and one west Motor Room openings, and replace with CMU and brick. These windows are not on exterior of building but open into the enclosed space under the bridge structure, so they are not needed.
2. Remove four windows from east Motor Room openings and replace with insulated translucent panels with 8x8-inch grid pattern and aluminum frame. Paint existing steel lintels with a chemical resistant epoxy paint system.
3. Seal around windows.

4.3.3.5 Doors

Doors to Screening Room are deteriorated and need replacement. The rollup door to the Motor Room also needs replacement. Note, rollup doors are not considered an exit from the room, so the current Pump and Motor rooms have only one exit. All other doors appear to be in good condition, but may be replaced so all doors are new. The design will include the following:

1. Remove rollup door on south Motor Room wall and masonry above door to bottom of concrete roof beam. Install new nominal 10-foot-high FRP double door and frame.
2. Monorail could be extended to run through the double door and have monorail seals on the doors.
3. Remove Screen Room south double door and single north door and replace with FRP doors and frames with heavy duty stainless steel hardware.
4. Seal around doors.
5. See document sections for Stair Enclosure, Restroom, and Control Room for additional doors.

4.3.3.6 Grating, Hatches, and Handrail

Grating in the Screen Room is missing or corroded and needs to be replaced. Grating in Motor Room is not level and is not attached, which is a tripping hazard. There is only one handrail on stair into Motor Room. Handrails are required by code on both sides of stairs. Roof hatch above Screening Room is rusted and in need of replacement. The design will include the following:

1. Remove Screen Room grating and replace with FRP grating. Make all grating level with floor.
2. Remove Motor Room grating, clean recesses and reinstall with clips and fasteners.
3. Add aluminum wall handrail on the north side of stair.
4. Remove existing hatch and replace with new Type 316 stainless steel hatch.

4.3.3.7 Wood Enclosure

The wood walls are a fire hazard and restrict exiting from Pump Station. The walls also trap moisture and will mold. The wood walls were installed as a means of access restriction to the area. The design will include the following:

1. Remove wood walls.
2. Install chain link security fence with 8-foot swing gate at east side of road above. Fence to be constructed to maintain access control from the Water Street overpass area.

4.3.4 New Rooms and Spaces

4.3.4.1 Restroom

No restroom, sink or drinking fountain is required by code but has been requested by Owner. The design will include the following:

1. Add CMU walls to enclose a restroom with a toilet and sink near the Motor Room stair.
2. Add FRP door and frame to Restroom with privacy lock.
3. Replace existing service sink with stainless steel service sink and faucet.
4. Add drinking fountain outside of restroom.
5. Add commercial grade stainless steel partitions and accessories.

4.3.4.2 Control Room

Enclose new electrical equipment so it can be climate controlled. The design will include the following:

1. Add CMU walls to enclose new control and electrical equipment in Motor Room.
2. Add FRP door and frame to Control Room.

SECTION 5

Heating, Ventilation, and Air Conditioning

5.1 Introduction

Ventilation measures will be established based on the 2012 National Fire Protection Association standard - *Fire Protection in Wastewater Treatment and Collection Facilities* (NFPA 820). NFPA 820 establishes outside air ventilation rate criteria as well as ventilation design recommendations for safeguarding against fire and explosion hazards specific to wastewater treatment plants and associated collection systems.

5.2 Design Approach

Air handling units will be located outside on an elevated platform above the sea level rise elevation on the east side of the structure. Air handling units serving electrically classified areas will be designed to supply tempered 100 percent outside air without recirculation, except where NFPA 820 allows dual ventilation rate during cold weather and the space atmosphere is relatively moisture and corrosive vapor free. Combustible gas detectors will override air handling systems operating in dual mode if combustible gases are detected.

Ventilation will be continuous and at rates adequate to reduce area NFPA 820 electrical classifications one category where required to suit the design. Ventilation systems that are required to reduce electrically classified spaces one category shall be monitored and provided with alarm stations located within and at entrances to these spaces. Air handling units in electrically classified areas will be designed in such a way as to isolate the unit supply air stream from the process area in the event the unit is turned off or loses power. An intermediate damper will open to atmosphere to provide a naturally vented air break space between the unit interior and the process space.

Air will be exhausted via exhaust fans mounted where foul air is not present within the space. Areas containing foul air will be exhausted to a Cross-flow Carbon Treatment System, as described in Section 9 – Odor Control in this report. Air will be exhausted low within the space to facilitate removal of hydrogen sulfide that collects along the floor.

Supplemental electric unit heaters will be provided throughout spaces as required to maintain local heating needs during winter.

Louvers/vents/exhaust fans or supply/exhaust fans will be used to supplement ventilation in areas requiring higher summer ventilation rates or intermittent ventilation.

Staff areas and electrical rooms requiring air conditioning will be provided with ductless split system DX equipment as required to suit the space need. Critical electrical and control rooms will be provided with redundant air conditioning systems if necessary to ensure space temperatures can be met if primary units should fail.

Facilities will be provided with an automatic temperature control (ATC) system for global monitoring and control of heating, ventilation, and air conditioning (HVAC) equipment. The control system will be based on an open architecture (Lon or BACnet) direct digital control (DDC) system or programmable logic controller (PLC) based system, the selection of which will be determined during design. ATC panels will be located in “clean spaces” (e.g., electric room, control room) where possible. Control devices such as sensors and thermostats will be provided with suitable enclosures designed for the associated atmosphere in which they are located.

A new heating/ventilating unit (HV-1) will be provided for the Screen Room. The unit will be located at grade above the flood protection elevation. The unit will supply 12 air changes/hour (ACH) with 100 percent outside air in order to reduce the NFPA electrical classification from Class 1 Division 1 to Class 1 Division 2. The supply air will be tempered to minimum 55 degrees F during winter in order to protect plumbing and water piping from freezing. The ventilation rate will be reduced to 6 ACH, as allowed by NFPA 820 and whenever the outside air temperature is 50 degrees F or below, the space is unoccupied and the combustible gas detector is 10 percent below the lower explosive limit of methane. The heating/ventilating unit and exhaust fans will be provided with AFDs and a separate exhaust fan will be provided to maintain proper temperature conditions for the pump motors during the summer months. The heating/ventilating unit (HV-1) will be sized to provide tempered make-up air for wet wells through screen room floor penetrations.

A separate heating/ventilating unit (HV-2) and exhaust fan will be will be provided for the Dry Well/Motor Control Center (MCC) Room. The unit (HV-2) will be located on an elevated platform on the east side of the building. The space will be heated and ventilated at a rate of 12 ACH with 100 percent outside air. The supply air will be tempered to minimum 55 degrees F during winter in order to protect plumbing and water piping from freezing.

5.3 Equipment

The specific type of equipment used on a particular building will be determined during detailed design based on application. Roof or platform mounted equipment will be used where possible to preserve floor space and to minimize equipment exposure to aggressive environments. The following types of HVAC equipment may be utilized on this project.

5.3.1 Heating Equipment

- Air handling units incorporating outside air hoods, filters, Natural Gas HX, fans, and air break plenums, as required.
- Electric unit heaters.

5.3.2 Ventilating Equipment

- Exhaust fans
- Supply fans
- Wall louvers
- Roof vents

5.3.3 Air Conditioning Equipment

- Split system air conditioning units

5.4 Materials

Table 5-1 provides various material choices that may be used for HVAC systems depending on the type of atmosphere in which equipment is installed. Specific materials will be selected during detailed design to suit the application.

Table 5-1. HVAC Materials of Construction

Area	Atmosphere [1]	Equipment or System	Materials of Construction
Process	Corrosive	Ductwork	SS, FRP
		Equipment	HPCS
Process	Non-corrosive	Ductwork	Al
		Equipment	HPCS
Non-process	Non-corrosive	Ductwork	GS/Al
		Equipment	GS/Al

Table Notes and Abbreviations:

[1] Corrosive areas are areas that have elevated levels of moisture, hydrogen sulfide or chemical vapors.

Al – Aluminum

FRP – Fiberglass Reinforced Plastic

GS – Galvanized Steel

HPCS – High Performance Coated Steel

SS – Stainless Steel (Type 316)

5.5 Design Criteria

5.5.1 Outdoor Design Criteria

Table 5-2. HVAC Outdoor Design Criteria

Location	Elevation (Ft.)	Cooling Criteria (ASHRAE 0.4%) [1]		Heating Criteria (ASHRAE 99.6%)
New Haven, CT	20	DB (°F)	MCWB (°F)	DB (°F)
		90.7	73.2	8.5

Table Notes and Abbreviations:

[1] Cooling criteria for critical spaces such as electrical equipment rooms shall be based on extreme conditions (100° F).

ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers, 2013 Fundamentals

DB – Dry Bulb Temperature

MCWB – Mean Coincident Wet Bulb Temperature

5.5.2 Mechanical System Criteria

Table 5-3. Mechanical System Criteria

Space or Area	Cooling (°F)	Cooling Method	Heating (°F)	Heating Method	Ventilation Basis
Process Areas	5-10 °F above ambient	Outside Air Ventilation	55	G	100% OA
Control Rooms	75	AC	68	E	6 ACH min (5 cfm/person and 0.06 cfm/ft^2 OA)
Electric Rooms	75	AC	55	E	6 ACH min (0% OA)
Personnel Areas	75	AC	68	G,E	6 ACH min (5 cfm/person and 0.06 cfm/ft^2 O.A.)

Table Abbreviations:

AC – Air Conditioning

ACH – Air changes/hour

E – Electric

G – Gas Heating Method

OA – Outside Air

5.5.3 Miscellaneous Design Criteria

Not Used.

5.5.4 Louver Sizing

1. Intake Louvers – 500 ft. per minute
2. Exhaust Louvers – 800 ft. per minute

5.5.5 Ductwork Friction Rate Sizing

1. Low Pressure: 0.1 in. of water column pressure drop per 100 ft. of ductwork up to an air velocity of 1,500 to 1,800 ft. per minute.
2. Medium Pressure: 0.2 in. of water column pressure drop per 100 ft. of ductwork up to an air velocity of 2,000 to 2,500 ft. per minute.
3. Transfer Ducts: 0.03-0.05 in. of water column pressure drop per 100 ft. of ductwork.
4. Outside Air Intake Shafts: 0.05-0.10 in. of water column pressure drop per 100 ft. of ductwork up to an air velocity of 1,000 ft. per minute.
5. Gravity Relief Shafts: 0.03-0.05 in. of water column pressure drop per 100 ft. of ductwork up to an air velocity of 1,000 ft. per minute.

5.6 References

5.6.1 Codes

The HVAC design shall follow all applicable local, state, and federal codes and criteria. The following codes will be used for the mechanical design of this project:

- 2016 Connecticut State Building Code

- 2012 International Building Code
- 2012 International Mechanical Code
- 2012 International Energy Conservation Code
- 2005 Connecticut State Fire Safety Code

5.6.2 Standards

The following standards and guides will be used for the mechanical design of this project:

1. ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers)
2. SMACNA (Sheet Metal and Air Conditioning Contractors' National Association)
3. ACGIH (American Conference of Governmental Industrial Hygienists) Industrial Ventilation Manual of Recommended Practice
4. NFPA (National Fire Protection Association)

5.6.3 Miscellaneous

5.6.3.1 Calculation Software

- Heating and Cooling Load Analysis: Trane Trace 700

SECTION 6

Plumbing and Fire Protection

6.1 Introduction

Any modification to existing plumbing system to support the existing or new processes and facilities including potable water piping, service water piping, sanitary drainage piping, storm drainage piping, will be selectively provided for each facility as required by the current building codes or local authority.

6.2 Design Approach

6.2.1 General

Limited existing plumbing system modification has been considered for project as detailed in subsequent sections.

- The existing plumbing fixtures are recommended to be replaced.
- The existing potable and non-potable water piping is recommended to be replaced with new piping, as required.
- Provide a new restroom facility.

6.3 Equipment, Materials and Systems

6.3.1 Equipment

The specific type of equipment that will be used on a particular building will be determined during detailed design based on application. Listed below are types of plumbing equipment that may be used for this project.

- Storage type electric or gas-fired water heaters
- Wall-mounted instantaneous electric water heaters
- Backflow preventers
- Emergency eyewash and shower stations
- Sump and sewage ejector pumps
- Plumbing fixtures such as service sink, water closet, lavatory, drinking fountain and kitchen sink
- Hose stations
- Floor, air gap, standpipe and roof drains
- Electric heat trace systems

6.3.2 Materials

Table 6-1. Plumbing and Fire Protection Materials of Construction

Area	Atmosphere [1]	Equipment or System	Materials of Construction
Process	Corrosive	Piping	SS/GS/CU/AL/HCI/CU/CPVC
		Equipment	Coated GS/Al/SS/CU
Process	Non-corrosive	Piping	CU/BS/CI/DI
		Equipment	Coated GS/Al
Administration	Non-corrosive	Piping	GS/BS/CU/DI/PVC
		Equipment	GS/CS
Administration - Toilet Rooms	Non-corrosive	Piping	CU/BS/CI/PVC
		Equipment	CU/DI/CI

Table Notes and Abbreviations:

[1] Corrosive areas are areas that have elevated levels of moisture, hydrogen sulfide or chemical vapors.

PVC – Polyvinyl Chloride

SS – Stainless Steel (Type 316)

GS – Galvanized Steel

Al – Aluminum

CU - Copper

CI – Cast Iron

DI – Ductile Iron

BS – Black Steel

HCI – High Silicon Cast Iron

CS – Carbon Steel

CPVC – Chlorinated Polyvinyl Chloride

6.4 Design Criteria

6.4.1 Potable Water System

- Water Source: City Water
- Minimum Pressure: 30 psi
- Maximum Pressure: 80 psi
- Maximum Velocity: 8 fps
- Hydrostatic Test Pressure: 100 psi minimum

6.4.2 Service Water System

- Water Source: City Water
- Minimum Pressure: 20 psi
- Maximum Pressure: 100 psi
- Maximum Velocity: 8 fps
- Hydrostatic Test Pressure: 150 psi minimum

6.4.3 Sanitary Drainage System

- Type: Gravity
- Minimum Pipe Slope: 1/8-in. per ft.
- Minimum Velocity: 4 fps

6.4.4 Storm Drainage System

- Type: Gravity
- Minimum Pipe Slope: 1/8-in. per ft.
- Minimum Cover: 4 ft.
- Minimum Velocity: 4 fps

6.5 References

6.5.1 Codes

The design of this project will be governed by the Connecticut State Building Code 2016 Edition, Connecticut State Fire Safety Code 2005 (with amendments) and all adopted International Codes including the International Plumbing and International Fire Codes.

6.5.2 Standards

The following standards and guides will be used for the plumbing and fire protection design of this project:

- ANSI (American National Standard Institute)
- ASPE (American Society of Plumbing Engineers)
- ASTM (American Society for Testing and Materials)
- AWWA (American Water Works Association)
- CISPI (Cast Iron Soil Pipe Institute)
- IBC (International Building Code)
- IFC (International Fire Code)
- IPC (International Plumbing Code)
- NFPA (National Fire Protection Association)

SECTION 7

Electrical

7.1 Introduction

The electrical work at Union pump station will consist of adding a generator and automatic transfer switch to supply backup power to the facility as well as new electrical service equipment, MCCs and switchgear. The existing switchgear is over 55 years old, and will be replaced in its entirety. New pump motors will be compatible with and controlled by adjustable frequency drives to provide precise control, improve efficiency, and reduce power factor losses.

Architectural improvements to the site will be made so that the motor room is sealed and is not exposed to Class I, Division 1 or 2 atmospheres. Most electrical equipment including the MCC, PLC, and adjustable frequency drives (AFDs) will be placed in a climate controlled electrical room.

The sequence of construction will be scheduled in order to minimize down time and allow suitable pumps to be available at all times, except for 4- to 8-hour shutdowns to transfer power and swap out individual pumps.

Close coordination with the local utility United Illuminating (UI) will be required throughout this project, as a new utility service will be provided for this facility.

The work required for this station is described in further detail below.

7.2 Codes and Standards

The following codes and standards will apply to the design, and may be referenced in this document:

1. National Fire Protection Association (NFPA): 70, National Electrical Code, 2014 Edition.
2. NFPA: 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities, 2016 Edition.
3. National Electrical Manufacturer's Association (NEMA)
4. Underwriter's Laboratory (UL)

7.3 Utility Service

The power provider to the Union Pump Station is United Illuminating (UI), which is based locally in New Haven. The UI transformer is enclosed in a separate above ground brick building on the south side of the pump station. The transformer could not be accessed during the site walk inspection.

CH2M contacted UI to discuss this service. UI indicated that the existing service is 300 kilovolt-amperes (kVA) (three 100 kVA single phase can-type transformers). The new load flow for this station is expected to be approximately 600 kVA, so the existing transformers must be replaced with new. The existing primary service voltage is 13.8 kV, and UI will need to provide an adequately sized transformer with a 480 volt secondary. UI indicated that they need to start an extensive study on how to provide this service at this location, as the existing service is underground, and space is limited. UI asked CH2M to formally request an engineering study be done in order to provide this service, and CH2M has made this request.

Arrangements will be made to keep existing equipment running from the existing service during construction. The new power feed from UI will not be installed until generator power is established to the new equipment.

7.4 Equipment and Sequence of Equipment Replacement

7.4.1 Existing Equipment

The existing switchgear and some of the motor controls were installed with the original station that was designed in 1959. The switchgear has outlived its useful life, and will be replaced. Existing motor controls are also contained within the existing switchgear. An external controller with an interface to a fiber cabinet was added at a later date.

All switchgear and motor controls will be demolished and replaced as a part of this project. Lighting panels, disconnects, cable, and exposed conduit will be replaced.

The existing generator manual transfer switch is rated 240 volts, and is being used to connect a portable 480-volt generator to the existing 480 volt MCC.

7.4.2 New Electrical Equipment

A new electrical room will be constructed in order to provide a conditioned space for most electrical equipment. The electrical equipment room will be located in the same area as the existing MCC, bounded by the stairwell, start of pump grating, west wall, and partial north wall where the existing generator disconnect is mounted.

The room is not large enough to house all of the electrical equipment. For this reason, two adjustable frequency drives, the automatic transfer switch, generator batteries and controls, and miscellaneous panelboards will need to be mounted outside of the conditioned space.

7.4.2.1 Generator and Related Equipment

A new 1000kVA generator is required to provide full backup power to this pump station. The generator will need to be located outdoors in the yard, to the west of the pump station. The recommended location is to the west of the existing screen room, as it is more accessible for maintenance than locations to the south of the building. The generator will be mounted in a weatherproof enclosure with top of floor elevation of 14.00 feet, to meet sea level rise criteria, so that the generator will be protected from flooding.

The generator diesel fuel tank will be located outdoors near the generator. It is also recommended that the diesel fuel tank be mounted on a pad with a pad elevation of 14.00 feet. It would also be acceptable to mount the tank lower and seal the tank so that water could not penetrate the tank below elevation 14.00. A 3000-gallon tank will provide at least 48 hours of run time under fully loaded conditions. This quantity of fuel storage will also be sufficient for 96 hours of run time at normal load.

Generator batteries and controls will be mounted in the generator enclosure.

7.4.2.2 Automatic Transfer Switch

An automatic transfer switch, rated 1200A, will be located in the motor room to automatically transfer power from the utility to the generator, then back to the utility upon return of generator power.

7.4.2.3 Motor Control Center

A 1200A motor control center, designated MCC-1, will distribute power to the station. The 1200A MCC will not be of an arc resistant configuration, because there is not room available in this building to provide the arc resistant configuration. The MCC will be located in the new electrical room. Low voltage switchgear will not be used for power distribution, as switchgear is wider and deeper, and there is no room available for low voltage switchgear at this facility.

7.4.2.4 Adjustable Frequency Drives

The MCC will feed five AFDs: three rated 250 horsepower (hp), and two rated 50 hp. One of the 250 hp AFDs are standby, while the others can be expected to run at the same time. All five AFDs can fit within the conditioned room. The 250hp AFDs will be eighteen pulse. Allen-Bradley drives may be too large to fit within the motor room, and they could be excluded from bidding Union Station if the current arrangement goes to bid. Allen-Bradley 250 hp AFDs are 65 inches wide and 26-32 inches deep, while the Cutler-Hammer offering is 48-60 inches wide and 26 inches deep. The exact dimensions of the PLC will be determined during detailed design, and this will determine whether or not the Allen-Bradley AFDs will fit in the conditioned room. The reason for the variation in the Cutler Hammer AFD sizing is that the lower value is for the selected horsepower number at variable torque. If a horsepower increase occurs, or a constant torque drive is required, the higher value would be required. The larger Cutler-Hammer enclosure is shown on the layout drawings. Most manufacturers other than Allen-Bradley will be able to fit their 18-pulse AFDs within this footprint. The 50hp AFDs will be six pulse, will be wall mounted, and their size is not of consequence to the design of the room (approximately 9” wide and 8” deep).

7.4.3 Sequence of Equipment Replacement

Existing equipment must remain in service to keep the pump station running during construction, with down time being limited to eight hours or less, preferably four or less. The following construction sequence will be used to accomplish this goal:

1. Install new motor control center.
2. Install automatic transfer switch, generator, generator batteries and associated controls.
3. Verify generator can power new switchgear.
4. Work with UI to determine optimal sequence to transition to new power feed. If a new feed can be brought to the pump station while existing feed powers existing equipment, establish new power feed to new gear while existing power is in place to existing gear. If this is not possible, new gear can be powered from the generator, or temporarily fed via a jumper from the existing gear. If UI must replace the transformer in place, the pump station will need to run on generator power during this time. If existing gear is still feeding equipment, the existing MCC will need to be temporarily fed from the generator.
5. Install AFD-1, AFD-3, and AFD-5, as these AFDs are not in locations occupied by the existing MCC. Terminate wiring to PLC in these AFDs.
6. Install Pump 5. Connect power cable from new MCC to AFD-5, and from AFD-5 to Pump 5. Run this pump in manual as it is required.
7. Swap out Pumps 1 and 3, one at a time. Connect power wire from the MCC to each AFD and connect power wire from the pumps to the AFD, and run them in manual as they are required.
8. De-energize and remove power feed to existing MCC. Remove the first column of this MCC. Temporarily feed existing MCC from new MCC.
9. Transfer miscellaneous feeds, from existing MCC to new MCC.
10. Repeat Steps 5 and 7 for Pump/AFDs 3 and 4.
11. Remove remnants of existing switchgear.
12. Install PLC and establish control of new equipment.
13. Demo existing equipment and remove temporary feeds.

7.5 Design Criteria

7.5.1 Energy Efficient Design

All pump motors are currently started across the line, and run at full speed. The new design will include AFD controllers for each pump motor. These AFDs will allow the pump to run at an optimum speed and higher efficiencies with lower power factor losses.

Existing pump station lighting will be replaced with more efficient LED type lighting wherever possible.

7.5.2 Area Classification

The existing facility was designed with the intent of the motor room and pump level below being unclassified. The screen room was designed to be a Class I, Division 1 area. Access hatches and vent pipes outside the building allow wastewater gasses to escape into the atmosphere near the building, per Figure 7-1.

Figure 7-1. Building Access Hatches and Vent Pipes

The boarded window in the photograph is not a properly sealed window. Since the gasses from the wet well below can escape into the motor room through this boarded window, the motor room, and therefore the pump room, is classified as Class I, Division 1, and the equipment is not rated for this environment.

Although the room is technically classified, it is not of immediate concern since the window is boarded up, the wet well access hatches are usually closed, and very little if any air is getting in through the boarded window. It is satisfactory to address this issue as a part of the upcoming project.

The solution is to replace the boarded up window with a concrete masonry unit wall.

Note the vent pipe shown in the lower left corner of the photo above. Per NFPA 820, Figure A.4.2.(c), the area is classified Class I, Division 1 within three feet of the vent outlet, and is classified Class I, Division 2 between a three and five foot radius of the vent. Fortunately, the west entrance to the motor room is six feet from the vent, so the gasses expelled through this vent will not reach the door and affect the classification of the room per NFPA 820.

The motor room, pump room, stairwell, and all new rooms created within motor room are unclassified per NFPA 820.

The wet well is a Class I, Division 1 area. The screenings room above the wet well is a Class I, Division 1 area if it is ventilated at less than 12 ACH. The screenings room will be classified as Class I, Division 2 if the room is ventilated at 12 or more ACH. There is a wet well vent near the north screenings room door. However, the vent does not affect the area classification of the screenings room, as this room as already classified.

7.5.3 Design Flood Elevation and Electrical Equipment Elevation

The new electrical equipment described below shall be mounted on an equipment pad 1 foot, 1 inch above the finished floor, to meet the criteria of design flood elevation (DFE) with one foot freeboard. It is not possible to meet the design criteria of DFE with sea level rise (SLR) of three feet above the base flood elevation. The bottom of the beams are only 10 feet above the floor. Equipment manufacturers will be required to manufacture their equipment such that all switches in their highest position are no more than 7 feet, 6 inches above the finished floor. If this is not possible, a stick will be provided per NEC to reach switches that are above that height. The motor control room and dry well will be additionally protected from flooding by dry floodproofing the exterior of the building.

Motor control centers are approximately 7½ feet tall. To meet the DFE with SLR criteria, the electrical equipment would be mounted on a pad 3 feet above finished floor (AFF). This would put the top of the MCC against the bottom of the beams. Even if the MCCs could be located in areas that are not below beams, other equipment such as AFDs would be located against the wall, and not be able to fit underneath the beam. Even in areas not under the beams, clearance required for conduit turns is inadequate.

All floor-mounted electrical equipment will be mounted on equipment pads 13 inches AFF. Existing equipment pads will be completely removed and reinstalled, and new pads will be installed where required.

The outdoor generator and fuel tank can be mounted above elevation 14.00 to meet DFE with SLR criteria, since it is outdoors. An elevated walkway will be required to access the generator weatherproof enclosure. The fuel tank may be mounted lower, if it is flood proofed below elevation 14.00.

7.5.4 Single Line Diagrams and Preliminary Equipment Layout

Refer to attached drawings for single line diagram and preliminary equipment layout.

7.5.5 Lighting

Existing lighting will be replaced with state-of-the-art LED type fixtures in all areas, including Class I, Division 1 and Class I, Division 2 areas. LED frog-eye type emergency lighting fixtures will also be provided.

Existing outdoor lighting fixtures will be replaced with metal halide or LED type fixtures. Where existing lighting is insufficient, new lighting will be added.

SECTION 8

Instrumentation and Controls

8.1 Introduction

This section documents the instrumentation and control (I&C) design concepts for the Union Pump Station. A state-of-art I&C system will be provided to ensure continuous and reliable process control and monitoring for the pump station, including remote monitoring and control from the East Shore WPAF.

8.1.1 Existing Instrumentation and Control System

The existing control system for the Union Pump Station is housed in two panels. The panels are mounted in the pump motor room.

The level based control logic for the pumps is executed in a pump control panel that receives the wet well level signal and turns the constant speed pumps on and off based on preset level setpoints. This panel also displays the wet well level, pump status and alarm signals, and provides the means to manually operate the pumps via HAND/OFF/AUTO and LEAD/LAG selector switches.

The second panel contains a Modicon Momentum PLC system that receives the pump status and alarm signals, and wet well level signals from the pump control panel, and communicates them to the East Shore WPAF plant SCADA system via a radio link. The radio antenna for communication with the East Shore WPAF is mounted on the building across from the pump station. The radio link does not provide equipment control from the plant.

There is no permanently mounted Operator Interface Terminal (OIT) or human-machine interface (HMI) computer at the pump station.

The level in the wet well is monitored by pressure transducers. The pump station flow is locally monitored by an electromagnetic flow meter. The pump station gates are manually operated.

There is no onsite generator at the pump station. A transfer switch provides means to hook up a portable generator in case of an emergency.

The pump station does not have an odor control system.

8.2 Design Approach

The existing instrumentation and control system at the Union Pump Station is out-of-date. It lacks the modern hardware and software, as well as instrumentation required for reliable operation. The overall goal is to remove obsolete control system equipment and to take advantage of the current technology for improved operational reliability and process optimization.

A new climate controlled electrical/control room will be provided at the pump station. The proposed location and layout of the room are detailed in the Architectural and Electrical Sections.

To bring the pump station to the same platform as the East Shore WPAF, a new control panel with redundant (hot backup) Allen-Bradley ControlLogix PLC system will be provided in the control room.

The PLC control panel will be equipped with an Allen-Bradley PanelView Plus 6 1500 OIT to provide means for local monitoring and control (e.g., LEAD/LAG/ALTERNATE selection, PLC AUTO/ PLC MANUAL mode selection, setpoints, etc.). A desktop HMI work station, loaded with Factory Talk View SE Standalone Client software, be also provided in the control room. All features available at the OIT will also be available at the HMI work station.

As detailed in the Process Mechanical Section, the new pumps at the Union Street Pump Station will be adjustable speed. The AFDs for the pumps will be installed in the electrical/control room.

Power monitors will be provided in the new MCC for monitoring power consumption and quality.

In addition to hardwired signals, device level rings (DLRs) will be used for Pump Station PLC communication with AFDs and power monitors to manage traffic on the control network.

Control system equipment will be powered from a true online double-conversion-type uninterruptable power supply (UPS) unit to maintain reliable operation during power system disturbances and outages. UPS unit will power the PLCs, operator interface terminals, and HMI operator workstation. UPS battery backup will have enough capacity to energize the control system for 30 minutes after a power failure. The low-battery alarm will be hardwired to the Plant PLC input/output (I/O) for monitoring. The panel will be designed to automatically switch over to the line power upon UPS failure.

For powering loop powered instruments, redundant 24 V DC power supplies will be provided in the PLC panel. The power supply failure alarm will be hardwired to the plant PLC I/O.

Electric or hydraulic actuation will be provided for all valves and gates. In general, electric actuators, rated for the environment, will be used. If the actuator can potentially be submerged, hydraulic actuation will be considered. Based on field observations, all gates and valves at the Union Pump Station can be electrically actuated.

To complement process redundancy, the monitoring and control signals for redundant equipment (e.g., pumps, grinders, etc.) will be split between separate I/O modules and racks (if necessary)

The control systems for the new odor control system and the new generator system will be PLC/OIT based. The package control systems will not be customized to use Allen-Bradley hardware if the system vendor's "standard" operating platform is different. Instead, gateways and/or protocol convertors will be provided for digital connection to the Pump Station PLC System. The system supplier will program the package PLCs. Hardwired I/O will be used for connecting critical monitoring and control signals from the package systems to the Pump Station PLC System. The digital interface will be used for monitoring of additional signals. Digital data interface requirements between the package systems and the Pump Station PLC System will be further developed during design development and coordinated with the package system vendors.

The sump pump control panel will be replaced. If new sump pumps are provided, a new control panel will be specified. The panel will be mounted above the flood plain or in the control room

The existing pressure transducers for wet well level monitoring will be replaced with new non-fouling, hydrostatic pressure type transmitters, designed specifically for wastewater applications. The transmitters will be installed in stilling wells. As a backup to the level transmitters, high and low level switches will be provided to operate the pumps upon failure of a transmitter.

A new electromagnetic flow meter will be provided for pump station flow monitoring. The meter will be located in a vault outside the pump station and will provide analog flow signal to the Pump Station PLC.

Detailed change-out procedure will be developed so that the new I&C equipment can be installed and tested prior to being put into operation. The design will allow the new Pump Station PLC System and the existing control system to coexist for some time as the new system is brought online and the old system is decommissioned. The pump station will remain operational during switchover.

Security camera system with DVR will be provided at the pump station. The location and quantity of cameras will be determined during design development.

8.3 Control System Design Philosophy

The following summarizes the control system design philosophy for the Union Pump Station.

8.3.1 Equipment Control

All equipment to be controlled by the Pump Station PLC System will have a local ON/OFF/AUTO selector switch located on or very close to the equipment. With this selector switch in the ON position, the equipment will operate. In the OFF position, the equipment will not run. When the selector switch is in the REMOTE position, the equipment will be controlled by the Pump Station PLC. AUTO status of the selector switch, and the ON, OFF, and FAIL status of the equipment, will be monitored by the Pump Station PLC. Process interlock and permissive functions will be programmed in the PLC. However, personnel and equipment safety functions (for example, pump low-low level and high-discharge-pressure shutdown) will use conventional control hardware, such as electromechanical relays. These interlocks will be hardwired to the equipment starter or AFD. The hardwired failure conditions will also be transmitted to the Pump Station PLC for alarming.

8.3.2 Valve and Gate Control

Modulating valves/gates will be electrically actuated with integral controllers. LOCAL/OFF/AUTO selector switches, OPEN/STOP/CLOSE pushbuttons, and 4-to-20-mA DC position transmitters will be provided locally. When the selector switch is in the LOCAL position, the valve/gate will be operated via the local OPEN/STOP/CLOSE pushbuttons. In AUTO position, the valve/gate will be controlled by the Pump Station PLC based on a 4-to-20-mA DC control signal from the PLC. The AUTO status of the selector switch and the valve position will be monitored by the Pump Station PLC.

OPEN/CLOSE service process valves/gates will be electrically actuated. LOCAL/OFF/AUTO selector switches and OPEN/CLOSE pushbuttons will be provided locally. When the selector switch is in the LOCAL position, the valve/gate will be operated via the local OPEN/CLOSE pushbuttons. In AUTO position, the valve will be controlled by the Pump Station PLC based on OPEN and CLOSE command signals from the PLC. Both OPEN and CLOSED limit switches will close the circuit at the end of travel and transmit a signal to the Pump Station PLC.

Reversing starters, control-power transformers, and all auxiliary controls required for electrically operated valve/gates will be part of the valve actuator package.

8.3.3 Motor Control Centers

Each MCC starter bucket will have a separate 120 V AC control power transformer. RUNNING and OFF status pilot lights, FAIL alarms pilot lights, and RESET pushbuttons will be provided on each bucket. Auxiliary contacts will be provided to connect to the Pump Station PLC System. As mentioned earlier, local control stations with ON/OFF/AUTO selector switches will normally be provided in the field. In some instances, these devices may be mounted on the MCCs. The local controls will be provided at only one location (MCC or field).

All motor-driven equipment that is energized by an MCC starter and controlled from the Pump Station PLC System will have the following features:

- All control devices, such as START/STOP pushbuttons and LOCAL/OFF/AUTO selector switches, regardless of their location, will be energized from the MCC's control power transformer.
- All solenoid-operated valves that are unique to the specific equipment will be powered from the MCC's control power transformer.

The following monitoring and control functions will be hardwired:

- AUTO status of the ON/OFF/AUTO selector switch to the Pump Station PLC
- RUN status to the Pump Station PLC
- START and STOP control signals from the Pump Station PLC when the selector switch is in the AUTO position
- Motor OVER LOAD alarm to the Pump Station PLC
- Individual FAIL alarms for the interlock signals that are hardwired to the MCC (for example, high temperature, low-low level, high-pressure shutdown) to the Pump Station PLC, as required for the specific application

8.3.4 Adjustable Frequency Drives

All AFDs that are 50 hp or smaller will be installed in the MCCs. Larger AFDs will have a standalone enclosure located in the electrical room.

RUNNING and OFF status pilot lights, FAIL alarms pilot lights, and RESET pushbuttons will be provided on each AFD. Auxiliary contacts will be provided to connect to the Pump Station PLC System. As mentioned earlier, local control stations with ON/OFF/AUTO switches will normally be provided in the field. In some instances, these devices may be mounted on the AFD enclosure. The local controls will only be provided at one location (AFD or field).

With the selector switch in the ON position, the equipment will operate, and its speed will be controlled via the HMI module at the AFD. In the OFF position, the equipment will not run. When the selector switch is in the AUTO position, the equipment will be controlled by the Pump Station PLC System based on START and STOP commands and the SPEED CONTROL signal from the PLC. The following monitoring and control functions will be hardwired:

- AUTO status of the ON/OFF/AUTO selector switch to the Pump Station PLC
- RUN status to the Pump Station PLC
- START and STOP control signals from the Pump Station PLC when the selector switch is in the AUTO position
- 4-to-20-mA DC SPEED CONTROL signal from the Pump Station PLC when the selector switch is in the AUTO position
- 4-to-20-mA DC SPEED FEEDBACK signal to the Pump Station PLC
- AFD FAIL alarm to the Pump Station PLC
- Individual FAIL alarms for the interlock signals that are hardwired to the AFD (for example, high temperature, low-low level, high-pressure shutdown) to the Pump Station PLC, as required for the specific application

As mentioned earlier, AFDs will also have an Ethernet DLR connection to the Pump Station PLC System. This will be used for monitoring purposes only. Smaller AFDs that are installed in the MCC will not be networked.

8.3.5 Power Monitors

Power monitors will be provided for the new MCCs. Power monitoring will be provided for each main feeder to the MCC and for major equipment (>50 hp) that is fed from the MCC.

As mentioned earlier, the power monitors will also have an Ethernet DLR connection to the Pump Station PLC System.

8.3.6 Instruments and Transmitters

"Smart" microprocessor-based field transmitters with HART protocol will be installed wherever possible. For configuring and calibrating instruments and transmitters, two universal hand-held programmers with appropriate software for each type of instrument will be provided. All field transmitters will be provided with a local signal indicator, calibrated in percent or actual engineering units.

Field instrument selection will be in accordance with GNHWPCA preferences.

8.3.7 Surge Suppressors

Surge suppressors will be provided at both ends for all signal and copper Ethernet cables that leave the envelope of the buildings. 120-V AC surge suppressors for all field instruments that require a 120-V AC power source will also be provided. All control panels will be provided with power line surge suppressors.

8.3.8 Pilot-Light Colors

The pilot light colors will follow the existing convention at the plant. RED/GREEN lights will be used to indicate RUNNING/OFF status for motors, OPEN/CLOSE status for valves, and TRIPPED/CLOSED status for circuit breakers. AMBER lights will be used for alarms.

8.3.9 Equipment and Instrument Tag Numbers

The equipment and instrument numbering will follow the existing unit process based convention at the plant.

8.3.10 PLC I/O signals

The following standard signal types will be used to stay compatible with the existing system:

- Digital inputs: 120 VAC rated dry contact in field
- Digital outputs: 120 VDC
- Analog inputs: 4-to-20-mA DC at 24-V DC into 750 ohms, powered from the PLC cabinet or field
- Analog output: 4-to-20-mA DC at 24-V DC into 750 ohms, powered from the PLC output module

A minimum of 20 percent installed spare I/O of each type will be provided. One of each type of I/O module (that is, analog input, analog output, digital input, digital output) will be provided per panel regardless of whether that panel requires that I/O type. Three empty I/O slots will be provided in each panel. Minimum of 20 percent spare terminal blocks will be provided in each panel. The spare PLC I/O will be wired to the terminal blocks

8.4 Control System Operating Philosophy

The system will be designed with four levels of control. Each level will provide progressively more process automation. With the exception of package control system panels, local area control panels will not be provided.

- **Local Manual Control.** Each piece of process equipment will be provided with local control stations for maintenance and troubleshooting operations. Local control stations will be located on or very close to the equipment being controlled. Examples are ON/OFF/AUTO and LOCAL/OFF/AUTO selector switches, START/STOP and OPEN/CLOSE pushbuttons, STOP lockout, and RESET pushbuttons. Local controls will allow operations and maintenance (O&M) staff to bypass automatic control. These controls are not intended for long-term equipment operation. Hardwired personnel

and equipment safety interlocks will stay active in this mode of operation. The process interlocks will be bypassed.

- **PLC Manual Control.** This control level will provide the capability to manually control the process equipment at the Pump Station OIT and HMI (for equipment controlled by the Pump Station PLC), or the package system OIT (for equipment controlled by the package system PLC). All of the hardwired equipment and personnel safety interlocks and some of the critical process interlocks with be active in this mode.
- **PLC Automatic Control.** This will be the normal mode of operation. In this mode, the PLCs will control the process equipment based on programmed control algorithms and functions, including continuous closed-loop control and sequential control. Operator will select the operating parameters and set points at the OITs or the HMI. All of the equipment and personnel safety interlocks, as well as process interlocks, will be active in this mode.
- **Plant SCADA Control.** This supervisory control level will provide control of the pump station from the East Shore WPAF. For example, the plant operators will be able to remotely change the operating mode of the equipment from PLC Auto to PLC Manual. This will allow the operators to Start/Stop the equipment and Open/Close the gates remotely from the plant. The available interlocks in this mode will be the same as the PLC Manual Control mode mentioned above. It is anticipated that this mode will be only be used occasionally if the operations staff is not able to drive to the pump station in a timely manner. Normally, the pump station operation from the East Shore WPAF will be limited to remote setpoints and operating parameter changes. A soft switch at the plant HMI with password security will be provided to enable this mode of operation. The switch to this mode will need to be carefully coordinated with the pump station operators.

8.5 Remote Telemetry System

The existing radio telemetry system at the Union Pump Station will be replaced by a 900 MHz Ethernet radio system for a better data throughput. The antennas at the pump station and at the East Shore WPAF will be replaced. The work will also include addition of Ethernet radios at the East Shore WPAF.

As a backup to the radio telemetry system, T1 line or cellular modems will be considered for communication between the pump station and the treatment plant. The possibility of buying bandwidth on the city's fiber optic network will also be evaluated. The system telemetry system will be configured to automatically fail over to the backup communication path upon primary path failure.

8.6 Codes and Standards

Following is the list of codes and standards that will be followed for the design:

- Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- International Society of Automation (ISA):
  - RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
  - S5.1, Instrumentation Symbols and Identification.
  - S5.4, Instrument Loop Diagrams.
  - S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.

  - TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.

- National Electrical Code (NEC).
- National Electrical Manufacturers Association (NEMA):
  - 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
  - ICS 1, Industrial Control and Systems General Requirements.
- National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panel

SECTION 9

Odor Control

9.1 Introduction

The Union Pump Station currently has no odor control. As part of this *Long-Term Control Plan Update*, and as a result of the close proximity of the Union Pump Station to public areas and highly utilized transportation routes, inclusion of odor control is recommended in order to mitigate odor complaints associated with continued operation of the facility.

The Union Pump Station processes that will receive odor control include an inlet chamber, two parallel channels that include grinders, an outlet chamber and two wet wells.

9.2 Basis of Design

This section provides information used as the basis for the odor control system design. The proposed odor control system is based on a "contain-convey-treat" design approach and as such includes design information for each component.

9.2.1 Containment

The existing channels contain sections of grating that allow for comingling of sewage vapors with the overlying room space that can then result in the release of sewage odors to the ambient atmosphere. Containment of foul air to within the process area, i.e., within channels, will be achieved by replacing the grating with solid panels to create a separate controlled headspace within the channels. Panels will be designed using materials of construction resistant to corrosion e.g., fiberglass reinforced plastic (FRP) or aluminum checker plate. Covers will be constructed using flat removable panels. The cover design will facilitate easy removal of individual panels by two people. Each panel will not weight more than 100 lbs and will have an integral nonskid surface. Lifting handles shall be provided on each panel. Each panel will have gasketed joints to prevent fugitive air release.

As a result of the containment of foul air within the process channels, protection of concrete against corrosion using either protective coatings or liners is recommended and will be included during detailed design.

9.2.2 Conveyance

Foul air will be conveyed from within the contained process channels and wet wells by FRP ductwork. It is anticipated that up to four foul air pickup locations will be designed, two associated with channels and one for each wet well. Each foul air pickup location will include a flow balancing damper to facilitate adjustment of flow for each pickup to design values. The foul air duct will connect to the covers through a flanged connection to allow for easy removal. The duct will rise vertically up and then move horizontally at a distance overhead ensuring clearance e.g., min 7 ft. The exact layout will be determined during detailed design.

Allowance for air flow into the covered process channels and wet wells will be included in the design. The relative locations of air entry and foul air extraction will be selected to achieve good overall air movement within the enclosed process area and minimize development of "dead zones" or short-circuiting.

The extraction of foul air will be achieved through use of a single exhaust fan constructed of FRP. A flow balancing damper will be located at the fan inlet to allow for adjustment of overall system air flow. The

fan will convey captured foul air to an odor control system where the odorous compounds, primarily hydrogen sulfide (H_2S), are removed prior to release to the ambient atmosphere.

9.2.3 Odor Control System Sizing

All process areas will be continuously ventilated at 12 ACH. Table 9-1 summarizes ventilation rates required for the Union Pump Station. A plan view containing process areas is shown in the plans. The total system ventilation rate is 5,000 cubic feet per minute (cfm).

Table 9-1. Process Area Ventilation Rates

Source	ID no.	Volume (ft3)	Ventilation Rate (ACH)	Ventilation Rate (cfm)	Design Ventilation Rate (cfm)
Inlet Box	1	1,278	12	255	300
East Channel	2	2,032	12	406	450
West Channel	3	2,032	12	406	450
Outlet Box	4	1,374	12	275	300
South Wetwell	5	10,370	12	2,074	2050
North Wetwell	6	7,205	12	1,441	1,450
Total				4,857	5,000

9.2.4 Anticipated Odor Causing Compounds

CH2M recommends that air sampling be completed at the Union Pump Station in order to definitively establish hydrogen sulfide (H_2S) concentrations and the nature of peaks observed during normal diurnal cycles. It is recommended that an instrument capable of measuring and logging H_2S concentrations (e.g., Odalog) be installed for a week. Based on data previously collected at East Street and Boulevard Pump Stations, and experience from other similar systems, it is anticipated that H_2S concentrations may average on order of 10 parts per million by volume (ppmv) with peaks as high as 100 ppmv. Additionally, it is anticipated that other odorous non- H_2S sulfur bearing compounds will total less than 1 ppmv.

9.3 Control Technology Selection

Due to the anticipated ventilation rates and relatively low H_2S concentrations to be treated, two options have been evaluated; biotowers and carbon scrubbers. Both of these systems have a proven record for odor control, have low operation and maintenance requirements, and have a relative small footprint.

Another biological-based odor control technology, biofilters, is not recommended for consideration due to the relatively large footprint associated with this technology and very limited available site space at Union Pump Station.

Wet chemical scrubbers are another proven technology that may have potential. However, this technology is not recommended for further consideration due to the congested nature of the pump station site and its close proximity to nearby public areas and the need to transport, store and use hazardous chemicals associated with chemical scrubbers, i.e., sodium hypochlorite and sodium hydroxide.

A brief description of biotower and carbon technologies are provided below.

9.3.1 Biotowers

In many ways, a biotower looks externally similar to a wet chemical scrubber, except that no hazardous chemical addition is required. Figure 9-1 depicts a simplified schematic diagram of a biotower system.

Systems are pre-engineered, vendor-supplied systems made of fiberglass-reinforced plastic or high density polyethylene shells. Biotowers use a biologically active media bed to absorb and oxidize odorous compounds from the foul air stream. One of the primary technical advances associated with this technology is the development of engineered inert media on which the biomass attaches. As the media is inert, it is not compromised by the acidic environment within the biotower and has lifespans on the order of 20 years. The media receives either constant recycle spray (bioscrubber) or intermittent once-through spray humidification (biotrickling filter), depending on the vendor's approach. The spray is also the source of trace nutrients for the biological system. There are typically two potential sources of water, potable or plant effluent. If potable water is used, then a supplemental nutrient supply containing trace organics, nitrogen, phosphorous, and potassium is required. If plant effluent is available, then supplemental nutrients are usually not required as the plant effluent water will contain sufficient nutrients. For Union Pump Station, potable water and supplemental nutrients would be required as plant effluent is not available.

Biotowers are usually designed in the form of a cylindrical arrangement such as those shown in Figure 9-2.

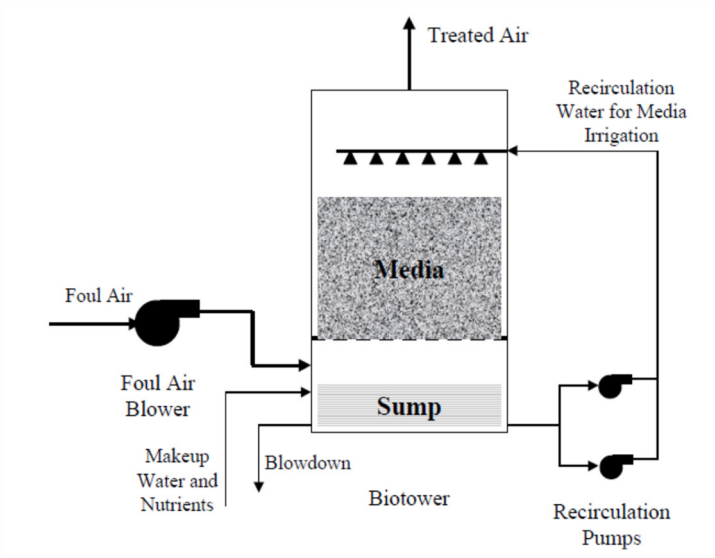

Figure 9-1. Simplified Schematic of a Biotower System

Figure 9-2. Photograph of a Biotower System

9.3.2 Carbon Scrubbers

Carbon scrubbers are the simplest of the vapor phase treatment technologies. They pass the foul air stream through a bed of dry (no irrigation) activated carbon. Odorous constituents diffuse into the media pore spaces and adsorb onto the media, and are thereby removed from the air stream. There are many types of activated carbon media designed for removal of various types of compounds. A single medium or a mixture of different media can be used. Carbon scrubbers have a small footprint compared to other technologies and can be configured with either vertical upward air flow through single, dual or radial flow beds or with horizontal flow configurations in locations where system height is constrained. Figures 9-3 and 9-4 depict a simplified schematic and photograph of a dual carbon bed system, respectively. Carbon scrubbers are effective at removing a range of compounds with excellent removal efficiency. One potential disadvantage is that under high H_2S loads, the media must be replaced frequently resulting in high annualized media replacement costs. However, the Union Pump Station is anticipated to have relatively low average H_2S concentrations (e.g., $\leq$ 10 ppmv); therefore, the potential use of carbon scrubbers as a treatment technology is recommended for consideration.

Carbon selection is an important part of designing carbon systems, because different types of carbon can be used depending on the nature of the odorant to be removed. For Union Pump Station, the primary odorant to be designed for is H_2S.

Various types of carbon are available. Virgin activated carbon is the lowest cost but also has the lowest overall capacity for H_2S resulting in relatively high frequency media replacements. Carbon adsorption capacity for H_2S can be increased with media that is impregnated with chemicals, such as sodium hydroxide (NaOH), to enhance contaminant removal. This, however, adds handling complexity because of the potentially hazardous nature of the impregnated carbon and potential for carbon bed fires. The

use of this type of impregnated carbon is not recommended for further consideration. Finally, there are carbons available that have been processed in a manner that results in high selective adsorptive capacity for H_2S (e.g., order of magnitude higher than virgin activated carbon). The use of this type of high capacity carbon is recommended for consideration as it will extend the useful life of the carbon significantly thereby reducing O&M issues and costs associated with frequent media replacement.

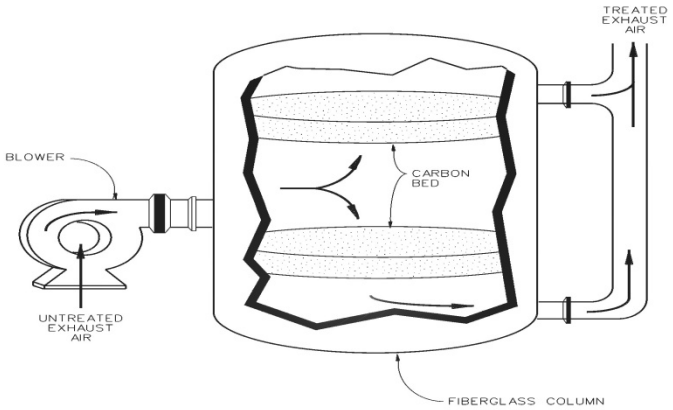

Figure 9-3. Schematic Dual Carbon Bed System

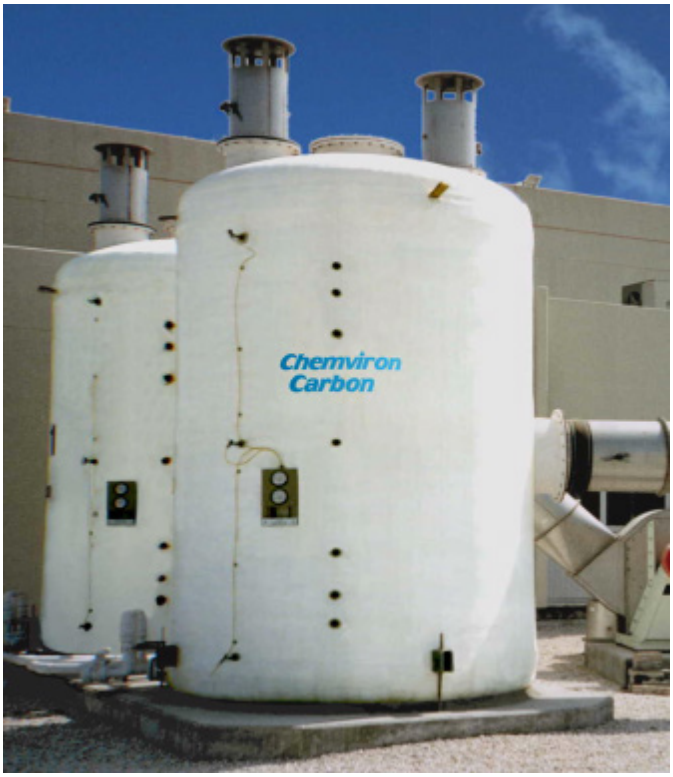

Figure 9-4. Photograph of a Dual Bed Carbon Scrubber

9.4 Economic Evaluation

An economic evaluation has been completed in order to compare capital costs, annual O&M costs and a 20-year net present value (NPV) for the carbon and biotower technologies.

Capital construction cost estimates were based on a database of recent vendor quotes for similar technology and were escalated to a midpoint of construction date of 2020. Operation and maintenance costs were estimated and combined with capital costs using a constant discount rate to determine a 20-year net present value. For planning purposes, it was assumed that the vapor phase treatment equipment has a life span of 20 years.

Unit costs and financial factors used in the cost estimate are listed in Table 9-2. As shown in Table 9-2, the inflation rate was assumed to be 6 percent and the discount rate was assumed to be 7 percent. The completion date was assumed to be 2020 and both the equipment life and planning horizon was 20 years. Factors were applied equally to each technology option.

Table 9-2. Capital, O&M and NPV Assumptions

Unit Costs		
Electricity	0.10	$/kW-hr
Labor	40	$/hr
Potable Water	4.4	$/1000 gal
Excavation	15	$/CY
Backfill	35	$/CY
Slab on Grade Concrete	525	$/SF
Support Wall Concrete	525	$/SF
Allowance Costs		
Equipment Installation	10	%
Field painting/finishes	1	%
Mechanical	8	%
Electrical	8	%
Instrumentation	5	%
Financial Factors		
Discount Rate	7	%
Annual Escalation Rate	3	%
Time Horizon	20	years
Construction Completion Year	2020	
Contractor Markups:		
General Conditions	7	%
Contractor Overhead & Profit	15	%
Bonds and Insurance	2	%
Contingency	30	%

Results of the economic evaluation are provided in Table 9-3.

As can be seen from the results of this evaluation, carbon has the lowest initial capital cost ($387,000 vs $655,000) and overall lowest NPV ($640,000 vs $804,000) compared to the biotower option, and therefore from a financial perspective, is the initial preferred option. However, given the sensitivity of carbon annual O&M costs and resultant NPV to the H_2S inlet concentration, further evaluations were completed to determine impacts of the assumption of an average 10 ppmv H_2S concentration on the economic results. Specifically, the assessment was repeated with increasingly higher concentrations of H_2S inlet to determine the point at which the biotower option had the lower NPV. This did not occur until inlet H_2S concentrations were 25 ppmv. Given the high ventilation rate included in the odor control design (i.e., 12 ACH), it is anticipated that the frequent turnover of air within the enclosed areas will prevent high concentrations of H_2S from accumulating, thus maintaining an inlet concentration of H_2S to the odor control system well below the 25 ppmv threshold. Therefore, carbon is recommended as the odor control technology of choice.

Table 9-3. Capital, Annual O&M and NPV Evaluation

Technology	Carbon	Biotower
Capital	$387,000	$655,000
Annual O&M	$22,000	$14,000
20 Yr NPV	$640,000	$804,000

9.5 Odor Control System Design Recommendations and Overview

A dual deep bed carbon scrubber utilizing carbon with high adsorptive capacity for H_2S is recommended. The use of the high adsorptive carbon will prolong carbon life and thereby increase the time between media replacements. Based on an average inlet concentration of 10 ppmv H_2S, it is anticipated that media replacement will be on the order of every two years.

As the site has significant space constraints, utilizing a dual deep bed system reduces footprint.

Recommended odor control system process equipment and anticipated design operating conditions are summarized in Table 9-4.

Table 9-4. Major Equipment, Design Criteria and Operating Conditions

Equipment/design criteria	Size/Operating conditions
Carbon Vessel	One (1) 8 ft diameter dual bed FRP vessel
Carbon type and replacement frequency	High adsorptive capacity carbon, e.g., 0.3 g H_2S/cc carbon; 24 month media replacement frequency
Carbon bed depth	3 ft each
Carbon bed face velocity	50 fpm
Odorous Air Fan	One (1) fan, FRP construction with sound enclosure; continuous operation
Fan design point	5,000 cfm at 8.5 inches w.c. pressure
Electrical requirements	480V/3-ph/60 Hz; 15 hp

Appendix A
Preliminary Design Drawings

INDEX TO DRAWINGS

100 - UNION PUMP STATION

SHEET NO.	DRAWING NO.	TITLE
GENERAL		
	100-G-001	UNION PUMP STATION INDEX OF DRAWINGS
	100-G-002	UNION PUMP STATION ABBREVIATIONS
	100-G-003	UNION PUMP STATION ABBREVIATIONS AND GENERAL LEGEND
	100-G-005	UNION PUMP STATION INSTRUMENTATION AND CONTROL LEGEND - SHEET 1
	100-G-006	UNION PUMP STATION INSTRUMENTATION AND CONTROL LEGEND - SHEET 2
	100-G-007	UNION PUMP STATION ARCHITECTURAL AND STRUCTURAL LEGEND
	100-G-013	UNION PUMP STATION HVAC LEGEND
	100-G-015	ELECTRICAL LEGEND 1
	100-G-016	ELECTRICAL LEGEND 2
	100-G-017	ELECTRICAL LEGEND 3
CIVIL		
	100-C-201	UNION PUMP STATION SITE PLAN
STRUCTURAL		
	100-S-201	UNION PUMP STATION FLOOD PROOFING FLOOR PLAN 35 MGD CAPACITY
ARCHITECTURAL		
	100-A-201	UNION PUMP STATION LOWER LEVEL PLAN 35 MGD CAPACITY
	100-A-202	UNION PUMP STATION GROUND FLOOR PLAN 35 MGD CAPACITY
	100-A-301	UNION PUMP STATION SECTION 35 MGD CAPACITY
	100-A-302	UNION PUMP STATION SECTION 35 MGD CAPACITY
HVAC		
	100-H-002	UNION PUMP STATION 35 MGD CAPACITY EQUIPMENT SCHEDULES
	100-H-202	UNION PUMP STATION 35 MGD CAPACITY EQUIPMENT PLATFORM PLAN
	100-H-203	UNION PUMP STATION 35 MGD CAPACITY GROUND FLOOR PLAN

SHEET NO.	DRAWING NO.	TITLE
MECHANICAL		
	100-M-201	UNION PUMP STATION 35 MGD CAPACITY LOWER PLAN
	100-M-202	UNION PUMP STATION 35 MGD CAPACITY UPPER PLAN
	100-M-301	UNION PUMP STATION 35 MGD CAPACITY SECTION
	100-M-302	UNION PUMP STATION 35 MGD CAPACITY SECTION
ELECTRICAL		
	100-E-201	UNION PUMP STATION SINGLE LINE DIAGRAM AND MCC ELEVATION
	100-E-202	UNION PUMP STATION GROUND FLOOR PLAN (35 MGD CAPACITY)
INSTRUMENTATION AND CONTROL		
	100-N-601	UNION PUMP STATION PROCESS FLOW DIAGRAM

NO.	DATE	DR	CHK	APVD	BY	APVD
DSGN	J. OSOSKIE	J. HARGIS	OC Review			Sealer

REVISION

PRELIMINARY – NOT FOR CONSTRUCTION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

GENERAL

UNION PUMP STATION
INDEX OF DRAWINGS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	100-G-001
SHEET	of

ABBREVIATIONS

A	AMMETER, AMPERES, AWNINGS
AB, ABV	ANCHOR BOLT, ABOVE
ABDN	ABANDON
AC	ACOUSTICAL, ACOUSTICAL CEILING
AC	ALTERNATING CURRENT
AC	ASPHALTIC CONCRETE
ACFL	ACCESS FLOORING
ACI	AMERICAN CONCRETE INSTITUTE
ACMU	ACOUSTICAL CONCRETE MASONRY UNIT, ACOUSTICAL CMU
ACP	ACOUSTICAL PANELS
ACST	ACOUSTICAL
ACT	ACOUSTICAL TILE
AD	AREA DRAIN
ADDL	ADDITIONAL
ADJ	ADJACENT
ADW	DRY WEATHER AVERAGE
AFD	ADJUSTABLE FREQUENCY DRIVE
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AG	ACOUSTICAL, ACOUSTICAL GLASS, AIR GAP (FIXED)
AGGR	AGGREGATE
AHR	ANCHOR
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AJ	ADJUSTABLE
AL	ALUMINUM
ALKY	ALKALINITY
ALTN	ALTERNATE
AM	AUTO-MANUAL
AMRD	ACOUSTICAL METAL ROOF DECKING
ANDZ	ANODIZE
APPROX	APPROXIMATE
APVD	APPROVED
ARCH	ARCHITECTURAL
AR	ANALOG RELAY
AS	AS SELECTED
ASSY	ASSEMBLY
ATS	AUTOMATIC TRANSFER SWITCH
AUTO	AUTOMATIC
AUX	AUXILIARY
AVG	AVERAGE
AWW	WET WEATHER AVERAGE
@	AT
B	BELL
BAL	BALANCE
BETW	BETWEEN
BF	BLIND FLANGE, BOTTOM FACE
BFV	BUTTERFLY VALVE
BL	BASELINE
BFP	BACKFLOW PREVENTER
BLDG	BUILDING
BLK	BLOCK
BM	BEAM, BENCHMARK
BO	BOTTOM OF
B.O.B.	BOTTOM OF BEAM
BOD	BOTTOM OF DUCT
BOP	BOTTOM OF PIPE
BOT	BOTTOM
BRG	BEARING
BRK	BRICK
BRKR	BREAKER
BSP	BLACK STEEL PIPE
BV	BALL VALVE, BLOCK VENT
BVC	BEGINNING OF VERTICAL CURVE
C	CONDUIT, CASEMENT
°C	DEGREE CELSIUS
C TO C	CENTER TO CENTER
CAB	CABINET
CB	CATCH BASIN, CIRCUIT BREAKER
CC	CENTER OF CIRCLE
CC	CONTROL CABLE
CCP	CENTRAL CONTROL PANEL
CCS	CENTRAL CONTROL SYSTEM
CDF	CONTROLLED DENSITY FILL
CE	CONSTRUCTION ENTRANCE
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHEM	CHEMICAL
CHKD	CHECKERED
CI	CAST IRON
CIP	CAST IRON PIPE, CAST IN PLACE
CIP	CULVERT INLET PROTECTION
CISP	CAST IRON SOIL PIPE
CJ	CONSTRUCTION JOINT
CKT	CIRCUIT
CL	CENTERLINE
CLDI	CEMENT LINED DUCTILE IRON
CLSF	CONTROLLED LOW STRENGTH FILL
CLG	CEILING
CLR	CLEAR, CLEARANCE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CMP	CENTRAL MONITORING PANEL
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CNTR	COUNTER
CO	CLEANOUT, CARBON MONOXIDE
COL	COLUMN, COLOR
CONC	CONCRETE
COND	CONDENSATE
CONDTN	CONDITIONED
CONN	CONNECTION
CONSTR	CONSTRUCTION
CONT	CONTINUED, CONTINUOUS, CONTINUATION
CONTR	CONTRACTOR
COORD	COORDINATE
COP	COPPER
CP	CENTER PIVOT
CP-X	CONTROL PANEL NO. X
CPLG	COUPLING
CPRSR	COMPRESSOR
CPT	CONTROL POWER TRANFORMER, CARPET
CPVC	CHLORINATED PVC
CR	CONTROL RELAY
CRS	COLD ROLLED STEEL
CRS	CONSTRUCTION ROAD STABILIZATION
CT	CERAMIC TILE
CT	CURRENT TRANSFORMER
CTC	COMPUTER TERMINAL CABINET
CTR	CENTER
CTRD	CENTERED
CTSK	COUNTERSUNK
CU	CUBIC
CU FT	CUBIC FOOT
CU IN	CUBIC INCH
CUH	COPPER TUBING, HARD DRAWN
CV	CHECK VALVE
CWR	CABINET DOOR MOUNTED WASTE RECEPTACLE
CY, CU YD	CUBIC YARD
CWS	CLEAN WATER SERVICES
D	DEEP, DRAIN
d	PENNY NAIL SIZE
DA	DUAL ACTION
DAS	DATA ACQUISTION SYSTEM
DBA	DEFORMED BAR ANCHOR
DBL	DOUBLE
DC	DIRECT CURRENT
DEG	DEGREE
DET	DETAIL
DF	DOUGLAS FIR, DRINKING FOUNTAIN
DDI	DROP INLET
DH	DOUBLE HUNG
DI	DUCTILE IRON
DIA	DIAMETER
DIAG	DIAGONAL
DIP	DUCTILE IRON PIPE
DIR	DIRECTION
DISCH	DISCHARGE
DN	DOWN
DO	DISSOLVED OXYGEN
DOL	DIRECT-ON-LINE
DP, DPNL	DISTRIBUTION PANEL
DR	DOOR
DS	DOWNSPOUT
DWG	DRAWING
DWL	DOWEL
△	DELTA
E	EAST, EMPTY
EA	EACH, EXHAUST AIR
EB, EBCT	EMPTY BED CONTACT TIME
ECC	ECCENTRIC
EE	EMERGENCY EYEWASH
EDF	EGG-SHAPED DIGESTER FACILITY
EF	EACH FACE, EXHAUST FAN
EFF	EFFICIENCY, EFFICIENT
EFL	EFFLUENT
EIFS	EXTERIOR INSULATION AND FINISH SYSTEM
EL	ELEVATION
ELB	ELBOW
ELC	ELECTRICAL LOAD CENTER
ELEC	ELECTRIC, ELECTRICAL
ENGR	ENGINEER
EOP	EDGE OF PAVEMENT
ESC	EROSION AND SEDIMENT CONTROL
EP	EXPLOSION PROOF, EDGE OF PAVING
EQL	EQUAL
EQL SP	EQUALLY SPACED
EQPT	EQUIPMENT
ESC	EROSION AND SEDIMENT CONTROL
ETM	ELAPSED TIME METER
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EWC	ELECTRIC WATER COOLER
EXH	EXHAUST
EXP	EXPANSION, EXPOSED
EXP AB	EXPANSION ANCHOR BOLT
EXP JT	EXPANSION JOINT
EXST, EXIST	EXISTING
EXT	EXTERIOR
°F	DEGREE FAHRENHEIT
FACP	FIRE ALARM CONTROL PANEL
FB	FLAT BAR
F, FU	FUSE
F, FX	FIXED
FAP	FIRE ALARM PANEL
FC	FLEXIBLE CONDUIT
FCA	FLANGED COUPLING ADAPTER
FCL2	FREE CHLORINE RESIDUAL
FCO	FLOOR CLEANOUT
FCTY	FACTORY
FD	FLOOR DRAIN
FDN	FOUNDATION
FDR	FEEDER
FEXT	FIRE EXTINGUISHER
FF	FINISHED FLOOR
FG	FINISH GRADE, FLOAT GLASS
FH	FLAT HEAD
FHY	FIRE HYDRANT
FIG	FIGURE
FL	FLOW LINE
FLG	FLANGE
FL	FLOOR
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FLUOR	FLUORESCENT
FNSH	FINISH
FOB	FLAT ON BOTTOM
FOT	FLAT ON TOP
FP	FIELD PANEL
FPM	FEET PER MINUTE
FR	FORWARD REVERSE
FRP	FIBERGLASS REINFORCED PLASTIC
FSHS	FOLDING SHOWER SEAT
FT	FOOT OR FEET
FTG	FOOTING
FU	FIXTURE UNIT
FVNR	FULL VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
FWD	FORWARD
G, GND	GROUND
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GB	GYPSUM BOARD
GC	GROOVED COUPLING
GCMU	GLAZED CONCRETE MASONRY UNITS
GFA	GROOVED FLANGE ADAPTER
GFI	GROUND FAULT INTERRUPTER
GFR	GROUND FAULT RELAY
GH	GREENHOUSE
GL	GLASS
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GPS	GLOBAL POSITION SYSTEM
GRTG	GRATING
GSB	GYPSUM SOFFIT BOARD
GSP	GALVANIZED STEEL PIPE
GV	GATE VALVE
GVL	GRAVEL
GWB	GYPSUM WALLBOARD
GYP	GYPSUM
H	HIGH, HORN OR HOWLER
H2S	HYDROGEN SULFIDE
H.A.S.	HEADED ANCHOR STUD
HC	HOLLOW CORE WOOD
HCL	HYDROCHLORIC ACID
HDNR	HARDENER
HDNS	HARDNESS
HDR	HEADER
HDW	HARDWARE
HGL	HYDRAULIC GRADE LINE
HK	HOOK
HGT	HEIGHT
HH	HANDHOLE
HID	HIGH INTENSITY DISCHARGE
HK	HOOK
HM	HOLLOW METAL
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
HORIZ	HORIZONTAL
HP	HORSEPOWER
HPT	HIGH POINT
HPU	HYDRAULIC POWER UNIT
HR	HOSE RACK, HANDRAIL
HV	HOSE VALVE
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HWL	HIGH WATER LEVEL
IC	INTERRUPTING CAPACITY
ID	INDUCED DRAFT, INSIDE DIAMETER
IE	INVERT ELEVATION
I.F.	INSIDE FACE
IG	INSULATING, INSULATING GLASS
IN	INCH
INCAND	INCANDESCENT
INFL	INFLUENT
INJS	INJECTIONS
INST	INSTANTANEOUS
INSTM	INSTRUMENT, INSTRUMENTATION
INSUL	INSULATION
INVT	INVERT
IP	INLET PROTECTION, INSTRUMENTATION PANEL
IRRIG	IRRIGATION
ITG	INSULATED TEMPERED GLASS
ITX	ISOLATION TRANSFORMER
IU	INTAKE UNIT
IW	IRRIGATION WELL
JA	JALOUSIE
JB	JAL-AWNING
JAN	JUNCTION BOX
JCT	JANITOR
JT	JUNCTION
K	JOINT
KIP	KEY GROUP, KEY INTERLOCK
KIT	THOUSAND POUNDS
K-PL	KITCHEN
KSK	KICKPLATE
KV	KITCHEN SINK
KVA	KILOVOLTS
KVAR	KILOVOLT AMPERES
KW	KILOVOLT AMPERES REACTIVE
L	KILOWATT
LA	ANGLE, LENGTH
LAB	LIGHTNING ARRESTER
LAM	LABORATORY
LAT	LAMINATE
LB	LATITUDE
LC	POUND
LD	LIGHTING CONTACTOR
LDG	COMBINATION LOUVER/DAMPER
LEL	LOADING DOCK
LF	LOWER EXPLOSIVE LIMIT
LG	LINEAR FEET
LH	LONG
LHR	LEFT HAND
LLH	LEFT HAND REVERSE
LLV	LONG LEG HORIZONTAL
LNTL	LONG LEG VERTICAL
LONG	LINTEL
LOS	LONGITUDINAL
LP	LOCK-OUT STOP PUSHBUTTON
LPT	LIGHT POLE, LIGHTING PANEL, LOCAL PANEL
LR	LOW POINT
LR	LATCHING RELAY
LR	LOCAL-REMOTE
LS	LONG RADIUS
LT	LABORATORY SINK
LTG, LTS	LEFT
LTX	LIGHTS OR LIGHTING
LWL	LIGHTING TRANSFORMER
	LOW WATER LEVEL
MA	MANUAL-AUTO
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MC	MASONRY CLEARANCE
MC	MODULATE-CLOSE
MCC	MOTOR CONTROL CENTER
MCJ	MASONRY CONTROL JOINT
MDO	MEDIUM DENSITY OVERLAY
MECH	MECHANICAL
MFD	MANUFACTURED
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE, MOUNTING HEIGHT
MIN	MINIMUM
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MLO	MAIN LUGS ONLY
MMDW	DRY WEATHER MAXIMUM MONTH
MMP	MECHANICAL MOUNTING PANEL
MMWW	WET WEATHER MAXIMUM MONTH
MO	MANUAL OPERABLE, MASONRY OPENING
MP	METAL PANEL
MPU	MULTIPURPOSE UNIT
MS	MANUFACTURER'S STANDARD
MSC	MANUFACTURER SUPPLIED CABLE
MSR	GROUPED MOTOR CONTROL
MT	MOUNT
MTD	MOUNTED
MTG	MOUNTING
MTS	MANUAL TRANSFER SWITCH
MTS	MILL TYPE STEEL PIPE
MU	MULCHING
MV	MERCURY VAPOR
MWS	MAXIMUM WATER SURFACE
N	NORTH, NEUTRAL
NA	NOT APPLICABLE
NA	NON-AUTOMATIC
NC	NORMALLY CLOSED
NEUT	NEUTRAL
NG	NATURAL GAS
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
N.O.	NORMALLY OPEN
NO., #	NUMBER
NOM	NOMINAL
NP	NON-PROTECTED
NPT	NATIONAL PIPE THREADS
NS	NON-SHRINK
NTS	NOT TO SCALE
O2	OXYGEN
O TO O	OUT TO OUT
OA	OVERALL, ODOROUS AIR
OC	ON CENTER
OC	OPEN-CLOSE (O)
OCA	OPEN-CLOSE-AUTO
OCR	OPEN-CLOSE-REMOTE
OD	OUTSIDE DIAMETER, OVERFLOW DRAIN
O.F.	OUTSIDE FACE
OFCI	OWNER FURNISHED, CONTRACTOR INSTALLED
OFOI	OWNER FURNISHED, OWNER INSTALLED
OL	OVERLOAD RELAY
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
OP	OPAQUE PANEL, OUTLET PROTECTION
OPER	OPERATOR
OPNG	OPENING
OPP	OPPOSITE
OSA	OUTSIDE AIR
OSC	OPEN-STOP-CLOSE
OSD	OPEN SITE DRAIN
OWSJ	OPEN WEB STEEL JOIST
OZ	OUNCE
P	PROJECTED
P	PILASTER, PIPE
PAVT	PAVER TILE
PB	PUSHBUTTON SWITCH
PC	POINT OF CURVE, PHOTOCELL
PC	PRECAST CONCRETE PANEL
PCCP	PRECAST CONCRETE CYLINDER PIPE
PCV	PRESSURE CONTROL VALVE
PE	PLAIN END
PED	PEDESTAL, PEDESTRIAN
PEP	POLYETHYLENE PIPE
PEN.	PENETRATION
PFC	POUNDS PER CUBIC FOOT
PH	PENTHOUSE
pH	HYDROGEN ION CONCENTRATION
PH	PHASE
PI	POINT OF INTERSECTION
PIT	PILOT TUBE TEST STATION
PJF	PREMOULDED JOINT FILLER
PL	PLATE (STEEL)
PL	PROPERTY LINE
PLAM	PLASTIC LAMINATE
PLAS	PLASTER, PLASTIC
PLC	PROGRAMMABLE LOGIC CONTROLLER
PLYWD	PLYWOOD
PNL	PANEL
PP	POWER POLE
P-P	PUSH-PULL
PPL	POLYPROPYLENE LINED
PR	PAIR
PRC	POINT OF REVERSE CURVE
PRCST	PRECAST
PREFAB	PREFABRICATION
PRES	PRESSURE
PRI	PRIMARY
PRM	PERMANENT REFERENCED MARKER
PROJ	PROJECTION
PROP	PROPERTY
PS	PLASTIC SHEET, POLYCARBONATE SHEET
PS	PAINT SYSTEM
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH, GAUGE
PT	POINT OF TANGENCY
PT	POTENTIAL TRANSFORMER
PT	PRESSURE TREATED
PTD	PAPER TOWEL DISPENSER
PTN	PARTITION
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
QAA	AVERAGE FLOW
QMM	MAXIMUM 30 DAY FLOW
QPI	PEAK INSTANTANEOUS FLOW
QPP	PEAK PUMPING FLOW
QT	QUARRY TILE
R	RISER
R OR RAD	RADIUS
RA	RETURN AIR
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RCPT	RECEPTACLE
RD	ROAD, ROOF DRAIN
RDCR	REDUCER
RDW	REDWOOD
RECIR	RECIRCULATION
REF	REFER OR REFERENCE
REFR	REFRIGERATE, REFRIGERANT
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RESIL	RESILIENT
RFS	ROLL-UP FIRE SHUTTER
RH	RIGHT HAND
RH	RODHOLE
RHR	RIGHT HAND REVERSE
RL	RAIN LEADER
RLS	RUBBER LINED STEEL
RM	ROOM
RO	ROUGH OPENING
ROL	RAISE-OFF-LOWER
RPM	REVOLUTIONS PER MINUTE
RR	RIPRAP

GENERAL NOTES:

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2. CONTACT ENGINEER FOR ABBREVIATIONS USED BUT NOT SHOWN ON THIS DRAWING.

NO.	DATE	DSGN
		J. OSOSKIE

REVISION

BY	CHK	DR
APVD	OC Review	J. HARGIS
APVD	Sealer	

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m.

GENERAL
UNION PUMP STATION ABBREVIATIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

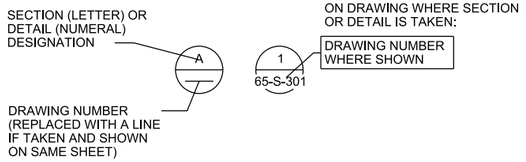
DATE	NOVEMBER 2016
PROJ	664626
DWG	100-G-002
SHEET	of

PRELIMINARY – NOT FOR CONSTRUCTION

ABBREVIATIONS

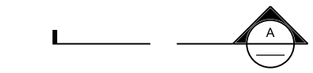
RRUB	RADIAL RUBBER
RS	RIGID STEEL
RST	REINFORCING STEEL
RT	RIGHT
RTN	RETURN
RTO	REGENERATIVE THERMAL OXIDIZER
RUB	RUBBER
RUBC	RUBBER CUSHIONED FLOORING
RUBS	RUBBER ESD CONTROL FLOORING
R/W	RIGHT OF WAY
S	I-BEAM
S	SLOPE, SOUTH, SWITCH
SA	SUPPLY AIR
SATC	SUSPENDED ACCUSTICAL TILE CEILING
SB	SEDIMENT BASIN
SC	SHOWER CURTAIN, SOLID CORE WOOD
SCADA	SUPERVISORY CONTROL AND DATA ACQUISITION
SCC	SOLID CORE
SCFM	STANDARD CUBIC FEED PER MINUTE
SCHED	SCHEDULE
SCU	SPEED CONTROL UNIT
SDP	SUB-DISTRIBUTION PANEL
SDWK	SIDEWALK
SEC	SECONDARY
SECT	SECTION
SED	SEDIMENTATION
SEW	SEWAGE
SG	LAMINATED SAFETY GLASS, SAFETY
SGWB	SUSPENDED GYPSUM WALL BOARD
SH	SHEET
SHA	SURFACE HARDENING AGENT
SHS	SOLIDS HANDLING SYSTEM
SIM	SIMILAR
SK	SINK
SLR	SEALER
SMLS	SEAMLESS EPOXY
SOI	SPRAY- ON INSULATION
SOLN	SOLUTION
SP	SPACE OR SPACES, SPANDREL PANEL, STORMPROOF
SPEC, SPECS	SPECIFICATIONS
SPD	SUMP PUMP DISCHARGE
SPG	SPACING
SPLY	SUPPLY
SQ	SQUARE
SQ FT	SQUARE FOOT, FEET
SQ IN	SQUARE INCH
SR	SHORT RADIUS
SS	START-STOP
SST	STAINLESS STEEL
SSC	SUPERVISORY SET POINT CONTROL
ST	STORM DRAIN
ST	STRAIGHT
STA	STATUS, STATION
STD	STANDARD
STIF	STIFFENER
STIRR	STIRRUP
STL	STEEL
STRL	STRUCTUAL
STRUCT	STRUCTURE
SUBFL	SUBFLOOR
SUSP	SUSPENDED
SV	SOLENOID VALVE
SVIN	SHEET VINYL
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYMM	SYMMETRICAL
T	THERMOSTAT, TREAD
T/	TOP OF
T&B	TOP AND BOTTOM
T&G	TONGUE AND GROOVE
TA	TRANSFER AIR
TAN	TANGENT
TB	TERMINAL BOARD
TBG	TUBING
TC	TIME TO CLOSE
TC	TURBIDITY CURTAIN
TCAD	TIME CLOSE AFTER DE-ENERGIZATION
TCAE	TIME CLOSE AFTER ENERGIZATION
TDH	TOTAL DYNAMIC HEAD
TDR	TIME DELAY RELAY
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPORARY, TEMPERATURE
TF	TOP FACE
TFG	TEMPERED FLOAT GLASS
TG	TEMPERED
TH	TOP-HINGED
THD	THREAD
THK	THICKNESS
THRU	THROUGH
TJB	TERMINAL JUNCTION BOX
TL	TEFLON LINED PIPE
T.O.	TIME TO OPEN, TOP OF
TOAE	TIME OPEN AFTER ENERGIZATION
TOC	TOP OF CONCRETE
TOC	TOP OF CURB
TOD	TIME ON DELAY, TOP OF DUCT TOTAL OXYGEN DEMAND
TOF	TOP OF FOOTING
TOG	TOP OF GROUT, TOP OF GRATE
T.O.P.	TOP OF PARAPET
TOS	TOP OF SLAB
TOW	TOP OF WALL
TP	TURNING POINT
TR	TRANSOM, TRUSS
TRANS	TRANSFORMER, TRANSITION
TRANSV	TRANSVERSE
TRD	TREAD
TS	TEMPORARY SEEDING, TUBE STEEL
TSHT	THRESHOLD
TSS	TOTAL SUSPENSION SOLIDS
TST	TOP OF STEEL
TTC	TELEPHONE TERMINAL CABINET
TTD	TOILET TISSUE DISPENSER
TU-X	TREATMENT UNIT NO. X
TURB	TURBIDITY
TWP	TRANSLUCENT WALL PANEL
TX	TRANSFORMER
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
UNO	UNLESS NOTED OTHERWISE
UPS	UNINTERRUPTIBLE POWER SUPPLY
USB	UNIT SUBSTATION
UVR	UNDER VOLTAGE RELAY
V	VENT, VALVE
V	VOLTMETER, VOLTS
VB	VAPOR BARRIER (RETARDER)
VC	VERTICAL CURVE
VCP	VITRIFIED CLAY PIPE
VCT	VINYL COMPOSITION TILE
VEL	VELOCITY
VERT	VERTICAL
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION
VIF	VERIFY IN FIELD
VIN	VINYL
VINT, VT	VINYL TILE
VP	VERTICAL PIVOTED
VPS	VENEER PLASTER SYSTEM
VPC	POINT OF VERTICAL CURVATURE
VPI	POINT OF VERTICAL INTERSECTION
VPT	POINT OF VERTICAL TANGENT
VS	VERTICAL SLIDE
VTR	VENT THRU ROOF
VWC	VINYL WALL COVERING
W	WEST
W/	WITH
WC	WATER COLUMN
WEASTRIP	WEATHERSTRIP
WG	WIRE, WIRE GLASS
WH	WATTHOUR METER
WHD	WATTHOUR DEMAND METER
WP	WATERPROOF, WEATHERPROOF, WORKPOINT
WR	WASTE RECEPTACLE
WRB	WATER RESISTANT GWB
WS	WATER SURFACE, WATERSTOP, WELDED STEEL
WWF	WELDED WIRE FABRIC
WWPH	WET WEATHER PEAK HOUR

SECTION / DETAIL DESIGNATIONS

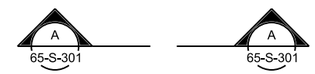


DRAWING TITLE
SCALE

ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (eg: ELEVATIONS)



SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT



SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET

GRID LINE INDICATOR

KEYNOTE NUMBER

REVISION / ADDENDA NUMBER

NORTH ARROW

DESIGN DETAIL DESIGNATION

NOTES:

1. ALL DESIGN DETAILS ARE TYPICAL AND MUST BE USED IF DESIGN DETAIL DESIGNATION IS NOT SHOWN
2. THE TERM STANDARD DETAIL, OR A FORM OF IT, IS SYNONYMOUS WITH DESIGN DETAIL. THE DESIGN DETAILS REPRESENT THE CHARACTER AND NATURE OF THE WORK REQUIRED THROUGHOUT THE PROJECT. ALL ASSOCIATED WORK SHALL BE IN ACCORDANCE WITH THE DESIGN DETAILS SHOWN WHETHER THE DETAILS ARE SPECIFICALLY REFERENCED OR NOT.

DRAWING NUMBER DESIGNATION

DRAWING NUMBER

100-S-201

- SEQUENTIAL NUMBER
- SHEET TYPE
  - 0 GENERAL, DIAGRAMS, SCHEMATICS
  - 1 DEMOLITION DRAWINGS
  - 2 PLANS
  - 3 SECTIONS AND OR ELEVATIONS
  - 4 LARGE SCALED VIEWS
  - 5 DETAILS
  - 6 SCHEDULES
- DISCIPLINE
  - G GENERAL
  - C CIVIL
  - L EROSION CONTROL
  - S STRUCTURAL
  - A ARCHITECTURAL
  - F FIRE PROTECTION
  - P PLUMBING
  - D PROCESS
  - Y PIPING
  - M MECHANICAL
  - E ELECTRICAL
  - N INSTRUMENTATION AND CONTROLS
- FACILITY
  - 100 - UNION PUMP STATOIN
  - 200 - EAST STREET PUMP STATION
  - 300 - BOULEVARD PUMP STATION

PROJECT NOTES:

1. PROJECT ELEVATIONS ARE BASED ON NAVD 88. EXISTING ELEVATIONS ARE BASED ON NGVD 29. EXISTING DRAWINGS WERE USED AS BACKGROUNDS FOR EXISTING BUILDINGS/STRUCTURES. EXISTING ELEVATIONS HAVE BEEN CONVERTED TO NAVD 88, UNLESS NOTED OTHERWISE. TO CONVERT BETWEEN NGVD 29 AND NAVD 88 USE THE FOLLOWING CONVERSIONS:

   NGVD 29 TO NAVD 88: SUBTRACT 1.04 FEET
   NAVD 88 TO NGVD 29: ADD 1.04 FEET

2. CONTRACTOR SHALL FIELD VERIFY EXISTING ELEVATIONS AND DIMENSIONS.

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NO.	DSGN	DATE	REVISION	CHK	APVD	BY	APVD
	J. OSOSKIE	J. HARGIS			OC Review		Sealer

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

GENERAL

UNION PUMP STATION
ABBREVIATIONS AND GENERAL LEGEND

PRELIMINARY – NOT FOR CONSTRUCTION

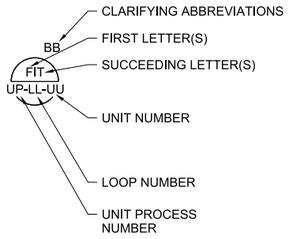
VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	100-G-003
SHEET	of

INSTRUMENT IDENTIFICATION

EXAMPLE SYMBOLS



DIGITAL SYSTEM INTERFACES

- ▲ ANALOG INPUT
- ▼ ANALOG OUTPUT
- $\triangle_X$ DISCRETE INPUT
- ∇_X DISCRETE OUTPUT

INSTRUMENT IDENTIFICATION LETTERS TABLE

LETTER	FIRST-LETTER		SUCCEEDING-LETTERS		
	PROCESS OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	READOUT OR PASSIVE FUNCTION	READOUT OR PASSIVE FUNCTION
A	ANALYSIS (+)		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
C	USER'S CHOICE (*)			CONTROL	
D	DENSITY (S.G.)	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT, SENSOR		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE (*)		GLASS, GAUGE VIEWING DEVICE	GATE	
H	HAND (MANUAL)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTION	MOMENTARY			MIDDLE, INTERMEDIATE
N	TORQUE		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
O	USER'S CHOICE (*)		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD OR PRINT		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTI VARIABLE		MULTI FUNCTION	MULTI FUNCTION	MULTI FUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED (*)	X AXIS	UNCLASSIFIED (*)	UNCLASSIFIED (*)	UNCLASSIFIED (*)
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION	Z AXIS		DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

TABLE BASED ON THE INSTRUMENTATION, SYSTEMS, AND AUTOMATION SOCIETY (ISA) STANDARD.

(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS AND LETTER SYMBOLS.
(*) WHEN USED, DEFINE THE MEANING HERE FOR THE PROJECT.

GENERAL INSTRUMENT OR FUNCTIONAL SYMBOLS

- FIELD MOUNTED
- REAR-OF-PANEL MOUNTED (OPERATOR INACCESSIBLE)
- PANEL MOUNTED (OPERATOR ACCESSIBLE)
- MCC MOUNTED

HAND SWITCHES AND INDICATING LIGHTS

ON AND OFF EVENT LIGHTS

ON-OFF HAND SWITCH, MAINTAINED CONTACT SWITCH (CONTROLLED DEVICE WILL RESTART ON RETURN OF POWER AFTER POWER FAILURE).

STOP-START HAND SWITCH MOMENTARY CONTACT SWITCHES (CONTROLLED DEVICE WILL NOT RESTART ON RETURN OF POWER AFTER POWER FAILURE).

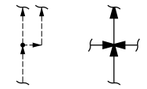
LINE LEGEND

- PRIMARY PROCESS (CLOSED CONDUIT, DASHED LINE INDICATES ALTERNATE FLOW STREAM)
- SECONDARY PROCESS
- BYPASS PROCESS
- PROCESS (OPEN CHANNEL)
- ANALOG SIGNAL (4 TO 20 mAdc, ETC.)
- DISCRETE (ON/OFF, ETC.)
- PNEUMATIC SIGNAL
- FILLED SYSTEM SIGNAL
- HYDRAULIC SYSTEM SIGNAL
- DATA LINK
- BUILDING OR FACILITY BOUNDARY
- PACKAGE SYSTEM EQUIPMENT
- SIMILAR PROCESS

PARALLELING LINES

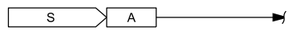
(A) TOTAL OF 2 SIGNALS

CONNECTING LINES



NON-CONNECTING LINES

INTERFACE SYMBOLS



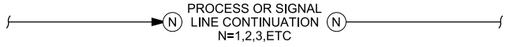
PROCESS INTERFACE

SIGNAL INTERFACE

A INTERFACE LETTER

D DESTINATION DRAWING NO.

S SOURCE DRAWING NO.



SELF CONTAINED VALVE & EQUIPMENT TAG NUMBERS

D-UP-LL-UU

D	ARV	AIR RELEASE VALVE
	AVRV	AIR AND VACUUM RELEASE VALVE
	E	EJECTOR
	G	GATE
	M	MECHANICAL EQUIPMENT
	P	PUMP
	T	TANK
UP		UNIT PROCESS NUMBER
LL		LOOP NUMBER
UU		UNIT NUMBER

ABBREVIATIONS & LETTER SYMBOLS

AC	ALTERNATING CURRENT
AM	AUTO-MANUAL
CL_2 etc.	CHLORINE (TYPICAL: USE STANDARD CHEMICAL ELEMENT ABBREVIATIONS)
COD	CHEMICAL OXYGEN DEMAND
CP-X	CONTROL PANEL NO. X (X = FACILITY NUMBER)
DC	DIRECT CURRENT
DO	DISSOLVED OXYGEN
FCL_2	FREE CHLORINE RESIDUAL
FOS	FAST-OFF-SLOW
FOSA	FAST-OFF-SLOW-AUTO
FOSR	FAST-OFF-SLOW-REMOTE
FP-W-X	FIELD PANEL NO. WX (W = UNIT PROCESS NUMBER X = PANEL NUMBER)
FR	FORWARD-REVERSE
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
ISR	INTRINSICALLY SAFE RELAY
LEL	LOWER EXPLOSIVE LIMIT
LOS	LOCKOUT STOP
LR	LOCAL-REMOTE
MA	MANUAL-AUTO
MC	MODULATE-CLOSE
MCC-X	MOTOR CONTROL CENTER NO. X
MSC	MANUFACTURER SUPPLIED CABLE
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OC	OPEN-CLOSE(D)
OCA	OPEN-CLOSE-AUTO
OCR	OPEN-CLOSE-REMOTE
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
ORP	OXIDATION REDUCTION POTENTIAL
OSC	OPEN-STOP-CLOSE
pH	HYDROGEN ION CONCENTRATION
PLC	PROGRAMMABLE LOGIC CONTROLLER
RIO	REMOTE I/O UNIT
RTU-X	REMOTE TELEMETRY UNIT NO. X
SOF	SLOW-OFF-FAST
SS	START-STOP
TCL_2	TOTAL CHLORINE RESIDUAL
TOC	TOTAL ORGANIC CARBON
TOD	TOTAL OXYGEN DEMAND
TURB	TURBIDITY
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION

GENERAL NOTES

1. COMPONENTS AND PANELS SHOWN WITH A SINGLE ASTERISK (✳) ARE TO BE PROVIDED AS PART OF A PACKAGE SYSTEM.
2. COMPONENTS AND PANELS SHOWN WITH A DOUBLE ASTERISK (✳✳) ARE TO BE PROVIDED UNDER DIVISION 26, ELECTRICAL.
3. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THE PROJECT.

NO.	DATE	DSGN	REVISION	CHK	DR
		J. OSOSKIE	J. HARGIS		

BY	APVD
	OC Review
	APVD
	Sealer

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m.

GENERAL
UNION PUMP STATION
INSTRUMENTATION AND CONTROL
LEGEND - SHEET 1

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
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0 1"

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SHEET	of

VALVE SYMBOLS

- GATE
- KNIFE GATE
- BUTTERFLY
- GLOBE
- BALL
- VEE-BALL
- SEAT PORT ECCENTRIC PLUG
- DIAPHRAGM
- PINCH
- NEEDLE
- SWING CHECK
- BALL CHECK
- BACKFLOW PREVENTER
- ROTARY
- TELESCOPING
- SAMPLE
- MUD
- PRESSURE RELIEF
- AIR AND/OR VACUUM RELEASE
- REGULATED SIDE PRESSURE CONTROL
- PRESSURE REGULATION (CLAY-TYPE)
- MULTI-PORT VALVE (GATE VALVE SHOWN. FOR OTHER VALVE TYPES, APPROPRIATE VALVE SYMBOL SHOWN.) SEAT PORTS ARE IMPLIED BY INDICATED FLOW PATTERN.
- ANGLE GATE

GATE SYMBOLS

- SLUICE
- FABRICATED SLIDE
- STOP LOG
- BUTTERFLY
- FLAP
- SHEAR

ACTUATOR SYMBOLS

- PNEUMATIC DIAPHRAGM SPRING-OPPOSED, SINGLE OR DOUBLE ACTING
- VALVE POSITIONER
- MANUAL
- PNEUMATIC CYLINDER SINGLE OR DOUBLE ACTING ACTUATED BY ONE INPUT
- HYDRAULIC
- ELECTRIC MOTOR
- DIAPHRAGM, DIFFERENTIAL PRESSURE
- SOLENOID
- ELECTROHYDRAULIC

NOTE:
ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL, OR HYDRAULIC)

XX: FO FAIL OPEN
FC FAIL CLOSED
FLP FAIL TO LAST POSITION

PRIMARY ELEMENT SYMBOLS

- PARSHALL FLUME
- PROPELLER OR TURBINE METER
- LEVEL (FLOAT)
- WEIR
- THERMAL FLOWMETER
- ROTAMETER
- ORFICE PLATE
- LEVEL (BUBBLER TUBE)
- DENSITY METER
- FLOW TUBE
- GENERIC
- ULTRASONIC FLOWMETER
- LEVEL (ULTRASONIC)
- ELECTROMAGNETIC FLOWMETER

PIPING DESIGNATION

RAS
FLOW STREAM IDENTIFICATION

MISCELLANEOUS SYMBOLS

- VENT TO ATMOSPHERE
- AIR GAP
- DRIP TRAP
- PIG INSERT POINT
- PIG CATCH POINT
- SELF CONTAINED AIR SUPPLY
- AIR PURGE SET
- FLUSHING CONNECTION
- SEAL WATER SET
- WATER PURGE SET
- FLEXIBLE CONNECTION
- AERATOR
- DIAPHRAGM SEAL
- ANNULAR DIAPHRAGM SEAL
- COMPOSITE SAMPLER
- FLAME TRAP
- CALIBRATION COLUMN
- INLINE SILENCER
- BLIND FLANGE
- PIPE CAP
- STRAINER
- BASKET STRAINER
- FILTER
- PULSATION DAMPENER
- EXPANSION CHAMBER
- SLUDGE GRINDER
- PANEL CONTINUED ON SAME OR OTHER DRAWING (FFLCPLLLX)
- PANEL OUTLINE
- PANEL NAME
- 120 VOLT, 60 HZ POWER
- 480 VOLT, 60 HZ POWER
- AIR SET XX = SUPPLY PRESSURE IN PSIG.
- PLUG
- RECEPTACLE
- RUPTURE DISK (VACUUM)
- RUPTURE DISK (PRESSURE)
- TV MONITOR
- TV CAMERA
- RADIO ANTENNA
- INTERLOCK, SEE CONTROL DIAGRAMS
- VOICE COMMUNICATION POINT
- SKIMMING MECHANISM
- SCREW CONVEYOR
- SUBMERSIBLE MIXER
- INTRINSIC SAFETY BARRIER/RELAY
- INLINE FAN
- SIGHT INDICATOR

PUMP AND COMPRESSOR SYMBOLS

- CENTRIFUGAL PUMP (DRY PIT)
- CENTRIFUGAL WET PIT PUMP OR TURBINE PUMP
- RECIPROCATING OR METERING PUMP (POSITIVE DISPLACEMENT)
- DIAPHRAGM PUMP
- GEAR PUMP OR BLOWER (POSITIVE DISPLACEMENT)
- PROGESSING CAVITY PUMP
- COMPRESSOR (CENTRIFUGAL)
- COMPRESSOR (PISTON)
- BLOWER OR FAN (CENTRIFUGAL)
- EJECTOR
- PISTON PUMP
- SUBMERSIBLE SUMP PUMP
- PERISTALLIC PUMP

XX: AS ADJUSTABLE SPEED
CS-1 CONSTANT SPEED (SINGLE SPEED)
CS-2 CONSTANT SPEED (TWO SPEED)

FLOW STREAM IDENTIFICATION

ALP	AIR LOW PRESSURE PROCESS	S	SANITARY SEWER (GRAVITY)
ARD	ACID RESISTANT DRAIN	SA	SAMPLE
ARV	ACID RESISTANT VENT	SC	SUPPLEMENTAL CARBON
BD	BLOW DOWN	SCS	SUPPLEMENTAL CARBON SOLUTION
BSD	BLENDED SLUDGE	SHC	SODIUM HYPOCHLORITE
BYP	BYPASS	SMD	SCUM DECANT
CA	SODIUM HYDROXIDE / CAUSTIC	SPD	SUMP PUMP DRAIN / DISCHARGE
CO	CONDENSATE DRAIN	SR	SCRUBBER RECIRCULATION
CSM	COMBINED SCUM	SSM	SECONDARY SCUM
D	DRAIN (PLUMBING)	SU	SULFURIC ACID
DR	DRAIN (PROCESS)	TA	TREATED AIR
FF	FIRE SUPPRESSION FOAM	TPSD	THICKENED PRIMARY SLUDGE
FO	FUEL OIL	TW	TEMPERED WATER (POTABLE)
FS	FIRE SPRINKLER WATER	TWAS	THICKENED WAS
G	NATURAL GAS (PROCESS)	V	VENT
GTO	GRAVITY THICKENER OVERFLOW	VR	VAPOR RECOVERY
HW	HOT WATER (POTABLE)	W1	CITY WATER (POTABLE)
HWR	HEATING WATER RETURN	W2	SEPARATED CITY WATER (NON-POTABLE)
HWS	HEATING WATER SUPPLY	W3	PLANT WATER (PLANT EFFLUENT)
ISD	IMPORTED SLUDGE	WAS	WASTE ACTIVATED SLUDGE
LPR	LOW PRESSURE RETURN (CONDENSATE)		
LPS	LOW PRESSURE STEAM		
NG	NATURAL GAS (PLUMBING)		
NRCY	NITRATE RICH RECYCLE		
OA	ODOROUS AIR		
OD	OVERFLOW ROOF DRAIN		
OF	OVERFLOW		
PE	PRIMARY EFFLUENT		
PSD	PRIMARY SLUDGE		
PSM	PRIMARY SCUM		
RAS	RETURN ACTIVATED SLUDGE		
RBSD	RECYCLE BLENDED SLUDGE		
RD	ROOF DRAIN		
RHG	REFRIGERANT HOT GAS		
RHW	RECIRCULATING HOT WATER		
RL	REFRIGERANT LIQUID		
RS	REFRIGERANT SUCTION		
RTW	RECIRCULATING TEMPERED WATER		

NOTE:
1. FOR EXISTING CIVIL YARD PIPING FLOW STREAM IDENTIFICATION, SEE CIVIL LEGEND.

NO.	DATE	DSGN	REVISION	CHK	BY	APVD
	J. OSOSKIE	DR	J. HARGIS	OC Review	APVD	Sealer

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

GENERAL
UNION PUMP STATION
INSTRUMENTATION AND CONTROL
LEGEND - SHEET 2

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	100-G-006
SHEET	of

GENERAL ARCHITECTURAL NOTES

1. UNLESS OTHERWISE INDICATED, PLAN DIMENSIONS ARE TO COLUMN GRID ON CENTERLINES, NOMINAL SURFACE OF MASONRY, FACE OF STUDS AND FACE OF CONCRETE WALLS.
2. "FLOOR LINE" REFERS TO TOP ON CONCRETE SLABS. FINISH FLOORING IS INSTALLED ABOVE THE FLOOR LINE. FOR DEPRESSED FLOORS AND CURBS, SEE STRUCTURAL DRAWINGS.
3. REPETITIVE FEATURES ARE NOT DRAWN IN THEIR ENTIRETY AND SHALL BE COMPLETELY PROVIDED AS IF DRAWN IN FULL.
4. WHERE DOOR IS LOCATED NEAR CORNER OF ROOM AND IS NOT LOCATED BY DIMENSION ON PLAN OR DETAILS, DIMENSION SHALL BE 3-INCHES FROM FACE OF STUD (WALL) TO FACE OF ROUGH OPENING. DIMENSION SHALL BE 6" FROM FACE OF WALL TO EDGE OF ROUGH OPENING AT CONCRETE WALLS, 8" AT CMU WALLS.
5. AT SOUND INSULATED WALLS, FULL HEIGHT PARTITIONS SHALL BE SEALED BOTH SIDES WITH ACOUSTIC SEALANT; TOP, BOTTOM, INTERSECTION, DOOR FRAMES, GLAZED OPENING FRAMES, AND OTHER PENETRATIONS.
6. LINE OF EXISTING GRADES, AS SHOWN ON THE BUILDING ELEVATIONS AND SECTIONS ARE APPROXIMATE. THEY ARE AT THE BUILDING FACE, OR ON THE SECTION END EXCEPT AS NOTED.
7. VERIFY ALL ROUGH-IN DIMENSIONS FOR EQUIPMENT PROVIDED IN THIS CONTRACT, OR BY OTHERS.
8. REFER TO ARCHITECTURAL, STRUCTURAL, MECHANICAL, ELECTRICAL AND OTHER CATEGORIES OR DRAWINGS FOR ADDITIONAL NOTES.
9. VERIFY SIZE AND LOCATION OF, AND PROVIDE: REQUIRED OPENINGS THROUGH FLOORS AND WALLS, ACCESS DOORS, FURRING, CURBS, ANCHORS AND INSERTS. PROVIDE ALL BASES AND BLOCKING REQUIRED FOR ACCESSORIES, MECHANICAL, ELECTRICAL AND OTHER EQUIPMENT.

ARCH/STRUCT MATERIAL SYMBOLS

SYMBOL	LEGEND
	GRATING, SPAN DIRECTION INDICATED
	CHECKERED PLATE
	GROUT
	GRANULAR FILL
	EARTH OR FINISH GRADE
	CONCRETE
	CMU WALL (PLAN)
	CMU WALL (SECTION)
	MASONRY WALL
	METAL STUD WALL (PLAN)
	WOOD STUD WALL (PLAN)
	RIGID INSULATION
	BATT INSULATION
	STEEL
	ALUMINUM
	PLYWOOD
	GYPSUM WALLBOARD
	ACOUSTICAL TILE
	WOOD, ROUGH CONTINUOUS
	WOOD, ROUGH NON-CONTINUOUS
	WOOD, FINISHED

ARCHITECTURAL/STRUCTURAL LEGEND

SYMBOL	LEGEND
A	NEW REFERENCE GRID INDICATOR
A	EXISTING REFERENCE GRID INDICATOR
ROOM NAME XX-101 OR ROOM NAME 101	ROOM IDENTIFIER
"XX" = FACILITY INDICATOR (IF SHOWN); DOOR LETTER; ROOM NUMBER; XX-101A	DOOR IDENTIFIER
XXW-1 OR W-1	WINDOW IDENTIFIER
XXR-1 OR R-1	RELIGHT IDENTIFIER
XXL-1 OR L-1	LOUVER IDENTIFIER
A	WALL TYPE INDICATOR
S-1	SIGNAGE IDENTIFIER
P-1	PRECAST PANEL IDENTIFIER
1 XX-A-301	EXTERIOR ELEVATION INDICATOR
QUANTITY AND DIRECTION OF POINTERS AS REQUIRED; A B C D E; 1 XX-A-301	INTERIOR ELEVATION INDICATOR
1 XX-A-401	DETAIL INDICATOR - SMALL CONDITION
⊗ 110.50	SPOT ELEVATION INDICATOR
	DIRECTION OF SLOPE DOWN
HINGE SIDE	DOOR/HATCH SWING INDICATOR
ACTIVE; INACTIVE; XX-101A	INDICATES PAIR OF DOORS
F.EXT-X	FIRE EXTINGUISHER "X" = NUMBER IN SPECIFICATIONS
	CONTROL JOINT
	EXPANSION JOINT
POST	RAILINGS

NO.	DATE	DSGN	DR	CHK	APVD
		J. OSOSKIE	J. HARGIS	OC Review	APVD

REVISION BY Sealer

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m.

GENERAL
UNION PUMP STATION
ARCHITECTURAL AND STRUCTURAL LEGEND

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE

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PIPE AND FITTING SYMBOLS

DOUBLE LINE	SINGLE LINE	
		EXISTING PIPE
		NEW PIPE
		EXISTING PIPE TO BE ABANDONED
		EXISTING PIPE TO BE REMOVED
		WELDED JOINT
		GROOVED END JOINT
		FLANGED JOINT
		MECHANICAL JOINT & PROPRIETARY RESTRAINED JOINT
		BELL & SPIGOT JOINT (LEADED)
		HUB & SPIGOT JOINT (RUBBER GASKET)
		BALL JOINT
		ADAPTER SIDE GROOVED END ADAPTER FLANGE
		FLANGED COUPLING ADAPTER (RESTRAINING SYSTEM BY MFR)
		RESTRAINED FLANGED COUPLING ADAPTER SEE (4005-545)
		FLEXIBLE COUPLING
		METAL BELLOWS EXP JOINT
		ELASTOMER BELLOWS EXP JOINT
		ELBOW UP
		ELBOW DOWN
		TEE UP
		TEE DOWN
		LATERAL UP
		LATERAL DOWN
		CONCENTRIC REDUCER
		ECCENTRIC REDUCER

DOUBLE LINE	SINGLE LINE	
		REDUCING BUSHING
		UNION
		CAP
		ANCHOR
		ELBOW, 90 DEGREE
		CROSS
		TEE
		ELBOW, 45 DEGREE
		LATERAL

NOTES:

1. ONLY FLANGED END CONNECTIONS ARE SHOWN HERE FOR DOUBLE LINE FITTINGS. FITTINGS WITH OTHER END PATTERNS ARE SHOWN SIMILARLY ON THE CONSTRUCTION DRAWINGS. ALSO SEE PIPING SPECIFICATIONS.
2. SYMBOLS SHOWN HERE FOR SINGLE LINE FITTINGS ARE GENERIC ONLY. REFER TO PIPING SPECIFICATIONS FOR SPECIFIC END CONNECTIONS FOR SINGLE LINE PIPE AND FITTINGS.
3. EXISTING PIPE AND EQUIPMENT IS SHOWN LIGHT-LINED AND/OR SCREENED. NEW PIPING AND EQUIPMENT IS SHOWN HEAVY-LINED.

VALVE SYMBOLS

SINGLE LINE	DOUBLE LINE
GATE	
KNIFE GATE	OR
BUTTERFLY	OR
GLOBE	OR
BALL	OR
SEATING PORT	
ECCENTRIC PLUG	OR
PLUG OR COCK	OR
NEEDLE	OR
DIAPHRAGM	OR
PINCH	OR
SWING CHECK	OR
BALL CHECK	OR

HOSE VALVE (HV- X) OR (V-X)
X = NO. IN SPECS

SAMPLE

MUD

PRESSURE RELIEF

AIR AND/OR VACUUM RELEASE

REGULATED SIDE
PRESSURE CONTROL (INTERNAL PILOT)

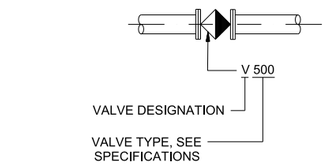
REGULATED SIDE
PRESSURE CONTROL (EXTERNAL PILOT)

MULTI-PORT VALVE,
ARROWS INDICATE FLOW PATTERN.
SEATING PORTS ARE IMPLIED BY
INDICATED FLOW PATTERN.

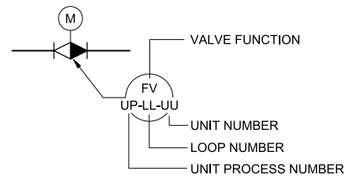
TELESCOPING

VALVE DESIGNATIONS

MANUAL VALVES AND CHECK VALVES

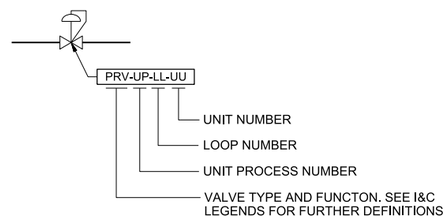


CONTROL VALVES



NOTE:
SEE I&C LEGENDS FOR FURTHER DEFINITIONS AND ACTUATOR TYPES.

SELF-CONTAINED REGULATING VALVES



ACTUATOR SYMBOLS

PNEUMATIC DIAPHRAGM

PNEUMATIC CYLINDER

(M) ELECTRIC MOTOR

(H) HYDRAULIC

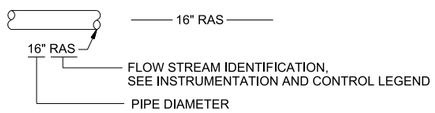
MANUAL

[S] SOLENOID

(E/H) ELECTRO HYDRAULIC

PIPING DESIGNATION

EXAMPLE:



GENERAL PIPING NOTES

1. LAY PIPE TO UNIFORM GRADE BETWEEN INDICATED ELEVATION POINTS.
2. SIZE OF FITTINGS SHOWN ON DRAWINGS SHALL CORRESPOND TO ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE INDICATED. TYPE OF JOINT AND FITTING MATERIAL SHALL BE THE SAME AS SHOWN FOR ADJACENT STRAIGHT RUN OF PIPE.
3. LOCATION AND NUMBER OF PIPE HANGERS AND PIPE SUPPORTS SHOWN IS ONLY APPROXIMATE. CONTRACTOR SHALL DESIGN SUPPORTS AS SPECIFIED.
4. ALL JOINTS SHALL BE WATERTIGHT. WALL PIPES SHALL BE USED WHEREVER PIPING PASSES FROM A STRUCTURE TO BACKFILL.
5. ALL FLEXIBLE CONNECTORS AND COUPLING ADAPTERS SHALL BE PROVIDED WITH THRUST PROTECTION AS SPECIFIED, UNLESS OTHERWISE NOTED. THRUST PROTECTION SHALL BE ADEQUATE FOR TEST PRESSURES SPECIFIED.
6. SYMBOLS, LEGENDS, AND PIPE USE IDENTIFICATIONS SHOWN SHALL BE FOLLOWED THROUGHOUT THE DRAWINGS, WHEREVER APPLICABLE. NOT ALL OF THE VARIOUS PIPING COMPONENTS ARE NECESSARILY USED IN THE PROJECT.
7. ALL BURIED PIPING SPECIFIED TO BE PRESSURE TESTED, EXCEPT FLANGED, WELDED, OR SCREWED PIPING, SHALL BE PROVIDED WITH THRUST PROTECTION AS SPECIFIED, UNLESS OTHERWISE NOTED.
8. NUMBER AND LOCATION OF UNIONS SHOWN ON DRAWINGS IS ONLY APPROXIMATE. PROVIDE ALL UNIONS NECESSARY TO FACILITATE CONVENIENT REMOVAL OF VALVES AND MECHANICAL EQUIPMENT.
9. WHERE A GROOVED END COUPLING IS SHOWN, IT SHALL BE THE RIGID JOINT TYPE, UNLESS OTHERWISE SPECIFIED. WHERE A FLANGED COUPLING ADAPTER IS SHOWN, A STANDARD FLANGE SHALL BE JOINED TO THE COUPLING ADAPTER.

NO.	DATE	DSGN
	S. CLARK	J. HARGIS

REVISION

BY	CHK
APVD	APVD
Sealer	QC Review

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

PRELIMINARY – NOT FOR CONSTRUCTION

GENERAL

UNION PUMP STATION
PROCESS MECHANICAL
LEGEND

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	100-G-012
SHEET	of

HVAC GENERAL NOTES

1. NOTES BELOW ARE NOT INTENDED TO REPLACE SPECIFICATIONS. SEE SPECIFICATIONS FOR REQUIREMENTS IN ADDITION TO GENERAL NOTES.
2. CONTRACTOR SHALL VISIT THE SITE AND BECOME INFORMED AS TO THE NATURE AND SCOPE OF WORK REQUIRED BY CONTRACT DOCUMENTS PRIOR TO BIDDING PROJECT.
3. PROVIDE ALL REQUIRED MATERIALS, LABOR, EQUIPMENT, AND SERVICES NECESSARY FOR THE INSTALLATION OF THE WORK AS SHOWN ON THESE DRAWINGS OR SPECIFIED BY THE BASE BUILDING DRAWING AND SPECIFICATIONS.
4. REFER TO AND CAREFULLY CHECK ARCHITECTURAL, ELECTRICAL, PLUMBING, AND FIRE PROTECTION DRAWINGS AND DETAILS. NOTES, LOCATIONS WHERE WALLS, PARTITIONS, CEILINGS, AND OTHER SURFACES ARE FLETTED, LOCATIONS OF SHAFTS, SOFFITS, AND CONFLICTS WITH WORK OF OTHER TRADES, AND ARRANGE WORK ACCORDINGLY. FURNISH ALL OFFSETS, DAMPERS, CONNECTORS, ETC., REQUIRED TO MEET SUCH CONDITIONS.
5. DUE TO SCALE OF DRAWINGS, ALL REQUIRED OFFSETS, DAMPERS, ETC., MAY NOT BE INDICATED.
6. COORDINATE DIFFUSERS LOCATIONS AND DUCT WITH LIGHTING FIXTURES AND SPRINKLER HEADS. SEE ARCHITECTURAL DRAWINGS FOR EXACT LOCATIONS AND DETAILS OF PARTITIONS, SUSPENDED CEILINGS, AND SOFFITS.
7. ALL DUCT PASSING THROUGH FIRE, SMOKE RATED OR SMOKE/FIRE RATED BARRIERS (WALLS, FLOOR) SHALL BE PROVIDED WITH FIRE, SMOKE OR SMOKE/FIRE DAMPERS. LOCATIONS OR RATED WALLS SEE ARCHITECTURAL DRAWINGS. CONTRACTOR SHALL VERIFY QUANTITY OF ALL DAMPERS IN ACCORDANCE WITH FINAL CONTRACT DOCUMENTS. ALL REQUIRED SMOKE DETECTORS PROVIDED BY DIV 23 SHALL BE CONNECTED TO FIRE ALARM SYSTEM.
8. CONTRACTOR SHALL OBTAIN AND PAY FOR ALL REQUIRED PERMITS AND ARRANGE FOR ALL REQUIRED INSPECTIONS IN ACCORDANCE WITH STATE AND LOCAL GOVERNING CODES.
9. THE TERM "PROVIDE" SHALL MEAN "TO FURNISH, INSTALL, AND CONNECT COMPLETELY".
10. TURN OVER TO THE OWNER ALL MANUFACTURER'S WARRANTIES FOR EQUIPMENT AND MATERIALS PROVIDED.
11. WHERE THE CONTRACTOR PROPOSES TO USE AN ITEM OF EQUIPMENT OTHER THAN THAT SPECIFIED OR DETAILED ON THE DRAWINGS WHICH REQUIRES ANY REDESIGN OF THE STRUCTURE, PARTITIONS, FOUNDATIONS, PIPING, WIRING OR ANY OTHER PART OF THE MECHANICAL, ELECTRICAL OR ARCHITECTURAL LAYOUT, ALL SUCH REDESIGN AND ALL NEW DRAWINGS AND DETAILING REQUIRED THEREFORE, SHALL BE PREPARED AT THE CONTRACTOR'S EXPENSE AND ARE SUBJECT TO THE REVIEW AND APPROVAL OF THE OWNER OR HIS AUTHORIZED REPRESENTATIVE. OWNER RESERVES THE RIGHT TO HAVE THE ARCHITECT OR ENGINEER OF HIS CHOICE PREPARE ANY REDESIGN WORK.
12. CONTRACTOR SHALL COORDINATE ELECTRICAL REQUIREMENTS OF MECHANICAL EQUIPMENT WITH DIVISION 26.
13. ALL WORK SHALL BE DONE WITH LICENSED WORKMEN IN ACCORDANCE WITH STATE AND LOCAL GOVERNING AUTHORITIES.
14. BEFORE SELECTING MATERIAL AND EQUIPMENT, AND PROCESSING THE WORK, INSPECT AREAS WHERE MATERIAL AND EQUIPMENT ARE TO BE INSTALLED TO INSURE SUITABILITY AND CHECK NEEDED SPACE FOR PLACEMENT AND CLEARANCES.
15. BEFORE CUTTING AND DRILLING INTO BUILDING ELEMENTS, INSPECT AND LAYOUT WORK TO AVOID DAMAGING STRUCTURAL ELEMENTS AND BUILDING UTILITIES.
16. CONTRACTOR RESPONSIBLE FOR REPAIR AND PAYMENT FOR ALL UTILITIES DAMAGE DURING CONSTRUCTION.
17. CONTRACTOR TO CONFIRM DUCTWORK LOCATIONS, ELEVATIONS AND SIZES BEFORE ANY WORK IS STARTED. IF ANY DISCREPANCIES ARE FOUNDED, NOTIFY ENGINEER BEFORE PROCEEDING WITH WORK, (SEE PAR, 48 "COORDINATION DRAWINGS").
18. FOLLOW MANUFACTURER'S RECOMMENDATIONS FOR INSTALLATION OF PROVIDED EQUIPMENT.
19. CONTRACTOR TO REPLACE ALL SUSPENDED CEILING TILES DAMAGED AS A RESULT OF HVAC SYSTEM INSTALLATION.
20. ALL SHOP DRAWINGS OF INDIVIDUAL COMPONENTS ARE TO BE SUBMITTED AS A COMPLETE PACKAGE.
21. HVAC DRAWINGS DO NOT NECESSARY SHOW ALL CONDITIONS OF BUILDING. CONTRACTOR TO USE ALL DRAWINGS AND SPECIFICATIONS OF CONTRACT DOCUMENTS AND INSPECTION OF FIELD CONDITIONS FOR DIVISION 23.
22. HVAC PLANS, DETAILS AND LINE DIAGRAMS SHOW THE GENERAL LOCATION AND ARRANGEMENT OF THE SYSTEM, THESE ARE DIAGRAMMATIC AND DO NOT SHOW ALL OFFSETS, HANGERS, ACCESS DOORS, ETC. WHICH THE CONTRACTOR MUST PROVIDE TO COMPLETE THE SYSTEM.
23. ALL WORK IN INTERIOR FINISHED SPACES EXCEPT INDICATED IS TO BE CONCEALED ABOVE CEILING. PROVIDE ALL NECESSARY CUTTING, PATCHING, REPAINTING AND/OR REPLACEMENT OF FINISHES AS REQUIRED TO PERFORM COORDINATE WITH OTHER DIVISIONS.
24. IF MANUFACTURER OF EQUIPMENT REQUIRES LARGER CAPACITY CIRCUITRY AND/OR EQUIPMENT THE CONTRACTOR SHALL PROVIDE SUCH CAPACITY AND/OR EQUIPMENT UNDER THIS CONTRACT AT NO COST TO THE OWNER.
25. SUPPORT DUCTWORK ABOVE SUSPENDED CEILING FROM CONSTRUCTION ABOVE AS CLOSE AS POSSIBLE TO BOTTOM OF SLABS, BEAMS, MAINTAINING HEADROOM AT ALL TIMES.
26. DO NOT SCALE DRAWINGS. CHECK EXISTING SPACE CONDITIONS AT THE JOB SITE.
27. DO NOT PENETRATE STAIR WALLS WITH ANY UTILITIES OR CONDUIT EXCEPT FOR UTILITIES SPECIFICALLY SERVING THAT STAIR.
28. CONTROL CONTRACTOR PROVIDE ALL CONTROL DEVICES, EQUIPMENT, ACCESSORIES, VFD DRIVES, OTHER APPARATUS, CONTROL VALVES AND DAMPERS, ACTUATORS, SENSORS, ETC, AND ALL CONTROL WIRING RELATED TO FACILITY MANAGEMENT SYSTEM (FMS), SEE SPECIFICATION SECTIONS 230900.
29. ALL DUCTWORK SHALL BE HUNG FROM STRUCTURE ABOVE.
30. PROVIDE FLEXIBLE JOINTS ON ALL PIPING AND DUCTWORK WHERE PENETRATING ALL BUILDING EXPANSION JOINTS.
31. PROVIDE FLEXIBLE CONNECTIONS BETWEEN MECHANICAL EQUIPMENT AND DUCTWORK AND PIPING.
32. PROVIDE MINIMUM OF 3' DUCT LINEAR AT EACH FAN-COIL UNIT BRANCH DUCT UNIT CONNECTION AND DUCT LINER FOR DUCT FROM FAN-COIL UNIT TO SUPPLY DIFFUSERS (SEE DETAILS).
33. PROVIDE VOLUME DAMPERS ON ALL BRANCHES OF DUCTWORK (SUPPLY, RETURN, EXHAUST).
34. PROVIDE FLEXIBLE DUCTWORK CONNECTION TO ALL CEILING SUPPLY DIFFUSERS, (MAXIMUM 3'-0" LONG).
35. REFER TO SPECIFICATION SECTION 078413 "THROUGH PENETRATION FIRESTOP SYSTEMS" FOR ALL MATERIALS AND METHODS FOR PENETRATION THROUGH FIRE AND SMOKE RATED ASSEMBLIES.
36. ALL PENETRATIONS THRU WALLS, ROOF, AND FLOORS TO BE COORDINATED BEFORE SITE WORK EXECUTION WITH STRUCTURAL ENGINEERS.
37. THERMOSTAT AND TEMPERATURE SENSOR LOCATIONS TO BE COORDINATED WITH INTERIOR WALL LAYOUT, REFER TO ARCHITECTURAL PLANS.
38. CEILING DIFFUSER AND REGISTER LOCATIONS TO BE COORDINATED WITH CEILING GRID, LIGHTING & SPRINKLER LAYOUT. REFER TO ARCHITECTURAL REFLECTED CEILING PLAN.
39. PROVIDE MINIMUM OF 20' DUCT LINER AT EACH AIR HANDLING UNIT (SUPPLY AND RETURN CONNECTIONS).
40. NO THREADED FITTINGS 2-1/2" AND LARGER ALLOWED FOR HYDRONIC HVAC PIPING.
41. CONTRACTOR SHALL SELECT AND PROVIDE EXPANSION JOINTS OR EXPANSION LOOPS AND ANCHORS AS REQUIRED TO PREVENT TEMPERATURE EXPANSION STRESSES OF HYDRONIC PIPES BASED ON ACTUAL INSTALLATION/CONDITIONS.
42. ELECTRICAL CHARACTERISTICS FOR MECHANICAL EQUIPMENT: EQUIPMENT OF HIGHER ELECTRICAL CHARACTERISTICS MAY BE FURNISHED PROVIDED SUCH PROPOSED EQUIPMENT IS APPROVED IN WRITING AND CONNECTING ELECTRICAL SERVICES, CIRCUIT BREAKERS, AND CONDUIT SIZES ARE APPROPRIATELY MODIFIED. IF MINIMUM ENERGY RATINGS OR EFFICIENCIES ARE SPECIFIED, EQUIPMENT SHALL COMPLY WITH REQUIREMENTS.
43. ALL SUPPLY, RETURN, TRANSFER, AND EXHAUST DUCTWORK EXPOSED IN A ROOM WITH NO CEILING(EXCEPT ELECTRICAL AND MECHANICAL ROOMS) SHALL BE DOUBLE WALL INSULATED DUCTWORK WITH PERFORATED INNER LINER.
44. ALL BASE-MOUNTED PUMPS SHALL BE INSTALLED WITH CONCRETE FILLED INERTIA BASE.
45. ALL ROOF MOUNTED EXHAUST AND SUPPLY FANS SHALL BE INSTALLED WITH ACOUSTICAL CURB.
46. ANY MATERIALS EXPOSED WITHIN THE PLENUM MUST BE NONCOMBUSTIBLE OR HAVE A MAXIMUM FLAME SPREAD INDEX OF 25 AND A MAXIMUM SMOKE-DEVELOPED INDEX OF 50 WHEN TESTED IN ACCORDANCE WITH ASTM E84.
47. WINGS: DETAIL MAJOR ELEMENTS, COMPONENTS, AND SYSTEM PF MECHANICAL EQUIPMENT AND MATERIALS IN RELATIONSHIPS WITH OTHER SYSTEMS, INSTALLATIONS, AND BUILDING COMPONENTS. SHOW SPACE REQUIREMENTS FOR INSTALLATION AND ACCESS. INDICATE IF SEQUENCE AND COORDINATION ARE IMPORTANT TO EFFICIENT FLOW OF THE WORK. INCLUDE THE FOLLOWING.

    A. PLANNED PIPING LAYOUT, INCLUDING VALVE AND SPECIALTY LOCATIONS AND VALVE-STEM MOVEMENT.
    B. CLEARANCES FOR INSTALLING AND MAINTAINING INSULATION.
    C. CLEARANCES FOR SERVING AND MAINTAINING EQUIPMENT, ACCESSORIES, AND SPECIALTIES, INCLUDING SPACE FOR DISASSEMBLY REQUIRED BY PERIODIC MAINTENANCE.
    D. EQUIPMENT AND ACCESSORY SERVICE CONNECTIONS AND SUPPORT DETAILS.
    E. EXTERIOR WALL AND FOUNDATION PENETRATIONS.
    F. FIRE-RATED WALL AND FLOOR PENETRATION.
    G. SIZES AND LOCATION OF REQUIRED CONCRETE PADS AND BASES.
    H. SCHEDULING, SEQUENCING, MOVEMENT, AND POSITIONING OF EQUIPMENT INTO BUILDING DURING CONSTRUCTION.
    I. FLOOR PLANS, ELEVATIONS, AND DETAILS TO INDICATE PENETRATIONS, FLOORS, WALLS, AND CEILINGS AND THEIR RELATIONSHIP TO OTHER PENETRATIONS AND INSTALLATIONS.
    J. REFLECTED CEILING PLANS TO COORDINATE AND INTEGRATE INSTALLATION OF AIR OUTLETS, LIGHT FIXTURES, COMMUNICATION SYSTEMS, COMPONENTS, SPRINKLERS, AND OTHER CEILING-MOUNTED ITEMS.
    K. ACCESS DOOR AND ACCESS PANEL LOCATIONS, WITH FIRE-RATINGS REQUIRED TO MAINTAIN FIRE RATING OF CONSTRUCTION, IN LOCATIONS AS REQUIRED FOR PROPER ACCESS FOR MAINTENANCE ADJUSTMENT, REPAIR AND REMOVAL OF ALL EQUIPMENT AND DEVICES.
    L. SCALE: MINIMUM 1/4"=1'-0" FOR FLOOR PLAN, 3/8"=1'-0" FOR MECHANICAL ROOMS.

48. ALL PENETRATIONS FOR THE INSTALLATION OF THE MECHANICAL SYSTEMS SHALL BE CAULKED AND SEALED FOR SMOKE AND FIRE AS REQUIRED.
49. LOCATE ROOF MOUNTED HVAC EQUIPMENT MORE 10 FEET FROM ROOF EDGE. PROVIDE HANDRAILS IF EQUIPMENT ON THE ROOF LOCATED LESS 10 FEET FROM ROOF EDGE (SEE ARCHITECTURAL DRAWINGS)
50. CONTROL CONTRACTOR TO PROVIDE ALL CONTROL DEVICES, EQUIPMENT, ACCESSORIES, OTHER APPARATUSES, CONTROL VALVES AND DAMPERS, ACTUATORS, SENSORS, ETC. AND ALL CONTROL WIRING AND LOW VOLTAGE POWER WIRING RELATED TO CENTRAL DDC CONTROL SYSTEM, SEE SPECIFICATION SECTION 230900.

ABBREVIATIONS

AFS	AIR FLOW MEASURING STATION
AC	AIR CONDITIONING
ACC	AIR COOLED CONDENSER UNIT (NO COMPRESSOR)
ACCU	AIR COOLED CONDENSING UNIT
AD	ACCESS DOOR
AHU	AIR HANDLING UNIT
AL	ALUMINUM DUCTWORK
AFF	ABOVE FINISH FLOOR
AMPS	AMPERE
BAL	BALANCE
BD	BAROMETRIC DAMPER
BDD	DAMPER BACK DRAFT
BHP	BREAK HORSEPOWER
BMS	BUILDING MANAGEMENT SYSTEM
BTU	BRITISH THERMAL UNIT
BTUH	BRITISH THERMAL UNIT/HR
DWD	DOUBLE WALL DUCTWORK
C-C	COLUMN ENCLOSURE TO COLUMN ENCLOSRE
C-W	COLUMN ENCLOSURE TO WALL
CA	COMBUSTION AIR
CENTRIF	CENTRIFUGAL
CFM	CUBIC FEET PER MINUTE
CO	CLEAN OUT
CW	DOMESTIC COLD WATER
CV	CONTROL VALVE
CMEU	CEILING MOUNTED EVAPORATOR
CUH	CABINET UNIT HEATER
DB	DRY BULB
DC	DIRECT CURRENT
DIA OR Ø	DIAMETER
DHW	DOMESTIC HOT WATER HEATER
DN	DOWN
DP	DEW POINT
EA	EXHAUST AIR
EAT	ENTERING AIR TEMPERATURE
EF	EXHAUST FAN
ESP	EXTERNAL STATIC PRESSURE
EWT	ENTERING WATER TEMPERATURE
EUH	ELECTRIC UNIT HEATER
EXH	EXHAUST
EXP	EXPANSION
FC	FLEXIBLE CONNECTOR
FD/AD	FIRE DAMPER/ACCESS DOOR
FLG	FLANGE
FCU	FAN COIL UNIT
FMS	FLOW MEASURING STATION
FPM	FEET PER MINUTE
°F	DEGREES FAHRENHEIT
FPS	FEET PER SECOND
FS	FLOW SWITCH
FT	FEET
FTR	FIN-TUBE RADIATION
FT3	CUBIC FEET
GA	GAUGE
GPM	GALLONS PER MINUTE
H	HEAT CONTENT (BTU/lb)
H	HUMIDISTAT
HC	HEATING COIL
HD	HEAD
HP	HORSEPOWER
HT	HEIGHT
HZ	CYCLES
ID	INSIDE DIAMETER
IN	INCHES
KVA	KILLOVOLT AMPERE
KW	KILOWATTS
L	LENGTH
LAT	LEAVING AIR TEMPERATURE
LB	POUNDS
LH	LATENT HEAT
LWT	LEAVING WATER TEMPERATURE
MD	MOTORIZED DAMPER
MAU	MAKE-UP AIR UNIT
MAX	MAXIMUM
MBH	THOUSAND BTU/HOUR
MIN	MINIMUM
MTS	MINUTES
MUW	MAKE-UP WATER
MV	MOTORIZED VALVE
NEG	NEGATIVE
NG	NATURAL GAS
NO	NUMBER
NRS	NON-RISING STEM
NTS	NOT TO SCALE
OA	OUTSIDE AIR
OBD	OPPOSED BLADE DAMPER
OCPD	OVER CURRENT PROTECTION DEVICE
OED	OPEN END DUCT, TERMINATE WITH STAINLESS STEEL BIRD SCREEN
OS&Y	OUTSIDE STEM & YOKE
P	PUMP
PBD	PARALLEL BLADE DAMPER
PEF	PROCESS EXHAUST FAN
PH	PHASE
PNL	PANEL
POS	POSITIVE
PRESS	PRESSURE
PRV	PRESSURE RELIEF VALVE
PS	PRESSURE SWITCH
PSIA	POUNDS PER SQUARE INCH ATMOSPHERE
PSIG	POUNDS PER SQUARE INCH GAUGE
RA	RETURN AIR
RECIRC	RECIRCULATING
RH	RELATIVE HUMIDITY
RPM	REVOLUTIONS PER MINUTE
SA	SUPPLY AIR
SATT	SOUND ATTENUATOR
SCFM	STANDARD CUBIC FEET/MINUTE
SENS	SENSOR
SF	SUPPLY FAN
SH	SENSIBLE HEAT
SCP	SHORT CIRCUIT CIRCULATION PUMP
SP	STATIC PRESSURE
STP	STANDARD TEMP & PRESSURE
SUP	SUPPLY
SV	SOLENOID VALVE
T&PV	TEMP & PRESSURE RELIEF VALVE
SFD/AD	COMBINATION SMOKE/FIRE DAMPER
TC	TEST CONNECTION WITH ACCESS DOOR
TEMP	TEMPERATURE
T	THERMOSTAT
TH	TOTAL HEAT
TRA	TRANSFER AIR
TRV	RELIEF VALVE TEMP
TSP	TOTAL STATIC PRESSURE
TS	TEMPERATURE SENSOR
TYP	TYPICAL
UH	UNIT HEATER
UN	UNIT
VD	VOLUME DAMPER
VT	VENT
VLV	VALVE
VI	VIBRATION ISOLATOR
V	VOLTS
W	WATTS
WB	WET BULB
WG	WATER GAUGE
WH	WATER HEATER
WI	WIDTH
WT	WEIGHT

DIFFUSER AND GRILLE ABBREVIATIONS

CDE	CEILING DIFFUSER - EXHAUST	SWS	SIDEWALL GRILLE - SUPPLY
TG	TRANSFER GRILLE	SWR	SIDEWALL GRILLE - RETURN
		SWE	SIDEWALL GRILLE - EXHAUST

NOTE: SOME SYMBOLS AND ABBREVIATIONS MAY OR MAY NOT APPEAR ON THE DRAWINGS.

SYMBOL LIST

- BALL VALVE
- BALANCING VALVE
- BUTTERFLY VALVE
- GATE VALVE
- ANGLE GATE VALVE
- GLOBE VALVE
- ISOLATION VALVE (REFER TO SPECS FOR TYPE)
- ANGLE GLOBE VALVE
- TWO WAY MOTORIZED CONTROL VALVE
- THREE WAY MOTORIZED CONTROL VALVE
- OS & Y
- MOTORIZED VALVE
- SAFETY RELIEF VALVE (PRESS.) (PRESSURE & TEMPERATURE)
- QUICK CLOSING LEVER VALVE
- PRV - PRESSURE REDUCING VALVE
- GAS COCK
- CHECK VALVE
- BACKFLOW PREVENTER
- HOSE END DRAIN
- HOSE BIB
- FLEXIBLE CONNECTION (PIPING) FLEXIBLE JOINT
- TRANSITION
- CAP
- PIPE CONNECTION, BOTTOM
- PIPE CONNECTION, TOP
- PIPE COUPLING (JOINT)
- ELBOW, 90°
- ELBOW, 45°
- PIPE TEE, OUTLET DOWN
- PIPE TEE, OUTLET UP
- PIPE UNION, SCREWED
- PIPE UNION, FLANGE
- PIPE UNION, SWEAT
- PIPE ELBOW, TURNED DOWN
- PIPE ELBOW, TURNED UP
- PIPE TEE
- DIRT TRAP
- FTR OR RP EQUIPMENT TAG
- EQUIPMENT TYPE DESIGNATION
- ACTIVE LENGTH (FT) / WATER FLOW RATE (GPM)
- TOTAL LENGTH (FT). PROVIDE ENCLOSURE FROM WALL TO WALL OR WALL TO COLUMN ENCLOSURE, ENCLOSURE SURFACE SHALL MATCH ACTIVE LENGTH ENCLOSURE SURFACE.
- TEMPERATURE/CO2 COMBINATION SENSOR
- WATER FLOW METER
- AIR VENT, AUTOMATIC
- AIR VENT, MANUAL
- PUMP
- STRAINER
- HUMIDISTAT/SENSOR
- OCCUPANCY SENSOR
- PRESSURE GAUGE WITH COCK VALVE
- RETURN / EXHAUST GRILLE
- THERMOSTAT/SENSOR
- PRESSURE SENSOR
- DUCT WORK, DIRECTION OF FLOW
- DUCT WORK, 90° ELBOW FITTING WITH TURNING VANES. PROVIDE TURNING ON ALL 90° ELBOW FITTING UNLESS OTHERWISE NOTED
- POSITIVE PRESSURE DUCT
- NEGATIVE PRESSURE DUCT
- CHANGE OF ELEVATION, DROP
- LINED DUCTWORK
- FLEXIBLE CONNECTION (DUCTWORK)
- FIRE DAMPER WITH ACCESS DOOR
- BALANCING DAMPER
- FIRE DAMPER / ACCESS DOOR
- SMOKE DAMPER / ACCESS DOOR
- COMBINATION FIRE & SMOKE DAMPER / ACCESS DOOR
- MOTORIZED DAMPER
- BAROMETRIC DAMPER
- BACKDRAFT DAMPER
- GRAVITY BACKDRAFT DAMPER
- RECTANGULAR TO RECTANGULAR OR ROUND TO ROUND
- RECTANGULAR TO ROUND TRANSITION
- VOLUME DAMPER
- THERMOMETER
- CONNECT PROVIDED PIPING/DUCT TO EXISTING PIPING/DUCT
- MECHANICAL NOTE REFERENCE, NUMBER INDICATES NOTE
- DIRECTION OF FLOW
- PITCH DOWN IN DIRECTION OF FLOW
- PITCH UP IN DIRECTION OF FLOW
- SMOKE DETECTOR
- TEMPERATURE SENSOR
- PIPING FLEX CONNECTION (DUCTWORK)
- ROOF MOUNTED EXHAUST FAN

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ONE-LINE DIAGRAM-1

SYMBOL	DESCRIPTION
	DRAWOUT AIR CIRCUIT BREAKER, LOW VOLTAGE
400	CIRCUIT BREAKER, THERMAL MAGNETIC TRIP SHOWN, 3 POLE, UNO
AS/AF or AT/AF	CIRCUIT BREAKER, STATIC TRIP UNIT, SENSOR AMP TRIP AND FRAME RATINGS SHOWN, 3 POLE, UNO
100/M	CIRCUIT BREAKER, MAGNETIC TRIP ONLY, TRIP RATING SHOWN, 3 POLE, UNO
400 400	CIRCUIT BREAKER WITH CURRENT LIMITING FUSES, TRIP AND FUSE RATING INDICATED, 3 POLE, UNO
400 225	FUSED SWITCH, SWITCH AND FUSE CURRENT RATING INDICATED, 3 POLE, UNO
100	SWITCH, CURRENT RATING INDICATED, 3 POLE, UNO
60 (3)	FUSE, CURRENT RATING AND QUANTITY INDICATED
1	MAGNETIC STARTER WITH OVERLOAD, NEMA SIZE INDICATED, FVNR UNO
AFD	ELECTRONIC STARTER/SPEED CONTROL RVSS = REDUCED VOLTAGE SOFT STARTER AFD = AC ADJUSTABLE FREQUENCY DRIVE DC = DC ADJUSTABLE SPEED DRIVE RVAT = REDUCED VOLTAGE AUTO TRANSFORMER TYPE RVRT = REDUCED VOLTAGE REACTOR TYPE
	CABLE OR BUS CONNECTION POINT
K	KEY INTERLOCK
	SURGE ARRESTER (GAP TYPE)
10	CAPACITOR - KVAR INDICATED, 3 PHASE
3	AC MOTOR, SQUIRREL CAGE INDUCTION - HORSEPOWER INDICATED
G 500/625	GENERATOR, KW/KVA RATING SHOWN
VS V 0-600V	ANALOG METER WITH SWITCH - SCALE RANGE SHOWN V = VOLTAGE KW = KILOWATTS A = AMPERAGE KVAR = KILOVARS PF = POWER FACTOR
DPM	DIGITAL POWER METER (MULTIFUNCTION)
	UTILITY REVENUE METER
	GROUND
15 KVA 480-120/240V 1 PH	TRANSFORMER, SIZE, VOLTAGE RATINGS, AND PHASE INDICATED
	SHIELDED ISOLATION TRANSFORMER
480-120V (3)	POTENTIAL TRANSFORMER, VOLTAGE RATING AND QUANTITY INDICATED
100:5 (3)	CURRENT TRANSFORMER, RATIO(100:5) AND QUANTITY INDICATED (3)
	CONNECTION POINT TO EQUIPMENT SPECIFIED IN OTHER DIVISIONS, RACEWAY, CONDUCTOR AND CONNECTION IN THIS DIVISION
SPD	SURGE PROTECTIVE DEVICE

ONE-LINE DIAGRAM-2

SYMBOL	DESCRIPTION
	DRAWOUT POWER CIRCUIT BREAKER, MEDIUM VOLTAGE
	NON DRAWOUT FUSED SWITCH, MEDIUM VOLTAGE
	DRAWOUT FUSED SWITCH AND CONTACTOR, MEDIUM VOLTAGE
	DRAWOUT FUSED SWITCH AND VACUUM CONTACTOR, MEDIUM VOLTAGE
	DRAWOUT VACUUM CONTACTOR, MEDIUM VOLTAGE
	MEDIUM VOLTAGE CABLE STRESS CONE TYPE TERMINATION, OPEN TERMINATOR OR ELBOW
	SWITCH - LOAD BREAK, GROUP OPERATED, MEDIUM VOLTAGE
	SWITCH W/ARCING HORNS, MEDIUM VOLTAGE
	DISCONNECTING FUSE - SOLID MATERIAL, MEDIUM VOLTAGE
	SWITCH - HOOK STICK OPERATED, SINGLE POLE, MEDIUM VOLTAGE
	FUSE - EXPULSION, HOOK STICK OPERATED, SINGLE POLE, MEDIUM VOLTAGE
	GROUND SWITCH, GANG OPERATED
	TERMINAL BLOCK LUG
	DELTA CONNECTION
	WYE GROUNDED CONNECTION, SOLID GROUND
R or Z	WYE NEUTRAL GROUND RESISTOR OR IMPEDANCE CONNECTION
86	RELAY OR DEVICE, FUNCTION NUMBER AS INDICATED
50:5 (1)	CURRENT TRANSFORMER, ZERO SEQUENCE, RATIO AND QUANTITY INDICATED
800/1200:5 (3)	BUSHING CURRENT TRANSFORMER, MULTI-RATIO AND QUANTITY INDICATED
MO	MOTOR OPERATOR, BREAKER OR SWITCH
EUM	ENERGY MONITORING UNIT
MRP	MOTOR PROTECTION RELAY
E N	TRANSFER SWITCH - LOW VOLTAGE
E N	TRANSFER SWITCH - MEDIUM VOLTAGE

NOTES:

1. THESE ARE STANDARD LEGEND SHEETS. SOME SYMBOLS AND ABBREVIATIONS MAY APPEAR ON THE LEGEND AND NOT ON THE DRAWINGS.
2. FOR ADDITIONAL ABBREVIATIONS OF OTHER DIVISIONS (HVAC, MECHANICAL, AND STRUCTURAL/ARCHITECTURAL) SEE OTHER LEGENDS.

CONTROL DIAGRAM-1

SYMBOL	DESCRIPTION
	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY OPEN
	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY CLOSED
	PUSH BUTTON SWITCH, MAINTAINED CONTACTS WITH MECHANICAL INTERLOCK
	3 POSITION SELECTOR SWITCH MAINTAINED CONTACT
HAND OFF REMOTE	SELECTOR SWITCH - MAINTAINED CONTACT - CHART IDENTIFIES OPERATION WHEN NEEDED FOR CLARITY:

	POSITION		
CKT	HAND	OFF	REMOTE
1	X	O	O
2	O	O	X

X - CLOSED CONTACT
O - OPEN CONTACT

SYMBOL	DESCRIPTION
	TOGGLE SWITCH, ON-OFF TYPE
ON OFF	SELECTOR SWITCH, ON-OFF TYPE
	MUSHROOM HEAD PUSHBUTTON SWITCH
A	INDICATING LIGHT, PUSH-TO-TEST, LETTER INDICATES COLOR
A	INDICATING LIGHT - LETTER INDICATES COLOR A - AMBER G - GREEN S - STROBE B - BLUE R - RED C - CLEAR W - WHITE
ETM	ELAPSED TIME METER
M	MOTOR STARTER CONTACTOR COIL
CRX	CONTROL RELAY, X INDICATES NUMERICAL ORDER IN CIRCUIT
TDR X	TIME DELAY RELAY, X INDICATES NUMERICAL ORDER IN CIRCUIT
SV X	SOLENOID VALVE, X INDICATES NUMERICAL ORDER IN CIRCUIT
	CONTACT - NORMALLY OPEN
	CONTACT - NORMALLY CLOSED
	REMOTE DEVICE
	TIME DELAY RELAY CONTACT, NORMALLY OPEN, CLOSES WHEN ENERGIZED AND TIMED OUT
	TIME DELAY RELAY CONTACT, NORMALLY CLOSED, OPENS WHEN ENERGIZED AND TIMED OUT
	TIME DELAY RELAY CONTACT, CLOSES WHEN ENERGIZED, OPENS WHEN DE-ENERGIZED AND TIMED OUT
	TIME DELAY RELAY CONTACT, OPENS WHEN ENERGIZED, CLOSES WHEN DE-ENERGIZED AND TIMED OUT
	MOTOR SPACE HEATER
	TERMINAL BLOCK, REMOTE
	TERMINAL BLOCK, INTERNAL
	FUSED TERMINAL BLOCK
	FUSE, RATING INDICATED
CPT 120V	TRANSFORMER, CONTROL POWER
	THERMOCOUPLE

CONTROL DIAGRAM-2

SYMBOL	DESCRIPTION
	CAPACITOR
+ −	BATTERY
	LIMIT SWITCH, NORMALLY OPEN, CLOSES AT END OF TRAVEL
	LIMIT SWITCH, NORMALLY CLOSED, OPENS AT END OF TRAVEL
	TEMPERATURE SWITCH, OPENS ON TEMPERATURE RISE
	TEMPERATURE SWITCH, CLOSES ON TEMPERATURE RISE
	FLOAT SWITCH, NORMALLY OPEN, CLOSES ON DESCENDING LEVEL
	FLOAT SWITCH, NORMALLY OPEN, CLOSES ON RISING LEVEL
	PRESSURE SWITCH, NORMALLY CLOSED, OPENS ON RISING PRESSURE
	PRESSURE SWITCH, NORMALLY OPEN, CLOSES ON RISING PRESSURE
	FLOW SWITCH, CLOSES ON INCREASED FLOW
	FLOW SWITCH, OPENS ON INCREASED FLOW
NGR	NEUTRAL GROUND CURRENT LIMITING RESISTOR
RES	CALIBRATING RESISTOR
T GEN	TACHOMETER GENERATOR
GFS	GROUND FAULT SENSOR
	FLASHER
	SEALED CONTACT
	BUZZER
	POTENTIOMETER
	RESISTOR
	BLOWN FUSE INDICATOR
	COAXIAL CABLE
	MULTICONDUCTOR SHIELDED CABLE
	DUPLEX RECEPTACLE
L U	RELAY, WITH MECHANICAL LATCH
	FULLWAVE DIODE BRIDGE (AC TO DC)

NO.	DATE	DSGN	DR	CHK	BY	APVD
	R. WOOD		M. REICHERT	OC Review		Sealer

REVISION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

GENERAL

ELECTRICAL LEGEND 1

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
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SHEET	of

POWER SYSTEM PLAN-1

SYMBOL	DESCRIPTION
	CONNECTION POINT TO EQUIPMENT SPECIFIED. RACEWAY, CONDUCTOR,TERMINATION AND CONNECTION IN THIS DIVISION.
MCC-A	MAJOR ELECTRICAL COMPONENT OR DEVICE - NAME OR IDENTIFYING SYMBOL AS SHOWN.
	PANELBOARD - SURFACE MOUNTED
LPXXA	PANELBOARD LETTER OR NUMBER FACILITY NUMBER LP - LOW VOLTAGE PANEL DP - DISTRIBUTION PANEL
	PANELBOARD - FLUSH MOUNTED
	TERMINAL JUNCTION BOX
M	MOTOR, SQUIRREL CAGE INDUCTION
G	GENERATOR, VOLTAGE AND SIZE AS INDICATED.
LPXXA	HOME RUN - DESTINATION SHOWN
or G	EXPOSED CONDUIT AND CONDUCTORS*
or G	CONCEALED CONDUIT AND CONDUCTORS*

NOTE:
ALL UNMARKED CONDUIT RUNS CONSIST OF TWO NO. 12, ONE NO. 12 GROUND CONDUCTORS IN 3/4" CONDUIT. RUNS MARKED WITH CROSSHATCHES INDICATE NUMBER OF NO. 12 CONDUCTORS. CROSSHATCH WITH SUBSCRIPT "G" INDICATES GREEN GROUND WIRE.

G	CROSSHATCHES WITH BAR INDICATE NO.10 CONDUCTOR. SIZE CONDUIT ACCORDING TO SPECIFICATIONS AND APPLICABLE CODE.
[A1]	CONDUIT AND CONDUCTOR CALLOUT, SEE LEGEND.
	CONDUIT DOWN
	CONDUIT UP
	CONDUIT, STUBBED AND CAPPED
	CONDUIT TERMINATION AT CABLE TRAY
EX	EXISTING CONDUIT/ DUCT BANK
BD	BUS DUCT - SEE SPECIFICATIONS
CE	CONCRETE ENCASED CONDUIT
DB	DIRECT BURIED CONDUIT
FO	FIBER OPTIC CONDUIT
XXXX	CONCRETE ENCASED DUCT BANK WHERE XXXX IS THE DUCT BANK NAME. SEE CIRCUIT AND RACEWAY CODING DEFINITION
	CONCEALED CONDUIT ROUTING AREA
	CONDUIT ROUTING AREA
	CABLE TRAY
T	TRANSFORMER
J or HH	GENERAL CONTROL OR WIRING DEVICE. LETTER SYMBOLS OR ABBREVIATIONS INDICATE TYPE OF DEVICE
CS	CONTROL STATION, SEE CONTROL DIAGRAMS FOR CONTROL DEVICE(S) REQUIRED.
30	NONFUSED DISCONNECT SWITCH, CURRENT RATING INDICATED, 3 POLE
60/40	FUSED DISCONNECT SWITCH, CURRENT RATING INDICATED (60/40, 60=SWITCH RATING / 40=FUSE RATING) 3 POLE
2	COMBINATION CIRCUIT BREAKER AND MAGNETIC STARTER, NEMA SIZE INDICATED

POWER SYSTEM PLAN-2

SYMBOL	DESCRIPTION
100/40	BREAKER, SEPARATELY MOUNTED, CURRENT RATING INDICATED (100/40, 100 = FRAME SIZE; 40 = TRIP RATING) 3 POLE
C 2	CONTACTOR, MAGNETIC, NEMA SIZE INDICATED
L 30	LIGHTING CONTACTOR, CURRENT RATING INDICATED
2	STARTER, MAGNETIC NEMA SIZE INDICATED
XX 2	CONVENIENCE RECEPTACLE - DUPLEX UNLESS NOTED OTHERWISE WP - WEATHERPROOF C - CLOCK HANGER TL - TWIST LOCK CRE - CORROSION RESISTANT GFCI - GROUND FAULT CIRCUIT INTERRUPTER SUBSCRIPT NUMBER AT RECEPTACLE INDICATES CIRCUIT
	240V RECEPTACLE
	CONVENIENCE RECEPTACLE - QUADRUPLEX
	MULTI OUTLET ASSEMBLY
	DUPLEX CONVENIENCE RECEPTACLE - FLUSH IN FLOOR
	CONVENIENCE RECEPTACLE, PEDESTAL, DUPLEX SINGLE FACE UNLESS INDICATED OTHERWISE
L20R 20	RECEPTACLE, SPECIAL PURPOSE-NEMA CONFIGURATION AND AMPERAGE INDICATED
T	THERMOSTAT
	UTILITY REVENUE METERING FACILITY
EUH	ELECTRIC UNIT HEATER
AC	ELECTRIC AIR CONDITIONER (SELF CONTAINED UNIT)
	UTILITY POLE

LIGHTING SYSTEM PLAN

1 or 1	LUMINAIRE, SEE SCHEDULE
1	LUMINAIRE, SEE SCHEDULE
1 or	LUMINAIRE WITH INTERNAL BATTERY BACKUP, SEE SCHEDULE
1	STRIP LUMINAIRE, SEE SCHEDULE
4 or 4	LUMINAIRE AND POLE, SEE SCHEDULE
5 or 5	WALL MOUNTED LUMINAIRE, SEE SCHEDULE
1	FLOOD LIGHTS - AIM IN THE DIRECTION SHOWN
	STANDBY LIGHTING UNIT, SURFACE MOUNTED, SEE SCHEDULE
XX or	EXIT LIGHTS - FILLED SECTION INDICATES LIGHTED FACE, ARROW INDICATES EGRESS DIRECTIONAL INDICATORS, XX = FIXTURE NUMBER, SEE SCHEDULE
$a or 2a	SMALL LETTER SUBSCRIPT AT SWITCH AND LUMINAIRE INDICATES SWITCHING. SUBSCRIPT NUMBER AT LUMINAIRE INDICATES CIRCUIT
$3	WALL SWITCH: 2- DOUBLE POLE 3- THREE WAY 4- FOUR WAY WP- WEATHERPROOF EX- EXPLOSIONPROOF M- MOTOR RATED P- PILOT LIGHT K- KEY OPERATED D- DIMMER CRE- CORROSION RESISTANT L- MOMENTARY 3-WAY MS- MANUAL STARTER WITH OVERLOADS
OS	OCCUPANCY SENSOR
LC	LIGHTING CONTACTOR
MD	MOTION DETECTOR
PC	PHOTOCELL

FIRE ALARM SYSTEM PLAN AND RISER

F P	FIRE ALARM STATION, MANUAL
	FIRE ALARM SYSTEM, AUTOMATIC SMOKE DETECTOR
HD	FIRE ALARM SYSTEM, AUTOMATIC, HEAT DETECTOR
F	FIRE ALARM BELL
F	FIRE ALARM HORN
	FIRE ALARM HORN/STROBE LIGHT
	FIRE ALARM STROBE LIGHT
	AIR DUCT DETECTOR
FS	FIRE SPRINKLER FLOW SWITCH
TS	FIRE SPRINKLER TAMPER SWITCH
D	DOOR HOLDER

TELEPHONE SYSTEM PLAN AND RISER

TTC	TELEPHONE TERMINAL CABINET
	TELEPHONE RECEPTACLE FLOOR BOX
	TELEPHONE RECEPTACLE
T	TELEPHONE SYSTEM RACEWAY

COMPUTER SYSTEM (DATA) PLAN AND RISER

CTC	COMPUTER SYSTEM TERMINAL CABINET
	COMPUTER NETWORK CONNECTION
	COMPUTER NETWORK CONNECTION, FLUSH IN FLOOR
D	DATA SYSTEM RACEWAY

COMBINED TELEPHONE/COMPUTER SYSTEM PLAN AND RISER

4	COMBINATION TELEPHONE/DATA RECEPTACLE, WALL MOUNTED, NUMBER OF PORTS INDICATED
4	COMBINATION TELEPHONE/DATA RECEPTACLE, FLOOR BOX, NUMBER OF PORTS INDICATED

CLOSED CIRCUIT/TELEVISION CABLE PLAN AND RISER

	COMBINATION CLOSED CIRCUIT TELEVISION RECEPTACLE (CCTV) AND DUPLEX CONVENIENCE RECEPTACLE IN TWO GANG BOX WITH BARRIER, 12" DOWN FROM CEILING
	COMBINATION TELEVISION CABLE RECEPTACLE (TV) AND DUPLEX CONVENIENCE RECEPTACLE IN TWO GANG BOX WITH BARRIER, 12" DOWN FROM CEILING
	CLOSED CIRCUIT TELEVISION RECEPTACLE, FLOOR BOX
	TELEVISION CABLE RECEPTACLE, FLOOR BOX

SOUND SYSTEM PLAN AND RISER

S	SPEAKER, CONE TYPE, RECESSED IN CEILING, SEE ARCHITECTURAL DRAWINGS FOR CEILING TYPE
S	SPEAKER, CONE TYPE, WALL MOUNTED
S	SPEAKER, CONE TYPE, SURFACE MOUNTED
V	VOLUME CONTROL, WALL MOUNT 5'-0" AFF
S	INTERIOR PAGING TRUMPET SOUND REPRODUCER WITH REMOTE AMPLIFIER, SURFACE MOUNTED
M	MICROPHONE OUTLET
S	SOUND SYSTEM RACEWAY
S	COMMUNICATION STATION

SECURITY SYSTEM PLAN AND RISER

CR	CARD KEY ACCESS
CS	CONTROL STATION
DS	DOOR SWITCH
EP	EGRESS PUSHBUTTON
	ELECTRONIC LOCK M = MAGENITIC S = STRIKE
	INTERCOM
	MONITOR
	MOTION SENSOR
	VIDEO CAMERA PTZ = PAN/TILT/ZOOM F = FIXED

GROUND SYSTEM PLAN

	GROUND ROD
	GROUND ROD IN TEST WELL
G	GROUNDING CONDUCTOR, SIZE AS INDICATED
	PIGTAIL FOR CONNECTION TO EQUIPMENT CABINET OR FRAME
G	EQUIPMENT GROUND BUS
N	EQUIPMENT NEUTRAL BUS

NO.	DATE	DSGN
	REVISION	
DR	M. REICHERT	CHK
R. WOOD		APVD

OC Review
BY APVD
Sealer

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m

GENERAL

ELECTRICAL LEGEND 2

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	100-G-016
SHEET	of

SYMBOL	DESCRIPTION

ONE LINE PROTECTION RELAYING AND ELEMENTARY DIAGRAMS-1

51 or 52	DEVICE FUNCTION NUMBER INDICATED, SEE DEVICE TABLE
CS T	CONTROL SWITCH TRIP
CS C	CONTROL SWITCH CLOSE
43/CS	43-DEVICE FUNCTION NUMBER, SEE DEVICE TABLE
VS	VOLTMETER SWITCH
AS	AMMETER SWITCH
A	INDICATING LAMP-SWITCHBOARD TYPE INDICATING LAMP LENS COLORS INDICATED AS FOLLOWS: A - AMBER R - RED B - BLUE W - WHITE G - GREEN
V	VOLTMETER
A	AMMETER
W	WATTMETER
F	FREQUENCY METER
PF	POWER FACTOR METER
WH	WATT-HOUR METER
ETM	ELAPSED TIME METER
RPM	TACHOMETER
W XD	WATTS TRANSDUCER
PF XD	POWER FACTOR TRANSDUCER
TD	TIME DELAY
4	RELAY COIL, DEVICE FUNCTION NUMBER PER ANSI 37.2 - AMERICAN STANDARD MANUAL AND AUTOMATIC STATION CONTROL, SUPERVISORY AND ASSOCIATED TELEMETRY EQUIPMENT
7 8	NORMALLY OPEN CONTACT
3 4	NORMALLY CLOSED CONTACT
	REMOTE DEVICE
	TEST SWITCH CURRENT ELEMENT
	TEST SWITCH POTENTIAL ELEMENT
	NEUTRAL CONNECTION
	DIODE
	INSTRUMENTATION CABLE, SHIELDED
NGR	NEUTRAL GROUNDING RESISTOR
PST	PHASE SHIFTING TRANSFORMER

DEVICE TABLE

ONE LINE PROTECTION RELAYING AND ELEMENTARY DIAGRAMS-2

DEVICE FUNCTION NO.	DEVICE DESCRIPTION
21	IMPEDANCE/DISTANCE RELAY
25A	AUTOMATIC SYNCHRONIZER
25C	SYNCH CHECK RELAY
27	UNDERVOLTAGE RELAY
32	REVERSE POWER RELAY
40	GENERATOR LOSS OF EXCITATION RELAY
43CSE	AUTOMATIC POWER TRANSFER AND LOAD CONTROL MODE SEL. SWITCH
43CSX	MODE SEL. SWITCH
46	GENERATOR CURRENT UNBALANCE RELAY
49	THERMAL RELAY
50GS	INSTANTANEOUS OVERCURRENT DEVICE, GROUND SENSOR
50	INSTANTANEOUS OVERCURRENT DEVICE,
51	TIME OVERCURRENT RELAY
51G	TIME OVERCURRENT RELAY, GROUND FAULT
51V	TIME OVERCURRENT, VOLTAGE RESTRAINED
52	POWER CIRCUIT BREAKER
52CSX	POWER CIRCUIT BREAKER CONTROL SWITCH
59	OVERVOLTAGE RELAY
60	VOLTAGE OR CURRENT BALANCE RELAY
65A	ENGINE GOVERNOR, SPEED CONTROL
65A, MOP	ENGINE GOVERNOR, SPEED CONTROL MOTOR OPERATED POTENTIOMETER
65A, RL	ENGINE GOVERNOR, SPEED CONTROL RAISE/LOWER SWITCH
65B	ENGINE GOVERNOR, LOAD CONTROL
65B, MOP	ENGINE GOVERNOR, LOAD CONTROL MOTOR OPERATED POTENTIOMETER
65B, RL	ENGINE GOVERNOR, % LOAD RAISE/LOWER SWITCH
65E	AUTOMATIC POWER TRANSFER AND LOAD CONTROL, WOODWARD APTL
65F	AUTOMATIC GENERATOR LOADING CONTROL, WOODWARD AGLC
67	DIRECTIONAL TIME OVERCURRENT RELAY
74	ALARM RELAY
81O/U	FREQUENCY RELAY, OVER/UNDER
86	LOCKOUT RELAY
87	DIFFERENTIAL PROTECTIVE RELAY
90	VOLTAGE REGULATOR
90, MOP	ENGINE EXCITATION, POWER OPERATED POTENTIOMETER
90PF	ENGINE EXCITATION, POWER FACTOR CONTROL
90RL	ENGINE EXCITATION, RAISE/ LOWER SWITCH

X = DEVICE NUMBER, WHEN THERE ARE MULTIPLE UNITS

CIRCUIT AND RACEWAY

GENERAL CIRCUIT CONDUCTOR AND CONDUIT IDENTIFICATION

POWER CIRCUIT CALLOUTS

[P1]	[1/2"FLEX, 2#12,#12G]	[P24]	[1"C,3#8,3#14,1#10G]
[P2]	[3/4"C,2#12,1#12G]	[P25]	[1"C,3#8,4#14,1#10G]
[P3]	[3/4"C,3#12,1#12G]	[P26]	[1"C,3#8,5#14,1#10G]
[P4]	[3/4"C,4#12,1#12G]	[P27]	[1"C,2#6, 1#10G]
[P5]	[3/4"C,5#12,1#12G]	[P28]	[1"C,3#6, 1#8G]
[P6]	[3/4"C,6#12,1#12G]	[P29]	[1"C,3#6, 2#14,1#8G]
[P7]	[3/4"C,7#12,1#12G]	[P30]	[1"C,3#6, 3#14,1#8G]
[P8]	[3/4"C,8#12,1#12G]	[P31]	[1"C,3#6, 4#14,1#8G]
[P9]	[3/4"C,3#12,2#14,1#12G]	[P32]	[1"C,3#6, 5#14,1#8G]
[P10]	[3/4"C,3#12,3#14,1#12G]	[P33]	[1"C,3#4,1#8G]
[P11]	[3/4"C,3#12,4#14,1#12G]	[P34]	[1 1/4"C,3#4,3#14,1#8G]
[P12]	[3/4"C,3#12,5#14,1#12G]	[P35]	[1 1/4"C,3#4,5#14,1#8G]
[P13]	[3/4"C,3#12,6#14,1#12G]	[P36]	[1 1/4"C,3#3, 1#6G]
[P14]	[3/4"C,3#12,7#14,1#12G]	[P37]	[1 1/4"C,3#3, 3#14,1#6G]
[P15]	[3/4"C,2#10,1#10G]	[P38]	[1 1/4"C,3#2, 1#6G]
[P16]	[3/4"C,3#10,1#10G]	[P39]	[1 1/4"C,3#1, 1#6G]
[P17]	[3/4"C,3#10,2#14,1#10G]	[P40]	[1 1/2"C,3#1, 3#14,1#6G]
[P18]	[3/4"C,3#10,3#14,1#10G]	[P41]	[1 1/2"C,3#2/0, 1#4G]
[P19]	[3/4"C,3#10,4#14,1#10G]	[P42]	[2"C,3#3/0, 1#4G]
[P20]	[3/4"C,3#10,5#14,1#10G]	[P43]	[2"C,3#4/0, 1#3G]
[P21]	[1"C,2#8,1#10G]		
[P22]	[1"C,3#8,1#10G]		
[P23]	[1"C,3#8,2#14,1#10G]		

MULTICONDUCTOR POWER CABLE CIRCUIT CALLOUTS

[PC1]	[3/4"C,1 (3C#12,1#12G) TYPE 2]
[PC2]	[3/4"C,1 (3C#10,1#10G) TYPE 2]
[PC3]	[1"C,1 (3C#8,1#10G) TYPE 2]
[PC4]	[1 1/4"C,2 (3C#12,1#12G) TYPE 2]
[PC5]	[1 1/2"C,2 (3C#10,1#10G) TYPE 2]
[PC1A]	[3/4"C,1 (2C#12,1#12G) TYPE 2]
[PC2A]	[3/4"C,1 (2C#10,1#10G) TYPE 2]

EMPTY CONDUIT

[EC-1]	[3/4"C,WITH PULL STRING]
[EC-2]	[1"C,WITH PULL STRING]
[EC-3]	[1 1/4"C,WITH PULL STRING]
[EC-4]	[1 1/2"C,WITH PULL STRING]
[EC-5]	[2"C,WITH PULL STRING]
[EC-6]	[3"C,WITH PULL STRING]
[EC-7]	[4"C,WITH PULL STRING]
[EC-8]	[5"C,WITH PULL STRING]

ANALOG CIRCUIT CALLOUTS

[A1]	[3/4"C,1 TYPE 3]
[A2]	[1"C,2 TYPE 3]
[A3]	[1"C,3 TYPE 3]
[A4]	[1"C,4 TYPE 3]
[A5]	[1 1/4"C,5 TYPE 3]
[A6]	[1 1/4"C,6 TYPE 3]
[A7]	[1 1/2"C,7 TYPE 3]
[A8]	[1 1/2"C,8 TYPE 3]
[A9]	[1 1/2"C,9 TYPE 3]
[A10]	[2"C,10 TYPE 3]
[A11]	[2"C,11 TYPE 3]
[A12]	[2"C,12 TYPE 3]
[A13]	[2"C,13 TYPE 3]
[A14]	[2"C,14 TYPE 3]
[A15]	[3/4"C,1 TYPE 4]
[A16]	[3/4"C,2 TYPE 4]
[A17]	[1"C,3 TYPE 4]
[A18]	[1 1/4"C,4 TYPE 4]
[A19]	[1 1/4"C,5 TYPE 4]
[A20]	[1 1/4"C,6 TYPE 4]
[A21]	[1 1/2"C,7 TYPE 4]
[A22]	[1 1/2"C,8 TYPE 4]
[A23]	[2"C,9 TYPE 4]
[A24]	[3/4"C,1-4 pr. TYPE 5]
[A25]	[1"C,2-4 pr. TYPE 5]

CONTROL CIRCUIT CALLOUTS

[C1]	[3/4"C,MSC]
[C2]	[3/4"C,2#14,1#14G]
[C3]	[3/4"C,3#14,1#14G]
[C4]	[3/4"C,4#14,1#14G]
[C5]	[3/4"C,5#14,1#14G]
[C6]	[3/4"C,6#14,1#14G]
[C7]	[3/4"C,7#14,1#14G]
[C8]	[3/4"C,8#14,1#14G]
[C9]	[3/4"C,9#14,1#14G]
[C10]	[3/4"C,10#14,1#14G]
[C11]	[3/4"C,11#14,1#14G]
[C12]	[3/4"C,12#14,1#14G]
[C13]	[3/4"C,13#14,1#14G]
[C14]	[3/4"C,14#14,1#14G]
[C15]	[3/4"C,15#14,1#14G]
[C16]	[3/4"C,16#14,1#14G]
[C17]	[3/4"C,17#14,1#14G]
[C18]	[3/4"C,18#14,1#14G]
[C19]	[3/4"C,19#14,1#14G]
[C20]	[1"C,20#14,1#14G]
[C21]	[1"C,21#14,1#14G]
[C22]	[1"C,22#14,1#14G]
[C23]	[1"C,23#14,1#14G]
[C24]	[1"C,24#14,1#14G]
[C25]	[1"C,25#14,1#14G]

MULTICONDUCTOR CONTROL CABLE CIRCUIT CALLOUTS

[CC5]	[3/4"C,1-5C TYPE 1]
[CC7]	[3/4"C,1-7C TYPE 1]
[CC9]	[1"C,1-9C TYPE 1]
[CC12]	[1"C,1-12C TYPE 1]
[CC19]	[1 1/2"C, 1-19C TYPE 1]
[CC25]	[1 1/2"C,1-25C TYPE 1]
[CC37]	[2"C,1-37C TYPE 1]
[CCC1]	[1-7C #12 TYPE 1]

NOTES:
1. FOR CABLE TYPES, SEE SPECIFICATIONS.
2. CONDUIT SIZES ARE BASE ON THE AREA OF THW CONDUCTORS.
3. SIZING OF CONDUCTORS #1AWG AND SMALLER BASED ON AMPACITIES AT 60 DEGREES C, SIZING OF CONDUCTORS #1/0AWG AND LARGER BASED ON AMPACITIES AT 75 DEGREES C.
4. WHERE CIRCUITS ARE UNDERGROUND, DIRECT BURIED OR CONCRETE ENCASED, MINIMUM CONDUIT SIZE SHALL BE 1".
5. FOR METRIC CONDUIT SIZES USE THE FOLLOWING CONVERSION:
   1/2" = 16 mm 1/4" = 35 mm
   3/4" = 21 mm 1 1/2" = 41 mm
   1" = 27 mm 2" = 53 mm

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
		R. WOOD	M. REICHERT	QC Review	APVD	Sealer	

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

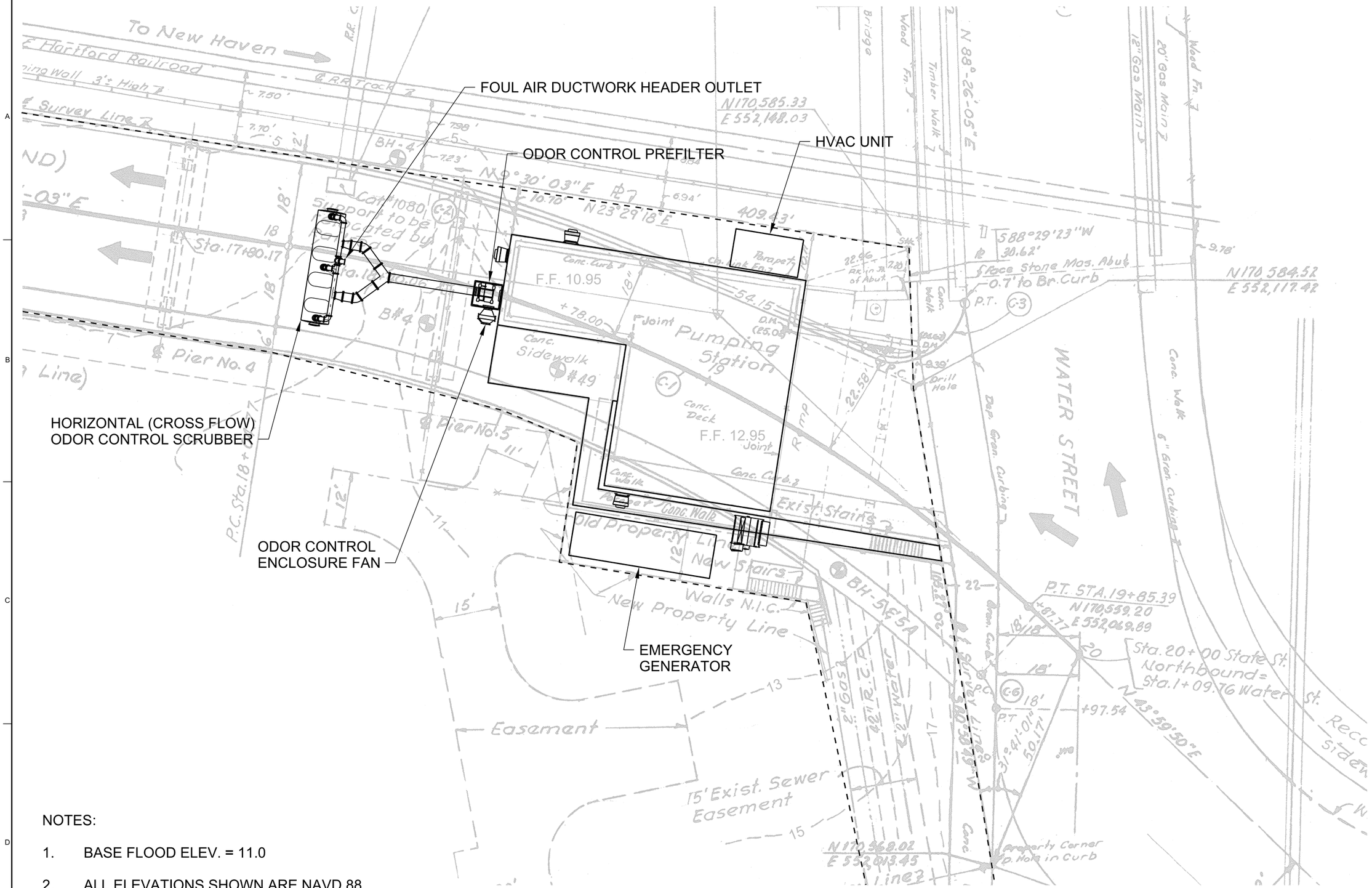
GENERAL

ELECTRICAL LEGEND 3

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	100-G-017
SHEET	of



NOTES:

1. BASE FLOOD ELEV. = 11.0
2. ALL ELEVATIONS SHOWN ARE NAVD 88
3. DESIGN RESILIENCY PROTECTION ELEV. = 14.0

UNION PUMP STATION SITE PLAN

1"=10'-0"

NO.	DATE	REVISION	BY	APVD
DSGN	RG SIEBERS	DR T. DUFFNEY	CHK	APVD

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

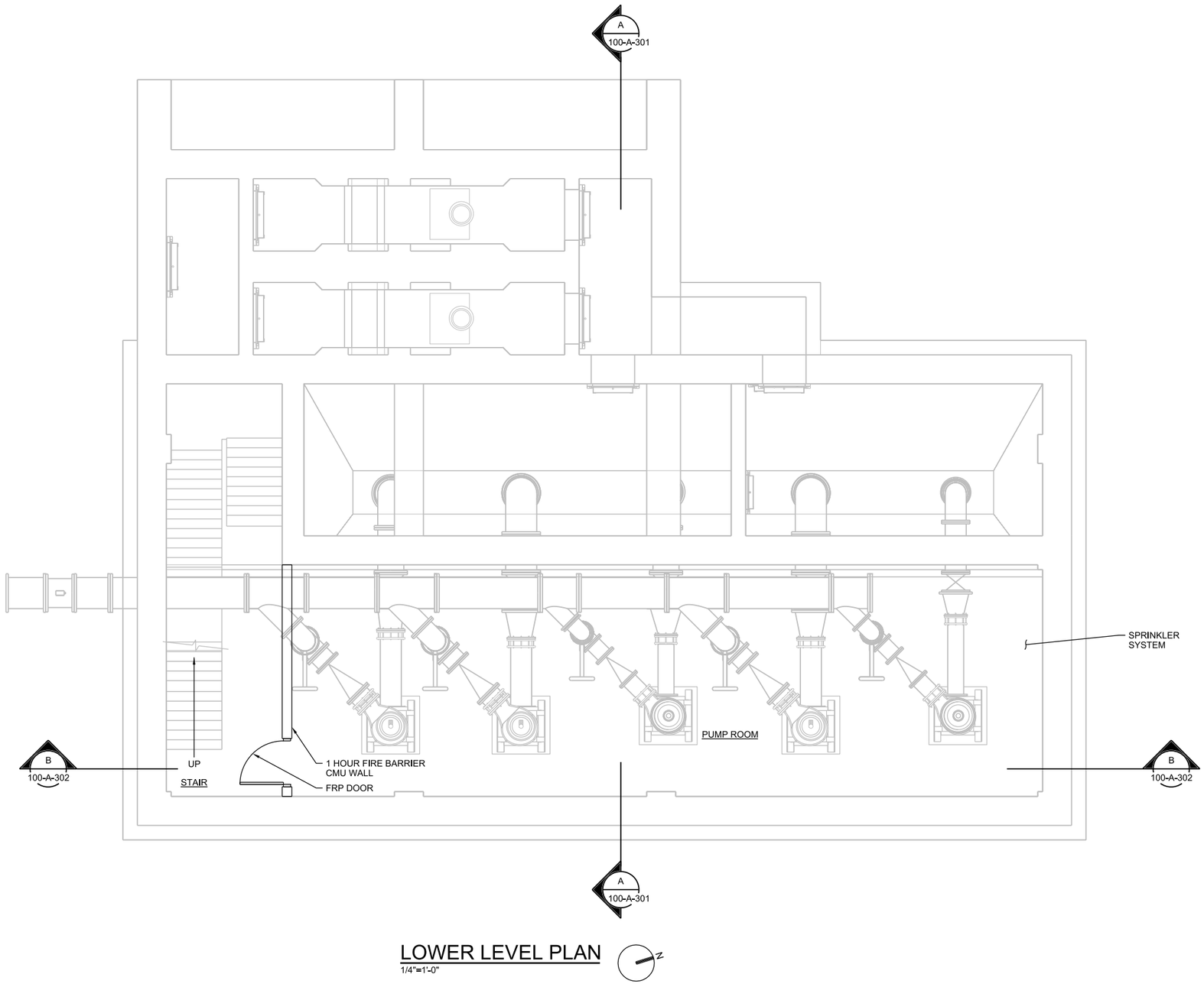
ch2m

CIVIL
UNION PUMP STATION SITE PLAN

PRELIMINARY – NOT FOR CONSTRUCTION

1"=10'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	100-C-201
SHEET	of



LOWER LEVEL PLAN

1/4"=1'-0"

NO.	DATE	REVISION	BY	APVD
DSGN	RG SIEBERS	DR	DL MICHALEK	CHK	APVD

PRELIMINARY – NOT FOR CONSTRUCTION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ARCHITECTURAL

UNION PUMP STATION
LOWER LEVEL PLAN
35 MGD CAPACITY

1/4"=1'-0"
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

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DWG	100-A-201
SHEET	of

CONC WALL TO MATCH EXISTING

16'x8' ROLL-UP DOOR

GENERATOR AND DIESEL FUEL (SEE SITE PLAN)

A
100-A-301

EYEWASH

TYPE 316 STAINLESS STEEL HATCH ABOVE

SCREEN ROOM

FRP GRATING, TYP

FRP DOOR, TYP

CONTROL ROOM

SECURITY FENCE

STAIR DN

8'-0" SWING GATE

1 HOUR FIRE BARRIER CMU WALL

8" CMU, TYP

CMU IN EXISTING WINDOW OPENING, TYP OF 3

DN

AL HANDRAIL

4" FACE BRICK, TYP

B
100-A-302

DRINKING FOUNTAIN

SERVICE SINK

EYEWASH

RESTROOM

MOTOR ROOM

B
100-A-302

BATTERY CONTAINMENT

A
100-A-301

INSULATED TRANSLUCENT PANEL WINDOW, TYP OF 4

GROUND FLOOR PLAN

1/4"=1'-0"

N

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GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m:

ARCHITECTURAL

UNION PUMP STATION
GROUND FLOOR PLAN
35 MGD CAPACITY

PRELIMINARY – NOT FOR CONSTRUCTION

1/4"=1'-0"

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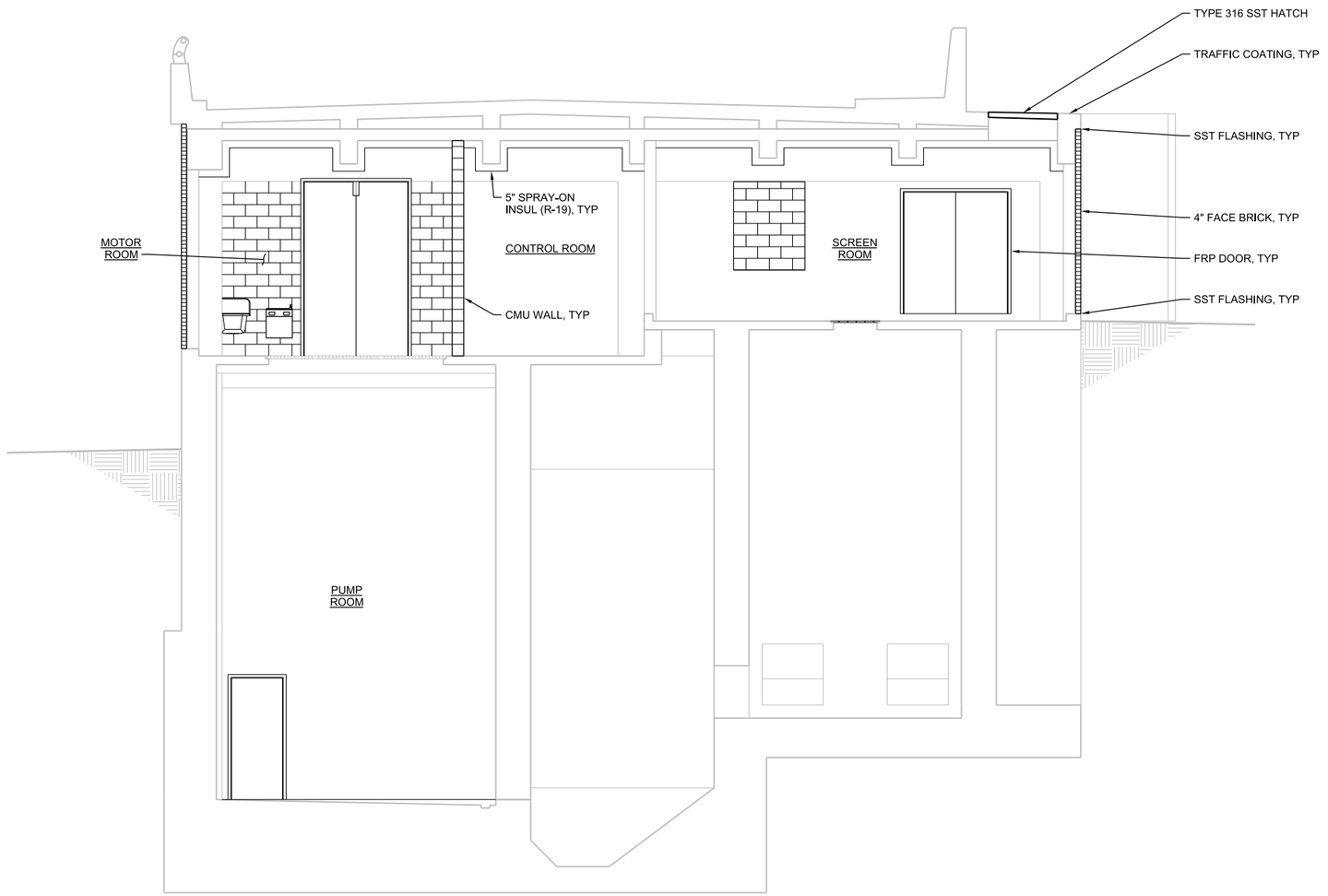

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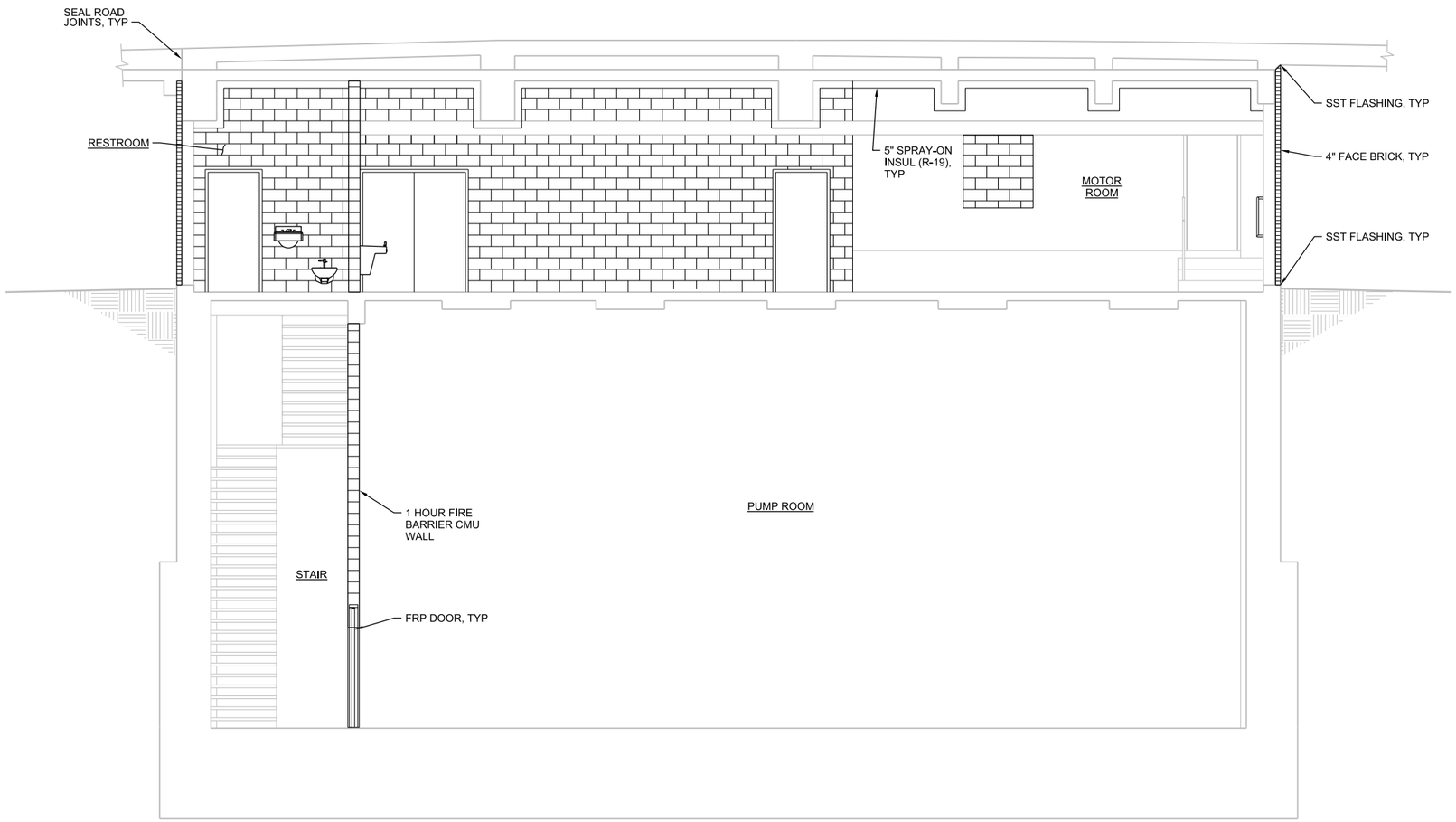

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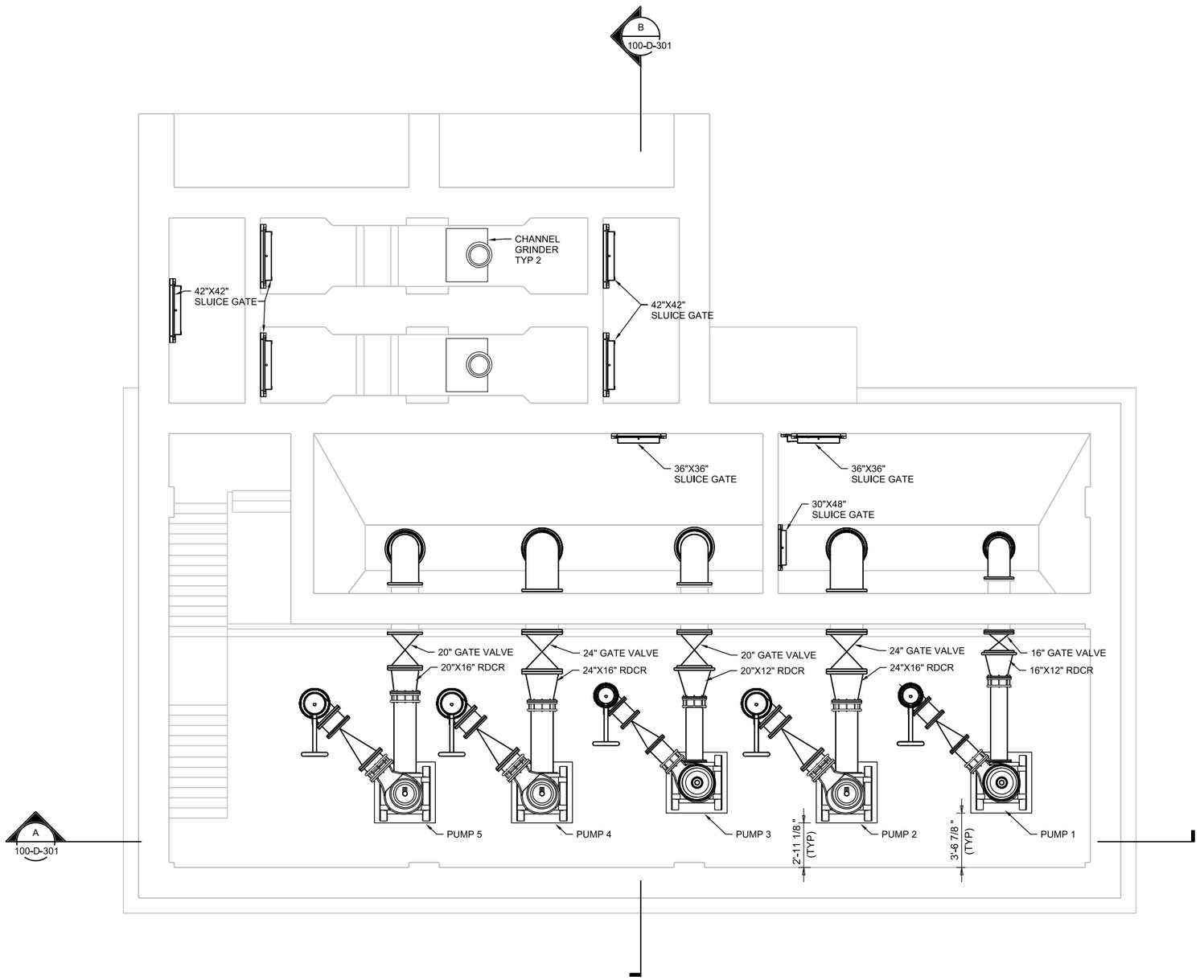

LOWER PLAN
1/4"=1'-0"

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NEW HAVEN, CONNECTICUT

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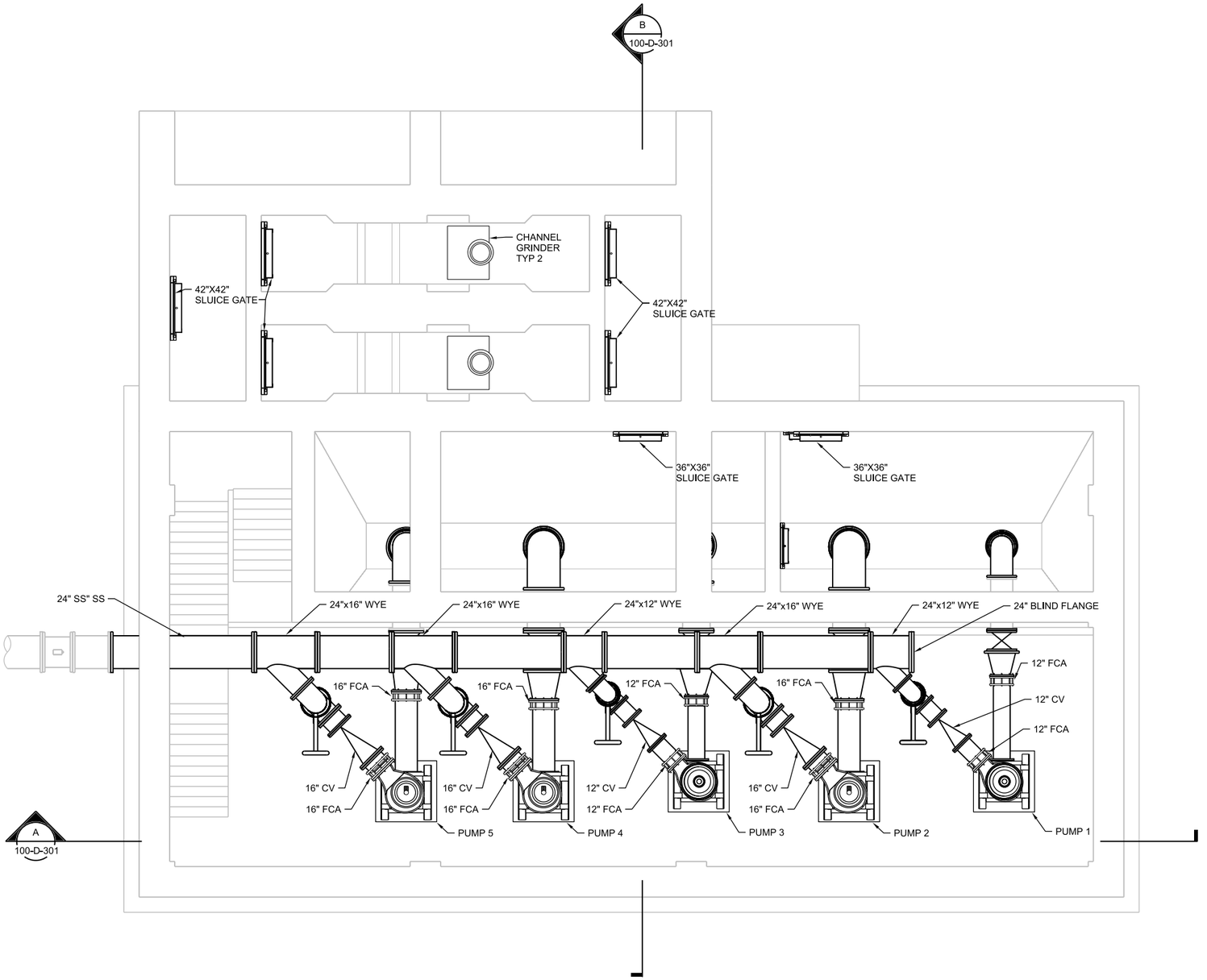

UPPER PLAN

1/4"=1'-0"

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

PROCESS MECHANICAL

UNION PUMP STATION
35 MGD CAPACITY
UPPER PLAN

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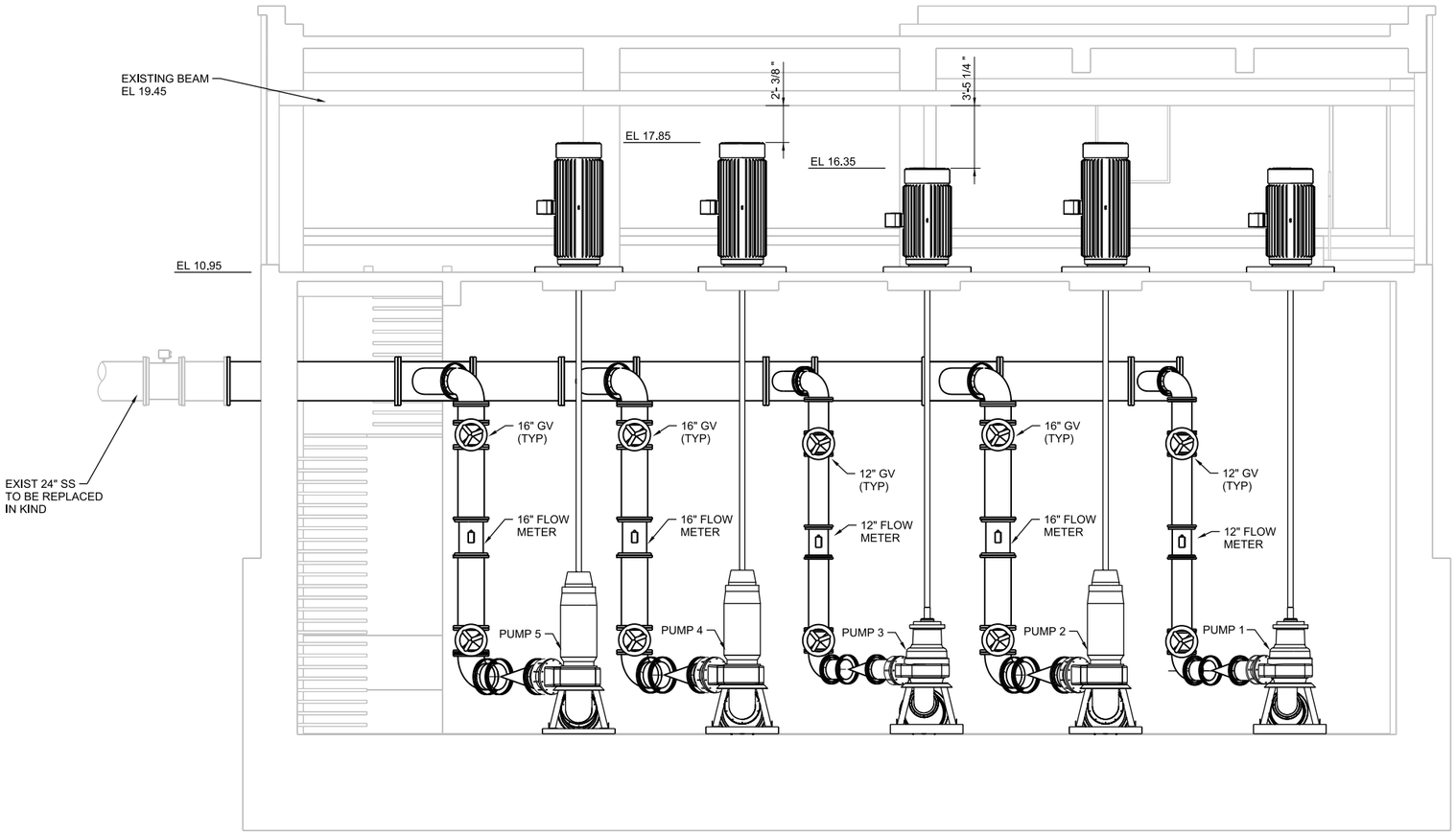

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NEW HAVEN, CONNECTICUT

PROCESS MECHANICAL
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35 MGD CAPACITY
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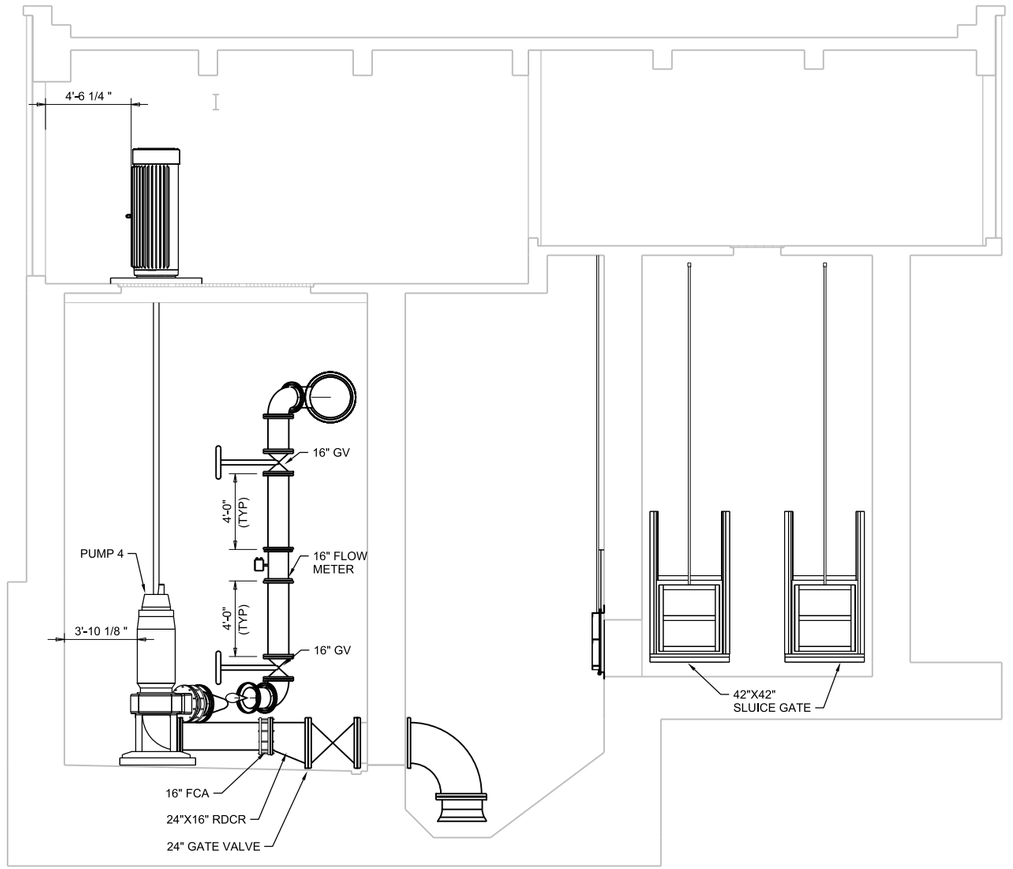

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PROCESS MECHANICAL

UNION PUMP STATION 35 MGD CAPACITY SECTION

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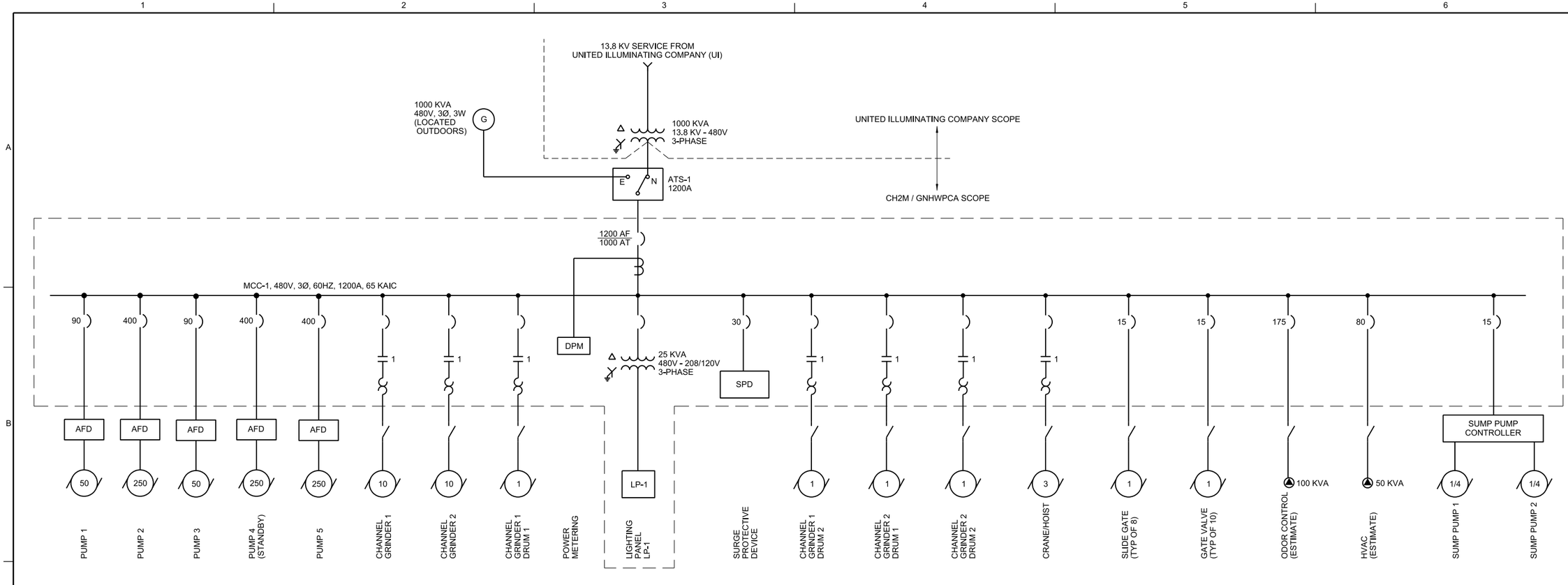
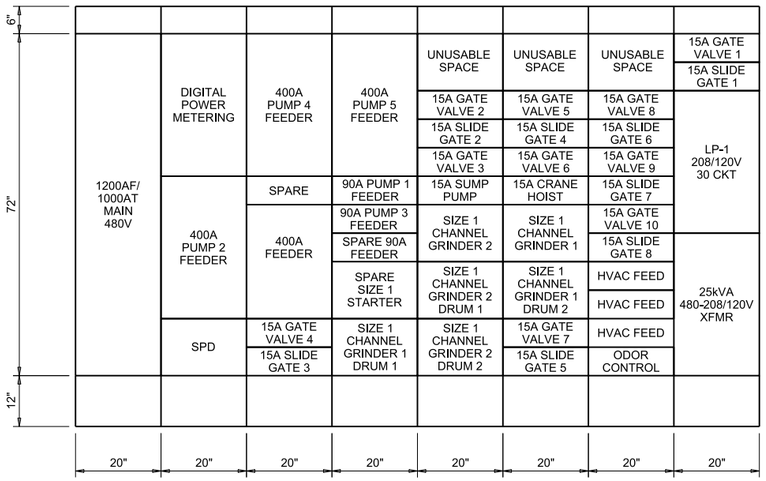


SINGLE LINE DIAGRAM

NTS



MCC ELEVATION

NTS

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GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION
CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ELECTRICAL

UNION PUMP STATION
SINGLE LINE DIAGRAM AND MCC ELEVATION

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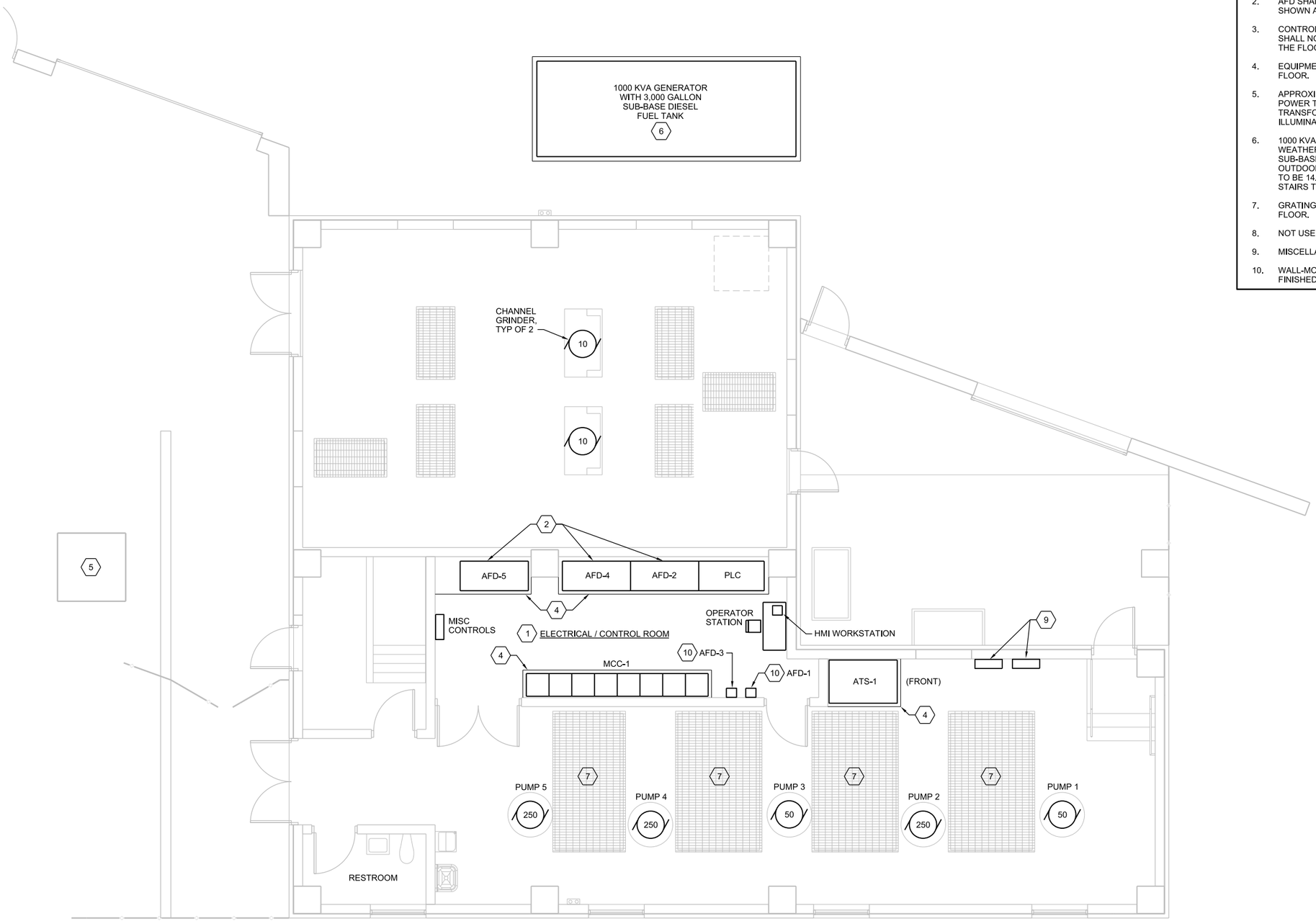
SHEET KEYNOTES

1. PLACE FLOOR MOUNTED AFD'S AND ELECTRICAL EQUIPMENT ON 1'-1" HIGH CONCRETE EQUIPMENT PAD.
2. AFD SHALL FIT WITHIN THE AVAILABLE SPACE SHOWN AND BE NO TALLER THAN 94-INCHES.
3. CONTROL SWITCHES AND DISCONNECT SWITCHES SHALL NOT BE MOUNTED MORE THAN 7'-6" ABOVE THE FLOOR.
4. EQUIPMENT ELEVATED 1'-1" ABOVE FINISHED FLOOR.
5. APPROXIMATE LOCATION OF EXISTING MAIN POWER TRANSFORMER. LOCATION OF NEW TRANSFORMER TO BE COORDINATED WITH UNITED ILLUMINATING (UI).
6. 1000 KVA, 1200 KW GENERATOR IN WEATHERPROOF ENCLOSURE WITH 3,000 GALLON SUB-BASE DIESEL FUEL TANK TO BE MOUNTED OUTDOORS ON PAD WITH TOP OF PAD ELEVATION TO BE 14.00 FEET. ACCESS PLATFORMS AND STAIRS TO BE PROVIDED AS NEEDED.
7. GRATING TO BE GROUNDED AND FLUSH WITH FLOOR.
8. NOT USED.
9. MISCELLANEOUS PANELBOARDS AS REQUIRED.
10. WALL-MOUNTED, BOTTOM OF AFD 36" ABOVE FINISHED FLOOR.



GROUND FLOOR PLAN

1/4"=1'-0"

N

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DR CHK APVD

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GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ELECTRICAL

UNION PUMP STATION
GROUND FLOOR PLAN
(35 MGD CAPACITY)

1/4"=1'-0"
VERIFY SCALE
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LCP-X
UNION PUMP STATION PLC PANEL

OIT

ETHERNET SWITCH

ETHERNET RADIO

ANTENNA

HMI

LCP-X
ODOR CONTROL SYSTEM PANEL

LCP-X
GENERATOR CONTROL PANEL

VFD-X (5)

FROM SEWER

CHANNEL GRINDER
M-XXX-X-X

DRUM, TYP

CHANNEL GRINDER
M-XXX-X-X

WETWELL 1

WETWELL 2

WETWELL

LE/LIT

PUMP 1
(50 HP)

PUMP 2
(250 HP)

PUMP 3
(50 HP)

PUMP 4
(250 HP)

PUMP 5
(250 HP)

PI

FM

EXISTING FORCE MAINT TO EAST PUMP STATION

PROCESS FLOW DIAGRAM
NTS

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		R. SRIVASTAVA	M. REICHERT				

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GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

INSTRUMENTATION AND CONTROL
UNION PUMP STATION
PROCESS FLOW DIAGRAM

VERIFY SCALE
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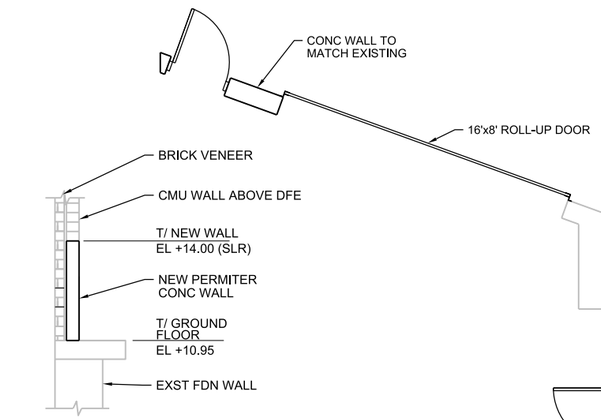
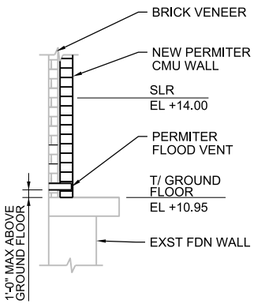
FLOOD PROOFING NOTES

1. BASE FLOOD EL (BFE) = 11.00
2. DESIGN FLOOD EL (DFE) = 12.00
3. PROJECTED SEA LEVEL RISE EL (SLR) = 14.00
4. THE GROUND FLOOR EL = 10.95
5. AREAS IDENTIFIED FOR WET FLOOD PROOFING SHALL CONFORM WITH THE FOLLOWING:
   a. AREA OF FLOOD RELIEF OPENINGS (Ao) = 2.5 in^2/1.0 ft^2
6. AREAS IDENTIFIED FOR DRY FLOOD PROOFING SHALL CONFORM WITH THE FOLLOWING:
   a. FLOOD PROOFING PLAN SHALL BE APPROVED BY "AHJ".
   b. A BUILDING CODE COMPLIANT EXIT DOOR FROM EACH ISOLATED ROOM WITHIN THE DRY FLOOD PROOF AREA SHALL BE PROVIDED.
   c. ALL ELECTRICAL, LIFE SAFETY AND ESSENTIAL EQUIPMENT SHALL BE LOCATED ABOVE THE DFE.



DRY FLOOD PROOFING PERMITER WALL

1 DETAIL
NTS



WET FLOOD PROOFING PERMITER WALL

2 DETAIL
NTS

GROUND FLOOR PLAN
1/4"=1'-0"

LEGEND

- NEW PERMANENT CONCRETE WALL
- PERIMETER FLOOD BARRICADE
- REMOVABLE FLOOD BARRICADE
- DRY FLOOD PROOF AREA WITH FLOOD BARRICADES
- WET FLOOD PROOF AREA WITH FLOOD VENTS

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GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

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FLOOD RESISTANT DESIGN
UNION PUMP STATION
FLOOD PROOFING FLOOR PLAN
35 MGD CAPACITY

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Appendix E
Boulevard Pump Station Preliminary Design Report

DRAFT REPORT

Long-Term Control Plan Update

Boulevard Pump Station – Preliminary Design Report

Prepared for

Greater New Haven Water Pollution Control Authority

November 2016

CH2M HILL Engineers, Inc.
100 Great Meadow Road
Suite 707
Wethersfield, CT 06109

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ACGIH	American Conference of Governmental Industrial Hygienists
ACH	air changes per hour
ACI	American Concrete Institute
AFD	adjustable frequency drive
AISC	American Institute of Steel Construction
ANSI	American National Standard Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
ATC	automatic temperature control
Authority	Greater New Haven Water Pollution Control Authority
AWWA	American Water Works Association
BEP	best efficiency point
BFE	base flood elevation
CAIECC	Connecticut Amendments to the International Energy Conservation Code
CFD	computational fluid dynamics
cfm	cubic feet per minute
cfph	cubic feet per hour
CISPI	Cast Iron Soil Pipe Institute
CMU	concrete masonry unit
CSBC	Connecticut State Building Code
CSO	combined sewer overflow
DC	direct current
DDC	direct digital control
DFE	design flood elevation
DLR	device level ring
DWF	dry weather flow
DX	direct expansion
FEMA	Federal Emergency Management Agency
fps	feet per second
FRP	fiberglass reinforced plastic
ft^2	square feet
ft^3	cubic feet
GNHWPCA	Greater New Haven Water Pollution Control Authority
gpm	gallon(s) per minute
H_2S	hydrogen sulfide
HI	Hydraulic Institute
HMI	human-machine interface
hp	horsepower
HSS	hollow structural sections
HVAC	heating, ventilation, and air conditioning

I&C	instrumentation and controls
I/O	input/output
IBC	International Building Code
ICRI	International Concrete Repair Institute, Inc.
IEBC	International Existing Building Code
IECC	International Energy Conservation Code
IMC	International Mechanical Code
IPC	International Plumbing Code
ksi	kilopound(s) per square inch
kV	kilovolt
kVA	kilovolt-ampere(s)
LTCP	long-term control plan
MAU	make-up air unit
MCC	motor control center
mgd	million gallon(s) per day
mph	mile(s) per hour
NaOH	sodium hydroxide
NAVD 88	North American Vertical Datum of 1988
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association (NEMA)
NFPA	National Fire Protection Association
NGVD 29	National Geodetic Vertical Datum of 1929
NPV	net present value
O&M	operations and maintenance
OIT	operator interface terminal
pcf	pound(s) per cubic foot
PLC	programmable logic controller
POR	preferred operating range
ppmv	part(s) per million by volume
psi	pound(s) per square inch
RPM	revolution(s) per minute
SLR	sea level rise
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SSPC	Structural Steel Painting Council
TDH	total dynamic head
UI	United Illuminating
UL	Underwriter's Laboratory
UPS	uninterruptable power supply
V	volt
VFD	variable-frequency drive
WEF	Water Environment Federation
WPAF	water pollution abatement facility
WSE	water surface elevation
WWF	wet weather flow
WWTP	wastewater treatment plant

SECTION 1

Hydraulics

1.1 Introduction

The *Long-Term Control Plan (LTCP) Update* includes alternatives that control combined sewer overflow (CSO) discharges from all CSO outfalls to meet a 2-year, 6-hour level of CSO control (zero discharges) by 2040. The LTCP Update includes short term, intermediate term, and long term improvements to meet these stated goals. This Preliminary Design Report of the LTCP focuses on long term improvements at the Boulevard (Boulevard) Pump Station. Preliminary Design Drawings are shown in Appendix A of the report.

1.2 Basis of Design

1.2.1 Hydraulic Design Objectives

The hydraulic design objective is to upgrade the Union, East Street and Boulevard Pump Stations to convey the maximum flow to the East Shore Water Pollution Abatement Facility (ESWPAF) resulting in CSO mitigation.

Models were developed to calculate how much flow can be conveyed to the wet well of the pump station using the existing infrastructure and to evaluate improvements to the pump station to allow the station to convey the design flows.

1.2.2 Design Flows and Pumping Strategy

The flow scenarios (Table 1-1) analyzed were developed from the 2015 Hydraulic Model. The model identified the design flows necessary for the system to meet the 2-year, 6-hour level of service. Three flow scenarios were analyzed during the LTCP Update. They are the short-term, intermediate-term, and long-term scenarios.

The short-term improvements do not impact the existing flows from the three pump stations. The total flow conveyed to the East Shore WPAF from the pump stations is 60 mgd split between Boulevard and East Street with each pump station pumping 30 mgd. Union currently pumps 15 mgd to East Street.

The intermediate term improvements increase the total flow conveyed to the ESWPAF. Union will be upgraded to pump 35 MGD capacity under the intermediate improvements, but capacity will be limited to between 15 and 25 MGD. East Street will be upgraded to pump up to 65 MGD, but capacity will be limited to 40 MGD. This is an increase of 10 MGD over existing capacity. Boulevard will be increased to pump up to 45 MGD, but capacity will be limited to 30 MGD.

The long-term improvements increase the total flow conveyed to the East Shore WPAF by the three pump stations to 110 mgd. The flows from the pump stations are 35 mgd from Union (pumping to East Street), 65 mgd from East Street, and 45 mgd from Boulevard.

Table 1-1. Flow Scenarios

Pump Station	Short-Term Flows (mgd)	Intermediate-Term Flows (mgd)	Long-Term Flows (mgd)
Union (to East)	15	25	35
East Street	30	40	65
Boulevard	30	30	45

The design parameters and considerations in selecting pumps for the stations include;

1. Create maximum reliability, efficiency and redundancy for flows in the dry weather range since flows in the dry weather range occur 98 percent of the time during a typical year.
2. Utilize extended shaft centrifugal pumps.
3. Maintain N+1 for dry weather and wet weather pumping conditions.
4. Consider space restrictions in existing station footprints.
5. Avoid cycling of flows at the East Street and Boulevard Pump Stations since these flows go directly to the ESWPAF.
6. Select pumps to operate well within the pump manufacturers' defined allowable operating range (AOR) for both wet and dry weather conditions.
7. For high frequency flow capacities, select pumps to operate within the pump's preferred operating range (POR) as defined by the Hydraulic Institute Standards (HIS) to obtain high wire-to-water pump efficiencies for both wet and dry weather conditions. For less frequent lower flow capacities, size pumps for operation well within the candidate pump manufacturers' defined allowable operating range (AOR).
8. Maintaining impeller tip speed to prevent accumulation of rags within the volute.
9. Maintaining scouring velocities in pump discharges to prevent grit accumulation.

Avoiding high VFD and corresponding pump speed turndown.

1.3 Hydraulic Model

Two models were developed for each pump station to identify the improvements necessary to meet the design flows.

Improvements necessary to convey the design flows by gravity from the sanitary sewer through the pump station's screening and grit systems to the wet well were identified by computing a hydraulic profile using CH2M's proprietary software, WinHydro. The hydraulic model was prepared using available mechanical, structural, and civil plan-and-profile record drawings, site visits and photos.

Improvements to the existing pump station pumping capacity and force mains were identified through incompressible pipe flow modeling using AFT Fathom version 8.0. The hydraulic model was prepared using available mechanical, structural, and civil plan-and-profile record drawings and photos.

Record drawings are in the National Geodetic Vertical Datum of 1929 (NGVD 29) and have been converted to the North American Vertical Datum of 1988 (NAVD 88) by subtracting 1.05 feet from NGVD 29. All elevations referenced in this section are in NAVD 88.

1.4 Hydraulic Analyses

1.4.1 Hydraulic Profile

The hydraulic profile from the influent sewer through the station and into the wet well at Boulevard includes the following:

- Influent Chamber flow split between screening channels
- Screening Channel (three channels)
- Junction Chamber downstream of the screening channels
- Flow Split between grit channels

- Grit channels (four channels)
- Junction Chamber downstream of the grit channels
- Flow split to the divided wet well

The analysis included four alternatives.

- **Alternative 1:** Three screens installed in screening channels and four grit channels.
- **Alternative 2:** Three screens installed in screening channels and two grit channels with the remaining two grit channels serving as high flow bypass channels.
- **Alternative 3:** Three screens installed in screening channels and zero grit channels. This alternative assumes grit removal is moved to the East Shore WPAF.
- **Alternative 4:** Zero screens and zero grit channels are installed. This assumes screening and grit removal is moved to East Shore WPAF.

The alternatives were run at the proposed long-term flow of 45 mgd. The results of the analysis are as follows:

- **Alternative 1:** The water surface elevation (WSE) coming into the influent chamber is -2.3. The sewer invert coming into the chamber is -5.1. This shows that at maximum flows, there is 2.8 feet of water depth as the sewer enters the chamber. A model run was performed with a WSE at the influent chamber of -2.3 and the run shows that the upstream infrastructure was able to deliver 44.7 mgd to the pump station under this alternative.
- **Alternative 2:** The WSE coming into the influent chamber is -3.4. At maximum flow, it is assumed all flow bypasses the grit channels in service and is conveyed through the high flow bypass channels. It was assumed for the bypass that the weir walls at the end of the existing grit channels would be demolished and all grit equipment would be removed. Influent gates would need to be opened during high flows to bypass the grit channels. A model run was performed with a WSE at the influent chamber of -3.4, the run shows that the upstream infrastructure was able to deliver 45 mgd to the pump station through the bypass channels.
- **Alternative 3:** The WSE coming into the influent chamber is -3.4. It was assumed that the weir walls at the end of the existing grit channels would be demolished and all grit equipment would be removed in all four grit channels. There is a drop in the invert from the screening channels to the grit channels, with the grit equipment removed and weir wall demolished the WSE in the influent chamber is minimally effected by the number of bypass channels at the maximum flow rate of 45 mgd. A model run was performed with a WSE at the influent chamber of -3.4, the run shows that the upstream infrastructure was able to deliver 45 mgd to the pump station through the channels.
- **Alternative 4:** The WSE coming into the influent chamber is -4.0. It was assumed that the existing screens would be removed, the weir walls at the end of the existing grit channels would be demolished, and all grit equipment would be removed in all four grit channels. A model run was performed with a WSE at the influent chamber of -4.0 and the run shows that the upstream infrastructure was able to deliver 45 mgd to the pump station through the channels.

1.4.2 Pipe Flow Modeling

A pipe flow model was created using AFT Fathom to represent the pressurized system. The model included East Street, Union, and Boulevard Pump Stations, their force mains, the harbor crossings, and force main to East Shore WPAF. The model base was built from existing conditions. Various alternatives were added to the model to identify the improvements necessary to meet the design flows at the short-term, intermediate-term, and long-term scenarios. All scenarios used an N+1 design to meet the design flow rate with the largest pump out of service.

1.4.2.1 Boulevard

Boulevard currently has four pumps installed with no space for additional pumps. The existing pumps have a rated capacity of 17.7 mgd. The stations firm capacity is 53.1 mgd and total capacity is 70.8 mgd. Through conversations with pump station operators, the station pumps approximately 30 mgd during peak flows. The pump station pumps to a 36-inch force main that joins the East Street force main upstream of the harbor crossing.

The long-term flow scenario for Boulevard is 45 mgd. The minimum dry weather flow is 7.4 mgd, the average dry weather flow is 12.5 mgd, and the maximum dry weather flow is 18.2 mgd.

The existing pumps do not have the capacity to meet the long-term pumping scenario with the largest pump out of service (N+1 redundancy criteria). Several scenarios were investigated to meet the design flows.

- **Scenario 1:** Four identical pumps installed in the existing pump station each rated at 15 mgd. A single pump in service would be used for dry weather flows and three pumps in service, with one pump in standby, would be used for the maximum wet weather flows. This scenario would have trouble pumping the minimum dry weather flows without cycling.
- **Scenario 2:** Two dry weather pumps and three wet weather pumps. The dry weather pumps were sized to efficiently pump the minimum flows to avoid cycling. To achieve this the dry weather pumps were sized for 12.5 mgd and would require both pumps in service to meet the maximum dry weather flowrate. Pump redundancy would be provided by one of the wet weather pumps which would cycle at the dry weather flows in the event one of the dry weather pumps was out of service. The wet weather pumps would be sized to pump the maximum flows with one pump out of service. Each wet weather pump would be rated at 22.5 mgd. In order to install five pumps in the existing station the two dry weather pumps are installed on a single suction header.
- **Scenario 3:** Three dry weather pumps and four wet weather pumps. The dry weather pumps are sized similar to scenario 2 but they have a standby pump to meet N+1 redundancy criteria. Installing seven pump requires the addition of a submersible pump station next to the existing station. The dry weather pump would be installed in the submersible pump station and the wet weather pumps would be installed in the existing pump station. Each wet weather pump would be rated at 15.00 mgd.

It was determined that Scenario 3 was the best option to meet the design flows. This scenario allows for N+1 redundancy for both dry weather and wet weather pumping and efficiently handles the minimum dry weather flows without cycling and peak wet weather flows.

Table 1-2 shows the proposed pump operation under several flow regimes for the Intermediate and Long Term Flow Scenario.

Table 1-2. Pump Operation

		Total Flow (mgd)	Dry Weather Pumps	Wet Weather Pumps
Intermediate Term	Min. Dry Weather	7.4	1 pump	0
	Avg. Dry Weather	12.5	1 pump	0
	Max. Dry Weather	18.2	2 pumps	0
	Max. Wet Weather	30	0	2 pumps
Long Term	Min. Dry Weather	7.4	1 pump	0
	Avg. Dry Weather	12.5	1 pump	0
	Max. Dry Weather	18.2	2 pumps	0
	Max. Wet Weather	45	0	3 pumps

1.4.2.2 Force Mains and Harbor Crossing

The existing force main from Boulevard is 36 inches before the junction with East Street.

East Street and Boulevard combine upstream of the harbor crossing. The force main increases to 48 inches downstream of this junction.

The existing twin harbor crossings are each 42 inches in diameter. The model assumed both crossings would be open during minimum dry weather flow and maximum wet weather flows.

The twin harbor crossing join together on the east side of the harbor into a 48-inch force main. The force main terminates at the East Shore WPAF.

Standard practice recommends velocities of 3 feet per second (fps) to provide self-cleaning velocities and limits force main velocities to 8 fps. Under the long-term flow scenario many of the force mains in the system would be below 3 fps during minimum dry weather flows and above 8 fps during maximum wet weather flows.

See Table 1-3 for a summary of force main velocities.

Table 1-3. Summary of Force Main Velocities

Force Main Segment	Min Dry Weather Flow Velocity (fps)	Average Dry Weather Flow Velocity (fps)	Maximum Dry Weather Flow Velocity (fps)	Max Wet Weather Flow Velocity (fps)
Boulevard 36-inch FM	1.5	2.6	3.7	9.3
48-inch FM DS of East and Boulevard Junction	1.6	2.7	4.1	12.8
42-inch Harbor Crossing (both open)	1.2	1.8	2.9	9.1
48-inch FM DS of Harbor Crossing to ESWPAF	1.6	2.7	4.1	12.8

SECTION 2

Process Mechanical

2.1 Introduction

This section describes the basis of the process mechanical design associated with improvements to meet the intermediate- and long-term flow scenarios and improve reliability of the station.

2.2 Pump Station Existing Conditions

2.2.1 Background and Existing Conditions

Boulevard was constructed in 1986 next to an existing treatment plant. The plant was abandoned once the pump station was in service. A 48-inch gravity sewer enters the pump station influent chamber. A sluice gate is installed on the incoming sewer. Flow can split between three screen channels. Each channel has a sluice gate on the influent and effluent. As-built drawings show coarse screens followed by fine screens in each channel. The fine screens have since been removed. Mechanically cleaned bar screens manufactured by Duperon Corporation have recently been installed in two of the channels. The screens have a ¾-inch opening.

The channels combine in a junction chamber downstream of the screens and splits into four grit channels. Sluice gates are located on each of the grit channels. An adjustable weir allows the operator to control the depth in the channel. The original grit removal mechanisms are planned to be replaced with a shaftless screw bottom collectors and a bucket removal system. Figure 2-1 shows the air piping entering the grit channels.

Figure 2-1: Existing Grit Channels

The grit channels combine before entering the wet well. There are sluice gates located on the inlet to each side of the wet well and a sluice gate on the wet well dividing wall.

The screenings and grit are conveyed to separate dumpsters in the pump station by belt conveyors. Overhead doors allow for bin removal.

Each side of the wet well has two 30-inch suction wall pipes for total of four. Four pumps are currently installed with no space for additional pumps. All four pumps are identical, as shown in Table 2-1. They are manufactured by Goulds and are extended shaft vertical centrifugal pumps.

Table 2-1. Existing Pumps

Pump	Make/Model	Rated Capacity	Motor Size	Speed
1	Goulds NCD 16x16	17.7 mgd	400 HP	710 rpm
2	Goulds NCD 16x16	17.7 mgd	400 HP	710 rpm
3	Goulds NCD 16x16	17.7 mgd	400 HP	710 rpm
4	Goulds NCD 16x16	17.7 mgd	400 HP	710 rpm

Figure 2-2 is a photograph of the pumps.

Figure 2-2: Existing Pumps

Each pump has a gate valve on the suction side and a modulating cone valve on the discharge. There is a flow meter located on each pump discharge. A plug valve isolates the pumps from the discharge manifold downstream of the flow meter. The pumps combine in a 36-inch force main before leaving the station to the north. A surge suppressor is connected to the force main inside the pump station. The surge suppressor drains to the wet well. Figure 2-3 is a photograph of the surge suppressor.

Figure 2-3: Existing Surge Suppressor

2.3 Inlet Works Facilities Design Criteria

2.3.1 Screening

The Boulevard Pump Station currently has two screens installed. The pump station cannot pass the 45 mgd through two screens. The third channel needs to be opened up for peak flows. To protect the pumps a mechanical screen can be provided in the channel. A third mechanical screen provides greater redundancy to the system if a screen needs to be taken offline for maintenance. The screen will match the existing screens.

The existing screening conveyors should be replaced with new conveyors. The new screenings system will include a grinder and compactor washer section. The grinder will have its own motor as will the compactor section, but the system will be operated by a common control panel that will be interlocked with the screen controls such that it is energized whenever the screen is operating.

The grinder section will precondition the screenings allowing a cleaner, drier, and more compact screenings product reducing odors and screenings volume. Spray washwater will be provided to allow organics to be washed back into the channel. The compactor (screw auger) portion of the grinder compactor will compact and convey clean screening into an adjacent screening bin.

Screenings loading is estimated to be 4.7 cubic feet per hour on average with peaks up to 16.9 cubic feet per hour. Screening design criteria are listed in Table 2-2.

Table 2-2. Screening Design Criteria

Design Criteria	
Screenings Capacity	71 cubic feet per hour
Spray Wash Water Capacity	249 gpm
Dry Solids Content	40%
Grinder Motor	5 HP
Compactor Motor	3 HP
Manufacturer	JWC, Franklin Miller

2.3.2 Grit Removal

The Authority is scheduled to replace the grit removal mechanisms on the four grit channels.

The existing grit conveyor should be replaced with new conveyors in the same alignment as the existing conveyor.

Grit loading is based on conservative assumptions of 8 cubic feet of grit for each per million gallons of flow. These values were selected based on review of the Water Environment Federation's (WEF's) *Manual of Practice 8* (MOP 8) and design experience from other Connecticut wastewater treatment plants (WWTPs):

- Grit 4.2 cubic feet per hour on average with peaks up to 15 cubic feet per hour.

2.4 Pumping Systems Design

2.4.1 Pump Configuration

As stated in Section 1, the proposed configuration for the Boulevard Pump Station is to install three dedicated dry weather pumps rated at 12.5 mgd, and four dedicated wet weather pumps rated at 15 mgd. The dry weather pumps would be installed in a submersible pump station and the wet weather pumps would be installed in the same locations as the existing pumps.

Table 2-3 lists the dry weather submersible pump selections.

Table 2-3. Dry Weather Pump Selections

Design Criteria	DWF Avg	DWF Min	DWF Max
Number of pumps	3	3	3
Number of pumps in operation	1	1	2
Design flow (mgd) (each pump)	12.5	7.4	9.1
Design flow (gpm) (each pump)	8,680	5,136	6,285
TDH at design flow (ft)	52	47	64
Efficiency at design flow	71%	75%	80%
NPSHA (ft)	33	33	33
NPSH3	25	15	17
Motor (HP)	215		
Impeller (in)	16.73		
Speed	1200 RPM		
Type of Pump	Submersible		
Model	NP3356.736		
Manufacturer	Flygt		

Table 2-4 lists preliminary wet weather pump selections.

Table 2-4. Wet Weather Pump Selections

Design Criteria	DWF Max	WWF
Number of pumps installed	4	4
Number of pumps operating	1	3
Design flow (mgd) (each pump)	18.2	15
Design flow (gpm) (each pump)	12,570	10,417
TDH at design flow (ft)	69	198
Efficiency at design flow	86%	82%
NPSHA (ft)	32	31
NPSH3	17	16
Motor (HP)	700	
Impeller (in)	32.48	
Speed	900 RPM	
Model	12MF29A	
Manufacturer	Flowserve	
Number of pumps installed	4	

Figures 2-4 and 2-5 show the system versus system curves containing the design points for dry and wet weather pumps.

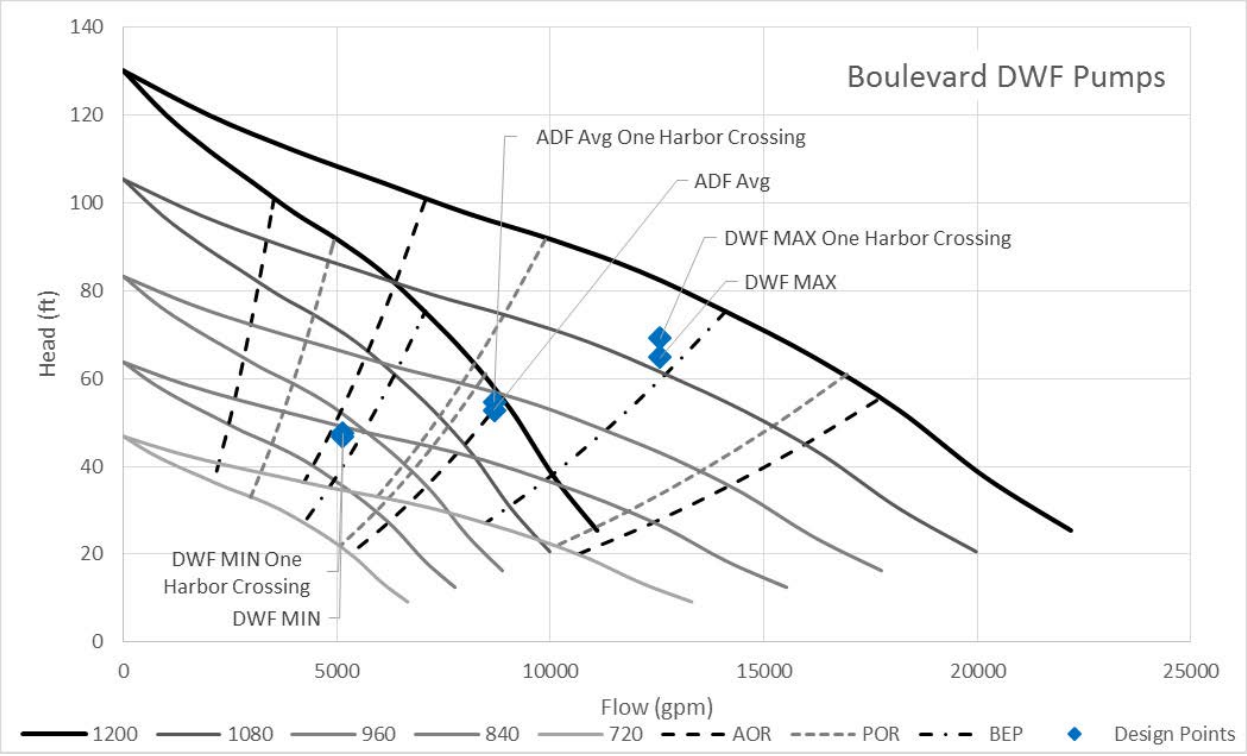


Figure 2-4. Dry Weather Pump and System Curves

Figure 2-4 shows the variable-frequency drive (VFD) curves for two pumps in operation. Under the minimum dry weather flow (DWF), a single pump is operating close to the Best Efficiency Point (BEP). A single pump meets the average DWF just outside preferred operating range (POR), but within the allowable operating range (AOR). Two pumps in operation meet the average DWF within the POR. Two pumps are necessary to meet the DWF maximum flow with both pumps operating within the POR close to the BEP.

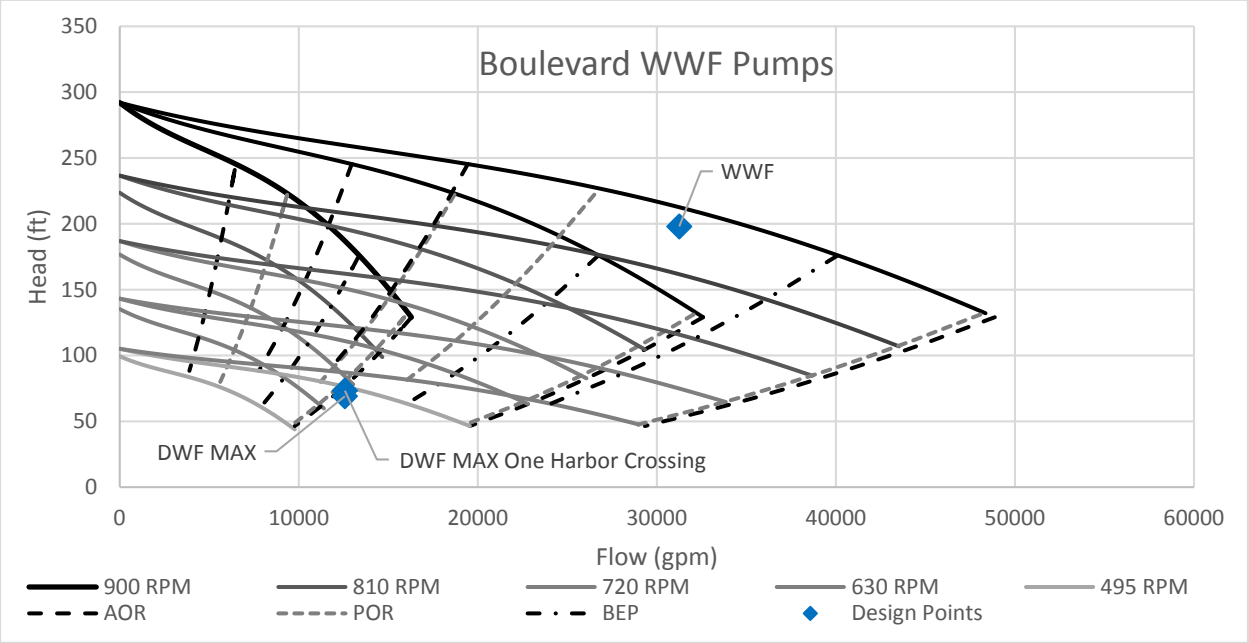


Figure 2-5: Wet Weather Pump and System Curves

Figure 2-5 shows that the maximum DWF is within the AOR range of a single wet weather pump. The The figure shows the max DWF is within the AOR and within the POR of two pumps in operation. The WWF is on the POR when three pumps are in operation.

The finish floor elevation of Boulevard is 10.70. The distance from the floor to the ceiling is approximately 17.65 feet or El. 28.60. This does not account for the existing bridge crane, the bridge crane elevation is not shown on existing as-builts and would need to be measured in the field.

The height of the motors would be approximately 6 feet tall. At the existing floor elevation, the top of the motors would be at an elevation of 16.7.

There should be sufficient space to install the motors with the existing bridge crane at the existing floor elevation.

2.4.2 Pump Operating Criteria

The minimum and average dry weather flow can be met with a single dry weather pump in operation. The maximum dry weather flows can be met with two dry weather pumps in operation or a single wet weather pump in operation.

Wet weather flows can be met with two wet weather pumps during the Intermediate Term and three wet weather pumps in operation during the Long Term.

2.4.3 Wet Well Intake Configuration

The existing wet well configuration does not meet Hydraulic Institute (HI) standards in the following areas:

- Anti-rotational baffles are required for pumps larger than 3,000 gpm (4.3 mgd).
- Pump suctions should be located in a confined wet well where each suction inlet bell is located in a confined pocket to isolate the pump from any flow disturbances that might be generated by adjacent pumps.

For retrofit designs, meeting the requirements of HI standards is often not feasible. If designs other than those required by HI standards are shown by prototype or model tests performed in accordance with HI standards the alternative designs are considered to comply with HI standards. During detailed design, the wet wells will be evaluated using computational fluid dynamics (CFD) modeling to verify the hydraulic efficiency and further physical testing may be required to model the existing wet well to identify measures that can be taken to comply with HI standards.

HI also provides recommendations for retrofit designs of rectangular wet wells that would help improve suction conditions. Recommendations are as follows:

- Inclusion of a baffle wall to minimize air entrainment due to falling liquid
- Setting the baffle wall below the maximum wet well level to allow any floatable material to pass over the wall
- Inclusion of fillets below the pump intake
- Inclusion of baffles between the pump intakes
- Inclusion of fillets along the sides of the wet well to eliminate dead zones

2.4.4 Effluent Piping

The proposed effluent piping follows the existing discharge piping layout.

2.4.5 Valves and Flow Meters

Gate valves are recommended for isolation upstream and downstream of each pump. The American Water Works Association (AWWA) C500 double disk metal seated valves are recommended for this application. Resilient seated gate valves (AWWA C509 or 515) are prone to damage from grit, while double disk metal seated valves are more robust than the resilient seated valves and leak less than a solid metal seated disk.

Check valves are provided for prevention of flow reversal on all pumps.

Flow meters are recommended on the discharge of each wet weather pump. It is not recommended to reduce a pipe size upstream and downstream of the flow meter. This is a standard practice to ensure adequate velocities through the flow meter but can cause turbulence reducing the accuracy of the instrument. At the minimum dry weather flow the velocity through the flow meter would be 3.6 fps. According to published literature for ABB mag meters, velocities greater than 1.6 fps result in +/-0.15% and the minimum flow through the meter is 33 gpm. The flow meter will have five upstream diameters and two downstream diameters of straight run.

A single flow meter will be installed on the discharge of the dry weather pump station.

2.4.6 Equipment Access and Removal

The existing monorail has a 5-ton capacity which is sufficient to remove the new extended shaft pumps.

The existing hatches are 7x8 feet. These are sufficient to remove the larger pumps.

Hatches will be provided above the pumps at the new dry weather submersible pump station for removal of the pumps. A hatch will be provided for access to the valve vault for removal of equipment.

SECTION 3

Structural

3.1 Introduction

This section is intended to assess the building structure components of the Boulevard Pump Station and identify design criteria for the rehabilitation of the facility. It outlines proposed solutions to address structural deterioration, deficiencies and upgrades to incorporate architectural, process mechanical, and MEP findings.

3.2 Codes and Standards

The current governing code utilized by the City of New Haven and the State of Connecticut are based on the 2016 Connecticut State Building Code.

The following standards shall be used in support of the building code:

Standards:

- ACI 318-11 – Building Code Requirements for Structural Concrete
- ACI 530-11 Building Code Requirements for Masonry Structures
- ASCE/SEI 7-10 - (Supp 1)—Minimum Design Loads for Buildings and Other Structures.
- ASCE 24 – 14 – Flood Resistant Design and Construction
- CH2M HILL Water Business Group Design Guide.
- International Concrete Repair Institute Technical Guidelines (ICRI)
- ICC-ES Evaluation Reports for specific products.
- Structural Steel Painting Council (SSPC)

Reinforced Concrete:

- Typical Unless Noted Otherwise: ACI 318-11 Building Code Requirements for Structural Concrete.
- Liquid Containment Structures: ACI 350-06 Code Requirements for Environmental Engineering Concrete Structures.

Concrete Repair:

- ICRI GS03130 Guide Specifications for Structural Concrete Repair
- ICRI Technical Guideline No. 03732 -Selecting and Specifying Concrete Surface Preparation for Coatings, Sealers, and Polymer Overlays

Steel:

- AISC 360-10 Specification for Structural Steel Buildings, including Supplement No. 1 dated 2005.
- Manual of Steel Construction, Thirteenth Edition.
- AWS – D1.1, Structural Welding Code–Steel Design Loads

3.3 Structural Condition Assessment

The construction of the Boulevard Pump Station structure was completed in 1986. The structure was designed by CE Maguire, Inc. Engineers of Providence, Rhode Island. Original design drawings available for review are dated June 13, 1986.

The Boulevard Pump Station structure is primarily composed of conventionally reinforced cast-in-place concrete. The foundation system is a mat foundation supported by undisturbed soils with 3-foot thick

concrete foundation walls around the below-grade wet well and dry well areas. The above-grade exterior elevations of the pump station structure are clad with brick veneer with a non-structural concrete masonry unit (CMU) backup. An 8-inch CMU partition wall has been provided between each of the five rooms.

3.3.1 Observations and Recommendations

The following observations and recommendations (in italics) are divided into the eight areas of the Boulevard Pump Station:

1. Pump Room: The Pump room houses electrical control panels, pump motors and provides access to the dry well area below.
    a. The concrete floor structure in the Pump Room is in good condition. Some cracking was evident throughout the floor area, but it does not appear to be structural distress cracking. Similar to findings at the East Street Pump Station, we suspect a concrete topping has been provided over the structural slab exacerbating the cracking. A protective traffic bearing floor coating should be placed on the floor to minimize potential deterioration. *A flexible polyurethane based coating will span the cracking, improve aesthetics and lighten appearance, and protect the floor system.*
    b. The cast-in-place roof structure above the pump room appears to be in good condition with no observed leaks or distress.
    c. A new Bridge Crane system is desired in the pump room. *Existing drawings for the original Operations building must be analyzed for structural capacity prior to the design and installation of a new bridge crane. Confirming the actual roof framing capacity could allow upsizing of the crane to handle larger pump systems.*
    a. There are two 6-foot-0-inch floor openings provided for access to the pumps in the dry well. Each opening is protected with aluminum grating. *Because of the increased loads expected for the new pump system, new heavy duty aluminum access hatches mounted flush with the existing floor will be provided.*
2. Mechanical Room: The mechanical room is located on the south side of the Inlet Works building and houses motor control panels, chemicals and other mechanical equipment.
    a. The concrete slab in the mechanical room exhibits significant deterioration totaling approximately 300 square feet (ft^2). It is suspected that this is due to the chemicals stored in the room and an unprotected floor surface. *All deteriorated concrete on the floor slab should be repaired, a new chemical resistant protective coating should be provided on all concrete and wall surfaces with in the chemical storage area.*
    b. The chemical storage area within the mechanical room does not have walls or a curb for chemical containment in the case of the spill. *Containment walls should be added to this area. All walls should be protected with a chemical resistant coating.*
3. Generator Room: The Generator room is located on the south east side of the pump station building and houses a fuel tank and the generator.
    a. The concrete slab in the generator room exhibits deflection and concrete spalling near the entrance and the generator pad has debonded from the existing base slab. From review of the wet well below, underside cracking was identified.

        In 2007, CH2M completed an analysis concerning deflection of the floor, cracking and spalling concrete below. The report stated that there is not an immediate structural concern but repairs would need to be completed in the near future to maintain structural capacity in this area. It is

our understanding that the recommended repairs have yet to be incorporated and the conditions may have further deteriorated.

Further structural analysis and field review will be needed for this area. Supplemental supports should be installed below the generator room when repair work is being completed in the wet well below. Concrete repairs should be completed on the top side and underside of the slab.

4. Blower Room: The Blower room is located on the west side of the pump station building and houses motor control panels, chemicals and other mechanical equipment.
    a. The concrete slab in the blower room exhibits significant deterioration totaling approximately 200 ft^2. We suspect this is due to the chemicals stored in the room and an unprotected floor surface. *All deteriorated concrete on the floor slab should be repaired, a new chemical resistant protective coating should be provided on all concrete and wall surfaces with in the chemical storage area.*
    b. The chemical storage area within the blower room does not have walls or a curb for chemical containment in the case of the spill. *Containment walls should be added to this area. All walls should be protected with a chemical resistant coating.*
5. Dry Well: The dry well is located approximately 22 feet below the Motor Room and houses the pumps for discharge from the adjacent wet well.
    a. The dry well area concrete surfaces were in good condition and painted. Some leakage was noted through the foundation walls. *All active leaks should be sealed. Damaged areas shall be re-coated*.
    b. The drains provided in the dry well floor are corroded. *Replace existing drain bodies and grates.*
    c. A steel platform composed of galvanized framing and grating is provided for access to each of the four pumps. Due to leaks at each of the pumps, the platform supports have been subjected to moisture. *Corroded stair and platform framing areas should be cleaned and protected with a new coating system*.
    d. The pump pedestals and steel pipe supports are also subjected to moisture due to leaks around the pump mechanism. *All deteriorated areas of steel and concrete should be cleaned, repaired and recoated with a protective coating system.*
6. Screening Room: The screening room is the largest room in the Inlet Works building and provides access to the influent, bar screen and grit collection channels:
    a. The reinforced concrete floor in the screening room appears to be in good condition. The floor appears to be constantly wet. *The floor should be planned for sealants in joints at perimeter walls and a protective coating system. This will protect the concrete structure and perimeter walls.*
    b. At the time of the site visit, the aluminum gratings over channel openings were being replaced with new composite grating. *All channels shall receive a protective coating system over concrete surfaces exposed to process fluids and moisture.*
7. Wet Well: The wet well is located below the generator and blower rooms north of the dry well. Access to the wet well is provided through a stairwell on the east side of the pump station building. The stairs leading down to the wet well are composed of cast-in-place concrete.
    a. The concrete stairs leading into the wet well were exhibiting deterioration, specifically along embedded nosing plates. All nosing plates shall be removed and concrete steps shall be repaired. *A new chemical resistant protective coating should be provided over all steps.*

b. The concrete foundation walls and framing within the wet well could not be reviewed up close. *Significant cracking and efflorescence on the ceiling below the generator room was noted.*

c. The existing walls and framing in the wet well were not protected by a coating system. *A new protective coating shall be applied to all wet well concrete and steel surfaces.*

d. The grating in the wet well could not be reviewed due to debris in the wet well. *The debris should be cleaned and all grating systems should be replaced in the wet well.*

e. The railings along the steps were loose. *Replace all railing systems in the wet well*.

8. Garage and Exterior of Building:

a. The garage portion of the building is located on the west side of the pump station building, at grade level and appears to be in good condition.

b. The exterior entrances and loading dock area on the west side of the pump station building is approximately 4 feet-0 inches above grade. There was concrete deterioration noted at embedded nosing plates on one of the two stairs. No sealants were provided along the brick veneer/concrete interface, in cracks or at construction joints. *Existing tread embedment plates should be removed from all exterior stairs and the damaged concrete repaired. New polyurethane sealant shall be provided along all walls, surface cracks and at construction joints*.

c. The exterior brick veneer appears to be in good condition with the exception of the northwest corner of the building. *The brick veneer does not have control joints and has shifted from the corner and cracked the foundation wall below. The damaged concrete wall should be repaired, and the brick veneer should be rebuilt at the corner incorporating a vertical masonry control joint.*

d. There are three exterior steel framed stairs with metal grating treads and landings. The metal treads are bent in several locations, and the grating at the landing has been covered with wood decking boards. *All landing grating and stair treads should be replaced with heavy duty galvanized grating at each of the three locations.*

3.4 Design Criteria

3.4.1 Loading

Loads shall be based on the most stringent criteria of the Building Codes and Standards listed above. In some cases, the minimum loads listed in the American Society of Civil Engineers *Minimum Design Loads for Buildings and other Structures* standards (ASCE 7) may be equivalent criteria and may be substituted for the loads listed below. In all cases, the minimum criteria shall conform to the minimum requirements of the IBC as amended by the State of Connecticut.

Design loading criteria was available for the Boulevard Pump Station drawings as follows

Snow Load	40 psf
<u>Live Loads</u>	
Stairs	100 psf
Inlet Area	150 psf
Heavy Equipment Rooms	300 psf or Weight of Equipment
Slab on Grade	350 psf

3.4.2 Resiliency Planning and Design Basis

As part of its recognition of future coastal resiliency impacts, the State of Connecticut has directed that all projects using State funding, such as the Clean Water Fund (CWF), must include features that address potential sea level rise and coastal resiliency issues within its design. Each of these stations are either within or directly adjacent to the 100-year floodplain, as determined by the Federal Emergency Management Agency (FEMA). The current Flood Insurance Rate Maps (FIRMs) for the New Haven area have recently been updated as a result of documented impacts from Hurricane Sandy, and recent regional evaluations of sea level rise trends and future projections. Due to this revision, the regulatory base flood elevations have risen by 1 foot at both East Street and Boulevard Pump Stations, but remain the same for Union Pump Station.

In accordance with the Public Act Nos. 13-15, the CWF is required to consider the necessity and feasibility of implementing measures designed to mitigate the impact of a rise in sea level over the projected life span of such a project. To further the abilities of municipalities to implement this requirement, the New England Interstate Water Pollution Control Commission (NEIWPCC) updated its Technical Release 16, Guides for the Design of Wastewater Treatment Works (TR-16) and provided guidance on selecting an appropriate protection elevation related to the criticality of each process component and the impact on the environment if that process was impacted during a storm event. The guidance document separates facilities into two types: critical and non-critical. Critical facilities are defined as those systems that are required for the conveyance of wastewater to and through a treatment facility. This includes all electrical, mechanical, and control systems within a pump station. The recommendation in TR-16 is to elevate these critical elements a minimum of 3 feet above the 100-year flood elevation.

As part of the recent Phase 1 Wet Weather Capacity Improvements and Nitrogen Reduction Project at the South Shore WPAF, an evaluation was conducted to establish the resiliency elevation for use during this construction project. This evaluation included consideration of recent regional coastal sea level rise evaluations, along with elevating equipment above the 500-year flood elevation. Combining these two elements resulted in a protection elevation for the East Shore WPAF of 2.95 feet (NAVD 88) above the established 100-year base flood elevation. As part of this Preliminary Design Report, the protection elevation is being set at 3 feet to be consistent with the TR-16 guidance.

The Boulevard Pump Station was evaluated for the feasibility and necessity of elevating critical equipment to maintain operations during a flooding event. It was deemed not feasible or cost-effective to elevate all equipment due to existing space limitations, or overall station configuration. In addition, due to the interconnectivity of the station with existing outfalls adjacent to the stations, certain areas will be inundated without the ability to protect the interior of the facilities from rising flood waters. For this purpose, GNH has taken the approach of providing dry floodproofing where critical equipment must remain below the resiliency protection elevation, and providing wet floodproofing where appropriate to maintain structural stability and allow the facility to quickly regain full operations once the flood waters recede. In general, floodproofing methods include construction of cast-in-place structural walls around the perimeter of each area to be dry floodproofed, with implementation of removable bulkheads at roll up doors and personnel doors as needed. Wet floodproofing methods include installation of flood vents to allow hydrostatic pressures to equalize on either side of facility walls during the flooding event allowing immediate return to service following cessation of flood waters. Specific floodproofing locations are included in the Preliminary Design Drawings included in Appendix A.

3.4.3 Design Loads

In some cases, minimum loads listed in ASCE 7 may be an equivalent criterion and may be substituted for the following loads. The following minimum criteria shall be used for design.

3.4.3.1 Floor Live Loads

In accordance with codes and standards listed above, and the following minimums:

Process Rooms	300 psf on slabs and beams and 200 psf on girders, columns
Electrical Rooms	300 psf
Storage Areas	150 psf
Mechanical/HVAC Rooms Allow for rolling equipment	150 psf or Equipment weight plus 50 psf
Stairs, Walkways and Platforms	100 psf
Platforms Only for Access	60 psf
Vehicular Traffic	AASHTO HS 20-44

3.4.3.2 Wind Loads

Wind loads will be based on Risk Category III unless otherwise noted, with an ultimate design wind speed (Vult) of 135 mph (3-second gust), Exposure C.

3.4.3.3 Snow Loads

Existing areas requiring analysis and areas of new construction will be analyzed with the following assumptions.

Ground Snow Loads	30 psf
Importance Factor	1.1
Snow Exposure Factor	1.0

3.4.3.4 Flood Loads

Hydrostatic Loading of 63 pounds per cubic foot (pcf) will be assumed up to the proposed Sea Level Rise (SLR) Elevation. The Boulevard Pump station is located outside of the Coastal A Zone, as identified by the Federal Emergency Management Agency (FEMA) and the ASCE *Flood Resistant Design and Construction* standards (ASCE 24). At this stage of design, it has not been determined if the structures will be designed for Wet or Dry Flood resistance.

The following assumptions apply to the Boulevard Pump Station, all elevations are based on NAVD 88.

Base Flood Elevation (BFE):	+12.0’
Design Flood Elevation (DFE):	+13.0’
Sea Level Rise Elevation (SLR):	+15.0’

3.4.3.5 Liquid Loads

Load cases that will be considered in design of liquid holding structures are:

- A fluid pressure of 62.43 pcf will be used for hydrostatic loads from ground water and flooding.
- A fluid pressure of 63 pcf will be used for process liquid in channels, unless otherwise noted.

3.4.4 Concrete

Materials and design procedures for concrete are described below.

3.4.4.1 Materials

The following minimum requirements apply (concrete compressive strength at 28 days):

- Typical Concrete, unless otherwise noted 4,500 psi
- Concrete Fill, unless otherwise noted 3,000 psi
- Concrete Fill exposed to liquid 4,500 psi
- Curbs and Sidewalks 3,000 psi
- Conduit Encasements and pipe (encasements not integral with foundation) 4,500 psi

Reinforcement:

- Conventional Steel: ASTM A615, Grade 60 (f_y = 60 kilopounds per square inch [ksi])

3.4.4.2 Design Procedures

Strength design will be used for concrete in accordance with ACI 318 unless noted otherwise. Hydraulic structures will be designed in accordance with ACI 350.

Design of concrete hydraulic structures will include use of environmental durability factor (Sd), for anticipated fluid and earth loads during normal operation only. Available capacity of members will be checked for loads that may occur during extreme design events.

Slab thickness will be checked to provide adequate embedment of post installed anchor bolts for mechanical equipment.

3.4.4.3 Details of Steel Reinforcement

Minimum concrete cover over steel reinforcement will be as follows:

- Surfaces cast against soil 3 inches
- Typical unless otherwise noted 2 inches

3.4.5 Masonry

Materials and design procedures for masonry are as follows.

3.4.5.1 Materials

The following requirements apply:

- Hollow concrete masonry units will conform to ASTM C 90 and will be normal- or medium-weight units with a net area compressive strength of 1,900 pounds per square inch (psi).
- Mortar will conform to ASTM C 270, Type S.
- Grout will conform to ASTM C 476. Minimum 28-day compressive strength will be 2,000 psi.
- Steel reinforcement will conform to ASTM A615, Grade 60.
- Horizontal joint reinforcing steel will conform to ASTM A82.

3.4.5.2 Design Procedures

Allowable stress design will be used for masonry in accordance with ACI 530. Compressive strength of masonry, f'_m, for masonry assembly will be 1,500 psi. For design, calculated tensile/compressive stress, f_s, of steel reinforcement is 24,000 psi for deformed bars and 30,000 psi for wire in joints.

3.4.5.3 Details of Steel Reinforcement

1. Limit maximum spacing of vertical steel reinforcement in bearing walls and partition walls to 4 feet and 8 feet., respectively.
2. Provide bond beams at top and bottom of walls.
3. Use joint reinforcement at 16 inches maximum vertical spacing.

3.4.6 Structural Steel

Materials and design procedures for structural steel are as follows.

3.4.6.1 Material

The material requirements for structural steel are listed in Table 3-1.

Table 3-1. Material Requirements for Structural Steel

Shape	ASTM	Grade	Fy (ksi)	Fu (ksi)
Rolled Shapes, Plates and Rods	A36	-	36	58
W-shapes & WT-shapes	A992	-	50	65
Pipes	A53	B	35	60
Round Hollow Structural Sections (HSS)	A500	B	42	58
Square and Rectangular Hollow Structural Sections (HSS)	A500	B	46	58
Bolts for Connections (1/2” to 1” diameter)	A325 or F1582	-	-	120
Anchor Rods – Dry Areas Only	F1554	36	36	58
Anchor Rods – Typical	F593	316, Cond. CW	40	80
Welding Electrode	E70XX			70

3.4.6.2 Design Procedures

Structural steel design will be in accordance with American Institute of Steel Construction’s (AISC’s) *Steel Construction Manual*.

3.4.7 Cranes

Cranes shall meet requirements of AISC *Steel Construction Manual* and ASCE 7. Unless noted otherwise, vertical impact shall be 25 percent of maximum wheel load. Lateral force on crane runway shall be calculated as 20 percent of sum of rated capacity of crane and weight of hoist and trolley. Lateral force shall be assumed to act horizontally at traction surface of a runway beam, in either direction perpendicular to beam. Longitudinal force on crane runway beams shall be calculated as 10 percent of maximum wheel loads of crane. Longitudinal force shall be assumed to act horizontally at traction surface of a runway beam in either direction parallel to beam.

SECTION 4

Architectural

4.1 Introduction

This section assesses the architectural components of the Boulevard Pump Station and presents the design criteria for upgrades to the facility. The architectural assessment consisted of three tasks: interviewing staff, visiting facility site, and reviewing available facility documentation. It outlines proposed solutions to deficiencies found from building and code assessment done. These recommendations are intended to serve as preliminary guidance for the design of facility renovations.

4.2 Building Codes

The 2016 Connecticut State Building Code with amendments will be used as a basis of this review.

4.2.1 Authorities Having Jurisdiction

The Boulevard Pump Station is located in the City of New Haven, Connecticut. The City of New Haven Building Department enforces the Connecticut State Building Code.

4.2.2 Current Connecticut Codes

Per the State of Connecticut Department of Construction Services, the following codes have been adopted and are applicable to this project:

Building Code:	2016 Connecticut State Building Code (CSBC)
	2012 International Building Code (IBC) as modified by CSBC.
Existing Building Code:	2012 International Existing Building Code (IEBC) as modified by CSBC.
Accessibility Code:	ICC/ANSI A117.1-2003 Accessible and Usable Buildings and Facilities as modified by CSBC.
Fire Code:	Connecticut State Fire Safety Code including all current Amendments to the fire code.
Energy Code:	2012 International Energy Conservation Code (IECC)
Mechanical Code:	2012 International Mechanical Code International Mechanical Code (IMC) as modified by CSBC.
Plumbing Code:	2012 International Plumbing Code (IPC) as modified by CSBC.
Electrical Code:	2014 National Electrical Code (NEC) as modified by CSBC.

4.3 Boulevard Pump Station

4.3.1 Building Code Analysis

4.3.1.1 Chemical Storage

There are corrosive chemicals stored in the Blower Room. There appears to be less than the code exempt amount of 500 gallons, so the room would not be an H-4 hazardous occupancy. The floors and walls are damaged from what appears to be chemical leaks. There is electrical equipment in this room with corrosive storage. There is a 4000 gallon above ground Diesel tank at the southwest corner of the

building, and 375-gallon Diesel day tank in the Mechanical Room. No. 2 Diesel Fuel is a Class II Combustible Liquid and irritant. The exempt amount of inside storage of diesel fuel is 120 gallons. Rooms with diesel tanks over the exempt amount would be H-3 hazardous occupancies. This requires fire separation from the rest of the building and sprinkler system. There is no containment for the inside diesel tanks and battery storage. The Diesel day tank blocks required 3 feet-0 inches clear egress width. No safety shower or eyewashes. There is an unused Bioxide tank in the Garage. There are two 55-gallon drums of hydraulic fluid is in the Pump Room at El. 6. Hydraulic fluid is an irritant and not considered hazardous by building code. The design will include the following components:

1. Limit the quantity of corrosive to 500 gallons to hazardous occupancy. The recommended odor control system will be an activated carbon system to all chemical tanks and pumps related to odor control will be demolished.
2. Provide containment for any chemical storage area. The containment has to contain largest tank and needs to be resistant to chemical emersion.
3. Remove electrical equipment from room with any corrosive chemicals.
4. Remove the existing inside Diesel storage tank and provide new day tank integral with the exterior emergency generator system. The emergency generator will be housed in a weatherproof enclosure.
5. Provide containment for battery storage.
6. Provide leak detection in all chemical containments.
7. Provide emergency safety shower and eyewash in Blower Room. Add emergency eyewash at battery storage and hydraulic fluid storage.
8. Add NFPA 704 Hazardous Material Signal signs at doors to chemical storage areas. Add Caution Corrosive sign at door to corrosive chemical storage area. Add Warning Diesel Fuel sign at outside Diesel storage tank.
9. Seal wall penetrations in Generator and Boiler rooms.
10. Demolish Bioxide tank in the Garage.

4.3.1.2 Sprinkler System

Current code requires floors with limited fire fighter access doors and openings to have a sprinkler system. The Pump Room lower levels has limited fire access, so a sprinkler system is required. The design will include the addition of a sprinkler system to Pump Room lower levels.

4.3.2 Building Condition Assessment

4.3.2.1 Roof

The 33-year-old gravel surfaced built-up roof is in need of replacement. The design will include the following components:

1. Remove existing roof down to concrete substrate.
2. Install vapor retarder on concrete deck.
3. Install polyisocyanurate insulation with ¼” per foot slope to drains, R-value of 20 minimum average.
4. Add overflow drains to comply with current plumbing code.
5. Install gravel surface 4-ply built-up roofing.
6. Add treated blocking on top of the parapets and add aluminum coping.
7. Modify existing lightning protection system to allow for new coping.
8. Add walkway pads from roof hatch to equipment.
9. Add stainless steel roof flashings.

10. Provide new curbs for new and existing roof top HVAC.
11. Replace roof hatch with aluminum roof hatch with safety rails.

4.3.2.2 Skylights and Hatch

The 33-year-old plastic domed skylight and roof hatch in is need of replacement. The design will include the following components:

1. Remove 17 existing domed skylights and protective screens.
2. Install 17 new translucent panel hip skylights on prefabricated insulated curbs.
3. Replace roof hatch with aluminum roof hatch with safety rails.

4.3.2.3 Exterior Masonry

Existing exposed concrete and brick walls are stained and deteriorated. There is some brick spalling. The design will include the following components:

1. Clean existing masonry with sand blasting and mild detergent.
2. Replace damaged bricks with new matching existing.
3. Tuck-point mortar joints.
4. Replace joint sealant in masonry joints. Install new sealant joints at outside corners.
5. Replace spalled concrete foundation at southwest corner of Garage.
6. Seal brick with clear breathable sealer.
7. Coat exposed concrete with breathable coating.

4.3.2.4 Doors and Louvers

The hollow metal and FRP doors are deteriorated and need replacement. 3 existing FRP double doors on south side of the building appear to be in good condition. Existing roll-up doors appear to be in good condition. Existing aluminum louvers appear to be in good condition. The design will include the following components:

1. Remove 11 single doors and replace with FRP doors and frames with heavy duty stainless steel hardware.
2. Remove one double door and replace with FRP doors and frames with heavy duty stainless steel hardware.
3. Remove single door between Garage and Screening. Patch CMU walls and floor.
4. Remove single door to wet well and install 2 Type 316 stainless steel watertight doors in lower level wet well Stair No. 2 wall openings.
5. Provide FRP louvers required for new ventilation.
6. Seal around doors and louvers.
7. Seal leaking conduit penetrations in Pump Room at El. 6.
8. See Control Room for additional door.

4.3.2.5 Grating, Stairs, and Handrails

Grating in screening and wet well is corroded and needs to be replaced. It appears that the existing grating in the screening area is being replaced with FRP grating. Handrails in Stair No. 2, wet well, and around west gates in screening area are corroded and need to be replaced. Three exterior metal stairs on north side and metal stair between Garage and Screening are in need of replacement. The other grating and handrails appear to be in good condition. There is only 1’-10” clear between conveyer support and guard post along egress path to Garage exit stair; code requires a 3-foot egress path. There are several tripping hazards on floor. The design will include the following components:

1. Remove all existing metal grating in Stair No. 2, wet well, and around west gates in Screening and replace with FRP grating. Make all grating level with floor.
2. Surface prepare and paint grating supports with a chemical resistant epoxy paint system.
3. Remove all existing metal handrail in Stair No. 2, wet well and around west gates in Screenings and replace with FRP handrail.
4. Remove 3 exterior metal stairs on north side and metal stair between Garage and Screening and replace with FRP stairs and handrails.
5. Modify conveyer support and/or guard post at Garage exit stair to provide code required 3-foot egress path.
6. Add limited headroom warning sign for low beams in Pump Room at El-12.
7. Add wall mounted handrail at south stair in Pump Room at El-12

4.3.2.6 Painting

The walls and ceilings are in need of repainting. Floors of Scrubber Area, Generator Room, Blower Room, Mechanical Room, and Pump Room are cracked and spalling. Bottom of walls are deteriorating in Screening, Stair No. 2 and Scrubber Area. Equipment and piping is in need of painting. The design will include the following components:

1. Surface prepare and paint walls and ceilings in all the rooms with a chemical resistant epoxy paint system.
2. After surface preparation and before painting the walls, patch holes and the base of the walls in Screening, Stair No. 2 and Scrubber Area with 100% solid epoxy filler.
3. Remove spalling concrete and patch Scrubber Area, Generator Room, Blower Room, Mechanical Room, and Pump Room floors.
4. Surface prepare and paint existing painted floor and Toilet floor with chemical resistant epoxy non-skid paint system.
5. Surface prepare and paint piping, equipment, and supports in all the rooms with a chemical resistant epoxy paint system, including exterior vent pipes.

4.3.2.7 Toilet and Service Sink

The plumbing fixtures and toilet accessories are deteriorated and in need of replacement. The design will include the following components:

1. Demolish existing toilet, service sink, and accessories.
2. Add toilet, sink, and service sink with stainless steel service sink and faucet.
3. Add drinking fountain outside of restroom.
4. Since only one Toilet Room is provided, provide privacy lock on door.
5. Add commercial grade stainless steel accessories.

4.3.3 New Rooms and Spaces

4.3.3.1 Control and Electrical Rooms

Enclose new electrical equipment so it can be climate controlled. The design will include the following components:

1. Add CMU walls to enclose new control and electrical equipment in ground level Pump Room.
2. Add double and single FRP doors to both Control Room and Electrical Room.

SECTION 5

Heating, Ventilation, and Air Conditioning

5.1 Introduction

Ventilation measures will be established based on the 2012 National Fire Protection Association standard - *Fire Protection in Wastewater Treatment and Collection Facilities* (NFPA 820). NFPA 820 establishes outside air ventilation rate criteria as well as ventilation design recommendations for safeguarding against fire and explosion hazards specific to wastewater treatment plants and associated collection systems.

5.2 Design Approach

Air handling units will be located outside on the roof structure or on an elevated platform adjacent to the structure. Air handling units serving electrically classified areas will be designed to supply tempered 100 percent outside air without recirculation, except where NFPA 820 allows dual ventilation rate during cold weather and the space atmosphere is relatively moisture and corrosive vapor free. Combustible gas detectors will override air handling systems operating in dual mode if combustible gases are detected.

Ventilation will be continuous and at rates adequate to reduce area NFPA 820 electrical classifications one category where required to suit the design. Ventilation systems that are required to reduce electrically classified spaces one category shall be monitored and provided with alarm stations located within and at entrances to these spaces. Air handling units in electrically classified areas will be designed in such a way as to isolate the unit supply air stream from the process area in the event the unit is turned off or loses power. An intermediate damper will open to atmosphere to provide a naturally vented air break space between the unit interior and the process space.

Air will be exhausted via exhaust fans mounted where foul air is not present within the space. Areas containing foul air will be exhausted to an activated carbon treatment system as described in Section 9 – Odor Control in this report. Air will be exhausted low within the space to facilitate removal of hydrogen sulfide that collects along the floor.

Supplemental unit heaters will be provided throughout spaces as required to maintain local heating needs during winter.

Louvers/vents/exhaust fans or supply/exhaust fans will be used to supplement ventilation in areas requiring higher summer ventilation rates or intermittent ventilation.

Staff areas and electrical rooms requiring air conditioning will be provided with packaged rooftop direct expansion (DX) equipment, self-contained DX equipment or ductless split system DX equipment as required to suit the space need. Critical electrical and control rooms will be provided with redundant air conditioning systems if necessary to ensure space temperatures can be met if primary units should fail.

Facilities will be provided with an automatic temperature control (ATC) system for global monitoring and control of heating, ventilation, and air conditioning (HVAC) equipment. The control system will be based on an open architecture (Lon or BACnet) direct digital control (DDC) system or programmable logic controller (PLC) based system, the selection of which will be determined during design. ATC panels will be located in “clean spaces” (e.g., electric room, control room) where possible. Control devices such as sensors and thermostats will be provided with suitable enclosures designed for the associated atmosphere in which they are located.

5.2.1 General

The existing heating and ventilation system in the Screen/Grit Works/Garage/Odor Control Room will be completely demolished and a new make-up air unit (MAU) will be provided for the Screen/Grit Works/Garage/Odor Control. The MAU may be located on the roof and will provide 12 air changes/hour (ACH) with 100 percent outside air that will be provided in order to reduce the NFPA electrical classification from Class 1 Division 1 to Class 1 Division 2. The supply air will be tempered to minimum 55 degrees F during winter in order to protect plumbing and water piping from freezing and ventilation system will be reduced to 6 ACH, as allowed by NFPA 820 and whenever the outside air temperature is 50 degrees F or below, the space is unoccupied and the combustible gas detector is 10 percent below the lower explosive limit of methane. The MAU and exhaust fans will be provided with VFDs and a separate exhaust fan will be provided to maintain proper temperature conditions for the pump motors during the summer months.

The 50 percent exhaust air during summer and 100 percent of exhaust air during winter (ambient temperature is 50 degrees F or below) from the Screen/Grit Works/Garage/Odor Control will be treated by the proposed odor control system.

The existing dual-fuel boiler is recommended to be replaced with a new duel-fuel boiler. The new boiler and the accessories should be sized to meet the new heating requirement.

A split system DX air conditioning system is recommended for the Pump Room to handle the heat dissipation from the VFDs, which will be located in this room.

A new heating and ventilation system will be recommended for the Screening Room to provide tempered air into the space.

5.3 Equipment

The specific type of equipment used on a particular building will be determined during detailed design based on application. Roof mounted equipment will be used where possible to preserve floor space and to minimize equipment exposure to aggressive environments. The following types of HVAC equipment may be utilized on this project.

5.3.1 Heating Equipment

- Air handling units incorporating outside air hoods, filters, Natural Gas HX, hot water heating coils, fans, and air break plenums, as required.
- Hot water and electric unit heaters.
- Gas fired hot water boilers and water circulating pumps.

5.3.2 Ventilating Equipment

- Exhaust fans
- Supply fans
- Wall louvers
- Roof vents

5.3.3 Air Conditioning Equipment

- Packaged roof top air conditioning units
- Split system air conditioning units

5.4 Materials

Table 5-1 provides various material choices that may be used for HVAC systems depending on the type of atmosphere in which equipment is installed. Specific materials will be selected during detailed design to suit the application.

Table 5-1. HVAC Materials of Construction

Area	Atmosphere [1]	Equipment or System	Materials of Construction
Process	Corrosive	Ductwork	SS, FRP
		Equipment	HPCS
Process	Non-corrosive	Ductwork	Al
		Equipment	HPCS
Non-Process	Non-corrosive	Ductwork	GS/Al
		Equipment	GS/Al

Table Notes and Abbreviations:

[1] Corrosive areas are areas that have elevated levels of moisture, hydrogen sulfide or chemical vapors.

Al – Aluminum

FRP – Fiberglass Reinforced Plastic

GS – Galvanized Steel

HPCS – High Performance Coated Steel

SS – Stainless Steel (Type 316)

5.5 Design Criteria

5.5.1 Outdoor Design Criteria

Table 5-2. HVAC Outdoor Design Criteria

Location	Elevation (ft.)	Cooling Criteria (ASHRAE 0.4%) [1]		Heating Criteria (ASHRAE 99.6%)
		DB (°F)	MCWB (°F)	DB (°F)
New Haven, CT	20	90.7	73.2	8.5

Table Notes and Abbreviations:

[1] Cooling criteria for critical spaces such as electrical equipment rooms shall be based on extreme conditions (100° F).

ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers, 2013 Fundamentals

DB – Dry Bulb Temperature

MCWB – Mean Coincident Wet Bulb Temperature

5.5.2 Mechanical System Criteria

Table 5-3. Mechanical System Criteria

Space or Area	Cooling (°F)	Cooling Method	Heating (°F)	Heating Method	Ventilation Basis
Process Areas	5-10 °F above ambient	Outside Air Ventilation	55	HW	100% OA
Control Rooms	75	AC	68	G, E	6 ACH min (5 cfm/person and 0.06 cfm/ft^2 OA)
Electric Room s	75	AC	55	E	6 ACH min (0% OA)
Personnel Areas	75	AC	68	G,E	6 ACH min (5 cfm/person and 0.06 cfm/ft^2 O.A.)

Table Abbreviations:

AC – Air Conditioning

ACH – Air changes/hour

E – Electric

G – Gas Heating Method

HW – Hot Water

OA – Outside Air

5.5.3 Miscellaneous Design Criteria

Not Used.

5.5.4 Louver Sizing

1. Intake Louvers – 500 ft. per minute
2. Exhaust Louvers – 800 ft. per minute

5.5.5 Ductwork Friction Rate Sizing

1. Low Pressure: 0.1 in. of water column pressure drop per 100 ft. of ductwork up to an air velocity of 1,500 to 1,800 ft. per minute.
2. Medium Pressure: 0.2 in. of water column pressure drop per 100 ft. of ductwork up to an air velocity of 2,000 to 2,500 ft. per minute.
3. Transfer Ducts: 0.03-0.05 in. of water column pressure drop per 100 ft. of ductwork.
4. Outside Air Intake Shafts: 0.05-0.10 in. of water column pressure drop per 100 ft. of ductwork up to an air velocity of 1,000 ft. per minute.
5. Gravity Relief Shafts: 0.03-0.05 in. of water column pressure drop per 100 ft. of ductwork up to an air velocity of 1,000 ft. per minute.

5.6 References

5.6.1 Codes

The HVAC design will follow shall follow all applicable local, state, and federal codes and criteria. The following codes will be used for the mechanical design of this project:

- 2016 Connecticut State Building Code
- 2012 International Building Code
- 2012 International Mechanical Code
- 2012 International Energy Conservation Code
- 2005 Connecticut State Fire Safety Code

5.6.2 Standards

The following standards and guides will be used for the mechanical design of this project:

1. ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers)
2. SMACNA (Sheet Metal and Air Conditioning Contractors' National Association)
3. ACGIH (American Conference of Governmental Industrial Hygienists) Industrial Ventilation Manual of Recommended Practice
4. NFPA (National Fire Protection Association)

5.6.3 Miscellaneous

5.6.3.1 Calculation Software

- Heating and Cooling Load Analysis: Carrier E20-II Hourly Analysis Program (HAP)

SECTION 6

Plumbing and Fire Protection

6.1 Introduction

Any modification to existing plumbing systems to support the existing or new processes and facilities including potable water piping, service water piping, sanitary drainage piping, storm drainage piping, will be selectively provided for each facility as required by the current building codes or local authority.

6.2 Design Approach

6.2.1 General

Limited existing plumbing system modification has been considered for this project. A summary of the improvements are as follows:

- The existing plumbing the fixtures are recommended to be replaced.
- The existing potable and non-potable water piping is recommended to be replaced with new piping as required.

6.3 Equipment, Materials and Systems

6.3.1 Equipment

The specific type of equipment that will be used on a particular building will be determined during detailed design based on application. Listed below are types of plumbing equipment that may be used for this project.

- Storage type electric or gas-fired water heaters
- Wall-mounted instantaneous electric water heaters
- Backflow preventers
- Emergency eyewash and shower stations
- Sump and sewage ejector pumps
- Plumbing fixtures such as service sink, water closet, lavatory, drinking fountain and kitchen sink
- Hose stations
- Floor, air gap, standpipe and roof drains
- Electric heat trace systems

6.3.2 Materials

Table 6-1. Plumbing and Fire Protection Materials of Construction

Area	Atmosphere [1]	Equipment or System	Materials of Construction
Process	Corrosive	Piping	SS/GS/CU/AL/HCI/CU/CPVC
		Equipment	Coated GS/Al/SS/CU
Process	Non-Corrosive	Piping	CU/BS/CI/DI
		Equipment	Coated GS/Al

Table 6-1. Plumbing and Fire Protection Materials of Construction

Area	Atmosphere [1]	Equipment or System	Materials of Construction
Administration	Non-Corrosive	Piping	GS/BS/CU/DI/PVC
		Equipment	GS/CS
Administration - Toilet Rooms	Non-Corrosive	Piping	CU/BS/CI/PVC
		Equipment	CU/DI/CI

Table Notes and Abbreviations:

[1] Corrosive areas are areas that have elevated levels of moisture, hydrogen sulfide or chemical vapors.

PVC – Polyvinyl Chloride

SS – Stainless Steel (Type 316)

GS – Galvanized Steel

Al – Aluminum

CU - Copper

CI – Cast Iron

DI – Ductile Iron

BS – Black Steel

HCI – High Silicon Cast Iron

CS – Carbon Steel

CPVC – Chlorinated Polyvinyl Chloride

6.4 Design Criteria

6.4.1 Potable Water System

- Water Source: City Water
- Minimum Pressure: 30 psi
- Maximum Pressure: 80 psi
- Maximum Velocity: 8 fps
- Hydrostatic Test Pressure: 100 psi minimum

6.4.2 Service Water System

- Water Source: City Water
- Minimum Pressure: 20 psi
- Maximum Pressure: 100 psi
- Maximum Velocity: 8 fps
- Hydrostatic Test Pressure: 150 psi minimum

6.4.3 Sanitary Drainage System

- Type: Gravity
- Minimum Pipe Slope: 1/8-in. per ft.
- Minimum Cover: 4 ft.
- Minimum Velocity: 4 fps

6.4.4 Storm Drainage System

- Type: Gravity
- Minimum Pipe Slope: 1/8-in. per ft.
- Minimum Cover: 4 ft.
- Minimum Velocity: 4 fps

6.5 References

6.5.1 Codes

The design of this project will be governed by the 2016 Connecticut State Building Code, Connecticut State Fire Safety Code and all adopted International Codes including the International Plumbing and International Fire Codes.

6.5.2 Standards

The following standards and guides will be used for the plumbing and fire protection design of this project:

- ANSI (American National Standard Institute)
- ASPE (American Society of Plumbing Engineers)
- ASTM (American Society for Testing and Materials)
- AWWA (American Water Works Association)
- CISPI (Cast Iron Soil Pipe Institute)
- IBC (International Building Code)
- IFC (International Fire Code)
- IPC (International Plumbing Code)
- NFPA (National Fire Protection Association)

SECTION 7

Electrical

7.1 Introduction

The existing electrical service to this facility is 480 volt, 3-phase via a single transformer, terminating at switchgear rated at 2500A. This service will need to be upgraded to a medium voltage service, as four 700 horsepower (hp) wet weather pumps are proposed for this project, and motors above 600 hp generally require medium voltage service. Three 480 volt, 215hp dry weather pumps are also required for this project.

The local electric utility that provides power to this facility is United Illuminating (UI). UI only offers 480 volt and below services and a 13.8kV service to its customers. UI does not provide a 4160-volt service, or any other service between 13.8kV and 480 volts.

The electrical work at Boulevard Pump Station will consist of replacing the incoming distribution switchgear, generator and an automatic transfer switch with 4160 volt rated equipment. A new 1200-amp low voltage switchgear will also be added to feed the dry weather pump motors and 480 volt MCC. The 480-volt motor control centers will also be replaced, as the existing electrical equipment will be over 30 years old by the time this project is implemented, and needs to be replaced in its entirety. New wet weather pump motors will be compatible with and controlled by 4160-volt adjustable frequency drives to provide precise control, improve efficiency, and reduce power factor losses. New dry weather pumps will be controlled by new 480-volt adjustable frequency drives.

The construction sequence will be staggered so that all pumps may remain operable during construction, and only short shutdowns are required to remove and install new pumps.

Electrical distribution equipment will be elevated 4 feet-0 inches above finish floor (AFF) to avoid flooding while accounting for sea level rise concerns.

The work required for this station is described in further detail below.

7.2 Codes and Standards

The following codes and standards will apply to the design, and may be referenced in this document:

1. National Fire Protection Association (NFPA): 70, National Electrical Code, 2014 Edition.
2. NFPA: 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities, 2016 Edition.
3. National Electrical Manufacturer's Association (NEMA)
4. Underwriter's Laboratory (UL)

7.3 Utility Service and Medium Voltage Switchgear

The power provider to the Boulevard Pump Station is UI, which is based locally in New Haven. The existing 480-volt service will need to be removed and replaced with a medium voltage service, as the proposed 700 hp wet weather pump motors will require 4160-volt service.

UI does not offer 4160 volts as a standard service, but does offer 13.8kV as a service voltage. Therefore, the new service voltage to the Boulevard station will be 13.8kV. 13.8kV and 4160-volt switchgear will be arcflash rated. A new medium voltage switchgear room will be created by combining the existing generator room with the northwest corner of the pump room, where an obsolete control panel is

currently located. This room will house all medium voltage switchgear and the automatic transfer switch. Construction of this room will be sequenced so that the existing engine-generator can remain in service as long as possible.

A 3000 kilovolt-amperes (kVA), 13.8 kV-4160 V transformer will be placed outdoors, mounted on a pad near the existing transformer in the northeast corner of the building. Note that the GNHWPCA, not UI, will be responsible for this transformer. The 4160 V secondary feeders will then return to a new 4160 V, 1200A arc flash rated switchgear, also located in the new medium voltage switchgear room. This 4160-volt switchgear will feed the wet weather pump AFDs, and a 750 kVA, 4160-480V, 3-phase, 3-wire transformer which will power a new 1200A low voltage switchgear.

7.3.1 Why 4160 Volt Distribution is Required

It is understood that GNHWPCA would prefer to avoid the use of medium voltage equipment, as their staff is not trained in its use, and they would either need to train their staff or outsource this equipment maintenance.

CH2M evaluated the possibilities of using 13.8 kV or 480 volt, 700hp motors. Although a 13.8kV motor is still medium voltage, it would avoid the addition of 4160-volt switchgear, and the transformers necessary to provide this voltage.

Motors at 13.8kV can be obtained, but they would be custom, and thus difficult to service. AFDs are available at this voltage, but not often used, and are sized for motors no smaller than 2000hp (as a result, custom motors made in the past may not be inverter duty rated). The 13.8kV drives are large, and would take up room saved by not adding 4160-volt distribution equipment.

There are at least three manufacturers that provide AFDs at 700hp, 480 volts, and they are Yasakawa, GE, and ABB. However, CH2M could not find any vertical pump motors at 700hp, 460 volts. Custom 480 volt, 700hp motors may be available, but CH2M does not recommend their use. Each motor could draw up to 1100 amperes at 480 volts, and three 400kcmil cables per phase would need to be run from the low voltage switchgear to the AFD. Due to excessive copper costs end the risks associated with a nonstandard installation, 480 volt, 700hp motors are not recommended.

7.4 Equipment and Sequence of Equipment Replacement

7.4.1 Existing Equipment

The existing service entrance switchgear and automatic transfer switch is located along the east wall of the pump room. The room also includes a motor control center (MCC), MCC-1, that feeds equipment on the east side of the pump station. The equipment in this room sits on the floor level on an equipment pad about 3 inches tall. This equipment was installed in 1988, and will be near the end of its useful life by the time this project is ready to be executed. Since the equipment is near the end of its useful life, and a new service voltage is required for this facility, this equipment will be replaced.

This service entrance switchgear also feeds MCC-2, which is located in the blower room. The blower room is located in the south central portion of the station. The blower room has become increasingly used for chemical storage in recent years. MCC-2 was also installed in 1988, and will be removed as a part of this project. The loads currently fed from MCC-2 will be fed from new MCC-1 in the electrical/control room to keep the electrical distribution equipment away from the chemicals being stored in the blower room.

The existing generator also appears to be late 1980s vintage, and will be due for replacement. The existing generator is 480 volt, 3-phase, 1300 kW/1625 kVA. This generator is also not adequate for the new installation, since a 4160-volt generator will be needed to power the new sewage pump motors. The existing generator fuel tank has a capacity of 4000 gallons and is located above ground and

outdoors, in front of the stairwell area at the east end of the pump station. The existing generator controls and batteries are also located in the generator room.

7.4.2 New Electrical Equipment

Sufficient space is available in the existing pump room to house the medium voltage switchgear, low voltage switchgear, motor control center, medium and low voltage adjustable frequency drives (AFDs), PLC, and operator/control interface. The 13.8 kV, 1200A service entrance switchgear and 4160 V, 1200A power distribution switchgear will be arc flash rated, and located in the new medium voltage switchgear room in the northwest corner of the pump room. The remainder of the equipment, including the medium voltage automatic transfer switch, medium voltage AFDs, low voltage switchgear, 480 V MCC, PLC, controls, and operator interfaces will be located in a new electrical/control room on the east side of the pump room. This pump room will be created by placing a wall on the east edge of the pump access grating to create a conditioned space for this electrical equipment. Electrical distribution equipment will be elevated 4 feet, 0 inches AFF to account for DFE with SLR concerns. Walkways and stairs with sufficient working space will be provided so that the equipment can be properly accessed.

New 3.0 megavolt ampere (MVA), 13.8 kV-4160 V, and 750 kVA 4160-480 V transformers will be pad mounted outdoors to the south of the existing transformer. The top of the pad will be at elevation 15.00, so that it is above the DFE with SLR concern elevation. The existing transformer will remain in service until the new service is commissioned.

The medium and low AFDs are currently shown on the plan drawings as Cutler-Hammer AFD dimensions. Sufficient space is available to accommodate the equipment of other manufacturers. Installation and demolition will be staggered, and temporary equipment provided where necessary to keep critical equipment running during construction, and keeping N+1 pumps available for use, except for a short shutdown to swap out the pumps.

The loads currently powered from MCC-2 will be powered from new MCC-1, located in the conditioned Electrical/Control Room. This will allow MCC-2 to remain in service while MCC-1 is installed and cables to these loads are pulled. This will also get all power distribution equipment away from chemicals and process equipment and into a conditioned space.

7.4.2.1 Generator and Associated Equipment

A new 2.75 MVA, 4160 V generator is required to provide full backup power to this pump station. The existing 480-volt generator will remain in service until the 4160-volt generator and service are commissioned, and all pump motors have been relocated to the 4160-volt switchgear.

Although the new generator may be able to fit into the existing generator room, this cannot be guaranteed for every manufacturer. To guarantee that the generator will fit in its proposed location and also allow more vendors to bid on the generator, the generator will be placed outdoors in a weatherproof enclosure, east of the pump station and south of the new transformers. The top of the pad will also be at elevation 15.00 to meet DFE with SLR criteria. Placing the generator outdoors will allow the existing generator to remain in service longer.

The existing 4000-gallon diesel fuel tank is located above grade, south of the east corner of the pump station. The tank appears to be in good condition, but further analysis will be required during detailed design to determine whether or not the tank can be reused. 7500 gallons of fuel are required to be available to provide 48 hours of run time at full load or 96 hours of run time at normal load. If the tank can be reused, a 3500-4000-gallon subbase tank will be placed under the generator. If the existing tank cannot be reused, it will be replaced in place with a 7500-gallon fuel tank. The subbase tank or new tank may be located below the DFE with SLR criteria elevation, as long as it is floodproofed.

7.4.2.2 Automatic Transfer Switch

A 4160-volt automatic transfer switch, rated 1200A, will be located in the electrical/control room. Construction sequence will allow for installation of the transfer switch after existing AFD is removed to make room for the switch. The transfer switch is recommended at the 4160-volt level rather than the 13.8kV level, so that the 13.8kV-4160V transformer T-1 is not a point of failure when on generator power.

7.4.2.3 Transformers

A new 3.0 MVA, 13.8 kV-4160 V, oil filled transformer and a 750 kVA 4160-480 V transformer will be mounted on pedestals outdoors to the south of the existing transformer. The 750 kVA transformer may be dry type or oil filled, and this will be determined in detailed design. The existing transformer will remain in service until the new service is established.

7.4.2.4 13.8kV Service Entrance Switchgear

A 13.8 kV service entrance switchgear is required, as UI does not offer 4160 volts as a service voltage. This switchgear will include service entrance metering and the main disconnect to the station. UI will provide a 13.8 kV disconnect for their purposes outside of the station. The switchgear will be arc flash rated, and feed the new 13.8kV-4160-volt transformer. The gear will be located in the new MV Switchgear room.

7.4.2.5 4160 Volt Switchgear

The new 4160 volts, 1200A switchgear will also be located in the new MV switchgear room. It will also be arc flash rated, and receive the incoming 4160-volt power from the 13.8kV-4160V transformer, and distribute power to the four 4160 volt AFDs and the 4160 V-480 V transformer located outdoors, which then feeds LVSWGR-1.

7.4.2.6 480 Volt Switchgear

480 Volt 1200A minimum rated switchgear, designated LVSWGR-1, will be located in the electrical and control room. This switchgear will feed the three low voltage dry weather pump AFDs and MCC-1.

7.4.2.7 480 Volt Motor Control Centers

A 480 volt, 600A motor control center, designated MCC-1, will be located in the electrical and control room, and distribute power to all small motor and miscellaneous loads in the pump station, including those loads formerly powered by MCC-2. Relocating these loads to MCC-1 will allow all power distribution equipment to be in a conditioned electrical room.

7.4.2.8 Medium Voltage Adjustable Frequency Drives

The medium voltage switchgear will feed four 700 hp AFDs. One of the AFDs is standby, while the others can be expected to run at the same time. AFDs will be eighteen pulse, and located in the electrical/control room. The AFDs are currently shown on the plan drawings as Cutler-Hammer AFD dimensions. However, there is also enough room to accommodate the medium voltage AFDs of any manufacturer.

7.4.2.9 Low Voltage Adjustable Frequency Drives

The low voltage switchgear will feed three 250hp AFDs. One of the AFDs is standby, while the others can be expected to run at the same time. AFDs will be eighteen pulse, and located in the electrical/ control room. The AFDs are currently shown on the plan drawings as Cutler-Hammer AFD dimensions. However, there is also enough room to accommodate the low voltage AFDs of any manufacturer. Motors are designated as 215hp, but the next highest standard AFD size is 250hp.

7.4.3 Sequence of Equipment Replacement

A preliminary sequence of construction is as follows (some steps may overlap during construction):

1. Install and wire, transformers, and new medium voltage switchgear (13.8 kV and 4160 V). The 4160 volt transfer switch will initially be bypassed.
2. Install new 4160 Volt Generator.
2. Obtain new 13.8 kV service from UI, and energize 13.8kV switchgear, transformer and 4160-volt switchgear. Install the automatic transfer switch in a temporary location (southwest area of pump room recommended). Leave enough slack in cables to reuse cable when transfer switch installed at the final location.
3. Install two 4160 volt AFDs in a temporary location. (southwest area of pump room recommended) AFDs may need to be run manually to minimize unnecessary control wiring.
4. Install two new 4160-volt sewage pumps (one at a time), and power from temporary AFDs.
5. Remove the two unused AFDs.
6. Install two permanent 4160 V AFDs.
7. Replace the other two pump motors (one at a time) with new 4160 V motors.
8. Remove the last two existing AFDs.
9. Move temporary AFDs to permanent location, one at a time. A spare AFD or across the line temporary starter may be required if the AFD cannot be relocated and rewired fast enough to provide the pump station its required backup pumping capacity (N+1 configuration).
10. Install and wire LVSWGR-1, low voltage AFDs, and dry weather pumps.
11. Install and provide power to new MCC-1.
12. Transfer loads and replace existing MCC loads with new, from existing MCC-1 and MCC-2 to new MCC-1.
13. Install new ATS at final location. Reconnect ATS to new generator, 13.8 kV switchgear, and 4160-volt switchgear. Test ATS functionality. Disconnect the pump station from utility power, and run the pump station on the generator.
14. Re-energize pump station with utility power through 4160 volt transfer switch.

7.5 Design Criteria

7.5.1 Energy Efficient Design

All pump motors are currently started across the line, and run at full speed. The new design will include AFD controllers for each pump motor. These AFDs will allow the pump to run at an optimum speed and higher efficiencies with lower power factor losses.

Existing pump station lighting will be replaced with more efficient LED type lighting wherever possible.

7.5.2 Area Classification

No changes in area classification are expected for this project. Headworks/screenings areas above ground will be ventilated at 12 ACH so that they are classified as Class I, Division 2. Wet wells are classified as Class I, Division 1. New electrical equipment will be provided per the area classification. Every effort will be made to place electrical equipment outside the classified area.

7.5.3 Design Flood Elevation and Electrical Equipment Elevation

All electrical distribution equipment is going to be relocated four feet above the finished floor, which is above the DFE with SLR criteria, so the equipment will be safe from any flood event.

The new generator will be installed on an equipment pad four feet above the original pump station finished floor, to meet DFE with SLR criteria.

7.5.4 Flooding of equipment that cannot be relocated Above DFE.

Some motors, actuators, local control panels, and other equipment could be in a position to be flooded because it is not practical to locate them above the DFE. Where possible, motors and panelboards should be located above the DFE level. Submersible rated motors are available 200 horsepower and below, but will be considered for critical functions only.

Portions of the facility will be dry floodproofed while other areas will receive wet floodproofing. The extent of floodproofing will be finalized during detailed design. Where panelboards must be elevated four feet above the floor, a platform will be provided with adequate working clearance behind it when required.

Submersible rated control panels, motors (under 200hp) and actuators should be provided for all critical loads that cannot be elevated four feet above the finished floor.

The garage floor is at elevation 8.00, about 3 feet below the pump room floor. It is not practical to raise equipment in this location above the DFE.

7.5.5 Single Line Diagrams and Preliminary Equipment Layout

Refer to attached drawings for single line diagram and preliminary equipment layout.

7.5.6 Lighting

Existing lighting will be replaced with state-of-the-art LED type fixtures in all areas, including Class I, Division 1 and Class I, Division 2 areas. LED frog-eye type emergency lighting fixtures will also be provided.

Existing outdoor lighting fixtures will be replaced with metal halide or LED type fixtures. Where existing lighting is insufficient, new lighting will be added.

7.5.7 Leaking Conduit

During a site inspection, a leaking conduit was observed where a duct bank enters the building, in a lower level in the pump shaft area. The source of this leak will be investigated during detailed design. Corroded conduits will be replaced.

SECTION 8

Instrumentation and Controls

8.1 Introduction

This section documents the instrumentation and control (I&C) design concepts for the Boulevard Pump Station. A state-of-art I&C system will be provided to ensure continuous and reliable process control and monitoring for the pump station, including remote monitoring and control from the East Shore WPAF.

8.1.1 Existing Instrumentation and Control System

The overall control system for the Boulevard Pump Station consists of several control panels.

A Modicon Momentum PLC based pump control panel is mounted adjacent to the pump drives in the pump motor room. This panel monitors and controls the pumps based on wet well level. The wet well level transmitters are wired to this panel. The pump control panel does not have a functional Operator Interface Terminal (OIT). The original OITs have been decommissioned. The panel has some status and alarm lights for the pumps.

The pump control panel communicates with an overall pump station control panel, also located in the pump motor room across from the pump drives. The pump station control panel is equipped with Modicon Momentum PLC hardware. The pump station control panel monitors and controls the rest of the equipment at the pump station and communicates with the East Shore WPAF over a T1 line. The communication link allows limited remote control from the plant. This panel is equipped with an OIT.

The generator system includes a PLC based control panel. Limited number of signals from this panel are hardwired to the pump station control panel

The odor control system includes a control panel. The pH and ORP signals for the odor control system are wired to this panel and the chemical feed is paced with the help of a Hach SC200 controller. This panel does not have any interface with the pump station control system.

Screens in both channels have been recently replaced and provided with new PLC based control panels equipped with OITs. Signals from these panels are hardwired to the pump station control panel. The bypass channel has a manual rack. The screenings are conveyed to a dumpster via a belt conveyor.

The bucket and chain style collector mechanisms in the grit channels are being replaced by screw mechanism. The grit is conveyed to a dumpster via a belt conveyor.

The level in the wet well is monitored by two bubbler systems that transmit signals to the pump control panel. The bubbler systems require frequent maintenance.

Each pump is equipped with an electromagnetic flow meter in the discharge line. The signals from these flow meters are wired to the pump station control panel. The location of the existing electromagnetic flow meters is not ideal for a reliable reading.

The pump station gates and some of the valves are hydraulically actuated. The hydraulic system control panels are not in good condition.

The pump station includes a surge control system. The surge control system valves and panels are in poor condition.

8.2 Design Approach

The existing instrumentation and control system at the Boulevard Pump Station is out-of-date. It lacks the modern hardware and software, as well as instrumentation required for reliable operation. The overall goal is to remove obsolete control system equipment and to take advantage of the current technology for improved operational reliability and process optimization.

The existing pump control panel and the pump station control panel in the pump motor room will be demolished. The pump station control will be consolidated in a single new control panel, located in new control room. The proposed location and layout of the room are detailed in the Architectural and Electrical Sections.

To bring the pump station to the same platform as the East Shore WPAF, the new control panel will be based on a redundant (hot backup) Allen-Bradley ControlLogix PLC system.

The PLC control panel will be equipped with an Allen-Bradley PanelView Plus 6 1500 OIT to provide means for local monitoring and control (e.g., LEAD/LAG/ALTERNATE selection, PLC AUTO/ PLC MANUAL mode selection, setpoints, etc.). A desktop human-machine interface (HMI) work station, loaded with Factory Talk View SE Standalone Client software, be also provided in the control room. All features available at the OIT will also be available at the HMI work station.

The AFDs for the new pumps will be installed in the control room.

Power monitors will be provided in the new MCC for monitoring power consumption and quality.

In addition to hardwired signals, device level rings (DLRs) will be used for Pump Station PLC communication with AFDs and power monitors to manage traffic on the control network.

Control system equipment will be powered from a true online double-conversion-type uninterruptable power supply (UPS) unit to maintain reliable operation during power system disturbances and outages. UPS unit will power the PLCs, operator interface terminals, and HMI operator workstation. UPS battery backup will have enough capacity to energize the control system for 30 minutes after a power failure. The low-battery alarm will be hardwired to the Plant PLC input/output (I/O) for monitoring. The panel will be designed to automatically switch over to the line power upon UPS failure.

For powering loop powered instruments, redundant 24 V DC power supplies will be provided in the PLC panel. The power supply failure alarm will be hardwired to the plant PLC I/O.

Electric or hydraulic actuation will be provided for all valves and gates. In general, electric actuators, rated for the environment, will be used. If the actuator can potentially be submerged, hydraulic actuation will be considered. Base on the field investigations, the wet well gate actuators at the Boulevard Pump Station can be submerged during wet weather conditions. For these gates, hydraulic actuation along with new hydraulic equipment, control panels and piping will be provided. The main influent gate will be modulating type to prevent flooding of the wet wells.

To complement process redundancy, the monitoring and control signals for redundant equipment (e.g., pumps, grinders, etc.) will be split between separate I/O modules and racks (if necessary)

The control systems for the new odor control system, the new bar screen in the bypass channel, and the new generator system will be PLC/OIT based. The package control systems will not be customized to use Allen-Bradley hardware if the system vendor's "standard" operating platform is different. Instead, gateways and/or protocol convertors will be provided for digital connection to the Pump Station PLC System. The system supplier will program the package PLCs. Hardwired I/O will be used for connecting critical monitoring and control signals from the package systems to the Pump Station PLC System. The digital interface will be used for monitoring of additional signals. Digital data interface requirements

between the package systems and the Pump Station PLC System will be further developed during design development and coordinated with the package system vendors.

The sump pump control panel will be replaced. If new sump pumps are provided, a new control panel will be specified. The panel will be mounted above the sea level rise protection elevation.

The hydraulic surge control valves will be replaced and a new control panel will be provided.

The existing bubbler systems, along with the associated compressors and receiver tanks will be replaced by non-fouling, hydrostatic pressure type transmitters, designed specifically for wastewater applications. The transmitters will be installed in stilling wells. As a backup to the level transmitters, high and low level switches will be provided to operate the pumps upon failure of a transmitter.

New electromagnetic flow meters will be provided in the discharge line of each pump. The installation will be coordinated with the new piping layout for better locations conforming to the upstream and downstream straight pipe length requirements.

Detailed change-out procedure will be developed so that the new I&C equipment can be installed and tested prior to being put into operation. The design will allow the new Pump Station PLC System and the existing control system to coexist for some time as the new system is brought online and the old system is decommissioned. The pump station will remain operational during switchover.

Security camera system with DVR will be provided at the pump station. The location and quantity of cameras will be determined during design development.

8.3 Control System Design Philosophy

The control system design philosophy at the Boulevard Pump Station will be the same as detailed in the Union and East Street Pump Station Instrumentation and Control Sections for overall consistency.

8.4 Control System Operating Philosophy

The control system operating philosophy at the Boulevard Pump Station will be the same as detailed in the Union and East Street Pump Station Instrumentation and Control Sections for overall consistency.

8.5 Remote Telemetry System

As a backup to the T1 line, a licensed frequency (900 MHz) Ethernet radio telemetry system will be considered for communication between the pump station and the plant. A path study will be conducted to determine the feasibility of utilizing radios. If radio telemetry is feasible, new Ethernet radio equipment and antennas will be installed at the pump station and at the East Shore WPAF.

If the path study is unfavorable, the use of cellular modems will be considered in lieu of radios. The possibility of buying bandwidth on the City's fiber optic network can also be considered. The system will be configured to automatically fail over to the backup communication path upon primary path failure

8.6 Codes and Standards

The Boulevard Pump Station design will follow the same codes and standards as the Union and East Street Pump Stations for consistency.

SECTION 9

Odor Control

9.1 Introduction

The Boulevard Pump Station has a crossflow scrubber that was originally designed for a total flow of 15,500 cfm and dual chemistry consisting of both sodium hypochlorite and sodium hydroxide for odor removal. Although the system is in operation, it is unknown how much foul air is actually being ventilated and only sodium hypochlorite is being added. Much of the supporting infrastructure such as the chemical transfer pumps, have deteriorated and are no longer functioning. It is recommended that this system be replaced.

The Boulevard Pump Station processes that require odor control include an inlet chamber, three parallel channels that include bar screens, four aerated grit chambers and two wet wells. There are belt conveyors that convey screenings and grit to two separate dumpsters located in the garage.

9.2 Basis of Design

This section provides information used as the basis for the odor control system design. The proposed odor control system is based on a “contain-convey-treat” design approach and as such includes design information for each component.

9.2.1 Containment

The existing channels contain sections of grating that are covered with mats to contain odors within the channels. The inlet chamber is uncovered and allows for comingling of sewage vapors with the overlying room space that can then result in the release of sewage odors to the ambient atmosphere. It is recommended that all grating be replaced and that the inlet chamber be covered with solid panels to prevent escape of raw sewage vapors into the overlying room space. Covers will be designed using materials of construction resistant to corrosion (e.g., fiberglass reinforced plastic (FRP) or aluminum checker plate). Covers will be constructed using flat removable panels. The cover design will facilitate easy removal of individual panels by two people. Each panel will not weigh more than 100 lbs and will have an integral nonskid surface. Lifting handles shall be provided on each panel. Each panel will have gasketed joints to prevent fugitive air release.

As a result of the containment of foul air within the process channels, protection of concrete against corrosion using either protective coatings or liners is recommended and will be included during detailed design.

Grit and screenings are currently conveyed to the garage where they are discharged into open dumpsters. As a result, the entire volume within the garage requires ventilation and odor control. It is recommended that foul air capture hoods be installed over each dumpster to facilitate focused air capture from the dumpsters thereby allowing for overall reduced foul air extraction rates from the garage.

9.2.2 Conveyance

Foul air will be conveyed from within the contained process channels and wet wells by FRP ductwork. It is anticipated that up to nine foul air pickup locations will be designed, three associated with channels, four associated with the grit chambers and one for each wet well. Each foul air pickup location will include a flow balancing damper to facilitate adjustment of flow for each pickup to design values. The foul air duct will connect to the covers through a flanged connection to allow for easy removal. The duct

will rise vertically straight up and then move horizontally at a distance overhead ensuring clearance (e.g., min. 7 feet). The exact layout will be determined during detailed design.

Allowance for air flow into the covered process channels and wet wells will be included in the design. The relative locations of air entry and foul air extraction will be selected to achieve good overall air movement within the enclosed process area and minimize development of "dead zones" or short-circuiting.

The extraction of foul air will be achieved through use of a single exhaust fan constructed of FRP. A flow balancing damper will be located at the fan inlet to allow for adjustment of overall system air flow. The fan will convey captured foul air to an odor control system where the odorous compounds, primarily hydrogen sulfide (H_2S), are removed prior to release to the ambient atmosphere.

9.2.3 Odor Control System Sizing

All process areas will be continuously ventilated at a rate of least 12 air changes per hour (ACH). Table 9-1 summarizes ventilation rates required for the Boulevard Pump Station. The total system ventilation rate is 17,000 cfm.

Table 9-1. Process Area Ventilation Rates

Source	Volume (ft^3)	Ventilation Rate (ACH)	Ventilation Rate (cfm)	Design Ventilation Rate (cfm)
Inlet Box and screen channels	11,400	12	2,280	2,400
Grit Chambers	30,750	12	6,150	6,400
Wet wells	34900	12	6,980	7,200
Screenings dumpster	540	12	108	500
Grit dumpster	540	12	108	500
Total				**17,000**

9.2.4 Anticipated Odor Causing Compounds

CH2M recommends that air sampling be completed at the Boulevard Pump Station in order to definitively establish current H_2S concentrations and the nature of peaks observed during normal diurnal cycles. It is recommended that an instrument capable of measuring and logging H_2S concentrations, (e.g., Odalog) be installed for a week. Based on data previously collected at East and Boulevard Pump Stations, and experience from other similar systems, it is anticipated that H_2S concentrations may average on order of 10 parts per million by volume (ppmv) with peaks as high as 100 ppmv. Additionally, it is anticipated that other odorous non-H2S sulfur bearing compounds will total less than 1 ppmv.

9.3 Odor Control Technology Selection

Three potential odor control technologies have been evaluated; biotowers, carbon and wet chemical scrubbers. A brief description of each technology is provided below.

9.3.1 Biotowers

In many ways, a biotower looks externally similar to a wet chemical scrubber, except that no hazardous chemical addition is required. Figure 9-1 depicts a simplified schematic diagram of a biotower system.

Systems are pre-engineered, vendor-supplied systems made of fiberglass-reinforced plastic or high density polyethylene shells. Biotowers use a biologically active media bed to absorb and oxidize odorous compounds from the foul air stream. One of the primary technical advances associated with this technology is the development of engineered inert media on which the biomass attaches. As the media is inert, it is not compromised by the acidic environment within the biotower and has lifespans on the order of 20 years. The media receives either constant recycle spray (bioscrubber) or intermittent once-through spray humidification (biotrickling filter), depending on the vendor's approach. The spray is also the source of trace nutrients for the biological system. There are typically two potential sources of water, potable or plant effluent. If potable water is used, then a supplemental nutrient supply containing trace organics, nitrogen, phosphorous, and potassium is required. If plant effluent is available, then supplemental nutrients are usually not required as the plant effluent water will contain sufficient nutrients. For Boulevard Pump Station, potable water and supplemental nutrients would be required as plant effluent is not available.

Biotowers are usually designed in the form of a cylindrical arrangement such as the one shown in Figure 9-2.

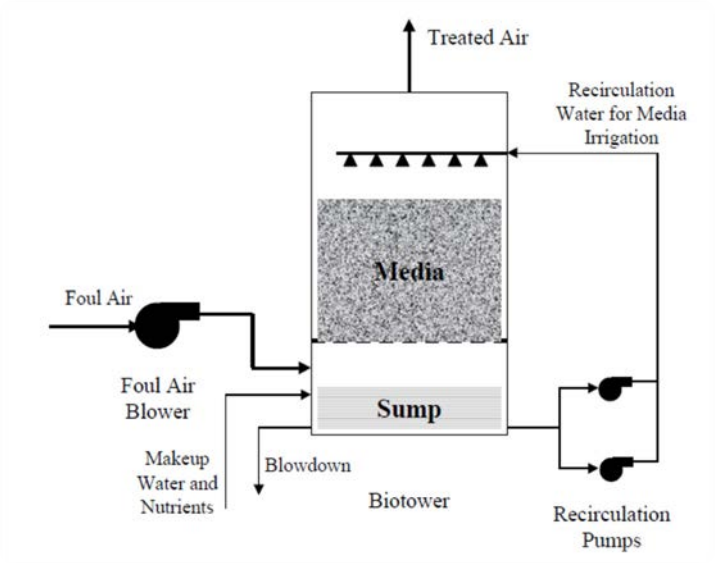


Figure 9-1. Simplified Schematic of a Biotower System

Figure 9-2. Photograph of a Biotower System

9.3.2 Carbon Scrubbers

Carbon scrubbers are the simplest of the vapor phase treatment technologies. They pass the foul air stream through a bed of dry (no irrigation) activated carbon. Odorous constituents diffuse into the media pore spaces and adsorb onto the media, and are thereby removed from the air stream. There are many types of activated carbon media designed for removal of various types of compounds. A single medium or a mixture of different media can be used. Carbon scrubbers have a small footprint compared to other technologies and can be configured with either vertical upward air flow through single, dual or radial flow beds or with horizontal flow configurations in locations where system height is constrained. Figures 9-3 and 9-4 depict a simplified schematic and photograph of a dual carbon bed system, respectively. Carbon scrubbers are effective at removing a range of compounds with excellent removal efficiency. One potential disadvantage is that under high H_2S loads, the media must be replaced frequently resulting in high annualized media replacement costs. However, the Boulevard Pump Station is anticipated to have relatively low average H_2S concentrations (e.g., $\leq$ 10 ppmv), therefore, the potential use of carbon scrubbers as a treatment technology is recommended for consideration.

Carbon selection is an important part of designing carbon systems, because different types of carbon can be used depending on the nature of the odorant to be removed. For Boulevard Pump Station, the primary odorant to be designed for is H_2S.

Various types of carbon are available. Virgin activated carbon is the lowest cost but also has the lowest overall capacity for H2S resulting in relatively high frequency media replacements. Carbon adsorption capacity for H2S can be increased with media that is impregnated with chemicals, such as sodium hydroxide (NaOH), to enhance contaminant removal. This, however, adds handling complexity because of the potentially hazardous nature of the impregnated carbon and potential for carbon bed fires. The

use of this type of impregnated carbon is not recommended for further consideration. Finally, there are carbons available that have been processed in a manner that results in high selective adsorptive capacity for H2S (e.g., order of magnitude higher than virgin activated carbon). The use of this type of high capacity carbon is recommended for consideration as it will extend the useful life of the carbon significantly thereby reducing O&M issues and costs associated with frequent media replacement.

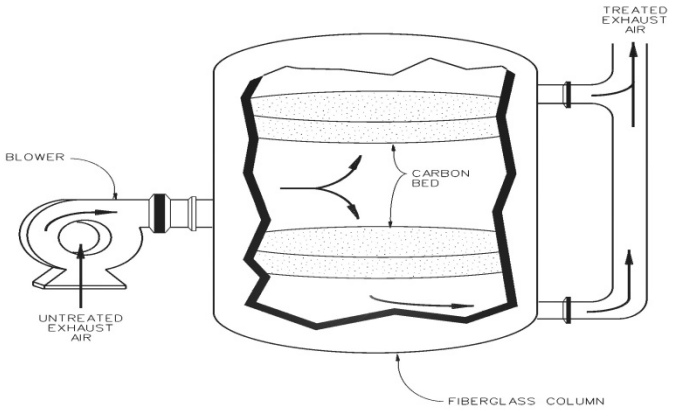


Figure 9-3. Schematic Dual Carbon Bed System

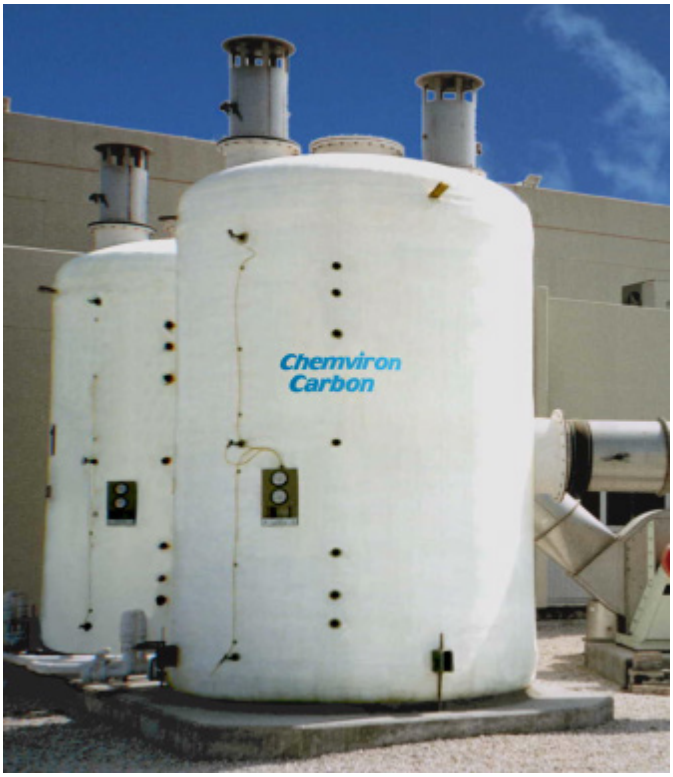


Figure 9-4. Photograph of a Dual Bed Carbon Scrubber

9.3.3 Chemical Scrubbers

Chemical scrubbers are similar to biotowers in that the foul air stream is passed through a bed of inert media that is continuously irrigated. Rather than using microbes to oxidize odorous compounds, chemicals are added to the irrigation water. Chemical scrubbers can be designed using several different configurations with separate stages using different chemistry. Some include a high pH stage with caustic

soda to facilitate dissolution of hydrogen sulfide into solution. Most have a stage with sodium hypochlorite added to oxidize reduced compounds. Other chemistries can be used to remove compounds, such as ammonia, that are less amenable to oxidation. Chemical scrubbers offer flexible configurations with smaller foot prints than are typical of biofilters and biotowers. Figure 9-5 shows an example. However, chemical scrubbers have the disadvantage that the cost to operate is proportional to the hydrogen sulfide loading. Significant hydrogen sulfide loadings, such as would be present at the headworks, can result in large operating costs. Nevertheless, chemical scrubbers are technically viable for this application and are therefore included in the technology cost comparison. For this application, a two stage dual chemistry chemical scrubber is recommended for consideration.

Figure 9-5. Photograph of a Chemical Scrubber

9.4 Economic Evaluation

An economic evaluation has been completed in order to compare capital costs, annual O&M costs and a 20-year net present value (NPV) for the biotower, carbon, and chemical scrubber technologies.

Capital construction cost estimates were based on a database of recent vendor quotes for similar technology. Operation and maintenance costs were estimated and combined with capital costs using a constant discount rate to determine a 20-year NPV. For planning purposes, it was assumed that the vapor phase treatment equipment has a life span of 20 years.

Unit costs and financial factors used in the cost estimate are listed in Table 9-2. As shown in Table 9-2, the inflation rate was assumed to be 6 percent and the discount rate was assumed to be 7 percent. Both the equipment life and planning horizon was 20 years. Factors were applied equally to each technology option.

Table 9-2. Capital, O&M and NPV Assumptions

Unit Costs		
Electricity	0.10	$/kW-hr
Labor	40	$/hr
Potable Water	4.4	$/1000 gal

Table 9-2. Capital, O&M and NPV Assumptions

Unit Costs		
Sodium Hydroxide (50% strength)	1.8	$/gal
Sodium Hypochlorite	0.7	$/gal
Excavation	15	$/CY
Backfill	35	$/CY
Slab on Grade Concrete	525	$/SF
Support Wall Concrete	525	$/SF
Allowance Costs		
Equipment Installation	10	%
Field painting/finishes	1	%
Mechanical	8	%
Electrical	8	%
Instrumentation	5	%
Financial Factors		
Discount Rate	7	%
Annual Escalation Rate	3	%
Time Horizon	20	years
Construction Completion Year	2020	
Contractor Markups:		
General Conditions	7	%
Contractor Overhead & Profit	15	%
Bonds and Insurance	2	%
Contingency	30	%

Results of the economic evaluation are provided in Table 9-3.

As can be seen from the results of this evaluation, carbon has the lowest initial capital cost ($734,000) and overall lowest NPV ($1,434,000) compared to the biotower and chemical scrubber options, and therefore from a financial perspective, is the initial preferred option. However, given the sensitivity of carbon annual O&M costs and resultant NPV to the H_2S inlet concentration, further evaluations were completed to determine impacts of the assumption of an average 10 ppmv H_2S concentration on the economic results. Specifically, the assessment was repeated with increasingly higher concentrations of H_2S inlet to determine at which point the biotower option had the lower NPV. As chemical scrubber annual O&M costs are also directly related to H2S inlet concentrations, the chemical scrubber option would not be more financially attractive at higher costs and was therefore not included in this additional analysis.

The biotower option did not have the lowest NPV until inlet H_2S concentrations were on the order of 25 ppmv. Given the high ventilation rate included in the odor control design (i.e., 12 ACH), it is anticipated

that the frequent turnover of air within the enclosed areas will prevent high concentrations of H_2S from accumulating, thus maintaining an inlet concentration of H_2S to the odor control system well below the 25 ppmv threshold. Therefore, carbon is recommended as the odor control technology of choice.

Table 9-3. Capital, Annual O&M and NPV Evaluation

Technology	Carbon	Biotower	Chemical Scrubber
Capital	$734,000	$1,662,000	$1,048,000
Annual O&M	$66,000	$29,000	$92,000
20 Yr NPV	$1,434,000	$1,970,000	$2,023,000

9.5 Odor Control System Design Recommendations and Overview

A dual deep bed carbon scrubber system utilizing carbon with high adsorptive capacity for H_2S is recommended. The use of the high adsorptive carbon will prolong carbon life and thereby increase the time between media replacements. Based on an average inlet concentration of 10 ppmv H_2S, it is anticipated that media replacement will be on the order of every 2 years.

As the site has significant space constraints, utilizing a dual deep bed system reduces footprint

Recommended odor control system process equipment and anticipated design operating conditions are summarized in Table 9-4.

Table 9-4. Major Equipment, Design Criteria and Operating Conditions

Equipment/design criteria	Size/Operating conditions
Carbon Vessel	Two (2) 10 ft diameter dual bed FRP vessels
Carbon type and replacement frequency	High adsorptive capacity carbon, e.g., 0.3 g H_2S/cc carbon; 24-month media replacement frequency
Carbon bed depth	3 ft each
Carbon bed face velocity	55 fpm
Odorous Air Fan	One (1) fan, FRP construction with sound enclosure; continuous operation
Fan design point	17,000 cfm at 9.5 inches w.c. pressure
Electrical requirements	480V/3-ph/60 Hz; 50 hp

Appendix A
Preliminary Design Drawings

INDEX TO DRAWINGS

300 - BOULEVARD PUMP STATION

SHEET NO.	DRAWING NO.	TITLE
GENERAL		
	300-G-001	BOULEVARD PUMP STATION INDEX OF DRAWINGS
	300-G-002	BOULEVARD PUMP STATION ABBREVIATIONS
	300-G-003	BOULEVARD PUMP STATION ABBREVIATIONS AND GENERAL LEGEND
	300-G-005	BOULEVARD PUMP STATION INSTRUMENTATION AND CONTROL LEGEND - SHEET 1
	300-G-006	BOULEVARD PUMP STATION INSTRUMENTATION AND CONTROL LEGEND - SHEET 2
	300-G-007	BOULEVARD PUMP STATION ARCHITECTURAL AND STRUCTURAL LEGEND
	300-G-012	BOULEVARD PUMP STATION PROCESS MECHANICAL LEGEND
	300-G-015	BOULEVARD PUMP STATION ELECTRICAL LEGEND 1
	300-G-016	BOULEVARD PUMP STATION ELECTRICAL LEGEND 2
	300-G-017	BOULEVARD PUMP STATION ELECTRICAL LEGEND 3
CIVIL		
	300-C-201	BOULEVARD PUMP STATION SITE PLAN
STRUCTURAL		
	300-S-201	BOULEVARD PUMP STATION FLOOD PROOFING PLAN 45 MGD CAPACITY
ARCHITECTURAL		
	300-A-201	BOULEVARD PUMP STATION LOWER PLANS45 MGD CAPACITY
	300-A-202	BOULEVARD PUMP STATION PLAN 45 MGD CAPACITY
	300-A-203	BOULEVARD PUMP STATION ROOF PLAN 45 MGD CAPACITY
MECHANICAL		
	300-M-201	BOULEVARD PUMP STATION 45 MGD CAPACITY PLAN
	300-M-215	BOULEVARD PUMP STATION ODOR CONTROL PLAN & SECTIONS
	300-M-301	BOULEVARD PUMP STATION 45 MGD CAPACITY SECTION
	300-M-302	BOULEVARD PUMP STATION 45 MGD CAPACITY SECTION
	310-M-201	BOULEVARD DRY WEATHER PUMP STATION PLAN & SECTION
ELECTRICAL		
	300-E-201	BOULEVARD PUMP STATION SINGLE LINE DIAGRAM
	300-E-202	BOULEVARD PUMP STATION MVSWGR-1 AND MCC-1 ELEVATIONS
	300-E-203	BOULEVARD PUMP STATION FIRST FLOOR PLAN

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN	J. OSOSKIE		Z BRYAN	OC Review	APVD		Sealer

PRELIMINARY – NOT FOR CONSTRUCTION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

GENERAL
BOULEVARD PUMP STATION
INDEX OF DRAWINGS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-G-001
SHEET	of

ABBREVIATIONS

A	AMMETER, AMPERES, AWNINGS
AB, ABV	ANCHOR BOLT, ABOVE
ABDN	ABANDON
AC	ACOUSTICAL, ACOUSTICAL CEILING
AC	ALTERNATING CURRENT
AC	ASPHALTIC CONCRETE
ACFL	ACCESS FLOORING
ACI	AMERICAN CONCRETE INSTITUTE
ACMU	ACOUSTICAL CONCRETE MASONRY UNIT, ACOUSTICAL CMU
ACP	ACOUSTICAL PANELS
ACST	ACOUSTICAL
ACT	ACOUSTICAL TILE
AD	AREA DRAIN
ADDL	ADDITIONAL
ADJ	ADJACENT
ADW	DRY WEATHER AVERAGE
AFD	ADJUSTABLE FREQUENCY DRIVE
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AG	ACOUSTICAL, ACOUSTICAL GLASS, AIR GAP (FIXED)
AGGR	AGGREGATE
AHR	ANCHOR
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AJ	ADJUSTABLE
AL	ALUMINUM
ALKY	ALKALINITY
ALTN	ALTERNATE
AM	AUTO-MANUAL
AMRD	ACOUSTICAL METAL ROOF DECKING
ANDZ	ANODIZE
APPROX	APPROXIMATE
APVD	APPROVED
ARCH	ARCHITECTURAL
AR	ANALOG RELAY
AS	AS SELECTED
ASSY	ASSEMBLY
ATS	AUTOMATIC TRANSFER SWITCH
AUTO	AUTOMATIC
AUX	AUXILIARY
AVG	AVERAGE
AWW	WET WEATHER AVERAGE
@	AT
B	BELL
BAL	BALANCE
BETW	BETWEEN
BF	BLIND FLANGE, BOTTOM FACE
BFV	BUTTERFLY VALVE
BL	BASELINE
BFP	BACKFLOW PREVENTER
BLDG	BUILDING
BLK	BLOCK
BM	BEAM, BENCHMARK
BO	BOTTOM OF
B.O.B.	BOTTOM OF BEAM
BOD	BOTTOM OF DUCT
BOP	BOTTOM OF PIPE
BOT	BOTTOM
BRG	BEARING
BRK	BRICK
BRKR	BREAKER
BSP	BLACK STEEL PIPE
BV	BALL VALVE, BLOCK VENT
BVC	BEGINNING OF VERTICAL CURVE
C	CONDUIT, CASEMENT
°C	DEGREE CELSIUS
C TO C	CENTER TO CENTER
CAB	CABINET
CB	CATCH BASIN, CIRCUIT BREAKER
CC	CENTER OF CIRCLE
CC	CONTROL CABLE
CCP	CENTRAL CONTROL PANEL
CCS	CENTRAL CONTROL SYSTEM
CDF	CONTROLLED DENSITY FILL
CE	CONSTRUCTION ENTRANCE
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHEM	CHEMICAL
CHKD	CHECKERED
CI	CAST IRON
CIP	CAST IRON PIPE, CAST IN PLACE
CIP	CULVERT INLET PROTECTION
CISP	CAST IRON SOIL PIPE
CJ	CONSTRUCTION JOINT
CKT	CIRCUIT
CL	CENTERLINE
CLDI	CEMENT LINED DUCTILE IRON
CLSF	CONTROLLED LOW STRENGTH FILL
CLG	CEILING
CLR	CLEAR, CLEARANCE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CMP	CENTRAL MONITORING PANEL
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CNTR	COUNTER
CO	CLEANOUT, CARBON MONOXIDE
COL	COLUMN, COLOR
CONC	CONCRETE
COND	CONDENSATE
CONDTN	CONDITIONED
CONN	CONNECTION
CONSTR	CONSTRUCTION
CONT	CONTINUED, CONTINUOUS, CONTINUATION
CONTR	CONTRACTOR
COORD	COORDINATE
COP	COPPER
CP	CENTER PIVOT
CP-X	CONTROL PANEL NO. X
CPLG	COUPLING
CPRSR	COMPRESSOR
CPT	CONTROL POWER TRANFORMER, CARPET
CPVC	CHLORINATED PVC
CR	CONTROL RELAY
CRS	COLD ROLLED STEEL
CRS	CONSTRUCTION ROAD STABILIZATION
CT	CERAMIC TILE
CT	CURRENT TRANSFORMER
CTC	COMPUTER TERMINAL CABINET
CTR	CENTER
CTRD	CENTERED
CTSK	COUNTERSUNK
CU	CUBIC
CU FT	CUBIC FOOT
CU IN	CUBIC INCH
CUH	COPPER TUBING, HARD DRAWN
CV	CHECK VALVE
CWR	CABINET DOOR MOUNTED WASTE RECEPTACLE
CY, CU YD	CUBIC YARD
CWS	CLEAN WATER SERVICES
D	DEEP, DRAIN
d	PENNY NAIL SIZE
DA	DUAL ACTION
DAS	DATA ACQUISTION SYSTEM
DBA	DEFORMED BAR ANCHOR
DBL	DOUBLE
DC	DIRECT CURRENT
DEG	DEGREE
DET	DETAIL
DF	DOUGLAS FIR, DRINKING FOUNTAIN
DDI	DROP INLET
DH	DOUBLE HUNG
DI	DUCTILE IRON
DIA	DIAMETER
DIAG	DIAGONAL
DIP	DUCTILE IRON PIPE
DIR	DIRECTION
DISCH	DISCHARGE
DN	DOWN
DO	DISSOLVED OXYGEN
DOL	DIRECT-ON-LINE
DP, DPNL	DISTRIBUTION PANEL
DR	DOOR
DS	DOWNSPOUT
DWG	DRAWING
DWL	DOWEL
△	DELTA
E	EAST, EMPTY
EA	EACH, EXHAUST AIR
EB, EBCT	EMPTY BED CONTACT TIME
ECC	ECCENTRIC
EE	EMERGENCY EYEWASH
EDF	EGG-SHAPED DIGESTER FACILITY
EF	EACH FACE, EXHAUST FAN
EFF	EFFICIENCY, EFFICIENT
EFL	EFFLUENT
EIFS	EXTERIOR INSULATION AND FINISH SYSTEM
EL	ELEVATION
ELB	ELBOW
ELC	ELECTRICAL LOAD CENTER
ELEC	ELECTRIC, ELECTRICAL
ENGR	ENGINEER
EOP	EDGE OF PAVEMENT
ESC	EROSION AND SEDIMENT CONTROL
EP	EXPLOSION PROOF, EDGE OF PAVING
EQL	EQUAL
EQL SP	EQUALLY SPACED
EQPT	EQUIPMENT
ESC	EROSION AND SEDIMENT CONTROL
ETM	ELAPSED TIME METER
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EWC	ELECTRIC WATER COOLER
EXH	EXHAUST
EXP	EXPANSION, EXPOSED
EXP AB	EXPANSION ANCHOR BOLT
EXP JT	EXPANSION JOINT
EXST, EXIST	EXISTING
EXT	EXTERIOR
°F	DEGREE FAHRENHEIT
FACP	FIRE ALARM CONTROL PANEL
FB	FLAT BAR
F, FU	FUSE
F, FX	FIXED
FAP	FIRE ALARM PANEL
FC	FLEXIBLE CONDUIT
FCA	FLANGED COUPLING ADAPTER
FCL2	FREE CHLORINE RESIDUAL
FCO	FLOOR CLEANOUT
FCTY	FACTORY
FD	FLOOR DRAIN
FDN	FOUNDATION
FDR	FEEDER
FEXT	FIRE EXTINGUISHER
FF	FINISHED FLOOR
FG	FINISH GRADE, FLOAT GLASS
FH	FLAT HEAD
FHY	FIRE HYDRANT
FIG	FIGURE
FL	FLOW LINE
FLG	FLANGE
FL	FLOOR
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FLUOR	FLUORESCENT
FNSH	FINISH
FOB	FLAT ON BOTTOM
FOT	FLAT ON TOP
FP	FIELD PANEL
FPM	FEET PER MINUTE
FR	FORWARD REVERSE
FRP	FIBERGLASS REINFORCED PLASTIC
FSHS	FOLDING SHOWER SEAT
FT	FOOT OR FEET
FTG	FOOTING
FU	FIXTURE UNIT
FVNR	FULL VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
FWD	FORWARD
G, GND	GROUND
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GB	GYPSUM BOARD
GC	GROOVED COUPLING
GCMU	GLAZED CONCRETE MASONRY UNITS
GFA	GROOVED FLANGE ADAPTER
GFI	GROUND FAULT INTERRUPTER
GFR	GROUND FAULT RELAY
GH	GREENHOUSE
GL	GLASS
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GPS	GLOBAL POSITION SYSTEM
GRTG	GRATING
GSB	GYPSUM SOFFIT BOARD
GSP	GALVANIZED STEEL PIPE
GV	GATE VALVE
GVL	GRAVEL
GWB	GYPSUM WALLBOARD
GYP	GYPSUM
H	HIGH, HORN OR HOWLER
H2S	HYDROGEN SULFIDE
H.A.S.	HEADED ANCHOR STUD
HC	HOLLOW CORE WOOD
HCL	HYDROCHLORIC ACID
HDNR	HARDENER
HDNS	HARDNESS
HDR	HEADER
HDW	HARDWARE
HGL	HYDRAULIC GRADE LINE
HK	HOOK
HGT	HEIGHT
HH	HANDHOLE
HID	HIGH INTENSITY DISCHARGE
HK	HOOK
HM	HOLLOW METAL
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
HORIZ	HORIZONTAL
HP	HORSEPOWER
HPT	HIGH POINT
HPU	HYDRAULIC POWER UNIT
HR	HOSE RACK, HANDRAIL
HV	HOSE VALVE
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HWL	HIGH WATER LEVEL
IC	INTERRUPTING CAPACITY
ID	INDUCED DRAFT, INSIDE DIAMETER
IE	INVERT ELEVATION
I.F.	INSIDE FACE
IG	INSULATING, INSULATING GLASS
IN	INCH
INCAND	INCANDESCENT
INFL	INFLUENT
INJS	INJECTIONS
INST	INSTANTANEOUS
INSTM	INSTRUMENT, INSTRUMENTATION
INSUL	INSULATION
INVT	INVERT
IP	INLET PROTECTION, INSTRUMENTATION PANEL
IRRIG	IRRIGATION
ITG	INSULATED TEMPERED GLASS
ITX	ISOLATION TRANSFORMER
IU	INTAKE UNIT
IW	IRRIGATION WELL
JA	JALOUSIE
JB	JAL-AWNING
JAN	JUNCTION BOX
JCT	JANITOR
JT	JUNCTION
K	JOINT
KIP	KEY GROUP, KEY INTERLOCK
KIT	THOUSAND POUNDS
K-PL	KITCHEN
KSK	KICKPLATE
KV	KITCHEN SINK
KVA	KILOVOLTS
KVAR	KILOVOLT AMPERES
KW	KILOVOLT AMPERES REACTIVE
L	KILOWATT
LA	ANGLE, LENGTH
LAB	LIGHTNING ARRESTER
LAM	LABORATORY
LAT	LAMINATE
LB	LATITUDE
LC	POUND
LD	LIGHTING CONTACTOR
LDG	COMBINATION LOUVER/DAMPER
LEL	LOADING DOCK
LF	LOWER EXPLOSIVE LIMIT
LG	LINEAR FEET
LH	LONG
LHR	LEFT HAND
LLH	LEFT HAND REVERSE
LLV	LONG LEG HORIZONTAL
LNTL	LONG LEG VERTICAL
LONG	LINTEL
LOS	LONGITUDINAL
LP	LOCK-OUT STOP PUSHBUTTON
LPT	LIGHT POLE, LIGHTING PANEL, LOCAL PANEL
LR	LOW POINT
LR	LATCHING RELAY
LR	LOCAL-REMOTE
LS	LONG RADIUS
LT	LABORATORY SINK
LTG, LTS	LEFT
LTX	LIGHTS OR LIGHTING
LWL	LIGHTING TRANSFORMER
	LOW WATER LEVEL
MA	MANUAL-AUTO
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MC	MASONRY CLEARANCE
MC	MODULATE-CLOSE
MCC	MOTOR CONTROL CENTER
MCJ	MASONRY CONTROL JOINT
MDO	MEDIUM DENSITY OVERLAY
MECH	MECHANICAL
MFD	MANUFACTURED
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE, MOUNTING HEIGHT
MIN	MINIMUM
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MLO	MAIN LUGS ONLY
MMDW	DRY WEATHER MAXIMUM MONTH
MMP	MECHANICAL MOUNTING PANEL
MMWW	WET WEATHER MAXIMUM MONTH
MO	MANUAL OPERABLE, MASONRY OPENING
MP	METAL PANEL
MPU	MULTIPURPOSE UNIT
MS	MANUFACTURER'S STANDARD
MSC	MANUFACTURER SUPPLIED CABLE
MSR	GROUPED MOTOR CONTROL
MT	MOUNT
MTD	MOUNTED
MTG	MOUNTING
MTS	MANUAL TRANSFER SWITCH
MTS	MILL TYPE STEEL PIPE
MU	MULCHING
MV	MERCURY VAPOR
MWS	MAXIMUM WATER SURFACE
N	NORTH, NEUTRAL
NA	NOT APPLICABLE
NA	NON-AUTOMATIC
NC	NORMALLY CLOSED
NEUT	NEUTRAL
NG	NATURAL GAS
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
N.O.	NORMALLY OPEN
NO., #	NUMBER
NOM	NOMINAL
NP	NON-PROTECTED
NPT	NATIONAL PIPE THREADS
NS	NON-SHRINK
NTS	NOT TO SCALE
O2	OXYGEN
O TO O	OUT TO OUT
OA	OVERALL, ODOROUS AIR
OC	ON CENTER
OC	OPEN-CLOSE (O)
OCA	OPEN-CLOSE-AUTO
OCR	OPEN-CLOSE-REMOTE
OD	OUTSIDE DIAMETER, OVERFLOW DRAIN
O.F.	OUTSIDE FACE
OFCI	OWNER FURNISHED, CONTRACTOR INSTALLED
OFOI	OWNER FURNISHED, OWNER INSTALLED
OL	OVERLOAD RELAY
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
OP	OPAQUE PANEL, OUTLET PROTECTION
OPER	OPERATOR
OPNG	OPENING
OPP	OPPOSITE
OSA	OUTSIDE AIR
OSC	OPEN-STOP-CLOSE
OSD	OPEN SITE DRAIN
OWSJ	OPEN WEB STEEL JOIST
OZ	OUNCE
P	PROJECTED
P	PILASTER, PIPE
PAVT	PAVER TILE
PB	PUSHBUTTON SWITCH
PC	POINT OF CURVE, PHOTOCELL
PC	PRECAST CONCRETE PANEL
PCCP	PRECAST CONCRETE CYLINDER PIPE
PCV	PRESSURE CONTROL VALVE
PE	PLAIN END
PED	PEDESTAL, PEDESTRIAN
PEP	POLYETHYLENE PIPE
PEN.	PENETRATION
PFC	POUNDS PER CUBIC FOOT
PH	PENTHOUSE
pH	HYDROGEN ION CONCENTRATION
PH	PHASE
PI	POINT OF INTERSECTION
PIT	PILOT TUBE TEST STATION
PJF	PREMOULDED JOINT FILLER
PL	PLATE (STEEL)
PL	PROPERTY LINE
PLAM	PLASTIC LAMINATE
PLAS	PLASTER, PLASTIC
PLC	PROGRAMMABLE LOGIC CONTROLLER
PLYWD	PLYWOOD
PNL	PANEL
PP	POWER POLE
P-P	PUSH-PULL
PPL	POLYPROPYLENE LINED
PR	PAIR
PRC	POINT OF REVERSE CURVE
PRCST	PRECAST
PREFAB	PREFABRICATION
PRES	PRESSURE
PRI	PRIMARY
PRM	PERMANENT REFERENCED MARKER
PROJ	PROJECTION
PROP	PROPERTY
PS	PLASTIC SHEET, POLYCARBONATE SHEET
PS	PAINT SYSTEM
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH, GAUGE
PT	POINT OF TANGENCY
PT	POTENTIAL TRANSFORMER
PT	PRESSURE TREATED
PTD	PAPER TOWEL DISPENSER
PTN	PARTITION
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
QAA	AVERAGE FLOW
QMM	MAXIMUM 30 DAY FLOW
QPI	PEAK INSTANTANEOUS FLOW
QPP	PEAK PUMPING FLOW
QT	QUARRY TILE
R	RISER
R OR RAD	RADIUS
RA	RETURN AIR
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RCPT	RECEPTACLE
RD	ROAD, ROOF DRAIN
RDCR	REDUCER
RDW	REDWOOD
RECIR	RECIRCULATION
REF	REFER OR REFERENCE
REFR	REFRIGERATE, REFRIGERANT
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RESIL	RESILIENT
RFS	ROLL-UP FIRE SHUTTER
RH	RIGHT HAND
RH	RODHOLE
RHR	RIGHT HAND REVERSE
RL	RAIN LEADER
RLS	RUBBER LINED STEEL
RM	ROOM
RO	ROUGH OPENING
ROL	RAISE-OFF-LOWER
RPM	REVOLUTIONS PER MINUTE
RR	RIPRAP

GENERAL NOTES:

1. THIS IS A STANDARD LEGEND SHEET. THEREFORE, NOT ALL OF THE INFORMATION SHOWN MAY BE USED ON THIS PROJECT.
2. CONTACT ENGINEER FOR ABBREVIATIONS USED BUT NOT SHOWN ON THIS DRAWING.

NO.	DATE	DSGN
		J. OSOSKIE
		DR
		Z BRYAN
		CHK
		OC Review
		APVD
		BY
		APVD

REVISION

Sealer

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m.

GENERAL

BOULEVARD PUMP STATION ABBREVIATIONS

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE

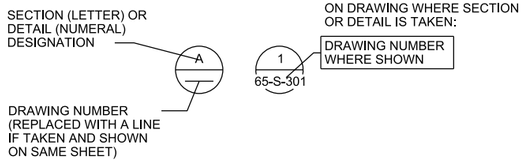
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-G-002
SHEET	of

ABBREVIATIONS

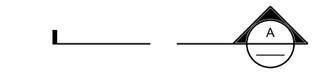
RRUB	RADIAL RUBBER
RS	RIGID STEEL
RST	REINFORCING STEEL
RT	RIGHT
RTN	RETURN
RTO	REGENERATIVE THERMAL OXIDIZER
RUB	RUBBER
RUBC	RUBBER CUSHIONED FLOORING
RUBS	RUBBER ESD CONTROL FLOORING
R/W	RIGHT OF WAY
S	I-BEAM
S	SLOPE, SOUTH, SWITCH
SA	SUPPLY AIR
SATC	SUSPENDED ACCUSTICAL TILE CEILING
SB	SEDIMENT BASIN
SC	SHOWER CURTAIN, SOLID CORE WOOD
SCADA	SUPERVISORY CONTROL AND DATA ACQUISITION
SCC	SOLID CORE
SCFM	STANDARD CUBIC FEED PER MINUTE
SCHED	SCHEDULE
SCU	SPEED CONTROL UNIT
SDP	SUB-DISTRIBUTION PANEL
SDWK	SIDEWALK
SEC	SECONDARY
SECT	SECTION
SED	SEDIMENTATION
SEW	SEWAGE
SG	LAMINATED SAFETY GLASS, SAFETY
SGWB	SUSPENDED GYPSUM WALL BOARD
SH	SHEET
SHA	SURFACE HARDENING AGENT
SHS	SOLIDS HANDLING SYSTEM
SIM	SIMILAR
SK	SINK
SLR	SEALER
SMLS	SEAMLESS EPOXY
SOI	SPRAY- ON INSULATION
SOLN	SOLUTION
SP	SPACE OR SPACES, SPANDREL PANEL, STORMPROOF
SPEC, SPECS	SPECIFICATIONS
SPD	SUMP PUMP DISCHARGE
SPG	SPACING
SPLY	SUPPLY
SQ	SQUARE
SQ FT	SQUARE FOOT, FEET
SQ IN	SQUARE INCH
SR	SHORT RADIUS
SS	START-STOP
SST	STAINLESS STEEL
SSC	SUPERVISORY SET POINT CONTROL
ST	STORM DRAIN
ST	STRAIGHT
STA	STATUS, STATION
STD	STANDARD
STIF	STIFFENER
STIRR	STIRRUP
STL	STEEL
STRL	STRUCTUAL
STRUCT	STRUCTURE
SUBFL	SUBFLOOR
SUSP	SUSPENDED
SV	SOLENOID VALVE
SVIN	SHEET VINYL
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYMM	SYMMETRICAL
T	THERMOSTAT, TREAD
T/	TOP OF
T&B	TOP AND BOTTOM
T&G	TONGUE AND GROOVE
TA	TRANSFER AIR
TAN	TANGENT
TB	TERMINAL BOARD
TBG	TUBING
TC	TIME TO CLOSE
TC	TURBIDITY CURTAIN
TCAD	TIME CLOSE AFTER DE-ENERGIZATION
TCAE	TIME CLOSE AFTER ENERGIZATION
TDH	TOTAL DYNAMIC HEAD
TDR	TIME DELAY RELAY
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPORARY, TEMPERATURE
TF	TOP FACE
TFG	TEMPERED FLOAT GLASS
TG	TEMPERED
TH	TOP-HINGED
THD	THREAD
THK	THICKNESS
THRU	THROUGH
TJB	TERMINAL JUNCTION BOX
TL	TEFLON LINED PIPE
T.O.	TIME TO OPEN, TOP OF
TOAE	TIME OPEN AFTER ENERGIZATION
TOC	TOP OF CONCRETE
TOC	TOP OF CURB
TOD	TIME ON DELAY, TOP OF DUCT TOTAL OXYGEN DEMAND
TOF	TOP OF FOOTING
TOG	TOP OF GROUT, TOP OF GRATE
T.O.P.	TOP OF PARAPET
TOS	TOP OF SLAB
TOW	TOP OF WALL
TP	TURNING POINT
TR	TRANSOM, TRUSS
TRANS	TRANSFORMER, TRANSITION
TRANSV	TRANSVERSE
TRD	TREAD
TS	TEMPORARY SEEDING, TUBE STEEL
TSHT	THRESHOLD
TSS	TOTAL SUSPENSION SOLIDS
TST	TOP OF STEEL
TTC	TELEPHONE TERMINAL CABINET
TTD	TOILET TISSUE DISPENSER
TU-X	TREATMENT UNIT NO. X
TURB	TURBIDITY
TWP	TRANSLUCENT WALL PANEL
TX	TRANSFORMER
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
UNO	UNLESS NOTED OTHERWISE
UPS	UNINTERRUPTIBLE POWER SUPPLY
USB	UNIT SUBSTATION
UVR	UNDER VOLTAGE RELAY
V	VENT, VALVE
V	VOLTMETER, VOLTS
VB	VAPOR BARRIER (RETARDER)
VC	VERTICAL CURVE
VCP	VITRIFIED CLAY PIPE
VCT	VINYL COMPOSITION TILE
VEL	VELOCITY
VERT	VERTICAL
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION
VIF	VERIFY IN FIELD
VIN	VINYL
VINT, VT	VINYL TILE
VP	VERTICAL PIVOTED
VPS	VENEER PLASTER SYSTEM
VPC	POINT OF VERTICAL CURVATURE
VPI	POINT OF VERTICAL INTERSECTION
VPT	POINT OF VERTICAL TANGENT
VS	VERTICAL SLIDE
VTR	VENT THRU ROOF
VWC	VINYL WALL COVERING
W	WEST
W/	WITH
WC	WATER COLUMN
WEASTRIP	WEATHERSTRIP
WG	WIRE, WIRE GLASS
WH	WATTHOUR METER
WHD	WATTHOUR DEMAND METER
WP	WATERPROOF, WEATHERPROOF, WORKPOINT
WR	WASTE RECEPTACLE
WRB	WATER RESISTANT GWB
WS	WATER SURFACE, WATERSTOP, WELDED STEEL
WWF	WELDED WIRE FABRIC
WWPH	WET WEATHER PEAK HOUR

SECTION / DETAIL DESIGNATIONS

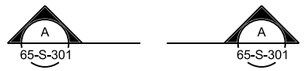


DRAWING TITLE
SCALE

ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (eg: ELEVATIONS)



SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT



SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET

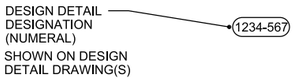
GRID LINE INDICATOR

KEYNOTE NUMBER

REVISION / ADDENDA NUMBER

NORTH ARROW

DESIGN DETAIL DESIGNATION



NOTES:

1. ALL DESIGN DETAILS ARE TYPICAL AND MUST BE USED IF DESIGN DETAIL DESIGNATION IS NOT SHOWN
2. THE TERM STANDARD DETAIL, OR A FORM OF IT, IS SYNONYMOUS WITH DESIGN DETAIL. THE DESIGN DETAILS REPRESENT THE CHARACTER AND NATURE OF THE WORK REQUIRED THROUGHOUT THE PROJECT. ALL ASSOCIATED WORK SHALL BE IN ACCORDANCE WITH THE DESIGN DETAILS SHOWN WHETHER THE DETAILS ARE SPECIFICALLY REFERENCED OR NOT.

DRAWING NUMBER DESIGNATION

DRAWING NUMBER

100-S-201

SEQUENTIAL NUMBER

SHEET TYPE
- 0 GENERAL, DIAGRAMS, SCHEMATICS
- 1 DEMOLITION DRAWINGS
- 2 PLANS
- 3 SECTIONS AND OR ELEVATIONS
- 4 LARGE SCALED VIEWS
- 5 DETAILS
- 6 SCHEDULES

DISCIPLINE
- G GENERAL
- C CIVIL
- L EROSION CONTROL
- S STRUCTURAL
- A ARCHITECTURAL
- F FIRE PROTECTION
- P PLUMBING
- D PROCESS
- Y PIPING
- M MECHANICAL
- E ELECTRICAL
- N INSTRUMENTATION AND CONTROLS

FACILITY
- 100 - UNION PUMP STATOIN
- 200 - EAST STREET PUMP STATION
- 300 - BOULEVARD PUMP STATION

PROJECT NOTES:

1. PROJECT ELEVATIONS ARE BASED ON NAVD 88. EXISTING ELEVATIONS ARE BASED ON NGVD 29. EXISTING DRAWINGS WERE USED AS BACKGROUNDS FOR EXISTING BUILDINGS/STRUCTURES. EXISTING ELEVATIONS HAVE BEEN CONVERTED TO NAVD 88, UNLESS NOTED OTHERWISE. TO CONVERT BETWEEN NGVD 29 AND NAVD 88 USE THE FOLLOWING CONVERSIONS:

   NGVD 29 TO NAVD 88: SUBTRACT 1.04 FEET
   NAVD 88 TO NGVD 29: ADD 1.04 FEET

2. CONTRACTOR SHALL FIELD VERIFY EXISTING ELEVATIONS AND DIMENSIONS.

GENERAL NOTES:

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2. CONTACT ENGINEER FOR ABBREVIATIONS USED BUT NOT SHOWN ON THIS DRAWING.

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DSGN	J. OSOSKIE	Z BRYAN	CHK	OC Review
DR			APVD	Sealer

PRELIMINARY – NOT FOR CONSTRUCTION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

GENERAL

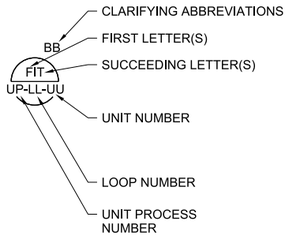
BOULEVARD PUMP STATION
ABBREVIATIONS AND GENERAL LEGEND

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-G-003
SHEET	of

INSTRUMENT IDENTIFICATION

EXAMPLE SYMBOLS



DIGITAL SYSTEM INTERFACES

- ▲ ANALOG INPUT
- ▼ ANALOG OUTPUT
- $\triangle_X$ DISCRETE INPUT
- ∇_X DISCRETE OUTPUT

INSTRUMENT IDENTIFICATION LETTERS TABLE

LETTER	FIRST-LETTER		SUCCEEDING-LETTERS		
	PROCESS OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	READOUT OR PASSIVE FUNCTION	READOUT OR PASSIVE FUNCTION
A	ANALYSIS (+)		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
C	USER'S CHOICE (*)			CONTROL	
D	DENSITY (S.G.)	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT, SENSOR		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE (*)		GLASS, GAUGE VIEWING DEVICE	GATE	
H	HAND (MANUAL)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTION	MOMENTARY			MIDDLE, INTERMEDIATE
N	TORQUE		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
O	USER'S CHOICE (*)		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD OR PRINT		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTI VARIABLE		MULTI FUNCTION	MULTI FUNCTION	MULTI FUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED (*)	X AXIS	UNCLASSIFIED (*)	UNCLASSIFIED (*)	UNCLASSIFIED (*)
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION	Z AXIS		DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

TABLE BASED ON THE INSTRUMENTATION, SYSTEMS, AND AUTOMATION SOCIETY (ISA) STANDARD.

(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS AND LETTER SYMBOLS.
(*) WHEN USED, DEFINE THE MEANING HERE FOR THE PROJECT.

GENERAL INSTRUMENT OR FUNCTIONAL SYMBOLS

- FIELD MOUNTED
- REAR-OF-PANEL MOUNTED (OPERATOR INACCESSIBLE)
- PANEL MOUNTED (OPERATOR ACCESSIBLE)
- MCC MOUNTED

HAND SWITCHES AND INDICATING LIGHTS

ON AND OFF EVENT LIGHTS

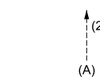
ON-OFF HAND SWITCH, MAINTAINED CONTACT SWITCH (CONTROLLED DEVICE WILL RESTART ON RETURN OF POWER AFTER POWER FAILURE).

STOP-START HAND SWITCH MOMENTARY CONTACT SWITCHES (CONTROLLED DEVICE WILL NOT RESTART ON RETURN OF POWER AFTER POWER FAILURE).

LINE LEGEND

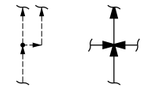
- PRIMARY PROCESS (CLOSED CONDUIT, DASHED LINE INDICATES ALTERNATE FLOW STREAM)
- SECONDARY PROCESS
- BYPASS PROCESS
- PROCESS (OPEN CHANNEL)
- ANALOG SIGNAL (4 TO 20 mAdc, ETC.)
- DISCRETE (ON/OFF, ETC.)
- PNEUMATIC SIGNAL
- FILLED SYSTEM SIGNAL
- HYDRAULIC SYSTEM SIGNAL
- DATA LINK
- BUILDING OR FACILITY BOUNDARY
- PACKAGE SYSTEM EQUIPMENT
- SIMILAR PROCESS

PARALLELING LINES



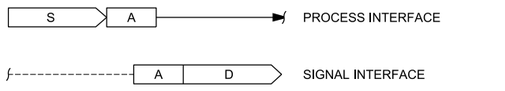
(A) TOTAL OF 2 SIGNALS

CONNECTING LINES



NON-CONNECTING LINES

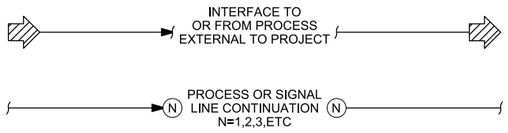
INTERFACE SYMBOLS



A INTERFACE LETTER

D DESTINATION DRAWING NO.

S SOURCE DRAWING NO.



ABBREVIATIONS & LETTER SYMBOLS

AC	ALTERNATING CURRENT
AM	AUTO-MANUAL
CL_2 etc.	CHLORINE (TYPICAL: USE STANDARD CHEMICAL ELEMENT ABBREVIATIONS)
COD	CHEMICAL OXYGEN DEMAND
CP-X	CONTROL PANEL NO. X (X = FACILITY NUMBER)
DC	DIRECT CURRENT
DO	DISSOLVED OXYGEN
FCL_2	FREE CHLORINE RESIDUAL
FOS	FAST-OFF-SLOW
FOSA	FAST-OFF-SLOW-AUTO
FOSR	FAST-OFF-SLOW-REMOTE
FP-W-X	FIELD PANEL NO. WX (W = UNIT PROCESS NUMBER X = PANEL NUMBER)
FR	FORWARD-REVERSE
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
ISR	INTRINSICALLY SAFE RELAY
LEL	LOWER EXPLOSIVE LIMIT
LOS	LOCKOUT STOP
LR	LOCAL-REMOTE
MA	MANUAL-AUTO
MC	MODULATE-CLOSE
MCC-X	MOTOR CONTROL CENTER NO. X
MSC	MANUFACTURER SUPPLIED CABLE
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OC	OPEN-CLOSE(D)
OCA	OPEN-CLOSE-AUTO
OCR	OPEN-CLOSE-REMOTE
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
ORP	OXIDATION REDUCTION POTENTIAL
OSC	OPEN-STOP-CLOSE
pH	HYDROGEN ION CONCENTRATION
PLC	PROGRAMMABLE LOGIC CONTROLLER
RIO	REMOTE I/O UNIT
RTU-X	REMOTE TELEMETRY UNIT NO. X
SOF	SLOW-OFF-FAST
SS	START-STOP
TCL_2	TOTAL CHLORINE RESIDUAL
TOC	TOTAL ORGANIC CARBON
TOD	TOTAL OXYGEN DEMAND
TURB	TURBIDITY
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION

SELF CONTAINED VALVE & EQUIPMENT TAG NUMBERS

D-UP-LL-UU

D	ARV	AIR RELEASE VALVE
	AVRV	AIR AND VACUUM RELEASE VALVE
	E	EJECTOR
	G	GATE
	M	MECHANICAL EQUIPMENT
	P	PUMP
	T	TANK
UP		UNIT PROCESS NUMBER
LL		LOOP NUMBER
UU		UNIT NUMBER

GENERAL NOTES

1. COMPONENTS AND PANELS SHOWN WITH A SINGLE ASTERISK (✳) ARE TO BE PROVIDED AS PART OF A PACKAGE SYSTEM.
2. COMPONENTS AND PANELS SHOWN WITH A DOUBLE ASTERISK (✳✳) ARE TO BE PROVIDED UNDER DIVISION 26, ELECTRICAL.
3. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THE PROJECT.

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
		J. OSOSKIE	Z BRYAN	OC Review	APVD	Sealer	

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

BOULEVARD PUMP STATION
INSTRUMENTATION AND CONTROL
LEGEND - SHEET 1

GENERAL

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-G-005
SHEET	of

PRELIMINARY – NOT FOR CONSTRUCTION

VALVE SYMBOLS

- GATE
- KNIFE GATE
- BUTTERFLY
- GLOBE
- BALL
- VEE-BALL
- SEAT PORT ECCENTRIC PLUG
- DIAPHRAGM
- PINCH
- NEEDLE
- SWING CHECK
- BALL CHECK
- BACKFLOW PREVENTER
- ROTARY
- TELESCOPING
- SAMPLE
- MUD
- PRESSURE RELIEF
- AIR AND/OR VACUUM RELEASE
- REGULATED SIDE PRESSURE CONTROL
- PRESSURE REGULATION (CLAY-TYPE)
- MULTI-PORT VALVE (GATE VALVE SHOWN. FOR OTHER VALVE TYPES, APPROPRIATE VALVE SYMBOL SHOWN.) SEAT PORTS ARE IMPLIED BY INDICATED FLOW PATTERN.
- ANGLE GATE

GATE SYMBOLS

- SLUICE
- FABRICATED SLIDE
- STOP LOG
- BUTTERFLY
- FLAP
- SHEAR

ACTUATOR SYMBOLS

- PNEUMATIC DIAPHRAGM SPRING-OPPOSED, SINGLE OR DOUBLE ACTING
- VALVE POSITIONER
- MANUAL
- PNEUMATIC CYLINDER SINGLE OR DOUBLE ACTING ACTUATED BY ONE INPUT
- HYDRAULIC
- ELECTRIC MOTOR
- DIAPHRAGM, DIFFERENTIAL PRESSURE
- SOLENOID
- ELECTROHYDRAULIC

NOTE:
ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL, OR HYDRAULIC)

XX: FO FAIL OPEN
FC FAIL CLOSED
FLP FAIL TO LAST POSITION

PRIMARY ELEMENT SYMBOLS

- PARSHALL FLUME
- PROPELLER OR TURBINE METER
- LEVEL (FLOAT)
- WEIR
- THERMAL FLOWMETER
- ROTAMETER
- ORFICE PLATE
- LEVEL (BUBBLER TUBE)
- DENSITY METER
- FLOW TUBE
- GENERIC
- ULTRASONIC FLOWMETER
- LEVEL (ULTRASONIC)
- ELECTROMAGNETIC FLOWMETER

PIPING DESIGNATION

RAS
FLOW STREAM IDENTIFICATION

MISCELLANEOUS SYMBOLS

- VENT TO ATMOSPHERE
- AIR GAP
- DRIP TRAP
- PIG INSERT POINT
- PIG CATCH POINT
- SELF CONTAINED AIR SUPPLY
- AIR PURGE SET
- FLUSHING CONNECTION
- SEAL WATER SET
- WATER PURGE SET
- FLEXIBLE CONNECTION
- AERATOR
- DIAPHRAGM SEAL
- ANNULAR DIAPHRAGM SEAL
- COMPOSITE SAMPLER
- FLAME TRAP
- CALIBRATION COLUMN
- INLINE SILENCER
- BLIND FLANGE
- PIPE CAP
- STRAINER
- BASKET STRAINER
- FILTER
- PULSATION DAMPENER
- EXPANSION CHAMBER
- SLUDGE GRINDER
- FFLCPLLLX — PANEL CONTINUED ON SAME OR OTHER DRAWING; PANEL OUTLINE; PANEL NAME
- 120V — 120 VOLT, 60 HZ POWER
- 480V — 480 VOLT, 60 HZ POWER
- XX — AIR SET XX = SUPPLY PRESSURE IN PSIG.
- PLUG
- RECEPTACLE
- RUPTURE DISK (VACUUM)
- RUPTURE DISK (PRESSURE)
- TV MONITOR
- TV CAMERA
- RADIO ANTENNA
- INTERLOCK, SEE CONTROL DIAGRAMS (OR)
- VOICE COMMUNICATION POINT
- SKIMMING MECHANISM
- SCREW CONVEYOR
- SUBMERSIBLE MIXER
- INTRINSIC SAFETY BARRIER/RELAY
- INLINE FAN
- SIGHT INDICATOR

PUMP AND COMPRESSOR SYMBOLS

- CENTRIFUGAL PUMP (DRY PIT)
- CENTRIFUGAL WET PIT PUMP OR TURBINE PUMP
- RECIPROCATING OR METERING PUMP (POSITIVE DISPLACEMENT)
- DIAPHRAGM PUMP
- GEAR PUMP OR BLOWER (POSITIVE DISPLACEMENT)
- PROGESSING CAVITY PUMP
- COMPRESSOR (CENTRIFUGAL)
- COMPRESSOR (PISTON)
- BLOWER OR FAN (CENTRIFUGAL)
- EJECTOR
- PISTON PUMP
- SUBMERSIBLE SUMP PUMP
- PERISTALLIC PUMP

XX: AS ADJUSTABLE SPEED
CS-1 CONSTANT SPEED (SINGLE SPEED)
CS-2 CONSTANT SPEED (TWO SPEED)

FLOW STREAM IDENTIFICATION

ALP	AIR LOW PRESSURE PROCESS	S	SANITARY SEWER (GRAVITY)
ARD	ACID RESISTANT DRAIN	SA	SAMPLE
ARV	ACID RESISTANT VENT	SC	SUPPLEMENTAL CARBON
BD	BLOW DOWN	SCS	SUPPLEMENTAL CARBON SOLUTION
BSD	BLENDED SLUDGE	SHC	SODIUM HYPOCHLORITE
BYP	BYPASS	SMD	SCUM DECANT
CA	SODIUM HYDROXIDE / CAUSTIC	SPD	SUMP PUMP DRAIN / DISCHARGE
CO	CONDENSATE DRAIN	SR	SCRUBBER RECIRCULATION
CSM	COMBINED SCUM	SSM	SECONDARY SCUM
D	DRAIN (PLUMBING)	SU	SULFURIC ACID
DR	DRAIN (PROCESS)	TA	TREATED AIR
FF	FIRE SUPPRESSION FOAM	TPSD	THICKENED PRIMARY SLUDGE
FO	FUEL OIL	TW	TEMPERED WATER (POTABLE)
FS	FIRE SPRINKLER WATER	TWAS	THICKENED WAS
G	NATURAL GAS (PROCESS)	V	VENT
GTO	GRAVITY THICKENER OVERFLOW	VR	VAPOR RECOVERY
HW	HOT WATER (POTABLE)	W1	CITY WATER (POTABLE)
HWR	HEATING WATER RETURN	W2	SEPARATED CITY WATER (NON-POTABLE)
HWS	HEATING WATER SUPPLY	W3	PLANT WATER (PLANT EFFLUENT)
ISD	IMPORTED SLUDGE	WAS	WASTE ACTIVATED SLUDGE
LPR	LOW PRESSURE RETURN (CONDENSATE)		
LPS	LOW PRESSURE STEAM		
NG	NATURAL GAS (PLUMBING)		
NRCY	NITRATE RICH RECYCLE		
OA	ODOROUS AIR		
OD	OVERFLOW ROOF DRAIN		
OF	OVERFLOW		
PE	PRIMARY EFFLUENT		
PSD	PRIMARY SLUDGE		
PSM	PRIMARY SCUM		
RAS	RETURN ACTIVATED SLUDGE		
RBSD	RECYCLE BLENDED SLUDGE		
RD	ROOF DRAIN		
RHG	REFRIGERANT HOT GAS		
RHW	RECIRCULATING HOT WATER		
RL	REFRIGERANT LIQUID		
RS	REFRIGERANT SUCTION		
RTW	RECIRCULATING TEMPERED WATER		

NOTE:
1. FOR EXISTING CIVIL YARD PIPING FLOW STREAM IDENTIFICATION, SEE CIVIL LEGEND.

NO.	DATE	DSGN
	REVISION	BY CHK
		APVD

DR J. OSOSKIE
OC Review Z BRYAN
APVD Sealer

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m

GENERAL
BOULEVARD PUMP STATION
INSTRUMENTATION AND CONTROL
LEGEND - SHEET 2

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-G-006
SHEET	of

GENERAL ARCHITECTURAL NOTES

1. UNLESS OTHERWISE INDICATED, PLAN DIMENSIONS ARE TO COLUMN GRID ON CENTERLINES, NOMINAL SURFACE OF MASONRY, FACE OF STUDS AND FACE OF CONCRETE WALLS.
2. "FLOOR LINE" REFERS TO TOP ON CONCRETE SLABS. FINISH FLOORING IS INSTALLED ABOVE THE FLOOR LINE. FOR DEPRESSED FLOORS AND CURBS, SEE STRUCTURAL DRAWINGS.
3. REPETITIVE FEATURES ARE NOT DRAWN IN THEIR ENTIRETY AND SHALL BE COMPLETELY PROVIDED AS IF DRAWN IN FULL.
4. WHERE DOOR IS LOCATED NEAR CORNER OF ROOM AND IS NOT LOCATED BY DIMENSION ON PLAN OR DETAILS, DIMENSION SHALL BE 3-INCHES FROM FACE OF STUD (WALL) TO FACE OF ROUGH OPENING. DIMENSION SHALL BE 6" FROM FACE OF WALL TO EDGE OF ROUGH OPENING AT CONCRETE WALLS, 8" AT CMU WALLS.
5. AT SOUND INSULATED WALLS, FULL HEIGHT PARTITIONS SHALL BE SEALED BOTH SIDES WITH ACOUSTIC SEALANT; TOP, BOTTOM, INTERSECTION, DOOR FRAMES, GLAZED OPENING FRAMES, AND OTHER PENETRATIONS.
6. LINE OF EXISTING GRADES, AS SHOWN ON THE BUILDING ELEVATIONS AND SECTIONS ARE APPROXIMATE. THEY ARE AT THE BUILDING FACE, OR ON THE SECTION END EXCEPT AS NOTED.
7. VERIFY ALL ROUGH-IN DIMENSIONS FOR EQUIPMENT PROVIDED IN THIS CONTRACT, OR BY OTHERS.
8. REFER TO ARCHITECTURAL, STRUCTURAL, MECHANICAL, ELECTRICAL AND OTHER CATEGORIES OR DRAWINGS FOR ADDITIONAL NOTES.
9. VERIFY SIZE AND LOCATION OF, AND PROVIDE: REQUIRED OPENINGS THROUGH FLOORS AND WALLS, ACCESS DOORS, FURRING, CURBS, ANCHORS AND INSERTS. PROVIDE ALL BASES AND BLOCKING REQUIRED FOR ACCESSORIES, MECHANICAL, ELECTRICAL AND OTHER EQUIPMENT.

ARCH/STRUCT MATERIAL SYMBOLS

SYMBOL	LEGEND
	GRATING, SPAN DIRECTION INDICATED
	CHECKERED PLATE
	GROUT
	GRANULAR FILL
	EARTH OR FINISH GRADE
	CONCRETE
	CMU WALL (PLAN)
	CMU WALL (SECTION)
	MASONRY WALL
	METAL STUD WALL (PLAN)
	WOOD STUD WALL (PLAN)
	RIGID INSULATION
	BATT INSULATION
	STEEL
	ALUMINUM
	PLYWOOD
	GYPSUM WALLBOARD
	ACOUSTICAL TILE
	WOOD, ROUGH CONTINUOUS
	WOOD, ROUGH NON-CONTINUOUS
	WOOD, FINISHED

ARCHITECTURAL/STRUCTURAL LEGEND

SYMBOL	LEGEND
A	NEW REFERENCE GRID INDICATOR
A	EXISTING REFERENCE GRID INDICATOR
ROOM NAME XX-101 OR ROOM NAME 101	ROOM IDENTIFIER
"XX" = FACILITY INDICATOR (IF SHOWN); DOOR LETTER; ROOM NUMBER; XX-101A	DOOR IDENTIFIER
XXW-1 OR W-1	WINDOW IDENTIFIER
XXR-1 OR R-1	RELIGHT IDENTIFIER
XXL-1 OR L-1	LOUVER IDENTIFIER
A	WALL TYPE INDICATOR
S-1	SIGNAGE IDENTIFIER
P-1	PRECAST PANEL IDENTIFIER
1 XX-A-301	EXTERIOR ELEVATION INDICATOR
QUANTITY AND DIRECTION OF POINTERS AS REQUIRED; A B C D E; 1 XX-A-301	INTERIOR ELEVATION INDICATOR
1 XX-A-401	DETAIL INDICATOR - SMALL CONDITION
⊗ 110.50	SPOT ELEVATION INDICATOR
	DIRECTION OF SLOPE DOWN
HINGE SIDE	DOOR/HATCH SWING INDICATOR
ACTIVE; INACTIVE; XX-101A	INDICATES PAIR OF DOORS
F.EXT-X	FIRE EXTINGUISHER "X" = NUMBER IN SPECIFICATIONS
	CONTROL JOINT
	EXPANSION JOINT
POST	RAILINGS

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
		J. OSOSKIE	Z BRYAN	OC Review	APVD	Sealer	

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

GENERAL
BOULEVARD PUMP STATION
ARCHITECTURAL AND STRUCTURAL LEGEND

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-G-007
SHEET	of

PIPE AND FITTING SYMBOLS

DOUBLE LINE	SINGLE LINE	
		EXISTING PIPE
		NEW PIPE
		EXISTING PIPE TO BE ABANDONED
		EXISTING PIPE TO BE REMOVED
		WELDED JOINT
		GROOVED END JOINT
		FLANGED JOINT
		MECHANICAL JOINT & PROPRIETARY RESTRAINED JOINT
		BELL & SPIGOT JOINT (LEADED)
		HUB & SPIGOT JOINT (RUBBER GASKET)
		BALL JOINT
		ADAPTER SIDE GROOVED END ADAPTER FLANGE
		FLANGED COUPLING ADAPTER (RESTRAINING SYSTEM BY MFR)
		RESTRAINED FLANGED COUPLING ADAPTER SEE (4005-545)
		FLEXIBLE COUPLING
		METAL BELLOWS EXP JOINT
		ELASTOMER BELLOWS EXP JOINT
		ELBOW UP
		ELBOW DOWN
		TEE UP
		TEE DOWN
		LATERAL UP
		LATERAL DOWN
		CONCENTRIC REDUCER
		ECCENTRIC REDUCER

DOUBLE LINE	SINGLE LINE	
		REDUCING BUSHING
		UNION
		CAP
		ANCHOR
		ELBOW, 90 DEGREE
		CROSS
		TEE
		ELBOW, 45 DEGREE
		LATERAL

NOTES:

1. ONLY FLANGED END CONNECTIONS ARE SHOWN HERE FOR DOUBLE LINE FITTINGS. FITTINGS WITH OTHER END PATTERNS ARE SHOWN SIMILARLY ON THE CONSTRUCTION DRAWINGS. ALSO SEE PIPING SPECIFICATIONS.
2. SYMBOLS SHOWN HERE FOR SINGLE LINE FITTINGS ARE GENERIC ONLY. REFER TO PIPING SPECIFICATIONS FOR SPECIFIC END CONNECTIONS FOR SINGLE LINE PIPE AND FITTINGS.
3. EXISTING PIPE AND EQUIPMENT IS SHOWN LIGHT-LINED AND/OR SCREENED. NEW PIPING AND EQUIPMENT IS SHOWN HEAVY-LINED.

VALVE SYMBOLS

SINGLE LINE	DOUBLE LINE
GATE	
KNIFE GATE	OR
BUTTERFLY	OR
GLOBE	OR
BALL	OR
SEATING PORT	
ECCENTRIC PLUG	OR
PLUG OR COCK	OR
NEEDLE	OR
DIAPHRAGM	OR
PINCH	OR
SWING CHECK	OR
BALL CHECK	OR

HOSE VALVE (HV- X) OR (V-X)
X = NO. IN SPECS

SAMPLE

MUD

PRESSURE RELIEF

AIR AND/OR VACUUM RELEASE

REGULATED SIDE
PRESSURE CONTROL (INTERNAL PILOT)

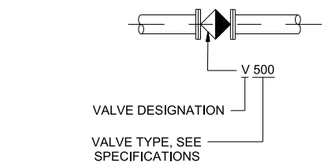
REGULATED SIDE
PRESSURE CONTROL (EXTERNAL PILOT)

MULTI-PORT VALVE,
ARROWS INDICATE FLOW PATTERN.
SEATING PORTS ARE IMPLIED BY
INDICATED FLOW PATTERN.

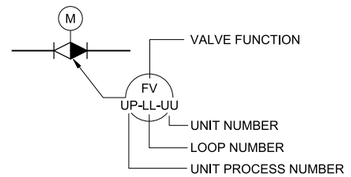
TELESCOPING

VALVE DESIGNATIONS

MANUAL VALVES AND CHECK VALVES

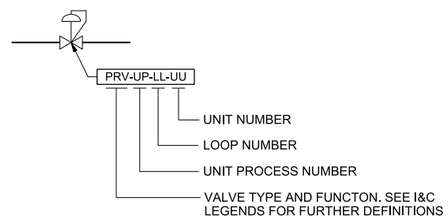


CONTROL VALVES



NOTE:
SEE I&C LEGENDS FOR FURTHER DEFINITIONS AND ACTUATOR TYPES.

SELF-CONTAINED REGULATING VALVES



ACTUATOR SYMBOLS

PNEUMATIC DIAPHRAGM

PNEUMATIC CYLINDER

ELECTRIC MOTOR (M)

HYDRAULIC (H)

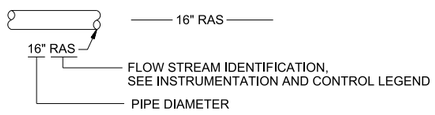
MANUAL

SOLENOID (S)

ELECTRO HYDRAULIC (E/H)

PIPING DESIGNATION

EXAMPLE:



GENERAL PIPING NOTES

1. LAY PIPE TO UNIFORM GRADE BETWEEN INDICATED ELEVATION POINTS.
2. SIZE OF FITTINGS SHOWN ON DRAWINGS SHALL CORRESPOND TO ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE INDICATED. TYPE OF JOINT AND FITTING MATERIAL SHALL BE THE SAME AS SHOWN FOR ADJACENT STRAIGHT RUN OF PIPE.
3. LOCATION AND NUMBER OF PIPE HANGERS AND PIPE SUPPORTS SHOWN IS ONLY APPROXIMATE. CONTRACTOR SHALL DESIGN SUPPORTS AS SPECIFIED.
4. ALL JOINTS SHALL BE WATERTIGHT. WALL PIPES SHALL BE USED WHEREVER PIPING PASSES FROM A STRUCTURE TO BACKFILL.
5. ALL FLEXIBLE CONNECTORS AND COUPLING ADAPTERS SHALL BE PROVIDED WITH THRUST PROTECTION AS SPECIFIED, UNLESS OTHERWISE NOTED. THRUST PROTECTION SHALL BE ADEQUATE FOR TEST PRESSURES SPECIFIED.
6. SYMBOLS, LEGENDS, AND PIPE USE IDENTIFICATIONS SHOWN SHALL BE FOLLOWED THROUGHOUT THE DRAWINGS, WHEREVER APPLICABLE. NOT ALL OF THE VARIOUS PIPING COMPONENTS ARE NECESSARILY USED IN THE PROJECT.
7. ALL BURIED PIPING SPECIFIED TO BE PRESSURE TESTED, EXCEPT FLANGED, WELDED, OR SCREWED PIPING, SHALL BE PROVIDED WITH THRUST PROTECTION AS SPECIFIED, UNLESS OTHERWISE NOTED.
8. NUMBER AND LOCATION OF UNIONS SHOWN ON DRAWINGS IS ONLY APPROXIMATE. PROVIDE ALL UNIONS NECESSARY TO FACILITATE CONVENIENT REMOVAL OF VALVES AND MECHANICAL EQUIPMENT.
9. WHERE A GROOVED END COUPLING IS SHOWN, IT SHALL BE THE RIGID JOINT TYPE, UNLESS OTHERWISE SPECIFIED. WHERE A FLANGED COUPLING ADAPTER IS SHOWN, A STANDARD FLANGE SHALL BE JOINED TO THE COUPLING ADAPTER.

NO.	DATE	DSGN
	S. CLARK	DR
REVISION	Z BRYAN	CHK
APVD	OC Review	APVD
BY	APVD	Sealer

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m.

GENERAL

BOULEVARD PUMP STATION
PROCESS MECHANICAL
LEGEND

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-G-012
SHEET	of

ONE-LINE DIAGRAM-1

SYMBOL	DESCRIPTION
	DRAWOUT AIR CIRCUIT BREAKER, LOW VOLTAGE
400	CIRCUIT BREAKER, THERMAL MAGNETIC TRIP SHOWN, 3 POLE, UNO
AS/AF or AT/AF	CIRCUIT BREAKER, STATIC TRIP UNIT, SENSOR AMP TRIP AND FRAME RATINGS SHOWN, 3 POLE, UNO
100/M	CIRCUIT BREAKER, MAGNETIC TRIP ONLY, TRIP RATING SHOWN, 3 POLE, UNO
400 400	CIRCUIT BREAKER WITH CURRENT LIMITING FUSES, TRIP AND FUSE RATING INDICATED, 3 POLE, UNO
400 225	FUSED SWITCH, SWITCH AND FUSE CURRENT RATING INDICATED, 3 POLE, UNO
100	SWITCH, CURRENT RATING INDICATED, 3 POLE, UNO
60 (3)	FUSE, CURRENT RATING AND QUANTITY INDICATED
1	MAGNETIC STARTER WITH OVERLOAD, NEMA SIZE INDICATED, FVNR UNO
AFD	ELECTRONIC STARTER/SPEED CONTROL RVSS = REDUCED VOLTAGE SOFT STARTER AFD = AC ADJUSTABLE FREQUENCY DRIVE DC = DC ADJUSTABLE SPEED DRIVE RVAT = REDUCED VOLTAGE AUTO TRANSFORMER TYPE RVRT = REDUCED VOLTAGE REACTOR TYPE
	CABLE OR BUS CONNECTION POINT
K	KEY INTERLOCK
	SURGE ARRESTER (GAP TYPE)
10	CAPACITOR - KVAR INDICATED, 3 PHASE
3	AC MOTOR, SQUIRREL CAGE INDUCTION - HORSEPOWER INDICATED
G 500/625	GENERATOR, KW/KVA RATING SHOWN
VS V 0-600V	ANALOG METER WITH SWITCH - SCALE RANGE SHOWN V = VOLTAGE KW = KILOWATTS A = AMPERAGE KVAR = KILOVARS PF = POWER FACTOR
DPM	DIGITAL POWER METER (MULTIFUNCTION)
	UTILITY REVENUE METER
	GROUND
15 KVA 480-120/240V 1 PH	TRANSFORMER, SIZE, VOLTAGE RATINGS, AND PHASE INDICATED
	SHIELDED ISOLATION TRANSFORMER
480-120V (3)	POTENTIAL TRANSFORMER, VOLTAGE RATING AND QUANTITY INDICATED
100:5 (3)	CURRENT TRANSFORMER, RATIO(100:5) AND QUANTITY INDICATED (3)
	CONNECTION POINT TO EQUIPMENT SPECIFIED IN OTHER DIVISIONS, RACEWAY, CONDUCTOR AND CONNECTION IN THIS DIVISION
SPD	SURGE PROTECTIVE DEVICE

ONE-LINE DIAGRAM-2

SYMBOL	DESCRIPTION
	DRAWOUT POWER CIRCUIT BREAKER, MEDIUM VOLTAGE
	NON DRAWOUT FUSED SWITCH, MEDIUM VOLTAGE
	DRAWOUT FUSED SWITCH AND CONTACTOR, MEDIUM VOLTAGE
	DRAWOUT FUSED SWITCH AND VACUUM CONTACTOR, MEDIUM VOLTAGE
	DRAWOUT VACUUM CONTACTOR, MEDIUM VOLTAGE
	MEDIUM VOLTAGE CABLE STRESS CONE TYPE TERMINATION, OPEN TERMINATOR OR ELBOW
	SWITCH - LOAD BREAK, GROUP OPERATED, MEDIUM VOLTAGE
	SWITCH W/ARCING HORNS, MEDIUM VOLTAGE
	DISCONNECTING FUSE - SOLID MATERIAL, MEDIUM VOLTAGE
	SWITCH - HOOK STICK OPERATED, SINGLE POLE, MEDIUM VOLTAGE
	FUSE - EXPULSION, HOOK STICK OPERATED, SINGLE POLE, MEDIUM VOLTAGE
	GROUND SWITCH, GANG OPERATED
	TERMINAL BLOCK LUG
	DELTA CONNECTION
	WYE GROUNDED CONNECTION, SOLID GROUND
R or Z	WYE NEUTRAL GROUND RESISTOR OR IMPEDANCE CONNECTION
86	RELAY OR DEVICE, FUNCTION NUMBER AS INDICATED
50:5 (1)	CURRENT TRANSFORMER, ZERO SEQUENCE, RATIO AND QUANTITY INDICATED
800/1200:5 (3)	BUSHING CURRENT TRANSFORMER, MULTI-RATIO AND QUANTITY INDICATED
MO	MOTOR OPERATOR, BREAKER OR SWITCH
EUM	ENERGY MONITORING UNIT
MRP	MOTOR PROTECTION RELAY
E N	TRANSFER SWITCH - LOW VOLTAGE
E N	TRANSFER SWITCH - MEDIUM VOLTAGE

NOTES:

1. THESE ARE STANDARD LEGEND SHEETS. SOME SYMBOLS AND ABBREVIATIONS MAY APPEAR ON THE LEGEND AND NOT ON THE DRAWINGS.
2. FOR ADDITIONAL ABBREVIATIONS OF OTHER DIVISIONS (HVAC, MECHANICAL, AND STRUCTURAL/ARCHITECTURAL) SEE OTHER LEGENDS.

CONTROL DIAGRAM-1

SYMBOL	DESCRIPTION
	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY OPEN
	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY CLOSED
	PUSH BUTTON SWITCH, MAINTAINED CONTACTS WITH MECHANICAL INTERLOCK
	3 POSITION SELECTOR SWITCH MAINTAINED CONTACT
HAND OFF REMOTE	SELECTOR SWITCH - MAINTAINED CONTACT - CHART IDENTIFIES OPERATION WHEN NEEDED FOR CLARITY:

	POSITION		
CKT	HAND	OFF	REMOTE
1	X	O	O
2	O	O	X

X - CLOSED CONTACT
O - OPEN CONTACT

SYMBOL	DESCRIPTION
	TOGGLE SWITCH, ON-OFF TYPE
ON OFF	SELECTOR SWITCH, ON-OFF TYPE
	MUSHROOM HEAD PUSHBUTTON SWITCH
A	INDICATING LIGHT, PUSH-TO-TEST, LETTER INDICATES COLOR
A	INDICATING LIGHT - LETTER INDICATES COLOR A - AMBER G - GREEN S - STROBE B - BLUE R - RED C - CLEAR W - WHITE
ETM	ELAPSED TIME METER
M	MOTOR STARTER CONTACTOR COIL
CRX	CONTROL RELAY, X INDICATES NUMERICAL ORDER IN CIRCUIT
TDR X	TIME DELAY RELAY, X INDICATES NUMERICAL ORDER IN CIRCUIT
SV X	SOLENOID VALVE, X INDICATES NUMERICAL ORDER IN CIRCUIT
	CONTACT - NORMALLY OPEN
	CONTACT - NORMALLY CLOSED
	REMOTE DEVICE
	TIME DELAY RELAY CONTACT, NORMALLY OPEN, CLOSES WHEN ENERGIZED AND TIMED OUT
	TIME DELAY RELAY CONTACT, NORMALLY CLOSED, OPENS WHEN ENERGIZED AND TIMED OUT
	TIME DELAY RELAY CONTACT, CLOSES WHEN ENERGIZED, OPENS WHEN DE-ENERGIZED AND TIMED OUT
	TIME DELAY RELAY CONTACT, OPENS WHEN ENERGIZED, CLOSES WHEN DE-ENERGIZED AND TIMED OUT
	MOTOR SPACE HEATER
	TERMINAL BLOCK, REMOTE
	TERMINAL BLOCK, INTERNAL
	FUSED TERMINAL BLOCK
	FUSE, RATING INDICATED
CPT 120V	TRANSFORMER, CONTROL POWER
	THERMOCOUPLE

CONTROL DIAGRAM-2

SYMBOL	DESCRIPTION
	CAPACITOR
+ −	BATTERY
	LIMIT SWITCH, NORMALLY OPEN, CLOSES AT END OF TRAVEL
	LIMIT SWITCH, NORMALLY CLOSED, OPENS AT END OF TRAVEL
	TEMPERATURE SWITCH, OPENS ON TEMPERATURE RISE
	TEMPERATURE SWITCH, CLOSES ON TEMPERATURE RISE
	FLOAT SWITCH, NORMALLY OPEN, CLOSES ON DESCENDING LEVEL
	FLOAT SWITCH, NORMALLY OPEN, CLOSES ON RISING LEVEL
	PRESSURE SWITCH, NORMALLY CLOSED, OPENS ON RISING PRESSURE
	PRESSURE SWITCH, NORMALLY OPEN, CLOSES ON RISING PRESSURE
	FLOW SWITCH, CLOSES ON INCREASED FLOW
	FLOW SWITCH, OPENS ON INCREASED FLOW
NGR	NEUTRAL GROUND CURRENT LIMITING RESISTOR
RES	CALIBRATING RESISTOR
T GEN	TACHOMETER GENERATOR
GFS	GROUND FAULT SENSOR
	FLASHER
	SEALED CONTACT
	BUZZER
	POTENTIOMETER
	RESISTOR
	BLOWN FUSE INDICATOR
	COAXIAL CABLE
	MULTICONDUCTOR SHIELDED CABLE
	DUPLEX RECEPTACLE
L U	RELAY, WITH MECHANICAL LATCH
	FULLWAVE DIODE BRIDGE (AC TO DC)

NO.	DATE	DSGN	DR	CHK	OC Review	BY	APVD
	R. WOOD		Z BRYAN		APVD		Sealer

REVISION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

GENERAL
BOULEVARD PUMP STATION
ELECTRICAL LEGEND 1

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-G-015
SHEET	of

POWER SYSTEM PLAN-1

SYMBOL	DESCRIPTION
	CONNECTION POINT TO EQUIPMENT SPECIFIED. RACEWAY, CONDUCTOR,TERMINATION AND CONNECTION IN THIS DIVISION.
MCC-A	MAJOR ELECTRICAL COMPONENT OR DEVICE - NAME OR IDENTIFYING SYMBOL AS SHOWN.
	PANELBOARD - SURFACE MOUNTED
LPXXA	PANELBOARD LETTER OR NUMBER FACILITY NUMBER LP - LOW VOLTAGE PANEL DP - DISTRIBUTION PANEL
	PANELBOARD - FLUSH MOUNTED
	TERMINAL JUNCTION BOX
M	MOTOR, SQUIRREL CAGE INDUCTION
G	GENERATOR, VOLTAGE AND SIZE AS INDICATED.
LPXXA	HOME RUN - DESTINATION SHOWN
or /G	EXPOSED CONDUIT AND CONDUCTORS*
or /G	CONCEALED CONDUIT AND CONDUCTORS*

NOTE:
ALL UNMARKED CONDUIT RUNS CONSIST OF TWO NO. 12, ONE NO. 12 GROUND CONDUCTORS IN 3/4" CONDUIT. RUNS MARKED WITH CROSSHATCHES INDICATE NUMBER OF NO. 12 CONDUCTORS. CROSSHATCH WITH SUBSCRIPT "G" INDICATES GREEN GROUND WIRE.

/G	CROSSHATCHES WITH BAR INDICATE NO.10 CONDUCTOR. SIZE CONDUIT ACCORDING TO SPECIFICATIONS AND APPLICABLE CODE.
[A1]	CONDUIT AND CONDUCTOR CALLOUT, SEE LEGEND.
	CONDUIT DOWN
	CONDUIT UP
	CONDUIT, STUBBED AND CAPPED
	CONDUIT TERMINATION AT CABLE TRAY
EX	EXISTING CONDUIT/ DUCT BANK
BD	BUS DUCT - SEE SPECIFICATIONS
CE	CONCRETE ENCASED CONDUIT
DB	DIRECT BURIED CONDUIT
FO	FIBER OPTIC CONDUIT
XXXX	CONCRETE ENCASED DUCT BANK WHERE XXXX IS THE DUCT BANK NAME. SEE CIRCUIT AND RACEWAY CODING DEFINITION
	CONCEALED CONDUIT ROUTING AREA
	CONDUIT ROUTING AREA
	CABLE TRAY
T	TRANSFORMER
J or HH	GENERAL CONTROL OR WIRING DEVICE. LETTER SYMBOLS OR ABBREVIATIONS INDICATE TYPE OF DEVICE
CS	CONTROL STATION, SEE CONTROL DIAGRAMS FOR CONTROL DEVICE(S) REQUIRED.
30	NONFUSED DISCONNECT SWITCH, CURRENT RATING INDICATED, 3 POLE
60/40	FUSED DISCONNECT SWITCH, CURRENT RATING INDICATED (60/40, 60=SWITCH RATING / 40=FUSE RATING) 3 POLE
2	COMBINATION CIRCUIT BREAKER AND MAGNETIC STARTER, NEMA SIZE INDICATED

POWER SYSTEM PLAN-2

SYMBOL	DESCRIPTION
100/40	BREAKER, SEPARATELY MOUNTED, CURRENT RATING INDICATED (100/40, 100 = FRAME SIZE; 40 = TRIP RATING) 3 POLE
C 2	CONTACTOR, MAGNETIC, NEMA SIZE INDICATED
L 30	LIGHTING CONTACTOR, CURRENT RATING INDICATED
2	STARTER, MAGNETIC NEMA SIZE INDICATED
XX 2	CONVENIENCE RECEPTACLE - DUPLEX UNLESS NOTED OTHERWISE WP - WEATHERPROOF C - CLOCK HANGER TL - TWIST LOCK CRE - CORROSION RESISTANT GFCI - GROUND FAULT CIRCUIT INTERRUPTER SUBSCRIPT NUMBER AT RECEPTACLE INDICATES CIRCUIT
	240V RECEPTACLE
	CONVENIENCE RECEPTACLE - QUADRUPLEX
	MULTI OUTLET ASSEMBLY
	DUPLEX CONVENIENCE RECEPTACLE - FLUSH IN FLOOR
	CONVENIENCE RECEPTACLE, PEDESTAL, DUPLEX SINGLE FACE UNLESS INDICATED OTHERWISE
L20R 20	RECEPTACLE, SPECIAL PURPOSE-NEMA CONFIGURATION AND AMPERAGE INDICATED
T	THERMOSTAT
	UTILITY REVENUE METERING FACILITY
EUH	ELECTRIC UNIT HEATER
AC	ELECTRIC AIR CONDITIONER (SELF CONTAINED UNIT)
	UTILITY POLE

LIGHTING SYSTEM PLAN

SYMBOL	DESCRIPTION
1 or 1	LUMINAIRE, SEE SCHEDULE
1	LUMINAIRE, SEE SCHEDULE
1 or	LUMINAIRE WITH INTERNAL BATTERY BACKUP, SEE SCHEDULE
1	STRIP LUMINAIRE, SEE SCHEDULE
4 or 4	LUMINAIRE AND POLE, SEE SCHEDULE
5 or 5	WALL MOUNTED LUMINAIRE, SEE SCHEDULE
1	FLOOD LIGHTS - AIM IN THE DIRECTION SHOWN
	STANDBY LIGHTING UNIT, SURFACE MOUNTED, SEE SCHEDULE
XX or	EXIT LIGHTS - FILLED SECTION INDICATES LIGHTED FACE, ARROW INDICATES EGRESS DIRECTIONAL INDICATORS, XX = FIXTURE NUMBER, SEE SCHEDULE
$a or 2a	SMALL LETTER SUBSCRIPT AT SWITCH AND LUMINAIRE INDICATES SWITCHING. SUBSCRIPT NUMBER AT LUMINAIRE INDICATES CIRCUIT
$3	WALL SWITCH: 2- DOUBLE POLE 3- THREE WAY 4- FOUR WAY WP- WEATHERPROOF EX- EXPLOSIONPROOF M- MOTOR RATED P- PILOT LIGHT K- KEY OPERATED D- DIMMER CRE- CORROSION RESISTANT L- MOMENTARY 3-WAY MS- MANUAL STARTER WITH OVERLOADS
OS	OCCUPANCY SENSOR
LC	LIGHTING CONTACTOR
MD	MOTION DETECTOR
PC	PHOTOCELL

FIRE ALARM SYSTEM PLAN AND RISER

SYMBOL	DESCRIPTION
F P	FIRE ALARM STATION, MANUAL
	FIRE ALARM SYSTEM, AUTOMATIC SMOKE DETECTOR
HD	FIRE ALARM SYSTEM, AUTOMATIC, HEAT DETECTOR
F	FIRE ALARM BELL
F	FIRE ALARM HORN
	FIRE ALARM HORN/STROBE LIGHT
	FIRE ALARM STROBE LIGHT
	AIR DUCT DETECTOR
FS	FIRE SPRINKLER FLOW SWITCH
TS	FIRE SPRINKLER TAMPER SWITCH
D	DOOR HOLDER

TELEPHONE SYSTEM PLAN AND RISER

SYMBOL	DESCRIPTION
TTC	TELEPHONE TERMINAL CABINET
	TELEPHONE RECEPTACLE FLOOR BOX
	TELEPHONE RECEPTACLE
T	TELEPHONE SYSTEM RACEWAY

COMPUTER SYSTEM (DATA) PLAN AND RISER

SYMBOL	DESCRIPTION
CTC	COMPUTER SYSTEM TERMINAL CABINET
	COMPUTER NETWORK CONNECTION
	COMPUTER NETWORK CONNECTION, FLUSH IN FLOOR
D	DATA SYSTEM RACEWAY

COMBINED TELEPHONE/COMPUTER SYSTEM PLAN AND RISER

SYMBOL	DESCRIPTION
4	COMBINATION TELEPHONE/DATA RECEPTACLE, WALL MOUNTED, NUMBER OF PORTS INDICATED
4	COMBINATION TELEPHONE/DATA RECEPTACLE, FLOOR BOX, NUMBER OF PORTS INDICATED

CLOSED CIRCUIT/TELEVISION CABLE PLAN AND RISER

SYMBOL	DESCRIPTION
	COMBINATION CLOSED CIRCUIT TELEVISION RECEPTACLE (CCTV) AND DUPLEX CONVENIENCE RECEPTACLE IN TWO GANG BOX WITH BARRIER, 12" DOWN FROM CEILING
	COMBINATION TELEVISION CABLE RECEPTACLE (TV) AND DUPLEX CONVENIENCE RECEPTACLE IN TWO GANG BOX WITH BARRIER, 12" DOWN FROM CEILING
	CLOSED CIRCUIT TELEVISION RECEPTACLE, FLOOR BOX
	TELEVISION CABLE RECEPTACLE, FLOOR BOX

SOUND SYSTEM PLAN AND RISER

SYMBOL	DESCRIPTION
S	SPEAKER, CONE TYPE, RECESSED IN CEILING, SEE ARCHITECTURAL DRAWINGS FOR CEILING TYPE
S	SPEAKER, CONE TYPE, WALL MOUNTED
S	SPEAKER, CONE TYPE, SURFACE MOUNTED
V	VOLUME CONTROL, WALL MOUNT 5'-0" AFF
S	INTERIOR PAGING TRUMPET SOUND REPRODUCER WITH REMOTE AMPLIFIER, SURFACE MOUNTED
M	MICROPHONE OUTLET
S	SOUND SYSTEM RACEWAY
S	COMMUNICATION STATION

SECURITY SYSTEM PLAN AND RISER

SYMBOL	DESCRIPTION
CR	CARD KEY ACCESS
CS	CONTROL STATION
DS	DOOR SWITCH
EP	EGRESS PUSHBUTTON
	ELECTRONIC LOCK M = MAGENITIC S = STRIKE
	INTERCOM
	MONITOR
	MOTION SENSOR
	VIDEO CAMERA PTZ = PAN/TILT/ZOOM F = FIXED

GROUND SYSTEM PLAN

SYMBOL	DESCRIPTION
	GROUND ROD
	GROUND ROD IN TEST WELL
G	GROUNDING CONDUCTOR, SIZE AS INDICATED
	PIGTAIL FOR CONNECTION TO EQUIPMENT CABINET OR FRAME
G	EQUIPMENT GROUND BUS
N	EQUIPMENT NEUTRAL BUS

NO.	DATE	DSGN
		R. WOOD
		DR
	REVISION	Z BRYAN
	CHK	
	OC Review	APVD
	BY	APVD

Sealer

PRELIMINARY – NOT FOR CONSTRUCTION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m

GENERAL

BOULEVARD PUMP STATION
ELECTRICAL LEGEND 2

VERIFY SCALE

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0 1"

DATE	NOVEMBER 2016
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DWG	300-G-016
SHEET	of

SYMBOL	DESCRIPTION

ONE LINE PROTECTION RELAYING AND ELEMENTARY DIAGRAMS-1

51 or 52	DEVICE FUNCTION NUMBER INDICATED, SEE DEVICE TABLE
CS T	CONTROL SWITCH TRIP
CS C	CONTROL SWITCH CLOSE
43/CS	43-DEVICE FUNCTION NUMBER, SEE DEVICE TABLE
VS	VOLTMETER SWITCH
AS	AMMETER SWITCH
A	INDICATING LAMP-SWITCHBOARD TYPE INDICATING LAMP LENS COLORS INDICATED AS FOLLOWS: A - AMBER R - RED B - BLUE W - WHITE G - GREEN
V	VOLTMETER
A	AMMETER
W	WATTMETER
F	FREQUENCY METER
PF	POWER FACTOR METER
WH	WATT-HOUR METER
ETM	ELAPSED TIME METER
RPM	TACHOMETER
W XD	WATTS TRANSDUCER
PF XD	POWER FACTOR TRANSDUCER
TD	TIME DELAY
4	RELAY COIL, DEVICE FUNCTION NUMBER PER ANSI 37.2 - AMERICAN STANDARD MANUAL AND AUTOMATIC STATION CONTROL, SUPERVISORY AND ASSOCIATED TELEMETRY EQUIPMENT
7 8	NORMALLY OPEN CONTACT
3 4	NORMALLY CLOSED CONTACT
	REMOTE DEVICE
	TEST SWITCH CURRENT ELEMENT
	TEST SWITCH POTENTIAL ELEMENT
	NEUTRAL CONNECTION
	DIODE
	INSTRUMENTATION CABLE, SHIELDED
NGR	NEUTRAL GROUNDING RESISTOR
PST	PHASE SHIFTING TRANSFORMER

DEVICE TABLE

ONE LINE PROTECTION RELAYING AND ELEMENTARY DIAGRAMS-2

DEVICE FUNCTION NO.	DEVICE DESCRIPTION
21	IMPEDANCE/DISTANCE RELAY
25A	AUTOMATIC SYNCHRONIZER
25C	SYNCH CHECK RELAY
27	UNDERVOLTAGE RELAY
32	REVERSE POWER RELAY
40	GENERATOR LOSS OF EXCITATION RELAY
43CSE	AUTOMATIC POWER TRANSFER AND LOAD CONTROL MODE SEL. SWITCH
43CSX	MODE SEL. SWITCH
46	GENERATOR CURRENT UNBALANCE RELAY
49	THERMAL RELAY
50GS	INSTANTANEOUS OVERCURRENT DEVICE, GROUND SENSOR
50	INSTANTANEOUS OVERCURRENT DEVICE,
51	TIME OVERCURRENT RELAY
51G	TIME OVERCURRENT RELAY, GROUND FAULT
51V	TIME OVERCURRENT, VOLTAGE RESTRAINED
52	POWER CIRCUIT BREAKER
52CSX	POWER CIRCUIT BREAKER CONTROL SWITCH
59	OVERVOLTAGE RELAY
60	VOLTAGE OR CURRENT BALANCE RELAY
65A	ENGINE GOVERNOR, SPEED CONTROL
65A, MOP	ENGINE GOVERNOR, SPEED CONTROL MOTOR OPERATED POTENTIOMETER
65A, RL	ENGINE GOVERNOR, SPEED CONTROL RAISE/LOWER SWITCH
65B	ENGINE GOVERNOR, LOAD CONTROL
65B, MOP	ENGINE GOVERNOR, LOAD CONTROL MOTOR OPERATED POTENTIOMETER
65B, RL	ENGINE GOVERNOR, % LOAD RAISE/LOWER SWITCH
65E	AUTOMATIC POWER TRANSFER AND LOAD CONTROL, WOODWARD APTL
65F	AUTOMATIC GENERATOR LOADING CONTROL, WOODWARD AGLC
67	DIRECTIONAL TIME OVERCURRENT RELAY
74	ALARM RELAY
81O/U	FREQUENCY RELAY, OVER/UNDER
86	LOCKOUT RELAY
87	DIFFERENTIAL PROTECTIVE RELAY
90	VOLTAGE REGULATOR
90, MOP	ENGINE EXCITATION, POWER OPERATED POTENTIOMETER
90PF	ENGINE EXCITATION, POWER FACTOR CONTROL
90RL	ENGINE EXCITATION, RAISE/ LOWER SWITCH

X = DEVICE NUMBER, WHEN THERE ARE MULTIPLE UNITS

CIRCUIT AND RACEWAY

GENERAL CIRCUIT CONDUCTOR AND CONDUIT IDENTIFICATION

POWER CIRCUIT CALLOUTS

[P1]	[1/2"FLEX, 2#12,#12G]	[P24]	[1"C,3#8,3#14,1#10G]
[P2]	[3/4"C,2#12,1#12G]	[P25]	[1"C,3#8,4#14,1#10G]
[P3]	[3/4"C,3#12,1#12G]	[P26]	[1"C,3#8,5#14,1#10G]
[P4]	[3/4"C,4#12,1#12G]	[P27]	[1"C,2#6, 1#10G]
[P5]	[3/4"C,5#12,1#12G]	[P28]	[1"C,3#6, 1#8G]
[P6]	[3/4"C,6#12,1#12G]	[P29]	[1"C,3#6, 2#14,1#8G]
[P7]	[3/4"C,7#12,1#12G]	[P30]	[1"C,3#6, 3#14,1#8G]
[P8]	[3/4"C,8#12,1#12G]	[P31]	[1"C,3#6, 4#14,1#8G]
[P9]	[3/4"C,3#12,2#14,1#12G]	[P32]	[1"C,3#6, 5#14,1#8G]
[P10]	[3/4"C,3#12,3#14,1#12G]	[P33]	[1"C,3#4,1#8G]
[P11]	[3/4"C,3#12,4#14,1#12G]	[P34]	[1 1/4"C,3#4,3#14,1#8G]
[P12]	[3/4"C,3#12,5#14,1#12G]	[P35]	[1 1/4"C,3#4,5#14,1#8G]
[P13]	[3/4"C,3#12,6#14,1#12G]	[P36]	[1 1/4"C,3#3, 1#6G]
[P14]	[3/4"C,3#12,7#14,1#12G]	[P37]	[1 1/4"C,3#3, 3#14,1#6G]
[P15]	[3/4"C,2#10,1#10G]	[P38]	[1 1/4"C,3#2, 1#6G]
[P16]	[3/4"C,3#10,1#10G]	[P39]	[1 1/4"C,3#1, 1#6G]
[P17]	[3/4"C,3#10,2#14,1#10G]	[P40]	[1 1/2"C,3#1, 3#14,1#6G]
[P18]	[3/4"C,3#10,3#14,1#10G]	[P41]	[1 1/2"C,3#2/0, 1#4G]
[P19]	[3/4"C,3#10,4#14,1#10G]	[P42]	[2"C,3#3/0, 1#4G]
[P20]	[3/4"C,3#10,5#14,1#10G]	[P43]	[2"C,3#4/0, 1#3G]
[P21]	[1"C,2#8,1#10G]		
[P22]	[1"C,3#8,1#10G]		
[P23]	[1"C,3#8,2#14,1#10G]		

MULTICONDUCTOR POWER CABLE CIRCUIT CALLOUTS

[PC1]	[3/4"C,1 (3C#12,1#12G) TYPE 2]
[PC2]	[3/4"C,1 (3C#10,1#10G) TYPE 2]
[PC3]	[1"C,1 (3C#8,1#10G) TYPE 2]
[PC4]	[1 1/4"C,2 (3C#12,1#12G) TYPE 2]
[PC5]	[1 1/2"C,2 (3C#10,1#10G) TYPE 2]
[PC1A]	[3/4"C,1 (2C#12,1#12G) TYPE 2]
[PC2A]	[3/4"C,1 (2C#10,1#10G) TYPE 2]

EMPTY CONDUIT

[EC-1]	[3/4"C,WITH PULL STRING]
[EC-2]	[1"C,WITH PULL STRING]
[EC-3]	[1 1/4"C,WITH PULL STRING]
[EC-4]	[1 1/2"C,WITH PULL STRING]
[EC-5]	[2"C,WITH PULL STRING]
[EC-6]	[3"C,WITH PULL STRING]
[EC-7]	[4"C,WITH PULL STRING]
[EC-8]	[5"C,WITH PULL STRING]

ANALOG CIRCUIT CALLOUTS

[A1]	[3/4"C,1 TYPE 3]
[A2]	[1"C,2 TYPE 3]
[A3]	[1"C,3 TYPE 3]
[A4]	[1"C,4 TYPE 3]
[A5]	[1 1/4"C,5 TYPE 3]
[A6]	[1 1/4"C,6 TYPE 3]
[A7]	[1 1/2"C,7 TYPE 3]
[A8]	[1 1/2"C,8 TYPE 3]
[A9]	[1 1/2"C,9 TYPE 3]
[A10]	[2"C,10 TYPE 3]
[A11]	[2"C,11 TYPE 3]
[A12]	[2"C,12 TYPE 3]
[A13]	[2"C,13 TYPE 3]
[A14]	[2"C,14 TYPE 3]
[A15]	[3/4"C,1 TYPE 4]
[A16]	[3/4"C,2 TYPE 4]
[A17]	[1"C,3 TYPE 4]
[A18]	[1 1/4"C,4 TYPE 4]
[A19]	[1 1/4"C,5 TYPE 4]
[A20]	[1 1/4"C,6 TYPE 4]
[A21]	[1 1/2"C,7 TYPE 4]
[A22]	[1 1/2"C,8 TYPE 4]
[A23]	[2"C,9 TYPE 4]
[A24]	[3/4"C,1-4 pr. TYPE 5]
[A25]	[1"C,2-4 pr. TYPE 5]

CONTROL CIRCUIT CALLOUTS

[C1]	[3/4"C,MSC]
[C2]	[3/4"C,2#14,1#14G]
[C3]	[3/4"C,3#14,1#14G]
[C4]	[3/4"C,4#14,1#14G]
[C5]	[3/4"C,5#14,1#14G]
[C6]	[3/4"C,6#14,1#14G]
[C7]	[3/4"C,7#14,1#14G]
[C8]	[3/4"C,8#14,1#14G]
[C9]	[3/4"C,9#14,1#14G]
[C10]	[3/4"C,10#14,1#14G]
[C11]	[3/4"C,11#14,1#14G]
[C12]	[3/4"C,12#14,1#14G]
[C13]	[3/4"C,13#14,1#14G]
[C14]	[3/4"C,14#14,1#14G]
[C15]	[3/4"C,15#14,1#14G]
[C16]	[3/4"C,16#14,1#14G]
[C17]	[3/4"C,17#14,1#14G]
[C18]	[3/4"C,18#14,1#14G]
[C19]	[3/4"C,19#14,1#14G]
[C20]	[1"C,20#14,1#14G]
[C21]	[1"C,21#14,1#14G]
[C22]	[1"C,22#14,1#14G]
[C23]	[1"C,23#14,1#14G]
[C24]	[1"C,24#14,1#14G]
[C25]	[1"C,25#14,1#14G]

MULTICONDUCTOR CONTROL CABLE CIRCUIT CALLOUTS

[CC5]	[3/4"C,1-5C TYPE 1]
[CC7]	[3/4"C,1-7C TYPE 1]
[CC9]	[1"C,1-9C TYPE 1]
[CC12]	[1"C,1-12C TYPE 1]
[CC19]	[1 1/2"C, 1-19C TYPE 1]
[CC25]	[1 1/2"C,1-25C TYPE 1]
[CC37]	[2"C,1-37C TYPE 1]
[CCC1]	[1-7C #12 TYPE 1]

NOTES:
1. FOR CABLE TYPES, SEE SPECIFICATIONS.
2. CONDUIT SIZES ARE BASE ON THE AREA OF THW CONDUCTORS.
3. SIZING OF CONDUCTORS #1AWG AND SMALLER BASED ON AMPACITIES AT 60 DEGREES C, SIZING OF CONDUCTORS #1/0AWG AND LARGER BASED ON AMPACITIES AT 75 DEGREES C.
4. WHERE CIRCUITS ARE UNDERGROUND, DIRECT BURIED OR CONCRETE ENCASED, MINIMUM CONDUIT SIZE SHALL BE 1".
5. FOR METRIC CONDUIT SIZES USE THE FOLLOWING CONVERSION:
   1/2" = 16 mm 1/4" = 35 mm
   3/4" = 21 mm 1 1/2" = 41 mm
   1" = 27 mm 2" = 53 mm

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
		R. WOOD	Z BRYAN	QC Review	APVD	Sealer	

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

GENERAL
BOULEVARD PUMP STATION
ELECTRICAL LEGEND 3

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
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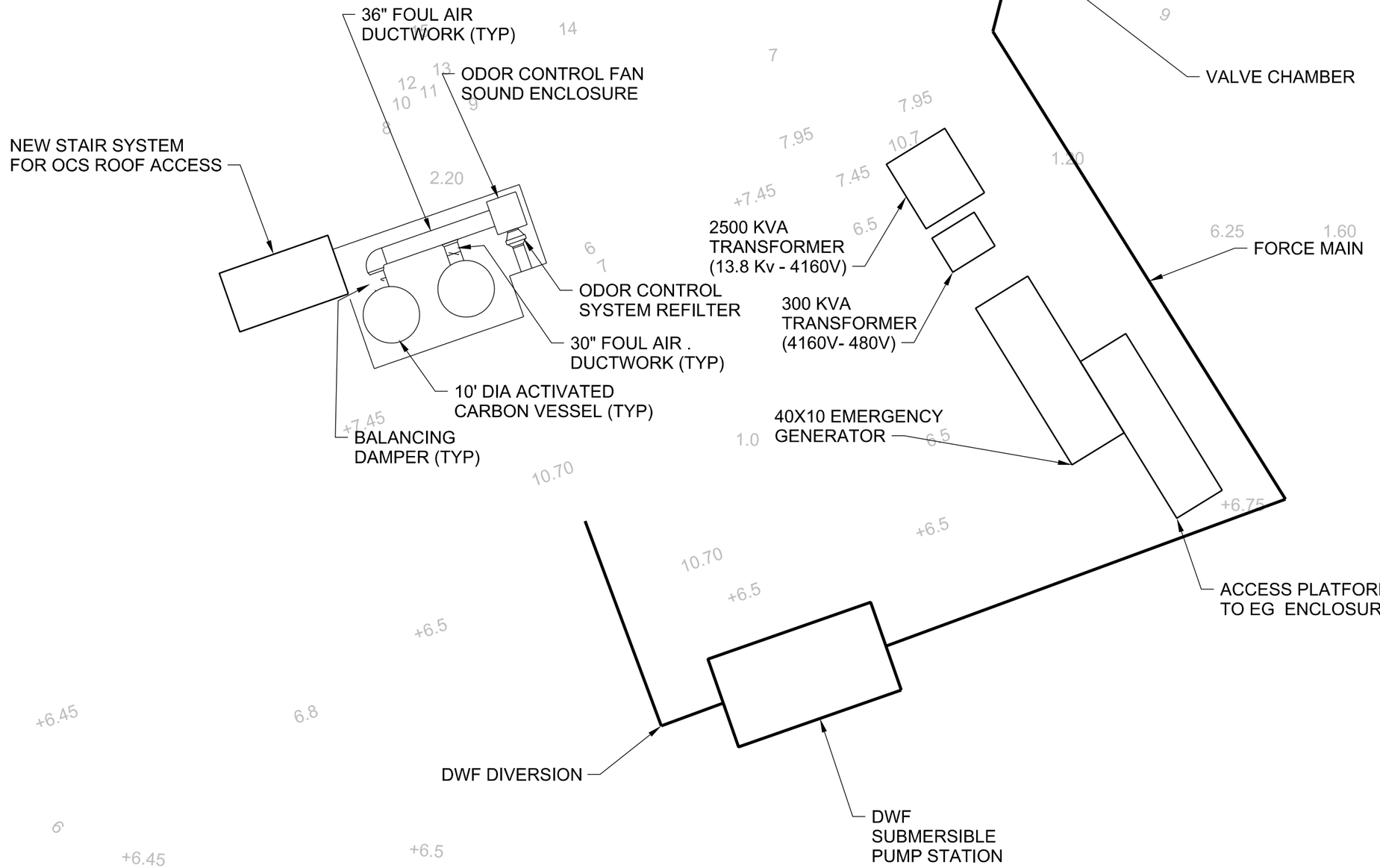

NOTES:

1. BASE FLOOD ELEV. = 12.0
2. ALL ELEVATIONS SHOWN ARE NAVD 88
3. DESIGN RESILIENCY PROTECTION ELEV. = 15.0

BOULEVARD PUMP STATION SITE PLAN

1"=10'-0"

NO.	DATE	REVISION	BY	APVD
DSGN	R. SIEBERS	DR	T. DUFFNEY	CHK	APVD

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

CIVIL
BOULEVARD PUMP STATION
SITE PLAN

PRELIMINARY – NOT FOR CONSTRUCTION

1"=10'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
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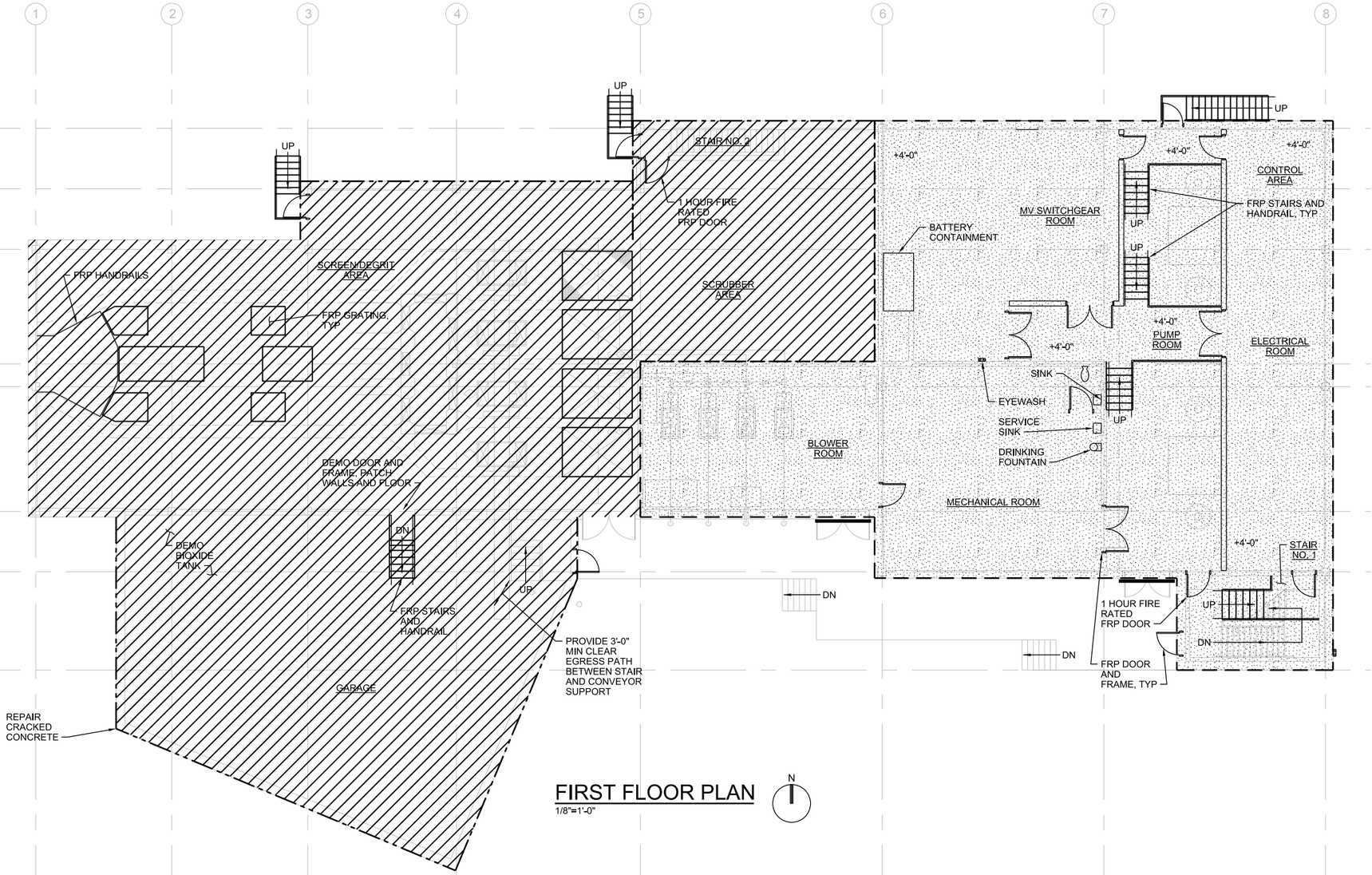
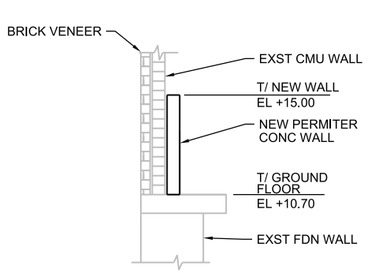
FLOOD PROOFING NOTES

1. BASE FLOOD EL (BFE) = 12.00
2. DESIGN FLOOD EL (DFE) = 13.00
3. PROJECTED SEA LEVEL RISE EL (SLR) = 15.00
4. THE GROUND FLOOR EL = 10.70
5. AREAS IDENTIFIED FOR WET FLOOD PROOFING SHALL CONFORM WITH THE FOLLOWING:
   a. AREA OF FLOOD RELIEF OPENINGS (Ao) = 2.5 in^2/1.0 ft^2
6. AREAS IDENTIFIED FOR DRY FLOOD PROOFING SHALL CONFORM WITH THE FOLLOWING:
   a. FLOOD PROOFING PLAN SHALL BE APPROVED BY "AHJ".
   b. A BUILDING CODE COMPLIANT EXIT DOOR FROM EACH ISOLATED ROOM WITHIN THE DRY FLOOD PROOF AREA SHALL BE PROVIDED.
   c. ALL ELECTRICAL, LIFE SAFETY AND ESSENTIAL EQUIPMENT SHALL BE LOCATED ABOVE THE DFE.



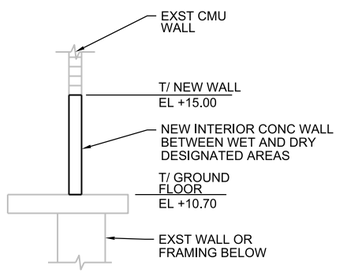
FIRST FLOOR PLAN

1/8"=1'-0"



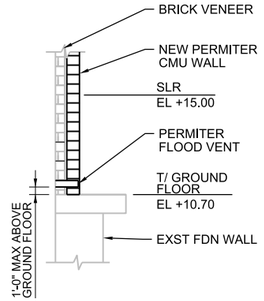
DRY FLOOD PROOFING PERMITER WALL

1 DETAIL NTS



DRY FLOOD PROOFING INTERIOR WALL

1a DETAIL NTS



WET FLOOD PROOFING PERMITER WALL

2 DETAIL NTS

LEGEND

- NEW PERMANENT CONCRETE WALL
- PERIMETER FLOOD BARRICADE
- REMOVABLE FLOOD BARRICADE
- DRY FLOOD PROOF AREA WITH FLOOD BARRICADES
- WET FLOOD PROOF AREA WITH FLOOD VENTS

NO.	DATE	DSGN	DR	CHK	APVD
		J. OSOKIE	M. DEL DUCA	BY	APVD

REVISION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

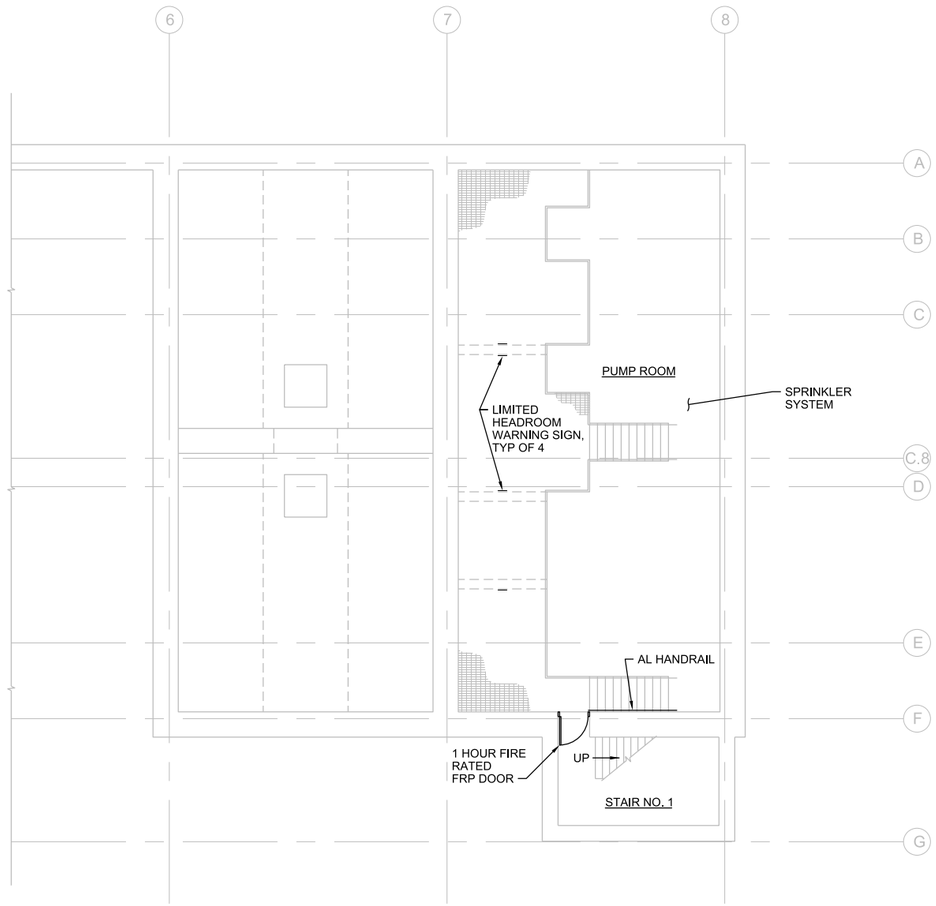
FLOOD RESISTANT DESIGN

BOULEVARD PUMP STATION
FLOOD PROOFING PLAN
45 MGD CAPACITY

PRELIMINARY – NOT FOR CONSTRUCTION

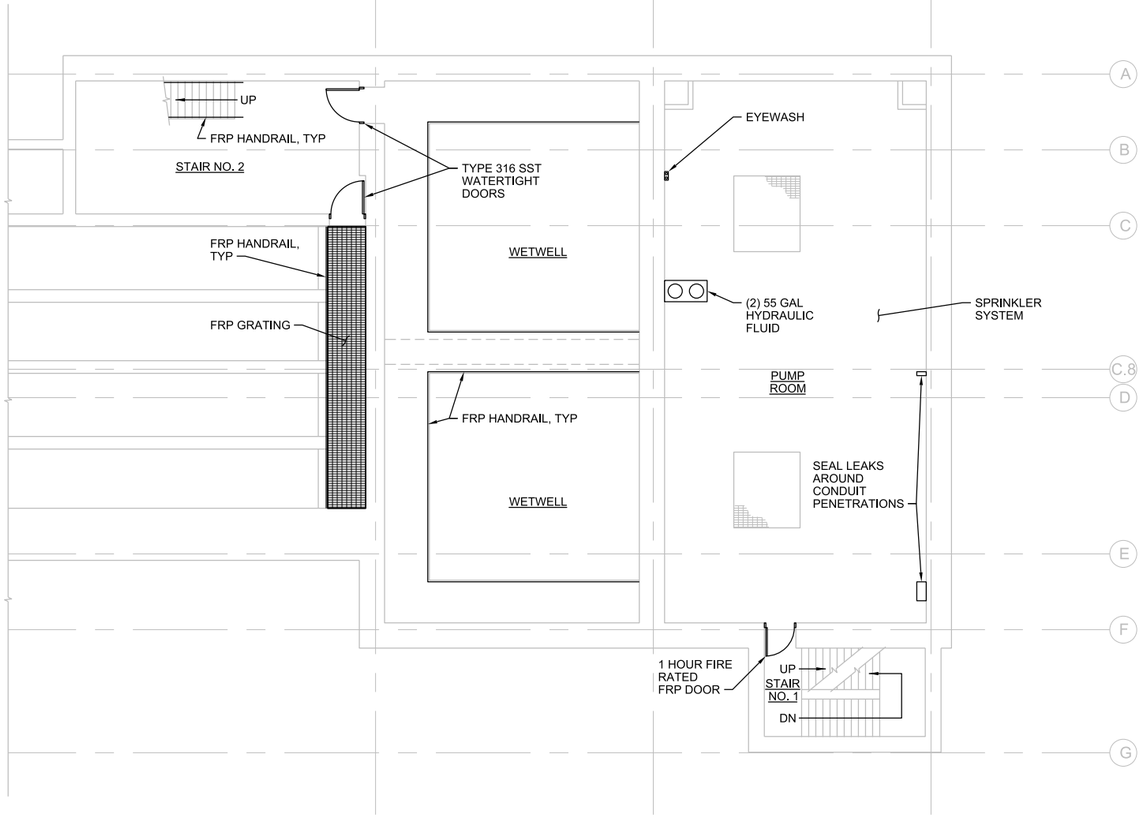
1/8"=1'-0"
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-S-201
SHEET	of



PLAN AT ELEV -12.00

1/8"=1'-0"



PLAN AT ELEV -6.00

1/8"=1'-0"

NO.	DATE	BY	APVD
DSGN	R. SIEBERS	DR	APVD
		CHK	D. MICHALEK

REVISION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

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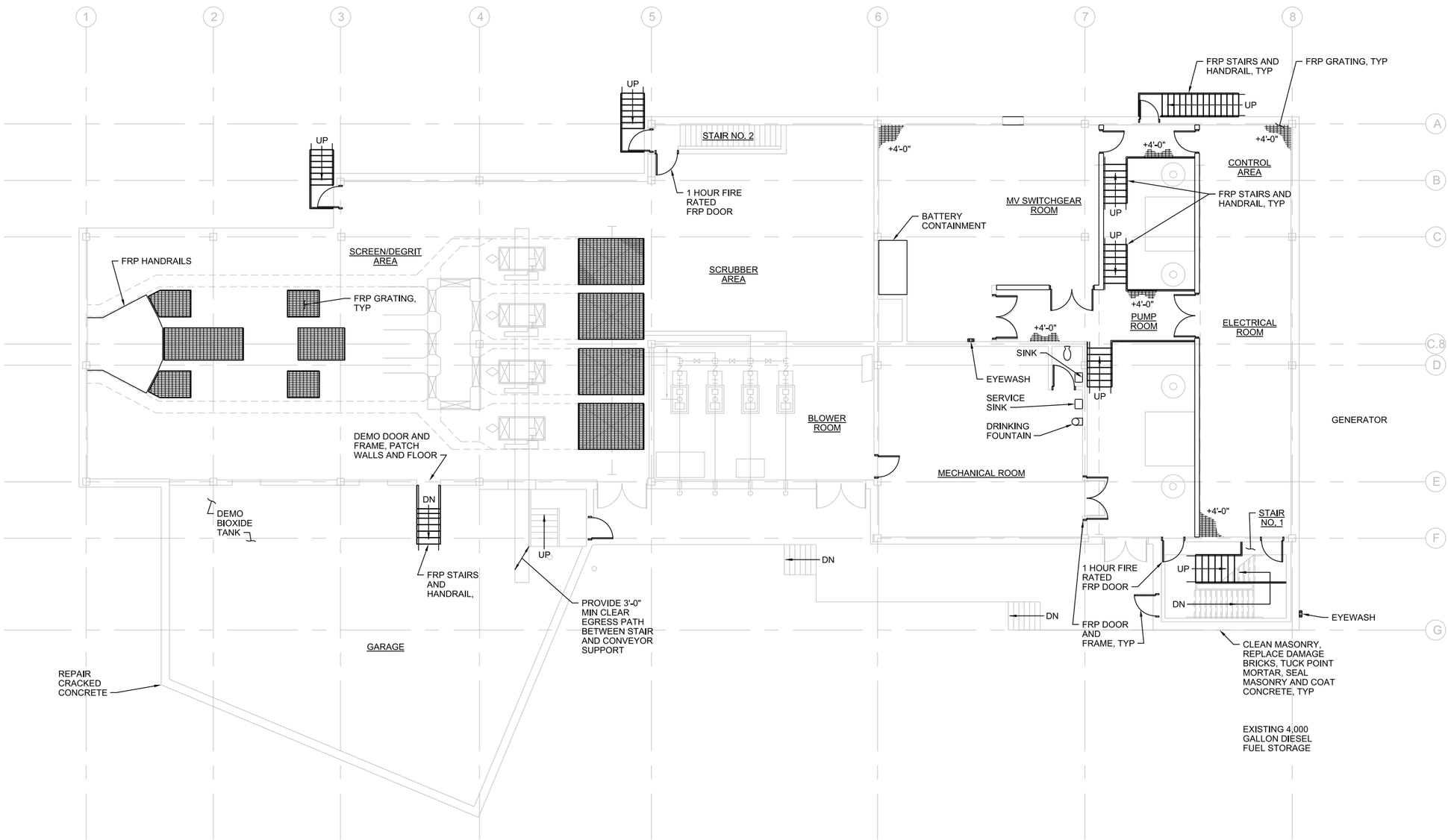
PRELIMINARY – NOT FOR CONSTRUCTION

ch2m

ARCHITECTURAL

BOULEVARD PUMP STATION
LOWER PLANS
45 MGD CAPACITY

1/8"=1'-0"	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	NOVEMBER 2016
PROJ	664626
DWG	300-A-201
SHEET	of



FIRST FLOOR PLAN

1/8"=1'-0"

N

NO.	DATE	REVISION	DR	CHK	APVD	BY
DSGN	R. SIEBERS		D. MICHALEK	APVD		

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

PRELIMINARY – NOT FOR CONSTRUCTION

ch2m

ARCHITECTURAL

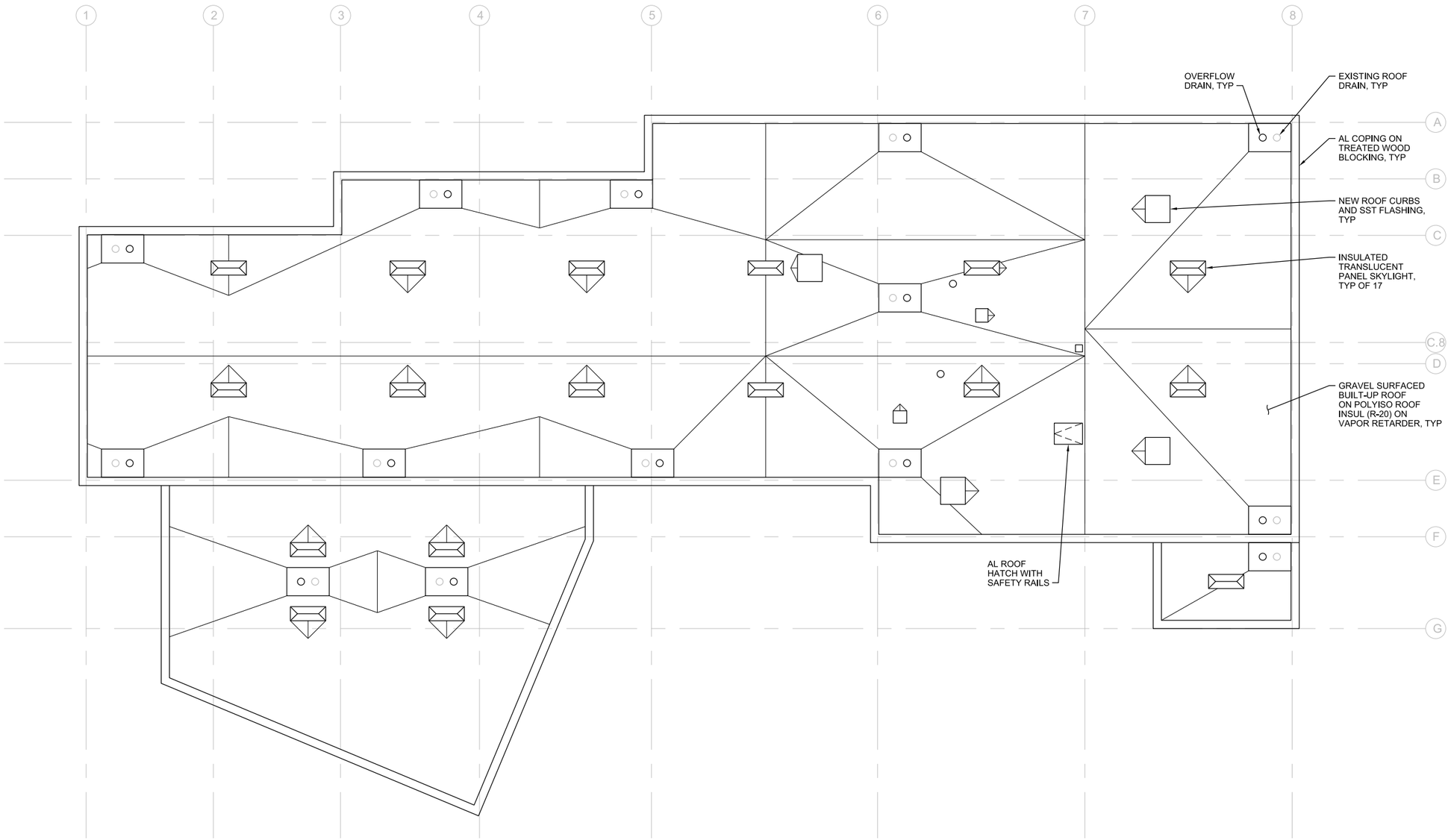
BOULEVARD PUMP STATION
PLAN
45 MGD CAPACITY

1/8"=1'-0"

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-A-202
SHEET	of



ROOF PLAN

1/8"=1'-0"

N

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN	R. SIEBERS		D. MICHALEK				

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ch2m:

ARCHITECTURAL

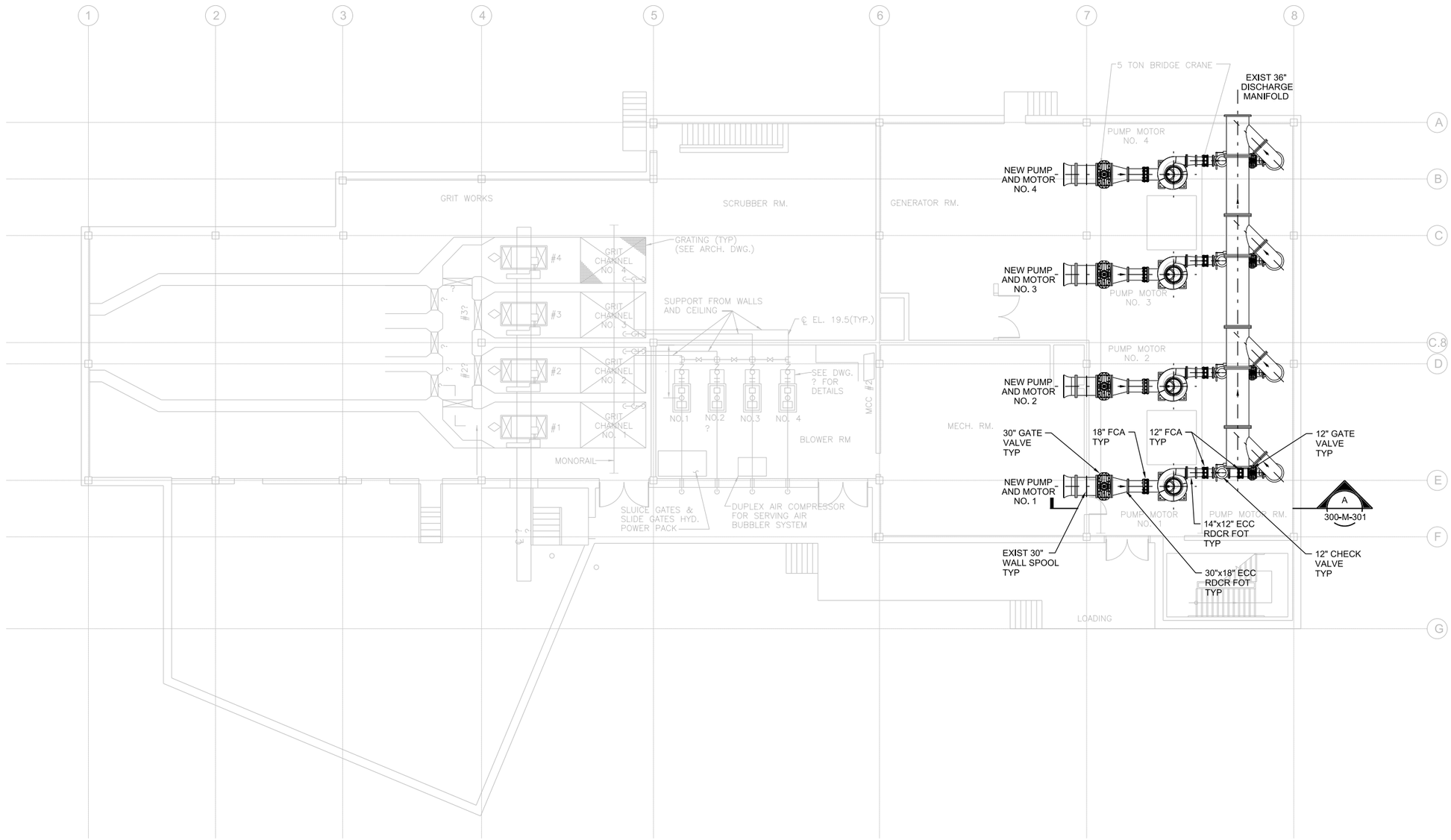
BOULEVARD PUMP STATION
ROOF PLAN
45 MGD CAPACITY

PRELIMINARY – NOT FOR CONSTRUCTION

1/4"=1'-0"
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-A-203
SHEET	of

GENERAL NOTES



N

BOULEVARD PUMP STATION - ALTERNATE 2 PLAN

1/8"=1'-0"

NO.	DATE	DR	CHK	APVD	REVISION
DSGN	S. CLARK	Z. BRYAN	OC	APVD	BY APVD

Seal

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

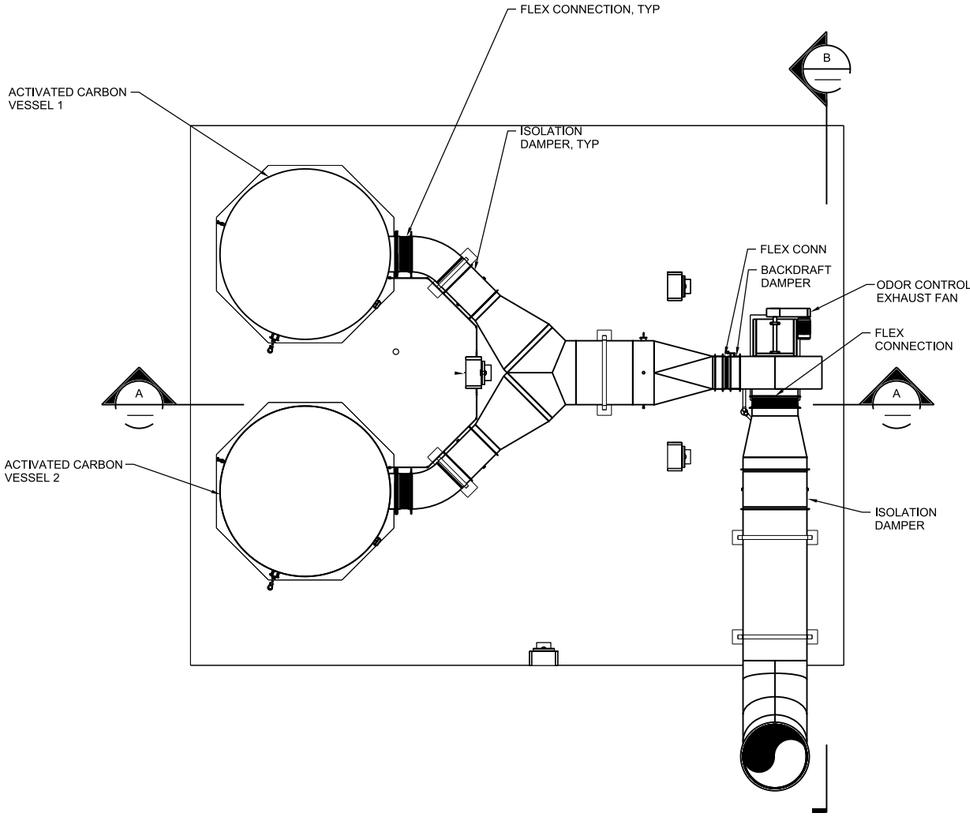
ch2m

PROCESS MECHANICAL
BOULEVARD PUMP STATION
45 MGD CAPACITY

PRELIMINARY – NOT FOR CONSTRUCTION

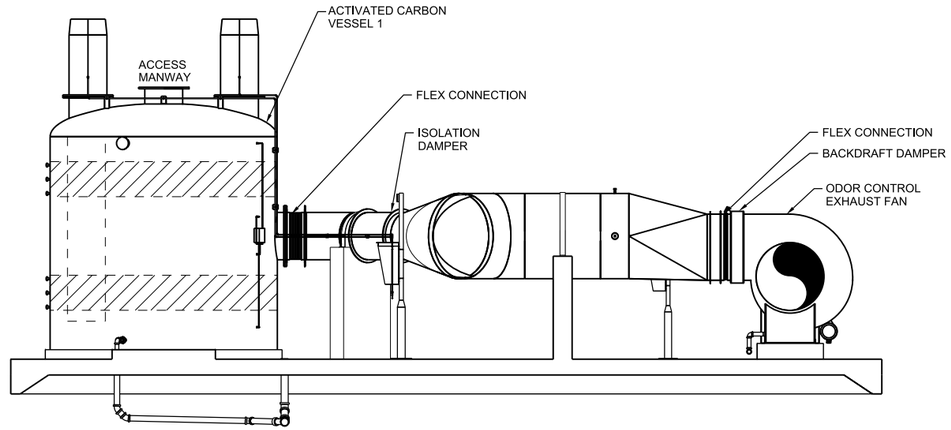
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-M-201
SHEET	of



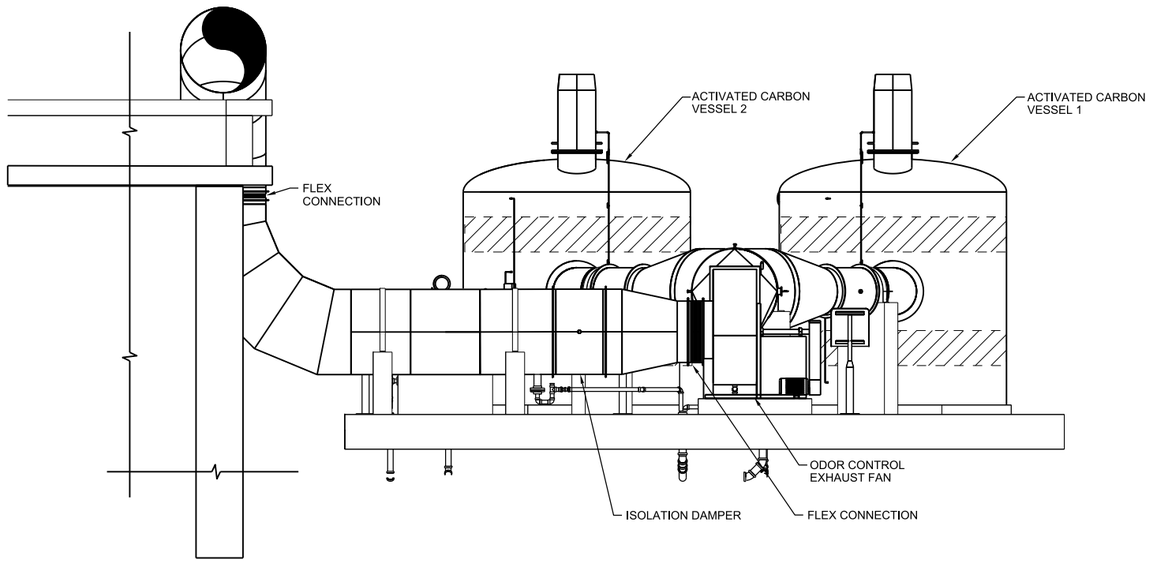
ODOR CONTROL - PLAN

3/16"=1'-0"



A SECTION

1/4"=1'-0"



B SECTION

1/4"=1'-0"

NO.	DSGN	DATE	DR	CHK	APVD
REVISION			Z. BRYAN		APVD
				BY	APVD

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

PROCESS MECHANICAL

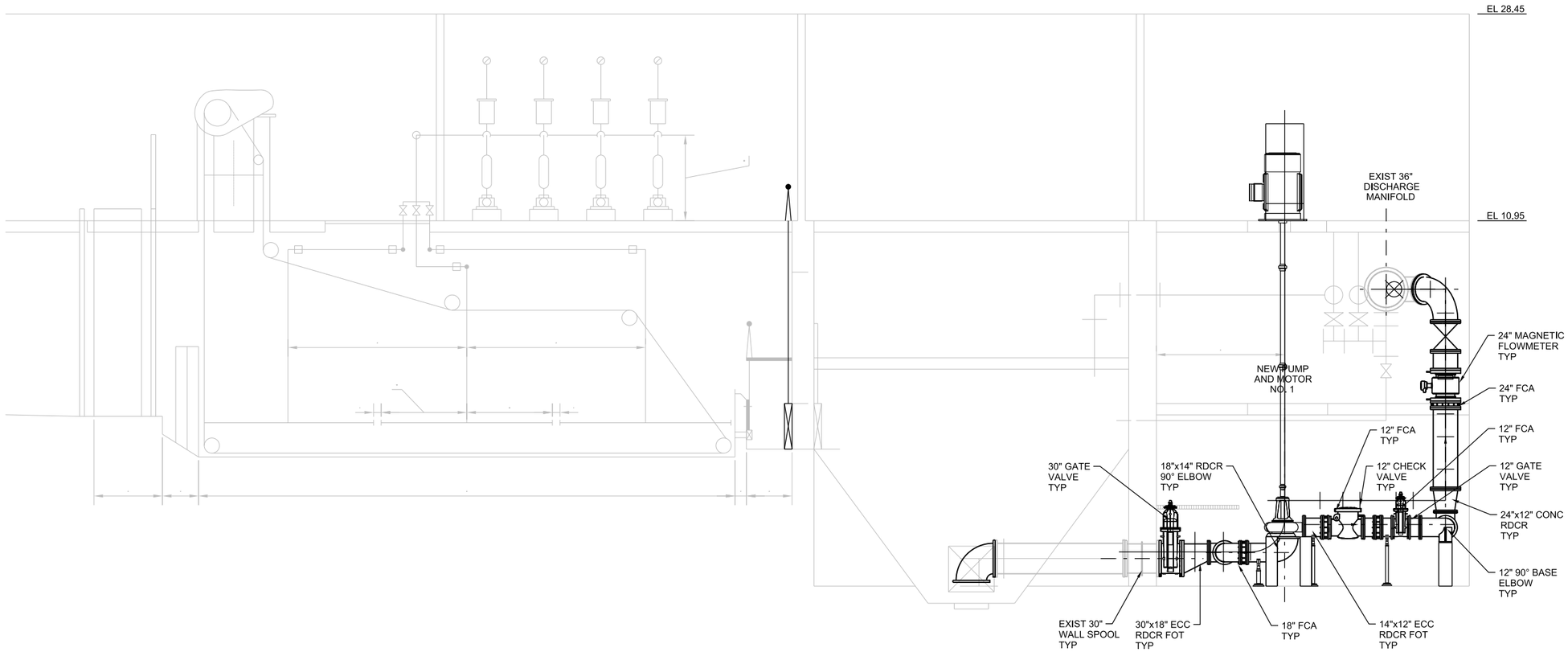
BLVD PUMP STAION
ODOR CONTROL
PLAN & SECTIONS

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-M-215
SHEET	of



A BOULEVARD PUMP STATION - ALTERNATE 2 SECTION
3/16"=1'-0"
300-M-201

NO.	DATE	DR	CHK	APVD	BY	APVD
DSGN	S. CLARK	Z. BRYAN	OC			Seal

REVISION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

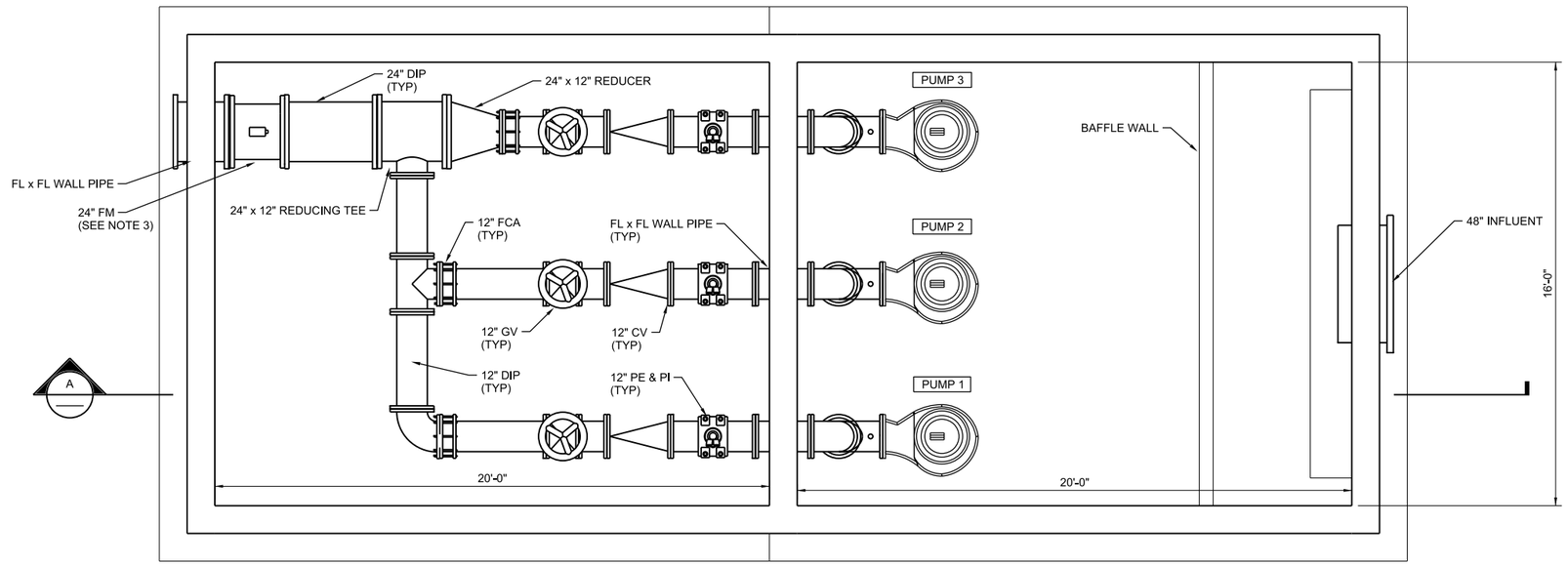
PROCESS MECHANICAL

BOULEVARD PUMP STATION
45 MGD CAPACITY
SECTION

PRELIMINARY – NOT FOR CONSTRUCTION

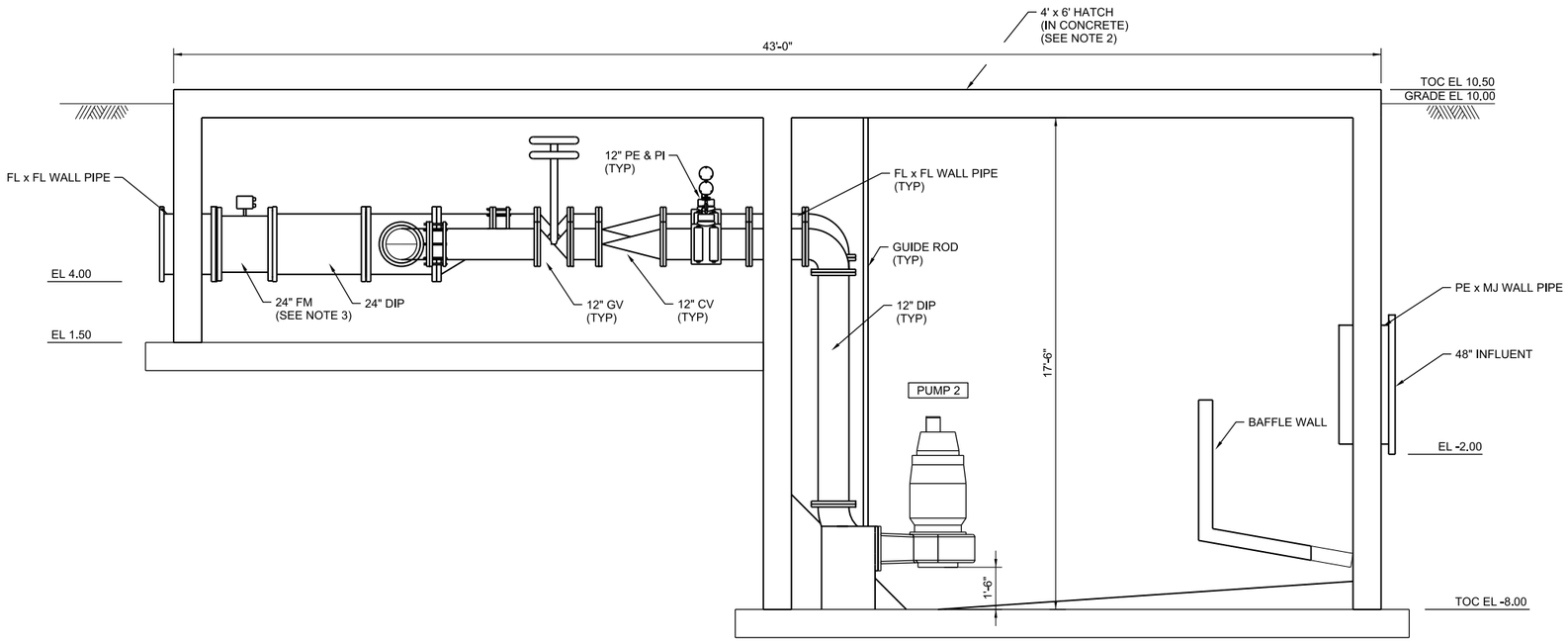
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-M-301
SHEET	of



DRY WEATHER PUMP STATION

3/8"=1'-0"



A SECTION

3/8"=1'-0"

GENERAL NOTES

1. PROVIDE A CHAIN ON PUMPS FOR REMOVAL IF NEEDED.
2. PROVIDE A 4' x 6' HATCH PER EACH PUMP FOR ACCESS. CENTER ACCESS HATCH OVER PUMPS.
3. PROVIDE A BURIED GATE VALVE DOWN STREAM OF THE FLOW METER.

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN		Engineer	ZBRYAN		OC		Seal

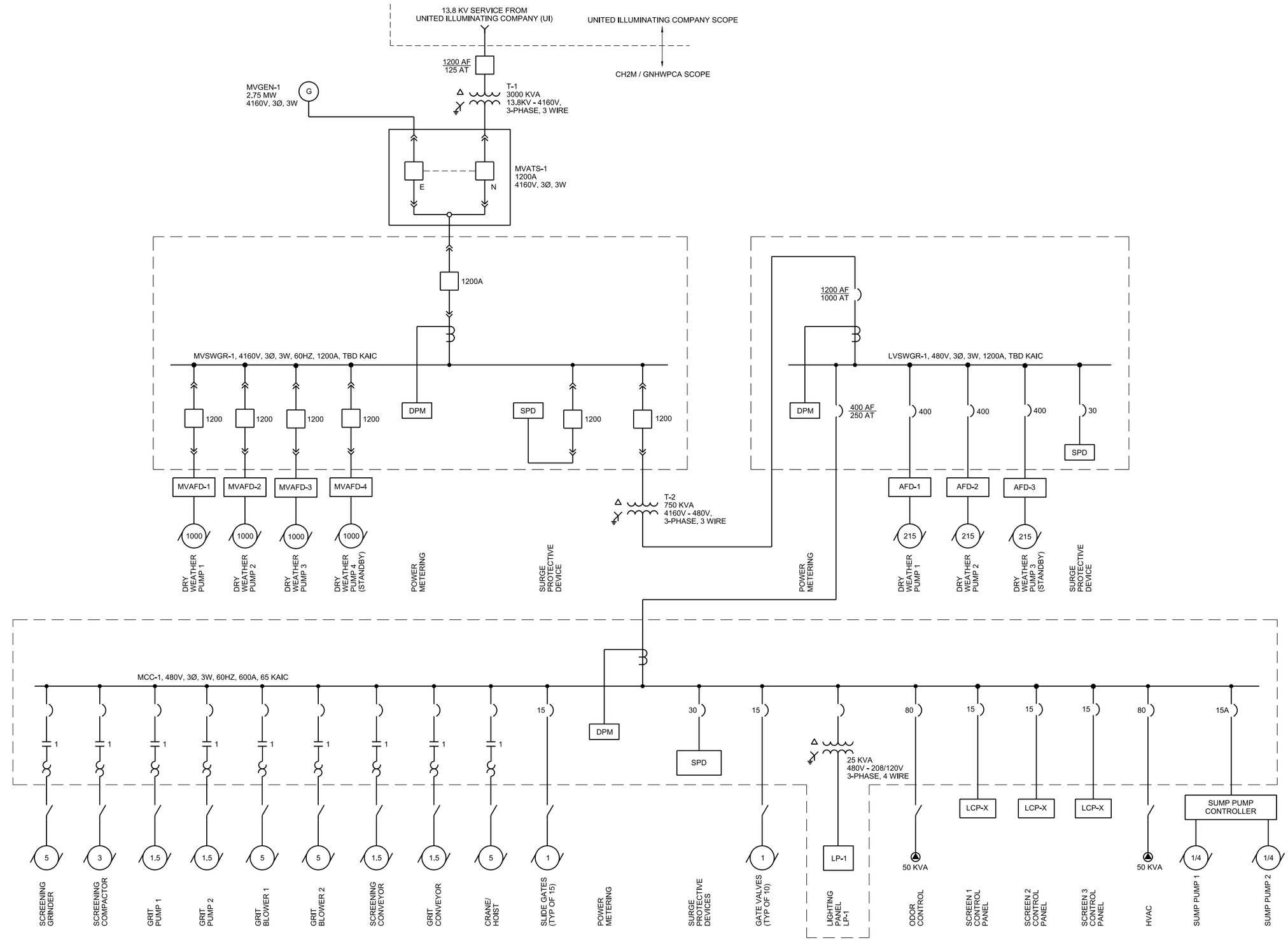
GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

PROCESS MECHANICAL
BOULEVARD
DRY WEATHER PUMP STATION
PLAN & SECTION

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	310-M-201
SHEET	of



SINGLE LINE DIAGRAM

NTS

NO.	DSGN	DATE	DR	REVISION	CHK	APVD	BY	APVD
		R. WOOD	M. REICHERT					

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ELECTRICAL

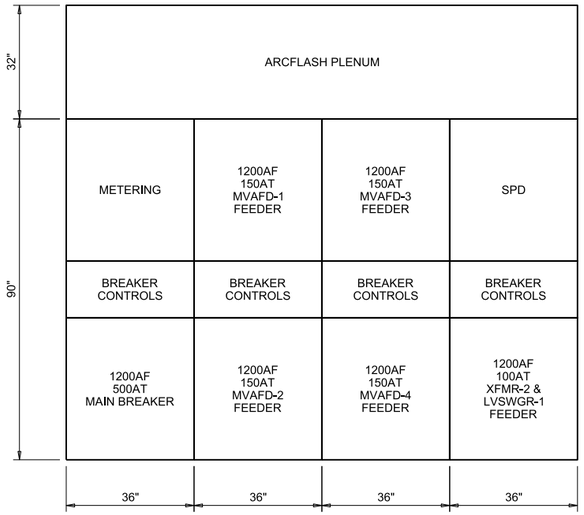
BOULEVARD PUMP STATION
SINGLE LINE DIAGRAM

VERIFY SCALE

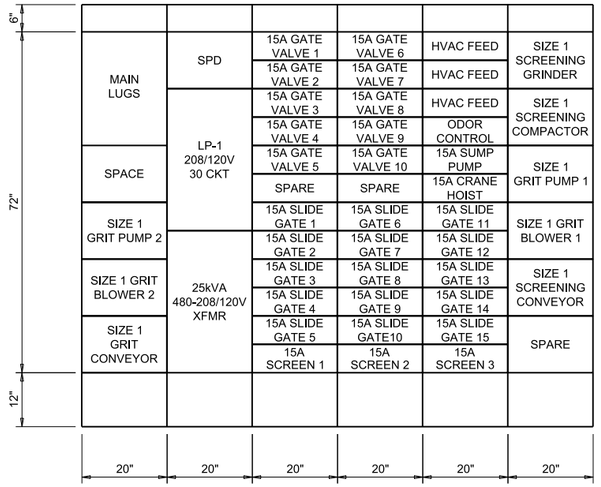
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-E-201
SHEET	of

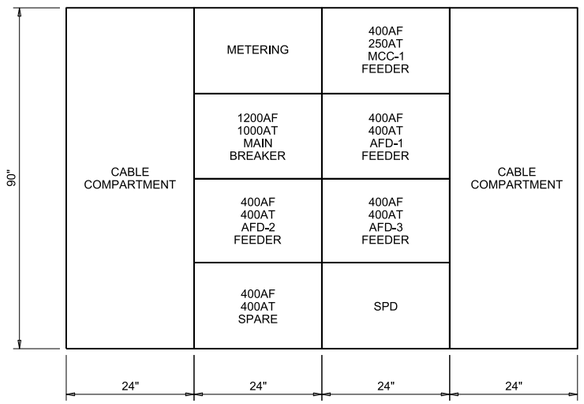
PRELIMINARY – NOT FOR CONSTRUCTION



MVSWGR-1 ELEVATION
NTS



MCC-1 ELEVATION
NTS



LVSWGR-1 ELEVATION
NTS

NO.	DSGN	DATE	DR	CHK	APVD	BY	REVISION
		R. WOOD	M. REICHERT	APVD	APVD		

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ELECTRICAL

BOULEVARD PUMP STATION
MVSWGR-1 AND MCC-1 ELEVATIONS

PRELIMINARY – NOT FOR CONSTRUCTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-E-202
SHEET	of

SHEET KEYNOTES

1. EXISTING GENERATOR TO BE DEMOLISHED.
2. NEW GENERATOR TO BE INSTALLED IN WEATHERPROOF ENCLOSURE ON PAD AT ELEVATION 15.00. PROVIDE ACCESS STAIRS AND WALKWAYS AS REQUIRED.
3. NEW 13.8 KV - 4160V, 3000 KVA TRANSFORMER. TOP OF PAD AT ELEVATION 15.00.
4. NEW 4160 - 480V, 750 KVA TRANSFORMER. TOP OF PAD AT ELEVATION 15.00.
5. EXISTING 13.8 KV - 480V TRANSFORMER. REMOVE AFTER NEW SERVICE INSTALLED.
6. REPLACE IN PLACE WITH NEW 3000 GALLON FUEL TANK OR REUSE EXISTING FUEL TANK. MOUNT TANK ON NEW PAD AT ELEVATION 15.00 OR PROVIDE WATERPROOFING FOR TANK BELOW ELEVATION 15.00. PROVIDE ACCESS STAIRS AND WALKWAYS AS REQUIRED.

SCREEN/DEGRIT AREA
SCRUBBER AREA
MVATS-1
MVSWGR-1
MV SWITCHGEAR ROOM
GENERATOR ROOM
13.8 KV SERVICE ENTRANCE
OPERATOR STATION
HMI WORKSTATION
PUMP 4
CONTROLS AREA
PLC
PUMP 3
AFD-3
LVSWGR-1
ELECTRICAL/ CONTROL ROOM
AFD-2
ELECTRICAL AREA
PUMP ROOM
PUMP 2
MVAFD-4
AFD-1
BLOWER ROOM
MECHANICAL ROOM
MVAFD-3
MCC-1
MVAFD-2
PUMP 1
MVAFD-1
GARAGE
GENERATOR FUEL TANK
GUARD POST, TYP

FIRST FLOOR PLAN
1/8"=1'-0"

NO.	DATE	DR	CHK	APVD	BY	APVD
DSGN	R. WOOD	M. REICHERT				

REVISION

GNHWPCA LONG TERM CONTROL PLAN
GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
NEW HAVEN, CONNECTICUT

ELECTRICAL
BOULEVARD PUMP STATION
FIRST FLOOR PLAN

1/8"=1'-0"
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2016
PROJ	664626
DWG	300-E-203
SHEET	of

PRELIMINARY – NOT FOR CONSTRUCTION

Appendix F
Construction Cost Estimate Breakdown

Intermediate-Term Improvements
Capacity Upgrade of East Street Pump Station

Facility Summary

	Project: East Street Pump Station	Estimator:	E.B. Smith/GNV, A. Frisch/PGH
Job Size: 1 LS	Project No.: 478874	Revision / Date:	Rev03/(10-4-2016)
Duration: 1 LS	Design Stage: conceptual	Estimate Class:	4

Facility	Description	Direct Amount	Grand Total w/Markups	Percent of Total
0200	**East Street Pump Station**	**8,199,409**	**19,115,106**	**65.986**
0305	**Dry Weather Pump Station**	**4,316,718**	**9,853,208**	**34.014**

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	7,826,612			27.02%
Material	12,839,365			44.32%
Subcontract	3,990,129			13.77%
Equipment	4,193,215			14.48%
Other	118,993			0.41%
Total Prime Contractor Costs	**28,968,314**	**28,968,314**		**100.00**

Detail Report

Job Size: 1 LS
Duration: 1 LS

Project: East Street Pump Station
Project No.: 478874
Design Stage: conceptual

Estimator: E.B. Smith/GNV, A. Frisch/PGH
Revision / Date: Rev03/(10-4-2016)
Estimate Class: 4

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
0200			East Street Pump Station											
	01.0		General Requirements											
		01.06	Startup & Commissioning											
			Startup and Testing											
			General Conditions, Other											
			Startup, Testing, and Contractor Commissioning Allowance	1.00 ls		81,263	0	-	27,976	-	109,238.91 /ls	109,239	233,776.16 /ls	233,776
			General Conditions, Other	1.00 LS		81,263			27,976		109,238.91 /LS	109,239	233,776.16 /LS	233,776
			Startup and Testing	1.00 LS		81,263			27,976		109,238.91 /LS	109,239	233,776.16 /LS	233,776
			01.06 Startup & Commissioning	1.00 LS		81,263			27,976		109,238.91 /LS	109,239	233,776.16 /LS	233,776
			01.0 General Requirements	1.00 LS		81,263			27,976		109,238.91 /LS	109,239	233,776.16 /LS	233,776
	02.0		Existing Conditions											
		02.40	Demolition											
			Selective Demolition											
			Structure/Building Demolition											
			Demolish existing grit equipment and all associated works	1.00 ea	293.1	22,223		-	3,944	-	26,166.41 /ea	26,166	59,922.25 /ea	59,922
			Demo pumps	4.00 ea	319.7	24,043	205	-	1,066	-	6,328.49 /ea	25,314	14,492.53 /ea	57,970
			Demo Diesel Tank	1.00 ea	32.0	2,404	-	-	400	-	2,803.97 /ea	2,804	6,421.21 /ea	6,421
			Door demolition, single, remove	1.00 ea	1.3	102	-	-	-	-	101.58 /ea	102	232.63 /ea	233
			Demolition Allowance	5.00 Days		0	-	12,809	-	-	2,561.89 /Days	12,809	5,866.84 /Days	29,334
			Demo Stair Opening	3.00 Days			-	7,686	-	-	2,561.89 /Days	7,686	5,866.84 /Days	17,601
			Demo existing roof	4,857.00 sf		12,941		-	19,411	-	6.66 /sf	32,352	15.25 /sf	74,088
			Structure/Building Demolition	1.00 SF	646.1	61,713	205	20,495	24,820		107,233.05 /SF	107,233	245,568.50 /SF	245,569
			Selective Demolition	1.00 LS	646.1	61,713	205	20,495	24,820		107,233.05 /LS	107,233	245,568.50 /LS	245,569
			Electrical Facility Demolition											
			Electrical Facility Demolition											
			Electrical demo, remove misc. electrical equipment, transformers, etc.	9,488.00 sf	9,479.8	776,200	-	-	-	-	81.81 /sf	776,200	187.35 /sf	1,777,532
			Electrical Facility Demolition	9,488.00 SF	9,479.8	776,200					81.81 /SF	776,200	187.35 /SF	1,777,532
			Electrical Facility Demolition	1.00 LS	9,479.8	776,200					776,199.85 /LS	776,200	1,777,532.46 /LS	1,777,532
			02.40 Demolition	1.00 LS	10,125.9	837,913	205	20,495	24,820		883,432.90 /LS	883,433	2,023,100.96 /LS	2,023,101
			02.0 Existing Conditions	1.00 LS	10,125.9	837,913	205	20,495	24,820		883,432.90 /LS	883,433	2,023,100.96 /LS	2,023,101
	03.0		Concrete Work											
		03.10	Cast-In-Place Concrete Work											
			Electrical Equipment Pads											
			Cast-in-Place Concrete, Purchase											
			Edge forms, housekeeping pads, up to 6"	242.00 lf	17.1	1,278	64	-	-	-	5.55 /lf	1,343	12.71 /lf	3,075
			Concrete, ready mix, 4000 psi	6.25 CY		-	769	-	-	-	122.97 /CY	769	281.61 /CY	1,760
			Add for concrete waste, 4000 psi	0.31 cy		-	38	-	-	-	122.98 /cy	38	281.67 /cy	88
			Finish housekeeping pads	506.25 sf	27.0	1,867	16	-	-	-	3.72 /sf	1,883	8.52 /sf	4,312
			Curing, membrane spray	506.25 sf	1.3	79	21	-	-	-	0.20 /sf	100	0.45 /sf	228
			Cast-in-Place Concrete, Purchase	1.00 CY	45.4	3,225	908				4,132.73 /CY	4,133	9,464.13 /CY	9,464
			Electrical Equipment Pads	1.00 CY	45.4	3,225	908				4,132.73 /CY	4,133	9,464.13 /CY	9,464
			Electrical Equipment Pad - Generator, Xfmrs											
			Cast-In-Place Concrete, Equipment Pads, 24" thick											
			Equipment pad forms, large	314.00 sf	104.6	7,824	483	-	-	-	26.46 /sf	8,307	60.58 /sf	19,023
			Reinforcing in place, A615 Gr 60, priced per lbs.	2,050.00 lb		-	1,050	840	-	-	0.92 /lb	1,891	2.11 /lb	4,330
			Concrete, ready mix, 4000 psi	20.00 CY		-	2,459	-	-	-	122.97 /CY	2,459	281.61 /CY	5,632
			Concrete, ready mix, 4000 psi	7.33 CY		-	902	-	-	-	122.97 /CY	902	281.60 /CY	2,065
			Add for concrete waste, 4000 psi	1.00 cy		-	123	-	-	-	122.98 /cy	123	281.65 /cy	282
			Add for concrete waste, 4000 psi	0.10 cy		-	12	-	-	-	122.90 /cy	12	281.70 /cy	28
			Add for concrete waste, 4000 psi	0.27 cy		-	33	-	-	-	123.00 /cy	33	281.61 /cy	75
			Finishing floors, monolithic, broom finish	297.00 sf	11.9	822	6	-	-	-	2.79 /sf	828	6.38 /sf	1,896
			Finishing floors, monolithic, broom finish	72.00 sf	2.9	199	1	-	-	-	2.79 /sf	201	6.38 /sf	459
			Patch & plug tieholes	246.00 sf	4.9	288	5	-	-	-	1.19 /sf	293	2.73 /sf	671
			Patch & plug tieholes	68.00 sf	1.4	80	1	-	-	-	1.19 /sf	81	2.73 /sf	186
			Sack rub	314.00 sf	16.7	981	10	-	-	-	3.15 /sf	990	7.22 /sf	2,268
			Curing, water	369.00 sf	1.6	96	19	-	-	-	0.31 /sf	115	0.71 /sf	263
			Cast-In-Place Concrete, Equipment Pads, 24" thick	1.00 CY	144.0	10,289	5,105	840			16,234.53 /CY	16,235	37,177.81 /CY	37,178
			Electrical Equipment Pad - Generator, Xfmrs	1.00 LS	144.0	10,289	5,105	840			16,234.53 /LS	16,235	37,177.81 /LS	37,178
			Concrete Wall - Floodproof Wall, 8" thick											
			Cast-In-Place Concrete, Straight Walls, 8" thick											
			Concrete pumping, subcontract, all inclusive price	31.61 cy		-	-	558	-	-	17.66 /cy	558	40.44 /cy	1,278
			Forms in place, structural walls, to 8' high, hand set	2,560.00 sf	587.7	43,972	3,014	-	-	-	18.35 /sf	46,986	42.03 /sf	107,601
			Speed Dowels, #5	320.00 ea		-	5,274	-	-	-	16.48 /ea	5,274	37.75 /ea	12,078
			Reinforcing in place, A615 Gr 60, priced per lbs.	5,688.89 lb		-	3,349	2,679	-	-	1.06 /lb	6,028	2.43 /lb	13,804
			Concrete, ready mix, 4000 psi	31.61 CY		-	4,205	-	-	-	133.04 /CY	4,205	304.66 /CY	9,629
			Add for concrete waste, 4000 psi	2.00 cy		-	266	-	-	-	133.04 /cy	266	304.67 /cy	609
			Placing concrete, concrete pump, for structural wall to 12" thick	31.61 cy	41.1	2,410	-	-	-	-	76.24 /cy	2,410	174.59 /cy	5,518
			Patch & plug tieholes	2,560.00 sf	58.8	3,443	60	-	-	-	1.37 /sf	3,504	3.13 /sf	8,023

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Cast-In-Place Concrete, Straight Walls, 8" thick											
			Sack rub	2,560.00 sf	156.7	9,185	90	-	-	-	3.62 /sf	9,275	8.30 /sf	21,241
			Curing, membrane spray	2,560.00 sf	7.8	459	121	-	-	-	0.23 /sf	580	0.52 /sf	1,328
			Cast-In-Place Concrete, Straight Walls, 8" thick	**31.61 CY**	**852.2**	**59,469**	**16,379**	**3,237**			**2,501.91 /CY**	**79,085**	**5,729.49 /CY**	**181,109**
			Concrete Wall - Floodproof Wall, 8" thick	**31.61 CY**	**852.2**	**59,469**	**16,379**	**3,237**			**2,501.91 /CY**	**79,085**	**5,729.49 /CY**	**181,109**
			Concrete Wall @ Upper Floor											
			Cast-In-Place Concrete, Straight Walls, 12" thick											
			Concrete pumping, subcontract, all inclusive price	50.00 cy		-	-	769	-	-	15.37 /cy	769	35.20 /cy	1,760
			Forms in place, structural walls, > 8' to 16' high, hand set	2,700.00 sf	719.4	53,823	3,459	-	-	-	21.22 /sf	57,282	48.58 /sf	131,178
			Reinforcing in place, A615 Gr 60, priced per lbs.	6,758.64 lb		-	3,463	2,770	-	-	0.92 /lb	6,233	2.11 /lb	14,275
			Concrete, ready mix, 4000 psi	50.00 CY		-	6,149	-	-	-	122.97 /CY	6,149	281.61 /CY	14,080
			Add for concrete waste, 4000 psi	2.50 cy		-	307	-	-	-	122.97 /cy	307	281.61 /cy	704
			Add amount for Fuel Surcharges - per concrete truck load	6.00 load		-	92	-	-	-	15.37 /load	92	35.20 /load	211
			Add amount for Environmental Fee - per concrete truck load	6.00 load		-	37	-	-	-	6.15 /load	37	14.08 /load	84
			Placing concrete, concrete pump, for structural wall to 12" thick	50.00 cy	56.6	3,318	-	-	-	-	66.36 /cy	3,318	151.97 /cy	7,599
			Patch & plug tieholes	2,700.00 sf	53.9	3,162	55	-	-	-	1.19 /sf	3,217	2.73 /sf	7,367
			Sack rub	2,700.00 sf	143.9	8,432	83	-	-	-	3.15 /sf	8,515	7.22 /sf	19,501
			Curing, membrane spray	2,700.00 sf	7.2	422	111	-	-	-	0.20 /sf	532	0.45 /sf	1,219
			Cast-In-Place Concrete, Straight Walls, 12" thick	**50.00 CY**	**981.0**	**69,157**	**13,756**	**3,539**			**1,729.03 /CY**	**86,452**	**3,959.56 /CY**	**197,978**
			Concrete Wall @ Upper Floor	**50.00 CY**	**981.0**	**69,157**	**13,756**	**3,539**			**1,729.03 /CY**	**86,452**	**3,959.56 /CY**	**197,978**
			SOG @ Door											
			Cast-In-Place Concrete, Slabs on Grade, 12" thick											
			Fine grade, for slab on grade, by hand	63.00 sf	0.6	34	2	-	-	-	0.58 /sf	36	1.32 /sf	83
			Concrete pumping, subcontract, all inclusive price	2.33 cy		-	-	36	-	-	15.37 /cy	36	35.20 /cy	82
			Slab on grade edge forms, 7" to 12"	55.00 sf	13.2	987	56	-	-	-	18.97 /sf	1,043	43.43 /sf	2,389
			Reinforcing in place, A615 Gr 60, priced per lbs.	315.40 lb		-	162	129	-	-	0.92 /lb	291	2.11 /lb	666
			Concrete, ready mix, 4000 psi	2.33 CY		-	287	-	-	-	122.97 /CY	287	281.60 /CY	657
			Add for concrete waste, 4000 psi	0.12 cy		-	14	-	-	-	123.00 /cy	14	281.71 /cy	33
			Add amount for Fuel Surcharges - per concrete truck load	1.00 load		-	15	-	-	-	15.37 /load	15	35.20 /load	35
			Add amount for Environmental Fee - per concrete truck load	1.00 load		-	6	-	-	-	6.15 /load	6	14.08 /load	14
			Placing concrete, concrete pump	2.33 cy	2.3	137	-	-	-	-	58.55 /cy	137	134.08 /cy	313
			Finishing floors, monolithic, trowel finish (machine)	63.00 sf	1.7	116	1	-	-	-	1.86 /sf	117	4.27 /sf	269
			Curing, water	63.00 sf	0.3	16	3	-	-	-	0.31 /sf	20	0.71 /sf	45
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	**2.33 CY**	**18.1**	**1,290**	**547**	**165**			**859.49 /CY**	**2,003**	**1,968.27 /CY**	**4,586**
			SOG @ Door	**2.33 CY**	**18.1**	**1,290**	**547**	**165**			**859.49 /CY**	**2,003**	**1,968.27 /CY**	**4,586**
			12" SOG											
			Cast-In-Place Concrete, Slabs on Grade, 12" thick											
			Fine grade, for slab on grade, by hand	115.00 sf	1.1	63	4	-	-	-	0.58 /sf	66	1.32 /sf	152
			Concrete pumping, subcontract, all inclusive price	4.26 cy		-	-	65	-	-	15.37 /cy	65	35.20 /cy	150
			Slab on grade edge forms, 7" to 12"	55.00 sf	13.2	987	56	-	-	-	18.97 /sf	1,043	43.43 /sf	2,389
			Reinforcing in place, A615 Gr 60, priced per lbs.	575.74 lb		-	295	236	-	-	0.92 /lb	531	2.11 /lb	1,216
			Concrete, ready mix, 4000 psi	4.26 CY		-	524	-	-	-	122.97 /CY	524	281.61 /CY	1,199
			Add for concrete waste, 4000 psi	0.21 cy		-	26	-	-	-	122.96 /cy	26	281.55 /cy	60
			Add amount for Fuel Surcharges - per concrete truck load	1.00 load		-	15	-	-	-	15.37 /load	15	35.21 /load	35
			Add amount for Environmental Fee - per concrete truck load	1.00 load		-	6	-	-	-	6.15 /load	6	14.07 /load	14
			Placing concrete, concrete pump	4.26 cy	4.3	249	-	-	-	-	58.55 /cy	249	134.08 /cy	571
			Finishing floors, monolithic, trowel finish (machine)	115.00 sf	3.1	212	2	-	-	-	1.87 /sf	214	4.27 /sf	491
			Curing, water	115.00 sf	0.5	30	6	-	-	-	0.31 /sf	36	0.71 /sf	82
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	**4.26 CY**	**22.1**	**1,541**	**935**	**301**			**651.86 /CY**	**2,777**	**1,492.79 /CY**	**6,359**
			12" SOG	**4.26 CY**	**22.1**	**1,541**	**935**	**301**			**651.86 /CY**	**2,777**	**1,492.79 /CY**	**6,359**
			03.10 Cast-In-Place Concrete Work	**1.00 CY**	**2,062.7**	**144,972**	**37,629**	**8,083**			**190,683.70 /CY**	**190,684**	**436,674.22 /CY**	**436,674**
			03.0 Concrete Work	**1.00 LS**	**2,062.7**	**144,972**	**37,629**	**8,083**			**190,683.70 /LS**	**190,684**	**436,674.22 /LS**	**436,674**
	04.0		**Masonry**											
		04.00	**Masonry**											
			CMU WAll											
			Masonry Concrete Masonry Units, 8"											
			Scaffolding, rented, 2 stories	110.00 sf		-	-	94	-	-	0.85 /sf	94	1.95 /sf	214
			Grout block cores, solid, 8" thick	110.00 sf		-	-	271	-	-	2.46 /sf	271	5.63 /sf	620
			Masonry reinforcing per square foot	110.00 sf		-	-	169	-	-	1.54 /sf	169	3.52 /sf	387
			Concrete block, back-up, reinforced, 8" thick	110.00 SF		-	-	750	-	-	6.82 /SF	750	15.61 /SF	1,717
			Waterproof sealer, masonry, 2 coats	220.00 sf		-	-	225	-	-	1.03 /sf	225	2.35 /sf	516
			Paint exterior masonry walls, latex	220.00 sf		-	-	225	-	-	1.03 /sf	225	2.35 /sf	516
			Masonry Concrete Masonry Units, 8"	**110.00 SF**				**1,734**			**15.76 /SF**	**1,734**	**36.09 /SF**	**3,970**
			CMU WAll	**110.00 SF**				**1,734**			**15.76 /SF**	**1,734**	**36.09 /SF**	**3,970**
			8" CMU WAll @ Stair											
			Masonry Concrete Masonry Units, 8"											
			Scaffolding, rented, 2 stories	480.00 sf		-	-	408	-	-	0.85 /sf	408	1.95 /sf	935
			Grout block cores, solid, 8" thick	480.00 sf		-	-	1,181	-	-	2.46 /sf	1,181	5.63 /sf	2,703
			Masonry reinforcing per square foot	480.00 sf		-	-	738	-	-	1.54 /sf	738	3.52 /sf	1,690
			Concrete block, back-up, reinforced, 8" thick	480.00 SF		-	-	3,271	-	-	6.82 /SF	3,271	15.61 /SF	7,491

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Masonry Concrete Masonry Units, 8"											
			Waterproof sealer, masonry, 2 coats	960.00 sf		-	-	984	-	-	1.03 /sf	984	2.35 /sf	2,253
			Paint exterior masonry walls, latex	960.00 sf		-	-	984	-	-	1.03 /sf	984	2.35 /sf	2,253
			Masonry Concrete Masonry Units, 8"	**480.00 SF**				**7,565**			**15.76 /SF**	**7,565**	**36.09 /SF**	**17,325**
			8" CMU WAll @ Stair	**480.00 SF**				**7,565**			**15.76 /SF**	**7,565**	**36.09 /SF**	**17,325**
			04.00 Masonry	**590.00 SF**				**9,299**			**15.76 /SF**	**9,299**	**36.09 /SF**	**21,295**
			04.0 Masonry	**590.00 SF**				**9,299**			**15.76 /SF**	**9,299**	**36.09 /SF**	**21,295**
	05.0		**Metals**											
		05.00	**Metals**											
			Railing											
			Metals, Handrailing, 3-Rail											
			Railing, pipe, aluminum, 3 rail, clear anodized	10.00 lf	3.1	285	615	-	49	-	94.93 /lf	949	217.40 /lf	2,174
			Metals, Handrailing, 3-Rail	**10.00 LF**	**3.1**	**285**	**615**		**49**		**94.93 /LF**	**949**	**217.40 /LF**	**2,174**
			Railing	**10.00 LF**	**3.1**	**285**	**615**		**49**		**94.93 /LF**	**949**	**217.40 /LF**	**2,174**
			05.00 Metals	**1.00 LS**	**3.1**	**285**	**615**		**49**		**949.31 /LS**	**949**	**2,173.98 /LS**	**2,174**
		05.10	**Structural Steel**											
			Modifications to Existing Monorail Beam											
			Metals, Structural Steel											
			Allowance to modify the existing monorail beam and all structural related works	1.00 ea				15,371	-	-	15,371.33 /ea	15,371	35,201.00 /ea	35,201
			Metals, Structural Steel	**1.00 TN**				**15,371**			**15,371.33 /TN**	**15,371**	**35,201.00 /TN**	**35,201**
			Modifications to Existing Monorail Beam	**1.00 LS**				**15,371**			**15,371.33 /LS**	**15,371**	**35,201.00 /LS**	**35,201**
			Miscellaneous Metals Allowance											
			Metals, Structural Steel											
			Misc. Metals Allowance	1.00 LS		0	0	5,124	-	-	5,123.77 /LS	5,124	11,733.68 /LS	11,734
			Metals, Structural Steel	**1.00 TN**				**5,124**			**5,123.77 /TN**	**5,124**	**11,733.68 /TN**	**11,734**
			Miscellaneous Metals Allowance	**1.00 LS**				**5,124**			**5,123.77 /LS**	**5,124**	**11,733.68 /LS**	**11,734**
			05.10 Structural Steel	**1.00 LS**				**20,495**			**20,495.10 /LS**	**20,495**	**46,934.68 /LS**	**46,935**
			05.0 Metals	**1.00 LS**	**3.1**	**285**	**615**	**20,495**	**49**		**21,444.41 /LS**	**21,444**	**49,108.66 /LS**	**49,109**
	06.0		**Wood, Plastics and Composites**											
		06.00	**Wood, Plastics and Composites**											
			FRP Grating											
			Wood & Plastics, FRP Fabrications, Gratings											
			Grating fbgls, molded, orange (hi crsv env), 2" sq mesh, 2" thk	854.00 sf	56.9	5,157	21,879	-	-	-	31.66 /sf	27,035	72.50 /sf	61,912
			Wood & Plastics, FRP Fabrications, Gratings	**854.00 SF**	**56.9**	**5,157**	**21,879**				**31.66 /SF**	**27,035**	**72.50 /SF**	**61,912**
			FRP Grating	**854.00 SF**	**56.9**	**5,157**	**21,879**				**31.66 /SF**	**27,035**	**72.50 /SF**	**61,912**
			06.00 Wood, Plastics and Composites	**1.00 LS**	**56.9**	**5,157**	**21,879**				**27,035.32 /LS**	**27,035**	**61,912.11 /LS**	**61,912**
			06.0 Wood, Plastics and Composites	**1.00 LS**	**56.9**	**5,157**	**21,879**				**27,035.32 /LS**	**27,035**	**61,912.11 /LS**	**61,912**
	07.0		**Thermal and Moisture Protection**											
		07.50	**Membrane Roofing**											
			Roofing											
			Thermal & Moisture Protection, Built Up Roofing											
			Roof deck insulation, perlite, 1-1/2" thick R4.17	4,857.00 sf	64.7	4,705	2,389	-	-	-	1.46 /sf	7,094	3.34 /sf	16,246
			Roof deck insulation, polyisocyanurate 2#/CF density, 2-1/2" thick R16	4,857.00 sf	51.8	3,765	5,027	-	-	-	1.81 /sf	8,792	4.15 /sf	20,135
			Built up roof, asphalt base sheet, 3-plies #15 felt, mopped w/ gravel	48.57 sq	164.7	11,812	4,106	-	2,784	-	385.05 /sq	18,702	881.79 /sq	42,828
			Coping, aluminum to .019", duranodic finish, 12" wall	265.00 lf	31.1	2,259	2,132	-	-	-	16.57 /lf	4,391	37.95 /lf	10,056
			Roof hatches	1.00 ea	5.3	390	1,537	-	-	-	1,926.88 /ea	1,927	4,412.64 /ea	4,413
			Skylight, allowance	8.00 ea		-	-	6,149	-	-	768.57 /ea	6,149	1,760.05 /ea	14,080
			Misc. Roofing	1.00 LS				10,248	-	-	10,247.55 /LS	10,248	23,467.36 /LS	23,467
			Drain, roof, 6"	5.00 ea	20.0	1,763	5,078	-	-	-	1,368.20 /ea	6,841	3,133.23 /ea	15,666
			Thermal & Moisture Protection, Built Up Roofing	**4,857.00 SF**	**337.5**	**24,694**	**20,269**	**16,396**	**2,784**		**13.21 /SF**	**64,143**	**30.24 /SF**	**146,891**
			Roofing	**1.00 LS**	**337.5**	**24,694**	**20,269**	**16,396**	**2,784**		**64,143.39 /LS**	**64,143**	**146,891.24 /LS**	**146,891**
			07.50 Membrane Roofing	**1.00 LS**	**337.5**	**24,694**	**20,269**	**16,396**	**2,784**		**64,143.39 /LS**	**64,143**	**146,891.24 /LS**	**146,891**
			07.0 Thermal and Moisture Protection	**1.00 LS**	**337.5**	**24,694**	**20,269**	**16,396**	**2,784**		**64,143.39 /LS**	**64,143**	**146,891.24 /LS**	**146,891**
	08.0		**Openings**											
		08.00	**Openings**											
			Doors											
			Openings, Doors, Frames and Hardware											
			Coml st doors, 316 SST 3'-0" x 7'-0"	2.00 ea	2.5	191	2,121	-	-	-	1,156.25 /ea	2,313	2,647.86 /ea	5,296
			Door hardware, average - H.M., wood, or aluminum	30.00 set	159.9	11,835	10,760	-	-	-	753.16 /set	22,595	1,724.76 /set	51,743
			Frames, steel, knock down, hollow metal, single, 16 ga., up to 5-3/4" deep, 7'-0" h x 3'-0" w	18.00 ea	24.0	1,829	2,859	-	-	-	260.43 /ea	4,688	596.40 /ea	10,735
			Frames, steel, knock down, hollow metal, double, 16 ga., up to 4-7/8" deep, 7'-0" h x 6'-0" w	6.00 ea	9.1	697	1,156	-	-	-	308.76 /ea	1,853	707.08 /ea	4,242
			Fiberglass, exterior, prehung door, 1-3/4", 3'-0" x 7'-0"	28.00 ea	39.8	3,034	13,199	-	-	-	579.75 /ea	16,233	1,327.66 /ea	37,175

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Openings, Doors, Frames and Hardware	28.00 EA	235.3	17,586	30,095				1,702.88 /EA	47,681	3,899.67 /EA	109,191
			Doors	**28.00 EA**	**235.3**	**17,586**	**30,095**				**1,702.88 /EA**	**47,681**	**3,899.67 /EA**	**109,191**
			Translucent Panels											
			Entrances, Storefronts and Curtain Walls											
			Translucent panels	112.00 sf	128.3	9,386	9,996	-	-	-	173.05 /sf	19,382	396.30 /sf	44,386
			Entrances, Storefronts and Curtain Walls	14.00 EA	128.3	9,386	9,996				1,384.43 /EA	19,382	3,170.40 /EA	44,386
			Translucent Panels	**1.00 LS**	**128.3**	**9,386**	**9,996**				**19,382.01 /LS**	**19,382**	**44,385.66 /LS**	**44,386**
			08.00 Openings	1.00 LS	363.6	26,972	40,091				67,062.60 /LS	67,063	153,576.35 /LS	153,576
		08.30	Specialty Doors and Frames											
			Overhead Door											
			Specialty Doors and Frames, Sectional Overhead Doors											
			Doors, rolling service, steel, manual, fire, class A, 20 gauge, 20' x 10' high, incl. hardware	1.00 ea	26.6	2,415	4,663	-	-	-	7,078.00 /ea	7,078	16,208.94 /ea	16,209
			Doors, rolling service, steel, manual, motor operators for, to 14' x 14' opening	1.00 ea	4.3	386	1,204	-	-	-	1,590.54 /ea	1,591	3,642.41 /ea	3,642
			Specialty Doors and Frames, Sectional Overhead Doors	1.00 EA	30.9	2,802	5,867				8,668.54 /EA	8,669	19,851.35 /EA	19,851
			Overhead Door	**1.00 EA**	**30.9**	**2,802**	**5,867**				**8,668.54 /EA**	**8,669**	**19,851.35 /EA**	**19,851**
			08.30 Specialty Doors and Frames	1.00 EA	30.9	2,802	5,867				8,668.54 /EA	8,669	19,851.35 /EA	19,851
			08.0 Openings	1.00 LS	394.5	29,774	45,957				75,731.14 /LS	75,731	173,427.70 /LS	173,428
	09.0		Finishes											
		09.10	Finishes, Special Coatings											
			Special Coating											
			Finishes, Chemical Resistant Coatings											
			Concrete Coating, Chemical Resistant, CRC-2	480.00 sf		-	-	9,838	-	-	20.50 /sf	9,838	46.93 /sf	22,529
			Finishes, Chemical Resistant Coatings	480.00 SF				9,838			20.50 /SF	9,838	46.93 /SF	22,529
			Finishes, Special Coating											
			Special Coatings, high build epoxy, 50 mil, max, pump room floors and walls	5,120.00 sf	574.4	35,853	52,467	-	-	-	17.25 /sf	88,320	39.50 /sf	202,257
			Special Coatings, high build epoxy, 50 mil, max, wetwell floor and walls	3,539.00 sf	397.0	24,782	36,266	-	-	-	17.25 /sf	61,048	39.50 /sf	139,803
			Special Coatings, high build epoxy, 50 mil, max, influent channel floor and walls	2,890.00 sf	324.2	20,237	29,615	-	-	-	17.25 /sf	49,853	39.50 /sf	114,165
			Finishes, Special Coating	11,549.00 SF	1,295.6	80,872	118,349				17.25 /SF	199,221	39.50 /SF	456,225
			Special Coating	**9,139.00 SF**	**1,295.6**	**80,872**	**118,349**	**9,838**			**22.88 /SF**	**209,059**	**52.39 /SF**	**478,753**
			09.10 Finishes, Special Coatings	1.00 LS	1,295.6	80,872	118,349	9,838			209,058.50 /LS	209,059	478,753.35 /LS	478,753
			09.0 Finishes	1.00 LS	1,295.6	80,872	118,349	9,838			209,058.50 /LS	209,059	478,753.35 /LS	478,753
	10.0		Specialties											
		10.00	Specialties											
			Toilet Accessories											
			Specialties Toilet & Bath Accessories											
			Partitions, toilet, floor mounted, headrail braced, stainless steel	1.00 ea	3.6	271	1,204	-	-	-	1,475.05 /ea	1,475	3,377.91 /ea	3,378
			Urinal screens, ceiling or floor mounted, stainless steel	1.00 ea	3.3	247	461	-	-	-	707.66 /ea	708	1,620.55 /ea	1,621
			Toilet tissue dispenser, surface mounted, stainless, double roll	1.00 ea	0.4	34	23	-	-	-	56.92 /ea	57	130.38 /ea	130
			Toilet Accessories, grab bars, straight, stainless steel, 24" long	1.00 ea	0.5	35	31	-	-	-	66.57 /ea	67	152.47 /ea	152
			Toilet Accessories, grab bars, straight, stainless steel, 36" long	1.00 ea	0.5	41	38	-	-	-	78.56 /ea	79	179.89 /ea	180
			Toilet Accessories, mirror, 48" x 24", with stainless steel 3/4" square frame	1.00 ea	1.1	81	156	-	-	-	237.06 /ea	237	542.88 /ea	543
			Toilet Accessories, soap dispenser, stainless steel, recessed, liquid	1.00 ea	1.1	81	170	-	-	-	251.40 /ea	251	575.72 /ea	576
			Toilet Accessories, towel dispenser, stainless steel, surface mounted	1.00 ea	0.7	51	49	-	-	-	99.47 /ea	99	227.78 /ea	228
			Toilet Accessories, waste receptacle, stainless steel, w/top, 13 gallon	1.00 ea	1.1	81	323	-	-	-	404.09 /ea	404	925.39 /ea	925
			Specialties Toilet & Bath Accessories	9.00 EA	12.2	922	2,455				375.20 /EA	3,377	859.22 /EA	7,733
			Toilet Accessories	**1.00 LS**	**12.2**	**922**	**2,455**				**3,376.78 /LS**	**3,377**	**7,732.97 /LS**	**7,733**
			10.00 Specialties	1.00 LS	12.2	922	2,455				3,376.78 /LS	3,377	7,732.97 /LS	7,733
			10.0 Specialties	1.00 LS	12.2	922	2,455				3,376.78 /LS	3,377	7,732.97 /LS	7,733
	21.0		Fire Suppression											
		21.00	Fire Suppression											
			Sprinkler System											
			Mechanical, Fire Sprinklers System											
			Sprinkler System	3,180.00 SF	1,590.0			48,881	-	-	15.37 /SF	48,881	35.97 /SF	114,383
			Mechanical, Fire Sprinklers System	1.00 LS	1,590.0			48,881			48,880.82 /LS	48,881	114,383.30 /LS	114,383
			Sprinkler System	**3,180.00 SF**	**1,590.0**			**48,881**			**15.37 /SF**	**48,881**	**35.97 /SF**	**114,383**
			21.00 Fire Suppression	1.00 LS	1,590.0			48,881			48,880.82 /LS	48,881	114,383.30 /LS	114,383
			21.0 Fire Suppression	1.00 LS	1,590.0			48,881			48,880.82 /LS	48,881	114,383.30 /LS	114,383
	22.0		Plumbing											
		22.00	Plumbing											
			Misc. Plumbing											
			Mechanical, Plumbing											

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Mechanical, Plumbing											
			Misc. Plumbing Allowance	1.00 LS		33,305		25,619	-	-	58,923.42 /LS	58,923	126,098.75 /LS	126,099
			Mechanical, Plumbing	**1.00 LS**		**33,305**		**25,619**			**58,923.42 /LS**	**58,923**	**126,098.75 /LS**	**126,099**
			Misc. Plumbing	**1.00 LS**		**33,305**		**25,619**			**58,923.42 /LS**	**58,923**	**126,098.75 /LS**	**126,099**
			Plumbing Fixtures											
			Mechanical, Plumbing											
			Urinals, wall hung, vitreous china, hanger & self-closing valve,siphon	1.00 ea	7.1	615	296	-	-	-	910.68 /ea	911	1,948.91 /ea	1,949
			Rough-in water supply, waste & vent for wall hung urinals	1.00 ea	7.5	651	538	-	-	-	1,189.47 /ea	1,189	2,545.51 /ea	2,546
			Water closet, tank type, vitreous china, floor mounted, close coupled, two piece, includes seat, supply pipe with stop	1.00 ea	4.0	348	236	-	-	-	583.48 /ea	583	1,248.68 /ea	1,249
			Water closet, tank type, vitreous china, floor mounted, rough-in, supply, waste and vent, one piece	1.00 ea	7.0	605	333	-	-	-	937.55 /ea	938	2,006.40 /ea	2,006
			Lavatory, vanity top, stainless steel, self-rimming, ledge, round, single bowl, 18-3/4", includes trim	1.00 ea	3.3	288	820	-	-	-	1,107.82 /ea	1,108	2,370.80 /ea	2,371
			Lavatory, vanity top, rough-in, supply, waste and vent	1.00 ea	9.3	802	223	-	-	-	1,025.02 /ea	1,025	2,193.57 /ea	2,194
			Sink, service, stainless steel, self rimming, triple bowl, 22" x 43", includes faucet and drain	1.00 ea	4.8	419	1,153	-	-	-	1,571.82 /ea	1,572	3,363.77 /ea	3,364
			Sink, service, rough-in, supply, waste and vent	1.00 ea	10.0	862	253	-	-	-	1,114.67 /ea	1,115	2,385.42 /ea	2,385
			Industrial safety fixture, eyewash station, stainless steel, pedestal mounted, unmounted, excludes rough-in	2.00 ea	10.7	922	570	-	-	-	745.80 /ea	1,492	1,596.06 /ea	3,192
			Mechanical, Plumbing	**1.00 LS**	**63.7**	**5,510**	**4,422**				**9,932.11 /LS**	**9,932**	**21,255.18 /LS**	**21,255**
			Plumbing Fixtures	**1.00 LS**	**63.7**	**5,510**	**4,422**				**9,932.11 /LS**	**9,932**	**21,255.18 /LS**	**21,255**
			22.00 Plumbing	**1.00 LS**	**63.7**	**38,815**	**4,422**	**25,619**			**68,855.53 /LS**	**68,856**	**147,353.93 /LS**	**147,354**
			22.0 Plumbing	**1.00 LS**	**63.7**	**38,815**	**4,422**	**25,619**			**68,855.53 /LS**	**68,856**	**147,353.93 /LS**	**147,354**
	23.0		**HVAC**											
		23.00	**HVAC**											
			HVAC Control Components/DDC Systems,											
			Mechanical, HVAC											
			Control Components/DDC Systems,	1.00 ls		-	-	-	-	25,619	25,618.88 /ls	25,619	54,825.55 /ls	54,826
			Mechanical, HVAC	**1.00 LS**						**25,619**	**25,618.88 /LS**	**25,619**	**54,825.55 /LS**	**54,826**
			HVAC Control Components/DDC Systems,	**1.00 LS**						**25,619**	**25,618.88 /LS**	**25,619**	**54,825.55 /LS**	**54,826**
			Misc. HVAC											
			Mechanical, HVAC											
			Misc. HVAC Allowance	1.00 ls		-	-	-	-	25,619	25,618.88 /ls	25,619	54,825.56 /ls	54,826
			Mechanical, HVAC	**1.00 LS**						**25,619**	**25,618.88 /LS**	**25,619**	**54,825.56 /LS**	**54,826**
			Misc. HVAC	**1.00 LS**						**25,619**	**25,618.88 /LS**	**25,619**	**54,825.56 /LS**	**54,826**
			23.00 HVAC	**1.00 LS**						**51,238**	**51,237.76 /LS**	**51,238**	**109,651.11 /LS**	**109,651**
			23.0 HVAC	**1.00 LS**						**51,238**	**51,237.76 /LS**	**51,238**	**109,651.11 /LS**	**109,651**
	26.0		**Electrical Work**											
		26.10	**Site Electrical**											
			Site Electrical, Buried Conduit											
			Site Electrical, Buried Conduit											
			PVC Sch 40 in Trench 2"	200.00 lf	11.7	945	177	-	-	-	5.61 /lf	1,123	13.42 /lf	2,683
			PVC Sch 40 in Trench 3"	640.00 lf	57.1	4,607	1,082	-	-	-	8.89 /lf	5,689	21.24 /lf	13,596
			PVC Sch 40 in Trench 3"	100.00 lf	8.9	720	169	-	-	-	8.89 /lf	889	21.24 /lf	2,124
			PVC Sch 40 90 deg Ell 2"	2.00 E	0.7	54	8	-	-	-	30.94 /E	62	73.95 /E	148
			PVC Sch 40 90 deg Ell 3"	8.00 E	4.3	344	100	-	-	-	55.51 /E	444	132.68 /E	1,061
			PVC Sch 40 90 deg Ell 3"	2.00 E	1.1	86	25	-	-	-	55.52 /E	111	132.70 /E	265
			PVC Coupling 2"	6.00 E	0.4	32	5	-	-	-	6.28 /E	38	15.01 /E	90
			PVC Coupling 3"	30.00 E	2.4	193	73	-	-	-	8.88 /E	266	21.22 /E	636
			PVC Female Adaptor 2"	4.00 E	0.7	56	5	-	-	-	15.26 /E	61	36.48 /E	146
			PVC Female Adaptor 3"	16.00 E	3.8	309	46	-	-	-	22.21 /E	355	53.08 /E	849
			PVC Female Adaptor 3"	4.00 E	1.0	77	11	-	-	-	22.21 /E	89	53.07 /E	212
			PVC Coated GRC in Trench 2"	20.00 lf	3.2	258	294	-	-	-	27.57 /lf	551	65.89 /lf	1,318
			PVC Coated GRC in Trench 3"	80.00 lf	18.0	1,452	2,244	-	-	-	46.21 /lf	3,697	110.44 /lf	8,836
			PVC Coated GRC in Trench 3"	20.00 lf	4.5	363	561	-	-	-	46.21 /lf	924	110.45 /lf	2,209
			PVC Coated GRC Elbow 36" Radius 2"	4.00 E	4.0	322	993	-	-	-	328.90 /E	1,316	786.09 /E	3,144
			PVC Coated GRC Elbow 36" Radius 3"	20.00 E	32.0	2,578	8,877	-	-	-	572.77 /E	11,455	1,368.96 /E	27,379
			PVC Base Spacers < 2"	188.00 E	12.5	1,010	193	-	-	-	6.40 /E	1,202	15.29 /E	2,874
			Duct Bank Warning Tape	570.00 lf	19.0	1,531	146	-	-	-	2.94 /lf	1,677	7.03 /lf	4,008
			PVC Solvent Cement - Qt	0.80 E	0.0	1	4	-	-	-	6.25 /E	5	14.95 /E	12
			PVC Solvent Cement - Qt	3.84 E	0.1	4	20	-	-	-	6.20 /E	24	14.81 /E	57
			PVC Solvent Cement - Qt	0.60 E	0.0	1	3	-	-	-	6.17 /E	4	14.72 /E	9
			Site Electrical, Buried Conduit	**940.00 LF**	**185.3**	**14,944**	**15,037**				**31.90 /LF**	**29,982**	**76.23 /LF**	**71,657**
			Site Electrical, Duct Bank											
			2500 psi Duct Bank Concrete	7.41 cy	6.4	517	797	-	-	-	177.44 /cy	1,314	424.08 /cy	3,142
			2500 psi Duct Bank Concrete	15.88 cy	13.8	1,109	1,709	-	-	-	177.43 /cy	2,818	424.06 /cy	6,734
			2500 psi Duct Bank Concrete	2.48 cy	2.1	173	267	-	-	-	177.44 /cy	440	424.08 /cy	1,052
			Add Color Die for Duct Bank Concrete	23.29 cy		-	430	-	-	-	18.45 /cy	430	44.08 /cy	1,027
			Add Color Die for Duct Bank Concrete	2.48 cy		-	46	-	-	-	18.45 /cy	46	44.10 /cy	109

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Site Electrical, Duct Bank											
			Duct Bank Concrete Forming	1,140.00 sf	455.6	36,741	2,336	-	-	-	34.28 /sf	39,077	81.93 /sf	93,396
			Duct Bank Reinforcing Re-bar #4	2,280.00 lf	30.4	2,449	1,171	-	-	-	1.59 /lf	3,620	3.79 /lf	8,651
			Duct Bank Reinforcing Re-bar #4 (Ties)	1,265.80 lf	42.2	3,400	676	-	-	-	3.22 /lf	4,075	7.70 /lf	9,740
			Site Electrical, Duct Bank	**25.77 CY**	**550.4**	**44,389**	**7,431**				**2,010.85 /CY**	**51,820**	**4,806.03 /CY**	**123,851**
			Site Electrical, Trenching											
			Electrical Trench Excavation - Soil Type C	245.37 cy	107.9	8,702	-	-	2,139	-	44.18 /cy	10,841	105.60 /cy	25,911
			Electrical Trench Bedding - Crushed Gravel	49.07 cy	32.7	2,637	1,509	-	475	-	94.16 /cy	4,621	225.06 /cy	11,044
			Electrical Trench Backfill - Reuse Trench Spoils	170.53 cy	61.3	4,948	-	-	2,973	-	46.45 /cy	7,921	111.02 /cy	18,932
			Electrical Trench Spoils - Waste on Site	74.85 cy	15.0	1,207	-	-	870	-	27.74 /cy	2,076	66.31 /cy	4,963
			Site Electrical, Trenching	**245.37 CY**	**216.8**	**17,494**	**1,509**		**6,457**		**103.76 /CY**	**25,460**	**247.99 /CY**	**60,850**
			Site Electrical, Grounding											
			CU Bare Stranded #4/0	660.00 lf	39.6	3,191	2,713	-	-	-	8.95 /lf	5,904	21.38 /lf	14,111
			Site Electrical, Grounding	**660.00 LF**	**39.6**	**3,191**	**2,713**				**8.95 /LF**	**5,904**	**21.38 /LF**	**14,111**
			Site Electrical, Buried Conduit	**1.00 LS**	**992.2**	**80,018**	**26,690**		**6,457**		**113,164.95 /LS**	**113,165**	**270,469.30 /LS**	**270,469**
			Electrical, Grounding											
			Site Electrical, Grounding											
			CU Bare Stranded #4/0	200.00 lf	12.0	967	822	-	-	-	8.95 /lf	1,789	21.38 /lf	4,276
			CU Bare Stranded #4/0	70.00 lf	4.2	338	288	-	-	-	8.95 /lf	626	21.38 /lf	1,496
			CU Bare Stranded #4/0	75.00 lf	4.5	362	308	-	-	-	8.94 /lf	671	21.38 /lf	1,603
			Hand Trench and Backfill, includes labor for layout	195.00 lf	52.0	4,190	-	-	-	-	21.49 /lf	4,190	51.35 /lf	10,013
			Copperclad Ground Rod 3/4" x 10'	16.00 E	17.1	1,375	524	-	-	-	118.67 /E	1,899	283.63 /E	4,538
			Compression Lug - 4/0	4.00 E	2.7	215	42	-	-	-	64.13 /E	257	153.27 /E	613
			Compression Lug - 4/0	4.00 E	2.7	215	42	-	-	-	64.13 /E	257	153.27 /E	613
			Cadweld Cable to Rod - 250 Max	16.00 E	10.7	859	328	-	-	-	74.21 /E	1,187	177.36 /E	2,838
			Cadweld Cable to Cable - 250 Max	16.00 E	10.7	859	328	-	-	-	74.21 /E	1,187	177.36 /E	2,838
			Cadweld Cable to Steel - 250 Max	8.00 E	5.3	430	164	-	-	-	74.20 /E	594	177.35 /E	1,419
			Grounding Bolt and Nut Set	8.00 E	0.5	43	8	-	-	-	6.39 /E	51	15.27 /E	122
			Drill and Tap for Ground Connection	8.00 E	5.3	430	2	-	-	-	53.96 /E	432	128.98 /E	1,032
			Above Grade Ground Wire Supports	12.00 E	1.6	129	18	-	-	-	12.28 /E	147	29.36 /E	352
			Above Grade Ground Wire Supports	12.00 E	1.6	129	18	-	-	-	12.28 /E	147	29.35 /E	352
			Site Electrical, Grounding	**345.00 LF**	**130.7**	**10,541**	**2,892**				**38.94 /LF**	**13,433**	**93.06 /LF**	**32,106**
			Electrical, Grounding	**345.00 LF**	**130.7**	**10,541**	**2,892**				**38.94 /LF**	**13,433**	**93.06 /LF**	**32,106**
			26.10 Site Electrical	**1.00 LS**	**1,122.9**	**90,559**	**29,583**		**6,457**		**126,598.16 /LS**	**126,598**	**302,575.27 /LS**	**302,575**
		26.15	**Process Electrical**											
			Electrical, Conduit and Wire/Cable - Power											
			Process Electrical, Wire/Cable											
			THHN-THWN Copper Stranded 1/C # 12	9,180.00 lf	85.6	6,907	933	-	-	-	0.85 /lf	7,840	2.04 /lf	18,737
			THHN-THWN Copper Stranded 1/C # 12	3,060.00 lf	28.5	2,302	311	-	-	-	0.85 /lf	2,613	2.04 /lf	6,246
			THHN-THWN Copper Stranded 1/C # 8	170.00 lf	2.3	183	44	-	-	-	1.33 /lf	226	3.18 /lf	540
			THHN-THWN Copper Stranded 1/C # 6	255.00 lf	4.1	329	100	-	-	-	1.68 /lf	429	4.02 /lf	1,025
			THHN-THWN Copper Stranded 1/C # 2	510.00 lf	12.2	986	461	-	-	-	2.84 /lf	1,447	6.78 /lf	3,459
			THHN-THWN Copper Stranded 1/C # 1/0	765.00 lf	22.4	1,808	1,064	-	-	-	3.76 /lf	2,872	8.97 /lf	6,865
			THHN-THWN Copper Stranded 1/C # 1/0	320.00 lf	9.4	756	445	-	-	-	3.76 /lf	1,202	8.97 /lf	2,872
			THHN-THWN Copper Stranded 1/C # 350	960.00 lf	51.2	4,125	4,400	-	-	-	8.88 /lf	8,526	21.23 /lf	20,377
			XHHW Copper Stranded 1/C # 6	240.00 lf	3.8	309	142	-	-	-	1.88 /lf	451	4.49 /lf	1,078
			XHHW Copper Stranded 1/C # 1/0	2,000.00 lf	58.6	4,727	4,395	-	-	-	4.56 /lf	9,122	10.90 /lf	21,802
			XHHW Copper Stranded 1/C # 1/0	1,800.00 lf	52.8	4,254	3,955	-	-	-	4.56 /lf	8,210	10.90 /lf	19,622
			5 KV Non Shielded XLP / PVC - 1/C #350 Copper	11,400.00 lf	926.4	74,703	88,318	-	-	-	14.30 /lf	163,020	34.18 /lf	389,626
			Copper XLP 133% Insulated 15 KV #1/0 Copper	720.00 lf	46.0	3,712	4,155	-	-	-	10.93 /lf	7,868	26.12 /lf	18,805
			Stakon Lug #12 - #10	288.00 E	38.4	3,094	74	-	-	-	11.00 /E	3,168	26.29 /E	7,571
			Compression Lug - # 8	4.00 E	0.8	64	9	-	-	-	18.47 /E	74	44.14 /E	177
			Compression Lug - # 6	10.00 E	2.0	161	22	-	-	-	18.36 /E	184	43.87 /E	439
			Compression Lug - # 2	12.00 E	4.0	322	70	-	-	-	32.67 /E	392	78.09 /E	937
			Compression Lug - 1/0	58.00 E	27.0	2,181	377	-	-	-	44.11 /E	2,558	105.42 /E	6,114
			Compression Lug - 1/0	4.00 E	1.9	150	26	-	-	-	44.11 /E	176	105.42 /E	422
			Compression Lug - 1/0	30.00 E	14.0	1,128	195	-	-	-	44.11 /E	1,323	105.42 /E	3,163
			Compression Lug - 350 MCM	12.00 E	9.6	773	175	-	-	-	79.03 /E	948	188.88 /E	2,267
			Motor Hook-up, 3 phase, 10 hp	36.00 E	86.3	6,961	2,094	-	-	-	251.53 /E	9,055	601.16 /E	21,642
			Equipmenmt Hook-up, 3 phase, 80A	2.00 E	10.4	838	237	-	-	-	537.48 /E	1,075	1,284.59 /E	2,569
			Motor Hook-up, 3 phase, 90 hp	3.00 E	24.0	1,934	477	-	-	-	803.66 /E	2,411	1,920.78 /E	5,762
			Motor Testing & Commissioning: 10HP / 480V / #12	36.00 E	33.6	2,707	-	-	-	-	75.20 /E	2,707	179.73 /E	6,470
			Equipment Testing & Commissioning: 80A / 480V / #4	2.00 E	2.9	236	-	-	-	-	118.18 /E	236	282.45 /E	565
			Motor Testing & Commissioning: 90 HP / 480v / 1/0	3.00 E	13.2	1,064	-	-	-	-	354.52 /E	1,064	847.33 /E	2,542
			600V Megger Testing	209.00 E	69.6	5,613	-	-	-	-	26.86 /E	5,613	64.19 /E	13,416
			Wire Markers	40.00 E	0.5	43	2	-	-	-	1.13 /E	45	2.69 /E	108
			Wire Markers	4.00 E	0.1	4	0	-	-	-	1.13 /E	5	2.69 /E	11
			Wire Markers	306.00 E	4.1	329	16	-	-	-	1.13 /E	344	2.69 /E	823
			Wire Markers	18.00 E	0.2	19	1	-	-	-	1.13 /E	20	2.69 /E	48
			Wire Markers	4.00 E	0.1	4	0	-	-	-	1.13 /E	5	2.69 /E	11
			Wire Markers	12.00 E	0.2	13	1	-	-	-	1.12 /E	13	2.68 /E	32
			Wire Markers	4.00 E	0.1	4	0	-	-	-	1.13 /E	5	2.69 /E	11

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Process Electrical, Wire/Cable											
			Wire Markers	30.00 E	0.4	32	2	-	-	-	1.13 /E	34	2.69 /E	81
			5 KV Compression Lug - # 350	210.00 E	251.8	20,304	2,834	-	-	-	110.18 /E	23,138	263.34 /E	55,301
			15 KV Indoor Termination Kit - 1/C # 1/0	6.00 E	16.0	1,289	307	-	-	-	266.09 /E	1,597	635.97 /E	3,816
			15 KV Outdoor Termination Kit - 1/C # 1/0	6.00 E	24.0	1,934	461	-	-	-	399.14 /E	2,395	953.96 /E	5,724
			15 KV Compression Lug - # 1/0	12.00 E	8.0	645	104	-	-	-	62.40 /E	749	149.13 /E	1,790
			5 KV Motor Connect & Test - 800 HP	5.00 E	53.3	4,297		-	-	-	859.42 /E	4,297	2,054.06 /E	10,270
			5 KV Motor Conn Insulating Boot - # 350	45.00 E	209.8	16,920	6,917	-	-	-	529.71 /E	23,837	1,266.03 /E	56,972
			5 KV Megger Testing	105.00 E	139.9	11,280	-	10,760	-	-	209.90 /E	22,040	501.68 /E	52,676
			15 KV Hi-Pot Testing	6.00 E	16.0	1,289	-	615	-	-	317.33 /E	1,904	758.43 /E	4,551
			MV Cable Tags	222.00 E	29.6	2,385	227	-	-	-	11.77 /E	2,612	28.13 /E	6,244
			Process Electrical, Wire/Cable	**31,380.00 LF**	**2,394.8**	**193,122**	**123,354**	**11,375**			**10.45 /LF**	**327,851**	**24.97 /LF**	**783,578**
			Process Electrical, Conduit											
			GRC Conduit @ Level 2 3/4"	2,700.00 lf	316.5	25,525	4,031	-	-	-	10.95 /lf	29,556	26.16 /lf	70,640
			GRC Conduit @ Level 2 1-1/4"	150.00 lf	21.4	1,724	486	-	-	-	14.74 /lf	2,210	35.22 /lf	5,283
			GRC Conduit @ Level 2 1-1/2"	225.00 lf	35.7	2,876	860	-	-	-	16.61 /lf	3,736	39.69 /lf	8,930
			GRC Conduit @ Level 2 1-1/2"	100.00 lf	15.9	1,278	382	-	-	-	16.61 /lf	1,661	39.69 /lf	3,969
			GRC Conduit @ Level 2 3"	1,000.00 lf	333.1	26,857	10,296	-	-	-	37.15 /lf	37,154	88.80 /lf	88,799
			GRC Conduit @ Level 2 3"	160.00 lf	53.3	4,297	1,647	-	-	-	37.15 /lf	5,944	88.80 /lf	14,208
			GRC Conduit @ Level 2 3"	1,500.00 lf	499.6	40,286	15,444	-	-	-	37.15 /lf	55,731	88.80 /lf	133,199
			GRC Elbow 3/4"	108.00 E	36.0	2,901	956	-	-	-	35.71 /E	3,857	85.35 /E	9,218
			GRC Elbow 1-1/4"	6.00 E	2.8	226	112	-	-	-	56.23 /E	337	134.39 /E	806
			GRC Elbow 1-1/2"	9.00 E	4.8	387	208	-	-	-	66.06 /E	595	157.89 /E	1,421
			GRC Elbow 1-1/2"	6.00 E	3.2	258	139	-	-	-	66.05 /E	396	157.87 /E	947
			GRC Elbow 3"	111.00 E	110.9	8,943	9,558	-	-	-	166.68 /E	18,501	398.37 /E	44,219
			GRC Couplng 3/4"	108.00 E	7.2	580	275	-	-	-	7.92 /E	855	18.92 /E	2,044
			GRC Couplng 1-1/4"	6.00 E	0.6	45	28	-	-	-	12.24 /E	73	29.26 /E	176
			GRC Couplng 1-1/2"	9.00 E	1.0	77	54	-	-	-	14.55 /E	131	34.78 /E	313
			GRC Couplng 1-1/2"	6.00 E	0.6	52	36	-	-	-	14.56 /E	87	34.80 /E	209
			GRC Couplng 3"	60.00 E	8.8	709	1,514	-	-	-	37.06 /E	2,223	88.57 /E	5,314
			GRC Couplng 3"	6.00 E	0.9	71	151	-	-	-	37.06 /E	222	88.56 /E	531
			GRC Couplng 3"	45.00 E	6.6	532	1,136	-	-	-	37.06 /E	1,668	88.57 /E	3,986
			Rigid Conduit Hub 3/4"	144.00 E	59.5	4,796	1,908	-	-	-	46.55 /E	6,703	111.26 /E	16,021
			Rigid Conduit Hub 3/4"	6.00 E	2.5	200	79	-	-	-	46.55 /E	279	111.26 /E	668
			Rigid Conduit Hub 1-1/4"	8.00 E	4.8	387	162	-	-	-	68.54 /E	548	163.82 /E	1,311
			Rigid Conduit Hub 1-1/2"	12.00 E	7.4	593	265	-	-	-	71.47 /E	858	170.83 /E	2,050
			Rigid Conduit Hub 1-1/2"	4.00 E	2.5	198	88	-	-	-	71.48 /E	286	170.83 /E	683
			Rigid Conduit Hub 3"	80.00 E	91.7	7,391	4,107	-	-	-	143.73 /E	11,498	343.52 /E	27,482
			Rigid Conduit Hub 3"	8.00 E	9.2	739	411	-	-	-	143.72 /E	1,150	343.51 /E	2,748
			Rigid Conduit Hub 3"	60.00 E	68.7	5,543	3,081	-	-	-	143.73 /E	8,624	343.52 /E	20,611
			Malleable LB Condulet - 3/4"	36.00 E	14.4	1,160	460	-	-	-	45.02 /E	1,621	107.60 /E	3,874
			Malleable LB Condulet - 1-1/4"	2.00 E	1.1	86	60	-	-	-	72.76 /E	146	173.90 /E	348
			Malleable LB Condulet - 1-1/2"	3.00 E	1.8	145	116	-	-	-	87.04 /E	261	208.03 /E	624
			Malleable TB Condulet - 1-1/2"	2.00 E	1.3	107	94	-	-	-	100.47 /E	201	240.12 /E	480
			EYS Seal Fitting 3"	15.00 E	30.0	2,417	1,590	-	-	-	267.11 /E	4,007	638.41 /E	9,576
			Unistrut Straps 3/4"	360.00 E	14.4	1,160	681	-	-	-	5.12 /E	1,842	12.23 /E	4,402
			Unistrut Straps 1-1/4"	20.00 E	1.1	86	48	-	-	-	6.72 /E	134	16.06 /E	321
			Unistrut Straps 1-1/2"	30.00 E	1.6	129	89	-	-	-	7.27 /E	218	17.37 /E	521
			Unistrut Straps 1-1/2"	14.00 E	0.7	60	42	-	-	-	7.27 /E	102	17.37 /E	243
			Unistrut Straps 3"	160.00 E	10.7	859	623	-	-	-	9.26 /E	1,482	22.14 /E	3,542
			Unistrut Straps 3"	195.00 E	13.0	1,047	759	-	-	-	9.26 /E	1,806	22.14 /E	4,317
			Unistrut Conduit Hanger Allowance 3/4"	360.00 E	19.2	1,547	369	-	-	-	5.32 /E	1,916	12.72 /E	4,579
			Unistrut Conduit Hanger Allowance 1-1/4"	20.00 E	1.6	129	26	-	-	-	7.73 /E	155	18.47 /E	369
			Unistrut Conduit Hanger Allowance 1-1/2"	44.00 E	3.5	284	68	-	-	-	7.98 /E	351	19.08 /E	839
			Unistrut Conduit Hanger Allowance 3"	355.00 E	47.3	3,814	728	-	-	-	12.79 /E	4,541	30.57 /E	10,854
			EF Sealtite Flex 3/4"	36.00 lf	1.4	116	91	-	-	-	5.75 /lf	207	13.75 /lf	495
			EF Sealtite Flex 1-1/4"	2.00 lf	0.1	9	10	-	-	-	9.54 /lf	19	22.80 /lf	46
			EF Sealtite Flex 1-1/2"	3.00 lf	0.2	16	18	-	-	-	11.48 /lf	34	27.43 /lf	82
			EF Sealtite Flex 1-1/2"	2.00 lf	0.1	11	12	-	-	-	11.46 /lf	23	27.39 /lf	55
			EF Sealtite Flex 3"	20.00 lf	2.4	193	359	-	-	-	27.60 /lf	552	65.97 /lf	1,319
			EF Sealtite Flex 3"	2.00 lf	0.2	19	36	-	-	-	27.61 /lf	55	65.98 /lf	132
			EF Sealtite Flex 3"	15.00 lf	1.8	145	269	-	-	-	27.60 /lf	414	65.96 /lf	989
			LT Flex Connector Straight 3/4"	72.00 E	8.6	696	372	-	-	-	14.83 /E	1,068	35.45 /E	2,552
			LT Flex Connector Straight 1-1/4"	4.00 E	0.6	52	52	-	-	-	25.91 /E	104	61.91 /E	248
			LT Flex Connector Straight 1-1/2"	10.00 E	1.9	150	184	-	-	-	33.41 /E	334	79.86 /E	799
			LT Flex Connector Straight 3"	74.00 E	21.7	1,749	13,213	-	-	-	202.19 /E	14,962	483.24 /E	35,759
			Conduit Wall Penetration - 1-1/2"	2.00 E	0.7	54	5	-	-	-	29.42 /E	59	70.30 /E	141
			Conduit Wall Penetration - 3"	20.00 E	8.0	645	102	-	-	-	37.35 /E	747	89.27 /E	1,785
			Conduit Wall Penetration - 3"	2.00 E	0.8	64	10	-	-	-	37.34 /E	75	89.25 /E	178
			Conduit Wall Penetration - 3"	15.00 E	6.0	483	77	-	-	-	37.35 /E	560	89.28 /E	1,339
			Fireproof Conduit Wall Penetration - 1-1/2"	2.00 E	1.3	107	20	-	-	-	63.55 /E	127	151.88 /E	304
			Fireproof Conduit Wall Penetration - 3"	20.00 E	16.0	1,289	300	-	-	-	79.47 /E	1,589	189.93 /E	3,799
			Fireproof Conduit Wall Penetration - 3"	2.00 E	1.6	129	30	-	-	-	79.48 /E	159	189.97 /E	380
			Fireproof Conduit Wall Penetration - 3"	15.00 E	12.0	967	225	-	-	-	79.47 /E	1,192	189.93 /E	2,849

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Process Electrical, Conduit											
			Conduit Floor Penetration - 3"	15.00 E	6.0	483	77	-	-	-	37.35 /E	560	89.28 /E	1,339
			Fireproof Conduit Floor Penetration - 3"	15.00 E	6.0	483	128	-	-	-	40.79 /E	612	97.48 /E	1,462
			Process Electrical, Conduit	**5,835.00 LF**	**1,963.8**	**158,364**	**78,756**				**40.64 /LF**	**237,120**	**97.13 /LF**	**566,727**
			Electrical, Conduit and Wire/Cable - Power	**1.00 LS**	**4,358.7**	**351,486**	**202,110**	**11,375**			**564,970.84 /LS**	**564,971**	**1,350,305.63 /LS**	**1,350,306**
			Electrical, Conduit and Wire/Cable - Controls											
			Process Electrical, Wire/Cable											
			THHN-THWN Copper Stranded 1/C # 14	5,100.00 lf	40.7	3,286	338	-	-	-	0.71 /lf	3,624	1.70 /lf	8,661
			THHN-THWN Copper Stranded 1/C # 14	1,275.00 lf	10.2	822	84	-	-	-	0.71 /lf	906	1.70 /lf	2,165
			THHN-THWN Copper Stranded 1/C # 14	377,740.00 lf	3,018.1	243,386	25,021	-	-	-	0.71 /lf	268,407	1.70 /lf	641,504
			THHN-THWN Copper Stranded 1/C # 14	1,360.00 lf	10.9	876	90	-	-	-	0.71 /lf	966	1.70 /lf	2,310
			Shielded PLTC / Inst Cable 1 Pair #16	595.00 lf	15.9	1,278	274	-	-	-	2.61 /lf	1,553	6.24 /lf	3,711
			Unshielded Twisted Pair Cable, 4-Pair CAT 6 350Mhz Ultra II	765.00 lf	17.8	1,438	306	-	-	-	2.28 /lf	1,744	5.45 /lf	4,168
			UTP Cable Connector, RJ45 CAT 6 Mini-Jack TX-5e (568A/B)	18.00 E	6.0	483	80	-	-	-	31.32 /E	564	74.85 /E	1,347
			UTP Patch Cord, RJ45/RJ45 CAT 6E 350Mhz Data-Patch - 5ft	9.00 E	0.7	58	49	-	-	-	11.93 /E	107	28.50 /E	257
			UTP Wall Plate, 4-Port, CAT 6 350Mhz, RJ45/110 (568B), White	9.00 E	3.0	242	18	-	-	-	28.80 /E	259	68.83 /E	620
			4 Pair UTP Continuity Test	9.00 E	3.0	242		-	-	-	26.85 /E	242	64.18 /E	578
			4 Pair UTP Certification with Documentation	9.00 E	7.6	609		-	-	-	67.67 /E	609	161.75 /E	1,456
			UTP Cable Supports	54.00 E	3.6	290	28	-	-	-	5.88 /E	318	14.06 /E	759
			Termination Labor Only - # 16 - #14	1,185.00 E	157.9	12,730	-	-	-	-	10.74 /E	12,730	25.68 /E	30,426
			Control Wire Testing	589.00 E	78.5	6,328	-	-	-	-	10.74 /E	6,328	25.68 /E	15,123
			Wire Markers	1,185.00 E	15.8	1,273	61	-	-	-	1.13 /E	1,334	2.69 /E	3,188
			Process Electrical, Wire/Cable	**386,835.00 LF**	**3,389.6**	**273,341**	**26,349**				**0.78 /LF**	**299,690**	**1.85 /LF**	**716,272**
			Process Electrical, Conduit											
			GRC Conduit @ Level 2 3/4"	4,425.00 lf	518.7	41,832	6,607	-	-	-	10.95 /lf	48,439	26.16 /lf	115,771
			GRC Conduit @ Level 2 3/4"	1,200.00 lf	140.7	11,344	1,792	-	-	-	10.95 /lf	13,136	26.16 /lf	31,396
			GRC Elbow 3/4"	45.00 E	15.0	1,209	398	-	-	-	35.71 /E	1,607	85.35 /E	3,841
			GRC Elbow 3/4"	132.00 E	44.0	3,545	1,169	-	-	-	35.71 /E	4,714	85.35 /E	11,266
			GRC Elbow 3/4"	21.00 E	7.0	564	186	-	-	-	35.71 /E	750	85.35 /E	1,792
			GRC Elbow 3/4"	27.00 E	9.0	725	239	-	-	-	35.71 /E	964	85.35 /E	2,304
			GRC Couplng 3/4"	225.00 E	15.0	1,209	573	-	-	-	7.92 /E	1,782	18.92 /E	4,258
			Rigid Conduit Hub 3/4"	30.00 E	12.4	999	397	-	-	-	46.55 /E	1,396	111.25 /E	3,338
			Rigid Conduit Hub 3/4"	88.00 E	36.3	2,931	1,166	-	-	-	46.55 /E	4,096	111.26 /E	9,791
			Rigid Conduit Hub 3/4"	14.00 E	5.8	466	185	-	-	-	46.55 /E	652	111.26 /E	1,558
			Rigid Conduit Hub 3/4"	18.00 E	7.4	599	238	-	-	-	46.55 /E	838	111.26 /E	2,003
			Malleable LB Condulet - 3/4"	75.00 E	30.0	2,417	959	-	-	-	45.02 /E	3,376	107.60 /E	8,070
			Unistrut Straps 3/4"	150.00 E	6.0	483	284	-	-	-	5.12 /E	767	12.23 /E	1,834
			Unistrut Straps 3/4"	440.00 E	17.6	1,418	833	-	-	-	5.12 /E	2,251	12.23 /E	5,380
			Unistrut Straps 3/4"	70.00 E	2.8	226	132	-	-	-	5.12 /E	358	12.23 /E	856
			Unistrut Straps 3/4"	90.00 E	3.6	290	170	-	-	-	5.12 /E	460	12.23 /E	1,100
			Unistrut Conduit Hanger Allowance 3/4"	750.00 E	40.0	3,223	769	-	-	-	5.32 /E	3,992	12.72 /E	9,540
			EF Sealtite Flex 3/4"	15.00 lf	0.6	48	38	-	-	-	5.75 /lf	86	13.74 /lf	206
			EF Sealtite Flex 3/4"	44.00 lf	1.8	142	111	-	-	-	5.76 /lf	253	13.76 /lf	605
			EF Sealtite Flex 3/4"	16.00 lf	0.6	52	41	-	-	-	5.76 /lf	92	13.76 /lf	220
			LT Flex Connector Straight 3/4"	30.00 E	3.6	290	155	-	-	-	14.83 /E	445	35.45 /E	1,063
			LT Flex Connector Straight 3/4"	88.00 E	10.6	851	454	-	-	-	14.83 /E	1,305	35.45 /E	3,119
			LT Flex Connector Straight 3/4"	14.00 E	1.7	135	72	-	-	-	14.83 /E	208	35.45 /E	496
			LT Flex Connector Straight 3/4"	18.00 E	2.2	174	93	-	-	-	14.83 /E	267	35.45 /E	638
			Process Electrical, Conduit	**5,625.00 LF**	**932.2**	**75,173**	**17,062**				**16.40 /LF**	**92,235**	**39.19 /LF**	**220,445**
			Electrical, Conduit and Wire/Cable - Controls	**1.00 LS**	**4,321.8**	**348,514**	**43,411**				**391,924.48 /LS**	**391,924**	**936,717.10 /LS**	**936,717**
			Electrical, Grounding											
			Process Electrical, Grounding											
			Miscellaneous Grounding	1.00 ls	79.9	6,446	2,562	-	-	-	9,007.61 /ls	9,008	21,528.58 /ls	21,529
			Process Electrical, Grounding	**1.00 LF**	**79.9**	**6,446**	**2,562**				**9,007.61 /LF**	**9,008**	**21,528.58 /LF**	**21,529**
			Electrical, Grounding	**1.00 LF**	**79.9**	**6,446**	**2,562**				**9,007.61 /LF**	**9,008**	**21,528.58 /LF**	**21,529**
			26.15 Process Electrical	**1.00 LS**	**8,760.4**	**706,446**	**248,082**	**11,375**			**965,902.93 /LS**	**965,903**	**2,308,551.31 /LS**	**2,308,551**
		26.20	**Facility Electrical**											
			Facility Electrical, Complete $/SF Cost											
			Facility Electrical, Complete $/SF Cost											
			PS Building, Electrical Subcontract, Division 16	9,488.00 sf		-	-	540,884	-	-	57.01 /sf	540,884	136.25 /sf	1,292,736
			Facility Electrical, Complete $/SF Cost	**9,488.00 SF**				**540,884**			**57.01 /SF**	**540,884**	**136.25 /SF**	**1,292,736**
			Facility Electrical, Complete $/SF Cost	**1.00 LS**				**540,884**			**540,883.67 /LS**	**540,884**	**1,292,736.21 /LS**	**1,292,736**
			26.20 Facility Electrical	**1.00 LS**				**540,884**			**540,883.67 /LS**	**540,884**	**1,292,736.21 /LS**	**1,292,736**
		26.25	**Electrical Equipment**											
			Electrical Equipment											
			Electrical, Testing											
			Megger/Check Elec Equipment	1.00 LS	166.5	13,429	-	-	-	-	13,428.58 /LS	13,429	32,094.93 /LS	32,095
			Electrical, Testing	**1.00 LS**	**166.5**	**13,429**					**13,428.58 /LS**	**13,429**	**32,094.93 /LS**	**32,095**
			Electrical Equipment, MCCs - General											
			LV MCC Vertical Sections - 600A	6.00 E	63.9	5,157	13,834	-	-	-	3,165.13 /E	18,991	7,564.80 /E	45,389

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Electrical Equipment, MCCs - General											
			MCC Main Breaker - 600A	1.00 E	6.7	537	6,328	-	-	-	6,865.01 /E	6,865	16,407.70 /E	16,408
			MCC FVNR Starter w/ Circuit Breaker - Size 1	9.00 E	9.6	774	3,062	-	-	-	426.17 /E	3,835	1,018.55 /E	9,167
			MCC Circuit Breaker - <30A	29.00 E	9.7	779	6,700	-	-	-	257.89 /E	7,479	616.36 /E	17,875
			MCC Circuit Breaker - 80A	2.00 E	2.0	161	507	-	-	-	334.19 /E	668	798.74 /E	1,597
			MCC Circuit Breaker - 150A	3.00 E	5.0	403	1,494	-	-	-	632.32 /E	1,897	1,511.27 /E	4,534
			Switchboard instruments, ground fault protection, ground return path	1.00 ea	3.9	318	6,917	-	-	-	7,235.39 /ea	7,235	17,292.92 /ea	17,293
			Voltage monitor systems, AC voltage remote, add-on det only, w/internal modem	1.00 ea		-	4,099	-	-	-	4,099.02 /ea	4,099	9,796.85 /ea	9,797
			Transformer, dry-type, ventilated, 3 phase 480 V primary 120/208 V secondary, 30 kVA	1.00 ea	2.4	191	1,512	-	-	-	1,702.48 /ea	1,702	4,069.01 /ea	4,069
			Panelboards, 3 phase 4 wire, main lugs, 120/208 V, 100 amp, 30 circuits, NQOD, incl 20 A 1 pole plug-in breakers	1.00 ea	2.0	162	1,153	-	-	-	1,315.02 /ea	1,315	3,142.94 /ea	3,143
			Electrical Equipment, MCCs - General	**1.00 LS**	**105.2**	**8,481**	**45,606**				**54,087.25 /LS**	**54,087**	**129,270.95 /LS**	**129,271**
			Electrical Equipment, Switchgear - 5 KV											
			Low Volt Swgr Section NEMA 1 1200A	7.00 E	139.9	11,280	35,866	-	-	-	6,735.20 /E	47,146	16,097.43 /E	112,682
			Low Volt Swgr Section NEMA 1 1200A	4.00 E	79.9	6,446	20,495	-	-	-	6,735.21 /E	26,941	16,097.45 /E	64,390
			Low Volt Swgr Section NEMA 1 1200A	2.00 E	40.0	3,223	10,248	-	-	-	6,735.19 /E	13,470	16,097.39 /E	32,195
			Low Volt Swgr Main Breaker 1200A	3.00 E	8.0	645	153,713	-	-	-	51,452.61 /E	154,358	122,974.06 /E	368,922
			Low Volt Swgr Main Breaker 1200A	1.00 E	2.7	215	51,238	-	-	-	51,452.60 /E	51,453	122,974.00 /E	122,974
			Low Volt Swgr Main Breaker 1200A	1.00 E	2.7	215	51,238	-	-	-	51,452.59 /E	51,453	122,974.02 /E	122,974
			Low Volt Swgr Tie Breaker 1200A	1.00 E	2.7	215	51,238	-	-	-	51,452.59 /E	51,453	122,973.99 /E	122,974
			Low Volt Swgr Metering	1.00 E	2.7	215		-	-	-	214.83 /E	215	513.47 /E	513
			Low Volt Swgr Metering	1.00 E	1.3	107	51,238	-	-	-	51,345.16 /E	51,345	122,717.22 /E	122,717
			Low Volt Swgr Feed Breaker 1200A	1.00 E	2.7	215	51,238	-	-	-	51,452.59 /E	51,453	122,974.01 /E	122,974
			Low Volt Swgr Feed Breaker 1200A	6.00 E	16.0	1,289	307,427	-	-	-	51,452.61 /E	308,716	122,974.05 /E	737,844
			Low Volt Swgr Metering	1.00 E	2.7	215	51,238	-	-	-	51,452.59 /E	51,453	122,973.98 /E	122,974
			Low Voltage Switchgear Breaker Calibration	13.00 E	17.3	1,397	666	-	-	-	158.67 /E	2,063	379.24 /E	4,930
			Low Voltage Switchgear Breaker Calibration	2.00 E	2.7	215	102	-	-	-	158.65 /E	317	379.18 /E	758
			Switchboard instruments, ground fault protection, ground return path	1.00 ea	3.9	318	6,917	-	-	-	7,235.39 /ea	7,235	17,292.92 /ea	17,293
			Voltage monitor systems, AC voltage remote, add-on det only, w/internal modem	1.00 ea		-	4,099	-	-	-	4,099.02 /ea	4,099	9,796.81 /ea	9,797
			Electrical Equipment, Switchgear - 5 KV	**46.00 EA**	**325.0**	**26,208**	**846,960**				**18,981.92 /EA**	**873,169**	**45,367.65 /EA**	**2,086,912**
			Electrical Equipment, Switches - General											
			Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 30 amp, NEMA 3R	34.00 ea	116.9	9,571	5,575	-	-	-	445.45 /ea	15,145	1,064.65 /ea	36,198
			Electrical Equipment, Switches - General	**1.00 LS**	**116.9**	**9,571**	**5,575**				**15,145.39 /LS**	**15,145**	**36,198.19 /LS**	**36,198**
			Electrical Equipment, VFDs - General											
			Variable frequency drives, enclosed, 460 volt, 90 HP motor size, NEMA 1, FBO	3.00 ea	159.9	13,063	47,959	-	1,174	-	20,731.80 /ea	62,195	49,549.92 /ea	148,650
			Variable frequency drives, enclosed, 480 volt, 500 HP motor size, NEMA 1, FBO	5.00 ea	475.8	38,879	1,025	-	2,329	-	8,446.41 /ea	42,232	20,187.29 /ea	100,936
			Electrical Equipment, VFDs - General	**1.00 LS**	**635.6**	**51,942**	**48,983**		**3,502**		**104,427.43 /LS**	**104,427**	**249,586.22 /LS**	**249,586**
			Electrical Equipment, Transformers - General											
			Transformer, liquid-filled, 5 kV primary, 480 V secondary, 3 phase, 500 kVA, pad mounted	1.00 ea	66.6	5,443	21,315	-	489	-	27,246.93 /ea	27,247	65,121.38 /ea	65,121
			Electrical Equipment, Transformers - General	**1.00 LS**	**66.6**	**5,443**	**21,315**		**489**		**27,246.93 /LS**	**27,247**	**65,121.38 /LS**	**65,121**
			Electrical Equipment, Generators - General											
			Generator set,diesel,1.0 kva,incl battery,charger,enclosure,muffler,day tank,excl conduit,wiring,& concrete	2.00 ea	619.5	49,355	368,912	-	3,314	-	210,790.59 /ea	421,581	503,798.97 /ea	1,007,598
			Electrical Equipment, Generators - General	**1.00 LS**	**619.5**	**49,355**	**368,912**		**3,314**		**421,581.18 /LS**	**421,581**	**1,007,597.95 /LS**	**1,007,598**
			Electrical Equipment	**1.00 LS**	**2,035.3**	**164,429**	**1,337,351**		**7,305**		**1,509,085.29 /LS**	**1,509,085**	**3,606,781.55 /LS**	**3,606,782**
			26.25 Electrical Equipment	**1.00 LS**	**2,035.3**	**164,429**	**1,337,351**		**7,305**		**1,509,085.29 /LS**	**1,509,085**	**3,606,781.55 /LS**	**3,606,782**
			26.0 Electrical Work	**1.00 LS**	**11,918.6**	**961,434**	**1,615,016**	**552,258**	**13,762**		**3,142,470.05 /LS**	**3,142,470**	**7,510,644.34 /LS**	**7,510,644**
	32.0		**Exterior Improvements**											
		32.50	**Site, Improvements**											
			Site Improvements, Pipe Bollards											
			Site Improvements, Bollards											
			Security vehicle barriers, pipe bollards, steel, concrete filled/painted, 8' L x 4' D hole, 8" diam.	21.00 ea	67.1	4,346	17,646	-	1,096	-	1,099.44 /ea	23,088	2,462.78 /ea	51,718
			Site Improvements, Bollards	**21.00 EA**	**67.1**	**4,346**	**17,646**		**1,096**		**1,099.44 /EA**	**23,088**	**2,462.78 /EA**	**51,718**
			Site Improvements, Pipe Bollards	**1.00 LS**	**67.1**	**4,346**	**17,646**		**1,096**		**23,088.14 /LS**	**23,088**	**51,718.47 /LS**	**51,718**
			32.50 Site, Improvements	**1.00 LS**	**67.1**	**4,346**	**17,646**		**1,096**		**23,088.14 /LS**	**23,088**	**51,718.47 /LS**	**51,718**
			32.0 Exterior Improvements	**1.00 LS**	**67.1**	**4,346**	**17,646**		**1,096**		**23,088.14 /LS**	**23,088**	**51,718.47 /LS**	**51,718**
	40.0		**Process Pipe**											
		40.00	**Exposed Process Pipe**											
			24" DI Pipe											
			Process Pipe, Ductile Iron, 24"											
			Dresser Coupling, 12"	10.00 ea	33.6	2,858	4,509	-	2,098	-	946.51 /ea	9,465	2,195.95 /ea	21,960
			Dresser Coupling, 14"	1.00 ea	4.5	381	564	-	279	-	1,224.19 /ea	1,224	2,840.18 /ea	2,840

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Process Pipe, Ductile Iron, 24"											
			Dresser Coupling, 24"	5.00 ea	28.4	2,416	5,073	-	1,773	-	1,852.38 /ea	9,262	4,297.60 /ea	21,488
			10" DI, FL, Ell, 90	5.00 ea	32.1	2,811	1,825	-	-	-	927.18 /ea	4,636	2,151.10 /ea	10,755
			Install 24" DI, flanged, spool <= 10'	20.00 ea	319.2	27,943	-	-	-	-	1,397.13 /ea	27,943	3,241.41 /ea	64,828
			24" Fabricated DI Spool, FxF, 2' 6" - FURNISH	5.00 ea		-	11,324	-	-	-	2,264.71 /ea	11,324	5,254.23 /ea	26,271
			24" Fabricated DI Spool, FxF, 4' 6" - FURNISH	5.00 ea		-	14,177	-	-	-	2,835.50 /ea	14,177	6,578.48 /ea	32,892
			24" Fabricated DI Spool, FxF, 5' 0" - FURNISH	5.00 ea		-	14,885	-	-	-	2,976.91 /ea	14,885	6,906.57 /ea	34,533
			24" Fabricated DI Spool, FxF, 5' 6" - FURNISH	5.00 ea		-	15,592	-	-	-	3,118.33 /ea	15,592	7,234.67 /ea	36,173
			24" DI, FL, Ell, 90	4.00 ea	63.8	5,589	8,408	-	-	-	3,499.00 /ea	13,996	8,117.85 /ea	32,471
			24" DI, FL, Ell, 45	5.00 ea	79.8	6,986	7,440	-	-	-	2,885.23 /ea	14,426	6,693.87 /ea	33,469
			24" DI, FL, reducer, 24" x 12"	5.00 ea	79.8	6,986	6,510	-	-	-	2,699.15 /ea	13,496	6,262.15 /ea	31,311
			24" DI, FL, reducer, 24" x 14"	5.00 ea	79.8	6,986	6,646	-	-	-	2,726.27 /ea	13,631	6,325.08 /ea	31,625
			Pipe support	15.00 ea	79.9	6,997	17,477	-	-	-	1,631.63 /ea	24,474	3,785.46 /ea	56,782
			FURNISH Gate valve, iron body, solid wedge, Flgd, 250#, HWO, 24"	10.00 ea		-	317,039	-	-	-	31,703.88 /ea	317,039	73,554.42 /ea	735,544
			Process Pipe, Ductile Iron, 24"	**87.50 LF**	**800.9**	**69,951**	**431,467**		**4,151**		**5,777.94 /LF**	**505,570**	**13,405.07 /LF**	**1,172,944**
			24" DI Pipe	**87.50 LF**	**800.9**	**69,951**	**431,467**		**4,151**		**5,777.94 /LF**	**505,570**	**13,405.07 /LF**	**1,172,944**
			Valves											
			Process Pipe, Ductile Iron, 12"											
			Install gate valve, Flgd, DIP, 12"	5.00 ea	40.0	3,403	-	-	2,497	-	1,180.07 /ea	5,900	2,737.81 /ea	13,689
			Install gate valve, Flgd, DIP, 24"	10.00 ea	165.2	14,065	-	-	10,323	-	2,438.78 /ea	24,388	5,658.08 /ea	56,581
			Gate valve, iron body, dbl disk, Flgd, 250#, HWO, 12"	5.00 ea		-	6,343	-	-	-	1,268.65 /ea	6,343	2,943.32 /ea	14,717
			Install check valve, Flgd, DIP, 12"	5.00 ea	40.0	3,403	-	-	2,497	-	1,180.07 /ea	5,900	2,737.81 /ea	13,689
			Check valve, iron body, swing check, Flgd, 250#, 12"	5.00 ea		-	14,710	-	-	-	2,942.07 /ea	14,710	6,825.74 /ea	34,129
			Install magnetic flow meter, (material FBO), 24"	5.00 ea	82.6	7,231	-	-	4,130	-	2,272.06 /ea	11,360	5,271.28 /ea	26,356
			CI Valve Box & Cover, w/ Concrete Collar included	5.00 ea	20.0	1,701	769	-	1,249	-	743.75 /ea	3,719	1,725.54 /ea	8,628
			Flow Meters 24"	5.00 ea	0.0		122,971	-	-	-	24,594.12 /ea	122,971	57,059.47 /ea	285,297
			Flow Meter: Electrical Hookup Only, 24"	5.00 ea	83.3	6,714	-	-	-	-	1,342.85 /ea	6,714	3,115.47 /ea	15,577
			Process Pipe, Ductile Iron, 12"	**1.00 LF**	**431.0**	**36,517**	**144,793**		**20,696**		**202,005.98 /LF**	**202,006**	**468,662.91 /LF**	**468,663**
			Valves	**1.00 LS**	**431.0**	**36,517**	**144,793**		**20,696**		**202,005.98 /LS**	**202,006**	**468,662.91 /LS**	**468,663**
			40.00 Exposed Process Pipe	**87.50 LF**	**1,231.8**	**106,469**	**576,260**		**24,847**		**8,086.58 /LF**	**707,576**	**18,761.22 /LF**	**1,641,607**
			40.0 Process Pipe	**87.50 LF**	**1,231.8**	**106,469**	**576,260**		**24,847**		**8,086.58 /LF**	**707,576**	**18,761.22 /LF**	**1,641,607**
	40.9		**Instrumentation & Controls**											
		40.90	**Instrumentation & Controls**											
			Instrumentation & Controls											
			I&C, Flow / Mag Meter / Indicators & Transmitters											
			FE - Flow Element - Mag Flowtube (inline)	4.00 ea	10.7	859	205	-	-	-	266.09 /ea	1,064	635.97 /ea	2,544
			FT / FIT - Flow Transmitter - Magnetic,	4.00 ea	66.6	5,371	73,782	-	-	-	19,788.45 /ea	79,154	47,295.29 /ea	189,181
			I&C, Flow / Mag Meter / Indicators & Transmitters	**4.00 EA**	**77.3**	**6,231**	**73,987**				**20,054.54 /EA**	**80,218**	**47,931.26 /EA**	**191,725**
			I&C, Level / Indicators & Transmitters											
			LE - Level Element / Sensor	2.00 ea	0.7	54	102	-	-	-	78.09 /ea	156	186.65 /ea	373
			LT / LIT - Level Transmitter	2.00 ea	6.0	483	2,613	-	-	-	1,548.28 /ea	3,097	3,700.45 /ea	7,401
			I&C, Level / Indicators & Transmitters	**2.00 EA**	**6.7**	**537**	**2,716**				**1,626.37 /EA**	**3,253**	**3,887.10 /EA**	**7,774**
			I&C, Pressure / Indicators & Transmitters											
			PI - Pressure Indicator - Stem Mounted	8.00 ea	5.3	430	2,664	-	-	-	386.76 /ea	3,094	924.38 /ea	7,395
			PE - Diaphragm Seal	8.00 ea	16.0	1,289	3,484	-	-	-	596.67 /ea	4,773	1,426.06 /ea	11,408
			I&C, Pressure / Indicators & Transmitters	**8.00 EA**	**21.3**	**1,719**	**6,149**				**983.43 /EA**	**7,867**	**2,350.44 /EA**	**18,804**
			I&C, Other / Switches											
			Control Stations	44.00 E	58.6	4,727	4,380	-	-	-	206.97 /E	9,107	494.68 /E	21,766
			I&C, Other / Switches	**1.00 EA**	**58.6**	**4,727**	**4,380**				**9,106.82 /EA**	**9,107**	**21,765.71 /EA**	**21,766**
			I&C, Panels & Stands											
			Instrument Stand-Single, Galv.	6.00 ea	10.0	806	307	-	-	-	185.52 /ea	1,113	443.40 /ea	2,660
			Instrument Stand-Single, Galv.	2.00 ea	3.3	269	102	-	-	-	185.51 /ea	371	443.37 /ea	887
			Instrument Stand-Single, Galv.	44.00 ea	73.3	5,909	2,254	-	-	-	185.52 /ea	8,163	443.41 /ea	19,510
			I&C, Panels & Stands	**52.00 EA**	**86.6**	**6,983**	**2,664**				**185.52 /EA**	**9,647**	**443.41 /EA**	**23,057**
			I&C, PLC, Control Panels, Network Hardware											
			Network Hardware	1.00 ls	10.7	859	5,124	-	-	-	5,983.17 /ls	5,983	14,300.06 /ls	14,300
			Ethernet Radio [Wireless] - SCADA	1.00 ea	53.3	4,297	25,619	-	-	-	29,916.00 /ea	29,916	71,500.59 /ea	71,501
			Local Control Panel, Odor Control, FBO	1.00 ea	20.0	1,611	205	-	-	-	1,816.40 /ea	1,816	4,341.26 /ea	4,341
			Local Control Panel, Sump Pump Controller, FBO	1.00 ea	20.0	1,611	205	-	-	-	1,816.40 /ea	1,816	4,341.29 /ea	4,341
			Local Control Panel, Screen Control, FBO	3.00 ea	59.9	4,834	615	-	-	-	1,816.37 /ea	5,449	4,341.21 /ea	13,024
			Local Control Panel, Generator Control, FBO	2.00 ea	40.0	3,223	410	-	-	-	1,816.40 /ea	3,633	4,341.28 /ea	8,683
			East Street PS - PLC Cabinet	1.00 ea	53.3	4,297	30,743	-	-	-	35,039.77 /ea	35,040	83,746.59 /ea	83,747
			I&C, PLC, Control Panels, Network Hardware	**1.00 EA**	**257.1**	**20,734**	**62,920**				**83,653.66 /EA**	**83,654**	**199,935.99 /EA**	**199,936**
			I&C, Sotfware, Programming											
			SCADA Software Licenses	1.00 ea	0.0		3,587	-	-	-	3,586.64 /ea	3,587	8,572.25 /ea	8,572
			PLC / SCADA Software Development	287.00 pts	1,720.5	138,744		-	-	-	483.43 /pts	138,744	1,155.42 /pts	331,604
			I&C, Sotfware, Programming	**1.00 EA**	**1,720.5**	**138,744**	**3,587**				**142,330.56 /EA**	**142,331**	**340,176.45 /EA**	**340,176**
			I&C, Instrument Tubing, Piping, etc.											
			Press Gauge / Press Sw Installation Materials - Stainless	8.00 ea	27.7	2,234	1,230	-	-	-	433.02 /ea	3,464	1,034.94 /ea	8,280

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			I&C, Instrument Tubing, Piping, etc.	**1.00 LF**	**27.7**	**2,234**	**1,230**				**3,464.17 /LF**	**3,464**	**8,279.51 /LF**	**8,280**
			I&C, Other											
			Receive & Store Instrument	61.00 ea	28.4	2,294	1	-	-	-	37.61 /ea	2,294	89.89 /ea	5,483
			Identification Tag - SS	6.00 ea	2.0	161	92	-	-	-	42.23 /ea	253	100.92 /ea	606
			Identification Tag - SS	2.00 ea	0.7	54	31	-	-	-	42.23 /ea	84	100.92 /ea	202
			Identification Tag - SS	8.00 ea	2.7	215	123	-	-	-	42.23 /ea	338	100.92 /ea	807
			Identification Tag - SS	1.00 ea	0.3	27	15	-	-	-	42.22 /ea	42	100.90 /ea	101
			Identification Tag - SS	44.00 ea	14.7	1,182	676	-	-	-	42.23 /ea	1,858	100.93 /ea	4,441
			Field Calibration - Simple	8.00 ea	5.3	430		-	-	-	53.72 /ea	430	128.39 /ea	1,027
			Field Calibration - Average	52.00 ea	207.8	16,759		-	-	-	322.29 /ea	16,759	770.28 /ea	40,054
			Field Calibration - Severe	1.00 ea	8.0	645		-	-	-	644.56 /ea	645	1,540.53 /ea	1,541
			Pre-Operation Check	61.00 ea	75.6	6,097		-	-	-	99.94 /ea	6,097	238.87 /ea	14,571
			Startup - Stand-By (Manhours)	60.00 ea	69.3	5,586		-	-	-	93.11 /ea	5,586	222.53 /ea	13,352
			Loop Check - Average	60.00 ea	138.5	11,173		-	-	-	186.21 /ea	11,173	445.05 /ea	26,703
			I&C, Other	**1.00 EA**	**553.3**	**44,620**	**938**				**45,558.67 /EA**	**45,559**	**108,887.26 /EA**	**108,887**
			Instrumentation & Controls	**1.00 LS**	**2,809.1**	**226,529**	**158,570**				**385,099.39 /LS**	**385,099**	**920,404.82 /LS**	**920,405**
			40.90 Instrumentation & Controls	**1.00 LS**	**2,809.1**	**226,529**	**158,570**				**385,099.39 /LS**	**385,099**	**920,404.82 /LS**	**920,405**
			40.9 Instrumentation & Controls	**1.00 LS**	**2,809.1**	**226,529**	**158,570**				**385,099.39 /LS**	**385,099**	**920,404.82 /LS**	**920,405**
	41.0		**Bulk Material Processing Equipment**											
		41.00	**Material Handling Equipment**											
			Monorail Crane											
			Material Handling, Monorail Cranes											
			Monorail Cranes, under hung hoist, electric operating, 7.5 ton,	1.00 ea	45.3	4,199	51,238	-	198	-	55,634.37 /ea	55,634	124,623.49 /ea	124,623
			Material Handling, Monorail Cranes	**1.00 EA**	**45.3**	**4,199**	**51,238**		**198**		**55,634.37 /EA**	**55,634**	**124,623.49 /EA**	**124,623**
			Monorail Crane	**1.00 EA**	**45.3**	**4,199**	**51,238**		**198**		**55,634.37 /EA**	**55,634**	**124,623.49 /EA**	**124,623**
			41.00 Material Handling Equipment	**1.00 LS**	**45.3**	**4,199**	**51,238**		**198**		**55,634.37 /LS**	**55,634**	**124,623.49 /LS**	**124,623**
			41.0 Bulk Material Processing Equipment	**1.00 LS**	**45.3**	**4,199**	**51,238**		**198**		**55,634.37 /LS**	**55,634**	**124,623.49 /LS**	**124,623**
	43.0		**Process Equipment - Industrial**											
		43.05	**Furnish and Install Process Equipment**											
			Odor Control											
			Cast-In-Place Concrete, Slabs on Grade, 12" thick											
			Fine grade, for slab on grade, by hand	729.00 sf	6.8	399	22	-	-	-	0.58 /sf	421	1.32 /sf	964
			Fill, gravel subbase, under building slab on grade	13.50 cy	9.0	527	484	-	-	-	74.90 /cy	1,011	171.53 /cy	2,316
			Concrete pumping, subcontract, all inclusive price	27.00 cy		-	-	415	-	-	15.37 /cy	415	35.20 /cy	950
			Slab on grade edge forms, 7" to 12"	112.00 sf	26.9	2,009	115	-	-	-	18.97 /sf	2,124	43.43 /sf	4,864
			Reinforcing in place, A615 Gr 60, priced per lbs.	3,510.00 lb		-	1,798	1,439	-	-	0.92 /lb	3,237	2.11 /lb	7,413
			Concrete, ready mix, 4000 psi	27.00 CY		-	3,320	-	-	-	122.97 /CY	3,320	281.61 /CY	7,603
			Add for concrete waste, 4000 psi	1.35 cy		-	166	-	-	-	122.97 /cy	166	281.61 /cy	380
			Add amount for Fuel Surcharges - per concrete truck load	3.00 load		-	46	-	-	-	15.37 /load	46	35.21 /load	106
			Add amount for Environmental Fee - per concrete truck load	3.00 load		-	18	-	-	-	6.15 /load	18	14.07 /load	42
			Placing concrete, concrete pump	27.00 cy	27.0	1,581	-	-	-	-	58.56 /cy	1,581	134.10 /cy	3,621
			Finishing floors, monolithic, trowel finish (machine)	729.00 sf	19.4	1,344	15	-	-	-	1.87 /sf	1,359	4.27 /sf	3,113
			Curing, water	729.00 sf	3.2	190	37	-	-	-	0.31 /sf	227	0.71 /sf	520
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	**27.00 CY**	**92.3**	**6,050**	**6,023**	**1,854**			**515.80 /CY**	**13,927**	**1,181.21 /CY**	**31,893**
			Odor Control Equipment											
			Furnish Scrubber equipment associated accessories	1.00 ea			***183,431***	-	-		183,431.18 /ea	183,431	420,065.62 /ea	420,066
			Install Scrubber equipment and all associated accessories	1.00 ea	79.9	6,011	25,619	-	-	-	31,629.69 /ea	31,630	72,433.42 /ea	72,433
			30" FRP shop fabricated duct - FURNISH	51.00 LF		-	3,711	-	-	-	72.76 /LF	3,711	166.62 /LF	8,498
			30" FRP shop Ell, 90	1.00 ea		-	604	-	-	-	603.58 /ea	604	1,382.21 /ea	1,382
			30" FRP shop Tee	1.00 ea		-	905	-	-	-	905.37 /ea	905	2,073.35 /ea	2,073
			30" shop weld	6.00 ea		-	1,814	-	-	-	302.30 /ea	1,814	692.29 /ea	4,154
			36" FRP shop fabricated duct - FURNISH	20.00 LF		-	1,701	-	-	-	85.06 /LF	1,701	194.78 /LF	3,896
			36" shop weld	2.00 ea		-	676	-	-	-	338.17 /ea	676	774.42 /ea	1,549
			Odor Control Equipment	**1.00 EA**	**79.9**	**6,011**	**218,461**				**224,471.71 /EA**	**224,472**	**514,050.27 /EA**	**514,050**
			Odor Control	**1.00 LS**	**172.2**	**12,061**	**224,484**	**1,854**			**238,398.36 /LS**	**238,398**	**545,942.93 /LS**	**545,943**
			500 HP Pumps											
			Vertical Centrifugal Pump: 501hp-1000hp											
			Functional Testing, Pumps, 501-1000 hp	5.00 ea	53.3	4,007	512	-	-	-	903.91 /ea	4,520	2,070.00 /ea	10,350
			Align Pump & Motor, 501-1000 hp	5.00 ea	53.3	4,007	-	7,173	-	-	2,236.09 /ea	11,180	5,120.75 /ea	25,604
			Vibration Testing, Pumps, 501-1000 hp	5.00 ea	26.6	2,004	-	3,587	-	-	1,118.05 /ea	5,590	2,560.40 /ea	12,802
			Witnessed factory test	5.00 ea		-	-	2,562	-	2,562	1,024.76 /ea	5,124	2,346.74 /ea	11,734
			Local panel	5.00 ea	40.0	3,005	7,686	-	-	-	2,138.21 /ea	10,691	4,896.59 /ea	24,483
			Pressure indicators	10.00 ea	20.0	1,503	2,562	-	-	-	406.46 /ea	4,065	930.81 /ea	9,308
			Sleeved anchor bolts - Large	50.00 ea	33.3	2,505	1,435	-	-	-	78.78 /ea	3,939	180.42 /ea	9,021
			Non-Shrink Machine Grout	60.00 cuft	75.9	5,710	4,550	-	-	-	171.00 /cuft	10,260	391.60 /cuft	23,496
			Grease, Oil, and Lube Pumps, 501-1000 hp	5.00 ea	26.6	2,004	769	-	-	-	554.44 /ea	2,772	1,269.70 /ea	6,348
			FURNISH Vertical Centrifugal Pump, 501 - 1000 hp	5.00 EA		-	1,465,400	-	-	-	293,079.99 /EA	1,465,400	671,166.31 /EA	3,355,832
			Set pump assembly, 501 - 1000 hp	5.00 ea	479.6	36,065	512	-	-	-	7,315.45 /ea	36,577	16,752.70 /ea	83,764

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Vertical Centrifugal Pump: 501hp-1000hp	5.00 EA	808.6	60,809	1,483,425	13,322		2,562	312,023.69 /EA	1,560,118	714,548.25 /EA	3,572,741
			500 HP Pumps	**5.00 EA**	**808.6**	**60,809**	**1,483,425**	**13,322**		**2,562**	**312,023.69 /EA**	**1,560,118**	**714,548.25 /EA**	**3,572,741**
			Misc. Equipment											
			Unit Price Code											
			55 Gal Hydraulic Fluid Tanks Allowance	2.00 EA		13,322	20,495	-	-	-	16,908.46 /EA	33,817	38,721.14 /EA	77,442
			Unit Price Code	1.00 LS		13,322	20,495				33,816.92 /LS	33,817	77,442.27 /LS	77,442
			Misc. Equipment	**1.00 LS**		**13,322**	**20,495**				**33,816.92 /LS**	**33,817**	**77,442.27 /LS**	**77,442**
			43.05 Furnish and Install Process Equipment	1.00 LS	980.9	86,192	1,728,404	15,176		2,562	1,832,333.75 /LS	1,832,334	4,196,126.45 /LS	4,196,126
			43.0 Process Equipment - Industrial	1.00 LS	980.9	86,192	1,728,404	15,176		2,562	1,832,333.75 /LS	1,832,334	4,196,126.45 /LS	4,196,126
	44.0		Process Equipment - Municipal											
		44.05	Furnish and Install Process Equipment											
			Miscellaneous Euipment											
			Process Equipment											
			Miscellaneous process equipment including, Mechanical Bar Screen, Conveyors, Washer, Grinder & compactor	1.00 ea	599.5	44,961	225,446	-	20,382	-	290,789.71 /ea	290,790	665,921.47 /ea	665,921
			Process Equipment	1.00 EA	599.5	44,961	225,446		20,382		290,789.71 /EA	290,790	665,921.47 /EA	665,921
			Miscellaneous Euipment	**1.00 LS**	**599.5**	**44,961**	**225,446**		**20,382**		**290,789.71 /LS**	**290,790**	**665,921.47 /LS**	**665,921**
			44.05 Furnish and Install Process Equipment	1.00 EA	599.5	44,961	225,446		20,382		290,789.71 /EA	290,790	665,921.47 /EA	665,921
			44.0 Process Equipment - Municipal	1.00 LS	599.5	44,961	225,446		20,382		290,789.71 /LS	290,790	665,921.47 /LS	665,921
			0200 East Street Pump Station	**1.00 LS**	**33,594.5**	**2,678,795**	**4,624,360**	**726,540**	**115,915**	**53,800**	**8,199,408.91 /LS**	**8,199,409**	**19,115,106.38 /LS**	**19,115,106**
0305			**Dry Weather Pump Station**											
	01.0		General Requirements											
		01.06	Startup & Commissioning											
			Startup and Testing											
			General Conditions, Other											
			Startup, Testing, and Contractor Commissioning Allowance	1.00 ls		39,457		-	13,152	-	52,609.37 /ls	52,609	112,586.44 /ls	112,586
			General Conditions, Other	1.00 LS		39,457			13,152		52,609.37 /LS	52,609	112,586.44 /LS	112,586
			Startup and Testing	**1.00 LS**		**39,457**			**13,152**		**52,609.37 /LS**	**52,609**	**112,586.44 /LS**	**112,586**
			01.06 Startup & Commissioning	1.00 LS		39,457			13,152		52,609.37 /LS	52,609	112,586.44 /LS	112,586
			01.0 General Requirements	1.00 LS		39,457			13,152		52,609.37 /LS	52,609	112,586.44 /LS	112,586
	02.0		Existing Conditions											
		02.40	Demolition											
			Demolition											
			General Site Demolition											
			Miscellaneous site demo	1.00 ls				25,293	-	-	25,292.96 /ls	25,293	57,922.01 /ls	57,922
			General Site Demolition	1.00 LS				25,293			25,292.96 /LS	25,293	57,922.01 /LS	57,922
			General Site Demolition, Aspalt Pavement											
			Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	277.78 sy	34.8	2,330	-	-	1,204	-	12.72 /sy	3,534	29.13 /sy	8,093
			load and haul pavement material for offiste disposal 15 miles	46.30 cy	6.4	429	-	-	700	-	24.39 /cy	1,129	55.85 /cy	2,585
			Dumping fees	46.30 cy				1,171	-	-	25.29 /cy	1,171	57.92 /cy	2,682
			General Site Demolition, Aspalt Pavement	277.78 SY	41.2	2,759		1,171	1,904		21.00 /SY	5,834	48.09 /SY	13,360
			General Site Demolition, Saw Cutting Asphalt											
			Selective demolition, saw cutting, each additional inch of depth over 3"	750.00 lf	64.6	4,516	223	-	2,184	-	9.23 /lf	6,923	21.14 /lf	15,854
			General Site Demolition, Saw Cutting Asphalt	750.00 LF	64.6	4,516	223		2,184		9.23 /LF	6,923	21.14 /LF	15,854
			Demolition	**1.00 LS**	**105.8**	**7,275**	**223**	**26,464**	**4,088**		**38,049.79 /LS**	**38,050**	**87,135.71 /LS**	**87,136**
			02.40 Demolition	1.00 LS	105.8	7,275	223	26,464	4,088		38,049.79 /LS	38,050	87,135.71 /LS	87,136
			02.0 Existing Conditions	1.00 LS	105.8	7,275	223	26,464	4,088		38,049.79 /LS	38,050	87,135.71 /LS	87,136
	03.0		Concrete Work											
		03.10	Cast-In-Place Concrete Work											
			36" Slab on Grade: 40' x 20' x 36" Thk											
			Cast-In-Place Concrete, Slabs on Grade, 36" thick											
			Fine grade, for slab on grade, by hand	800.00 sf	7.4	432	24	-	-	-	0.57 /sf	456	1.31 /sf	1,044
			Fill, gravel subbase, under building slab on grade	29.63 cy	19.5	1,142	1,049	-	-	-	73.95 /cy	2,191	169.35 /cy	5,018
			Concrete pumping, subcontract, all inclusive price	88.89 cy		-	-	1,349	-	-	15.18 /cy	1,349	34.75 /cy	3,089
			Slab on grade edge forms, > 24"	360.00 sf	118.4	8,856	455	-	-	-	25.87 /sf	9,312	59.23 /sf	21,324
			Waterstop, PVC, center bulb, 6" wide	160.00 lf	16.8	1,260	324	-	-	-	9.90 /lf	1,583	22.66 /lf	3,626
			Reinforcing in place, A615 Gr 60, priced per lbs.	14,222.22 lb		-	7,194	5,756	-	-	0.91 /lb	12,950	2.09 /lb	29,656
			Concrete, ready mix, 4000 psi	88.89 CY		-	10,792	-	-	-	121.41 /CY	10,792	278.03 /CY	24,713
			Add for concrete waste, 4000 psi	4.44 cy		-	540	-	-	-	121.41 /cy	540	278.02 /cy	1,236
			Placing concrete, concrete pump	88.89 cy	87.7	5,139	-	-	-	-	57.81 /cy	5,139	132.39 /cy	11,768
			Finishing floors, monolithic, trowel finish (machine)	800.00 sf	21.0	1,457	16	-	-	-	1.84 /sf	1,473	4.22 /sf	3,374
			Curing, membrane spray	800.00 sf	2.1	123	32	-	-	-	0.20 /sf	156	0.45 /sf	357
			Polyethelene vapor barrier, 10 mil thick	8.00 sq	2.3	171	86	-	-	-	32.15 /sq	257	73.62 /sq	589
			Cast-In-Place Concrete, Slabs on Grade, 36" thick	88.89 CY	275.2	18,580	20,513	7,105			519.71 /CY	46,197	1,190.16 /CY	105,793

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			36" Slab on Grade: 40' x 20' x 36" Thk	**88.89 CY**	**275.2**	**18,580**	**20,513**	**7,105**			**519.71 /CY**	**46,197**	**1,190.16 /CY**	**105,793**
			12" SOG @ Valve Vault											
			Cast-In-Place Concrete, Slabs on Grade, 12" thick											
			Fine grade, for slab on grade, by hand	378.00 sf	3.5	204	11	-	-	-	0.57 /sf	216	1.31 /sf	494
			Concrete pumping, subcontract, all inclusive price	14.00 cy		-	-	212	-	-	15.18 /cy	212	34.75 /cy	487
			Slab on grade edge forms, 7" to 12"	78.00 sf	18.5	1,382	79	-	-	-	18.72 /sf	1,460	42.88 /sf	3,345
			Reinforcing in place, A615 Gr 60, priced per lbs.	1,820.00 lb		-	921	737	-	-	0.91 /lb	1,657	2.09 /lb	3,795
			Concrete, ready mix, 4000 psi	14.00 CY		-	1,700	-	-	-	121.41 /CY	1,700	278.02 /CY	3,892
			Add for concrete waste, 4000 psi	0.70 cy		-	85	-	-	-	121.40 /cy	85	278.01 /cy	195
			Add amount for Fuel Surcharges - per concrete truck load	2.00 load		-	30	-	-	-	15.18 /load	30	34.77 /load	70
			Add amount for Environmental Fee - per concrete truck load	2.00 load		-	12	-	-	-	6.07 /load	12	13.90 /load	28
			Placing concrete, concrete pump	14.00 cy	13.8	809	-	-	-	-	57.81 /cy	809	132.39 /cy	1,853
			Finishing floors, monolithic, trowel finish (machine)	378.00 sf	9.9	688	8	-	-	-	1.84 /sf	696	4.22 /sf	1,593
			Curing, water	378.00 sf	1.7	97	19	-	-	-	0.31 /sf	116	0.70 /sf	266
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	**14.00 CY**	**47.4**	**3,180**	**2,865**	**949**			**499.58 /CY**	**6,994**	**1,144.07 /CY**	**16,017**
			12" SOG @ Valve Vault	**14.00 CY**	**47.4**	**3,180**	**2,865**	**949**			**499.58 /CY**	**6,994**	**1,144.07 /CY**	**16,017**
			24" Exterior Concrete Walls: 120' L x 20' H x 24" Thk											
			Cast-In-Place Concrete, Straight Walls, 24" thick											
			Concrete pumping, subcontract, all inclusive price	177.78 cy		-	-	2,698	-	-	15.18 /cy	2,698	34.75 /cy	6,178
			Forms in place, structural walls, > 16' high, hand set	4,800.00 sf	1,073.2	80,297	6,556	-	-	-	18.09 /sf	86,853	41.44 /sf	198,897
			Waterstop, PVC, center bulb, 6" wide	240.00 lf	25.3	1,889	486	-	-	-	9.90 /lf	2,375	22.66 /lf	5,439
			Reinforcing in place, A615 Gr 60, priced per lbs.	32,000.00 lb		-	16,187	12,950	-	-	0.91 /lb	29,137	2.09 /lb	66,726
			Concrete, ready mix, 4000 psi	177.78 CY		-	21,583	-	-	-	121.41 /CY	21,583	278.03 /CY	49,427
			Add for concrete waste, 4000 psi	8.89 cy		-	1,079	-	-	-	121.41 /cy	1,079	278.02 /cy	2,471
			Placing concrete, concrete pump, for structural wall >12" - 24" thick	177.78 cy	175.4	10,277	-	-	-	-	57.81 /cy	10,277	132.39 /cy	23,536
			Patch & plug tieholes	4,800.00 sf	94.7	5,550	97	-	-	-	1.18 /sf	5,647	2.69 /sf	12,933
			Sack rub	4,800.00 sf	252.5	14,800	146	-	-	-	3.11 /sf	14,945	7.13 /sf	34,226
			Curing, membrane spray	4,800.00 sf	12.6	740	194	-	-	-	0.20 /sf	934	0.45 /sf	2,139
			Below grade damproofing, Bituminous Asphalt	2,400.00 sf		-	2,428	-	-	-	1.01 /sf	2,428	2.32 /sf	5,561
			Cast-In-Place Concrete, Straight Walls, 24" thick	**177.78 CY**	**1,633.7**	**113,554**	**48,757**	**15,648**			**1,001.00 /CY**	**177,959**	**2,292.34 /CY**	**407,533**
			24" Exterior Concrete Walls: 120' L x 20' H x 24" Thk	**177.78 CY**	**1,633.7**	**113,554**	**48,757**	**15,648**			**1,001.00 /CY**	**177,959**	**2,292.34 /CY**	**407,533**
			12" Walls @ Valve Vault											
			Cast-In-Place Concrete, Straight Walls, 12" thick											
			Concrete pumping, subcontract, all inclusive price	23.70 cy		-	-	360	-	-	15.18 /cy	360	34.75 /cy	824
			Forms in place, structural walls, to 8' high, hand set	1,280.00 sf	252.5	18,894	1,295	-	-	-	15.77 /sf	20,189	36.12 /sf	46,233
			Reinforcing in place, A615 Gr 60, priced per lbs.	3,204.10 lb		-	1,621	1,297	-	-	0.91 /lb	2,917	2.09 /lb	6,681
			Concrete, ready mix, 4000 psi	23.70 CY		-	2,878	-	-	-	121.41 /CY	2,878	278.03 /CY	6,590
			Add for concrete waste, 4000 psi	1.19 cy		-	144	-	-	-	121.40 /cy	144	278.01 /cy	329
			Add amount for Fuel Surcharges - per concrete truck load	3.00 load		-	46	-	-	-	15.18 /load	46	34.76 /load	104
			Add amount for Environmental Fee - per concrete truck load	3.00 load		-	18	-	-	-	6.07 /load	18	13.90 /load	42
			Placing concrete, concrete pump, for structural wall to 12" thick	23.70 cy	26.5	1,553	-	-	-	-	65.52 /cy	1,553	150.04 /cy	3,557
			Patch & plug tieholes	1,280.00 sf	25.3	1,480	26	-	-	-	1.18 /sf	1,506	2.69 /sf	3,449
			Sack rub	1,280.00 sf	67.3	3,947	39	-	-	-	3.11 /sf	3,985	7.13 /sf	9,127
			Curing, membrane spray	1,280.00 sf	3.4	197	52	-	-	-	0.20 /sf	249	0.45 /sf	570
			Cast-In-Place Concrete, Straight Walls, 12" thick	**23.70 CY**	**375.0**	**26,071**	**6,118**	**1,656**			**1,428.06 /CY**	**33,845**	**3,270.32 /CY**	**77,507**
			12" Walls @ Valve Vault	**23.70 CY**	**375.0**	**26,071**	**6,118**	**1,656**			**1,428.06 /CY**	**33,845**	**3,270.32 /CY**	**77,507**
			12" Elevated Slab: 40' L x 20' W x 12" Thk											
			Cast-In-Place Concrete, Elevated Decks, 12" thick											
			Concrete pumping, subcontract, all inclusive price	29.63 cy		-	-	450	-	-	15.18 /cy	450	34.75 /cy	1,030
			Forms in place, elevated slab, soffit	800.00 sf	210.4	15,745	1,012	-	-	-	20.95 /sf	16,756	47.97 /sf	38,373
			Forms in place, elevated slab, edge form	120.00 sf	39.5	2,952	152	-	-	-	25.87 /sf	3,104	59.23 /sf	7,108
			Slab shoring	16,000.00 cf	147.4	11,025	809	-	-	-	0.74 /cf	11,835	1.69 /cf	27,102
			Waterstop, PVC, center bulb, 6" wide	240.00 lf	25.3	1,889	486	-	-	-	9.90 /lf	2,375	22.66 /lf	5,439
			Reinforcing in place, A615 Gr 60, priced per lbs.	6,518.52 lb		-	3,297	2,638	-	-	0.91 /lb	5,935	2.09 /lb	13,592
			Concrete, ready mix, 4000 psi	29.63 CY		-	3,597	-	-	-	121.41 /CY	3,597	278.02 /CY	8,238
			Add for concrete waste, 4000 psi	1.48 cy		-	180	-	-	-	121.41 /cy	180	278.04 /cy	412
			Placing concrete, concrete pump, for elevated slab to 12" thick	29.63 cy	19.5	1,142	-	-	-	-	38.54 /cy	1,142	88.26 /cy	2,615
			Curing, membrane spray	800.00 sf	2.1	123	32	-	-	-	0.20 /sf	156	0.45 /sf	357
			Cast-In-Place Concrete, Elevated Decks, 12" thick	**29.63 CY**	**444.1**	**32,877**	**9,565**	**3,088**			**1,536.61 /CY**	**45,530**	**3,518.90 /CY**	**104,265**
			12" Elevated Slab: 40' L x 20' W x 12" Thk	**29.63 CY**	**444.1**	**32,877**	**9,565**	**3,088**			**1,536.61 /CY**	**45,530**	**3,518.90 /CY**	**104,265**
			12" Elevated Slab @ Valve Vault											
			Cast-In-Place Concrete, Elevated Decks, 12" thick											
			Concrete pumping, subcontract, all inclusive price	14.00 cy		-	-	212	-	-	15.18 /cy	212	34.75 /cy	487
			Forms in place, elevated slab, soffit	378.00 sf	99.4	7,439	478	-	-	-	20.95 /sf	7,917	47.97 /sf	18,131
			Forms in place, elevated slab, edge form	78.00 sf	25.6	1,919	99	-	-	-	25.87 /sf	2,018	59.23 /sf	4,620
			Slab shoring	3,024.00 cf	27.9	2,084	153	-	-	-	0.74 /cf	2,237	1.69 /cf	5,122
			Reinforcing in place, A615 Gr 60, priced per lbs.	1,892.42 lb		-	957	766	-	-	0.91 /lb	1,723	2.09 /lb	3,946
			Concrete, ready mix, 4000 psi	14.00 CY		-	1,700	-	-	-	121.41 /CY	1,700	278.03 /CY	3,892
			Add for concrete waste, 4000 psi	0.70 cy		-	85	-	-	-	121.40 /cy	85	278.01 /cy	195
			Add amount for Fuel Surcharges - per concrete truck load	2.00 load		-	30	-	-	-	15.18 /load	30	34.75 /load	70
			Add amount for Environmental Fee - per concrete truck load	2.00 load		-	12	-	-	-	6.07 /load	12	13.91 /load	28

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Cast-In-Place Concrete, Elevated Decks, 12" thick											
			Placing concrete, concrete pump, for elevated slab to 12" thick	14.00 cy	9.2	540	-	-	-	-	38.54 /cy	540	88.26 /cy	1,236
			Curing, membrane spray	378.00 sf	1.0	58	15	-	-	-	0.20 /sf	74	0.45 /sf	169
			Cast-In-Place Concrete, Elevated Decks, 12" thick	14.00 CY	163.1	12,040	3,529	978			1,181.97 /CY	16,548	2,706.77 /CY	37,895
			12" Elevated Slab @ Valve Vault	**14.00 CY**	**163.1**	**12,040**	**3,529**	**978**			**1,181.97 /CY**	**16,548**	**2,706.77 /CY**	**37,895**
			8" Baffle Wall @ Wetwell											
			Cast-In-Place Concrete, Straight Walls, 8" thick											
			Concrete pumping, subcontract, all inclusive price	3.75 cy		-	-	57	-	-	15.18 /cy	57	34.76 /cy	130
			Forms in place, structural walls, > 8' to 16' high, hand set	304.00 sf	80.0	5,983	384	-	-	-	20.95 /sf	6,367	47.97 /sf	14,582
			Reinforcing in place, A615 Gr 60, priced per lbs.	760.97 lb		-	385	308	-	-	0.91 /lb	693	2.09 /lb	1,587
			Concrete, ready mix, 4000 psi	3.75 CY		-	456	-	-	-	121.41 /CY	456	278.03 /CY	1,043
			Add for concrete waste, 4000 psi	0.19 cy		-	23	-	-	-	121.44 /cy	23	278.03 /cy	52
			Add amount for Fuel Surcharges - per concrete truck load	1.00 load		-	15	-	-	-	15.17 /load	15	34.76 /load	35
			Add amount for Environmental Fee - per concrete truck load	1.00 load		-	6	-	-	-	6.07 /load	6	13.89 /load	14
			Placing concrete, concrete pump, for structural wall to 12" thick	3.75 cy	4.2	246	-	-	-	-	65.52 /cy	246	150.05 /cy	563
			Patch & plug tieholes	304.00 sf	6.0	352	6	-	-	-	1.18 /sf	358	2.69 /sf	819
			Sack rub	304.00 sf	16.0	937	9	-	-	-	3.11 /sf	947	7.13 /sf	2,168
			Curing, membrane spray	304.00 sf	0.8	47	12	-	-	-	0.19 /sf	59	0.45 /sf	135
			Cast-In-Place Concrete, Straight Walls, 8" thick	3.75 CY	107.0	7,565	1,297	365			2,460.33 /CY	9,226	5,634.27 /CY	21,129
			8" Baffle Wall @ Wetwell	**3.75 CY**	**107.0**	**7,565**	**1,297**	**365**			**2,460.33 /CY**	**9,226**	**5,634.27 /CY**	**21,129**
			03.10 Cast-In-Place Concrete Work	351.75 CY	3,045.5	213,866	92,644	29,789			956.07 /CY	336,298	2,189.45 /CY	770,138
			03.0 Concrete Work	1.00 LS	3,045.5	213,866	92,644	29,789			336,298.25 /LS	336,298	770,138.09 /LS	770,138
	08.0		Openings											
		08.10	Doors and Frames											
			Access Door											
			Specialty Doors and Frames, Access Doors											
			Floor, industrial, steel 300 psf L.L., dbl leaf, 6' x 4' opening, 645#	3.00 opng	63.1	5,723	20,032	-	-	-	8,585.02 /opng	25,755	19,660.06 /opng	58,980
			Specialty Doors and Frames, Access Doors	3.00 EA	63.1	5,723	20,032				8,585.02 /EA	25,755	19,660.06 /EA	58,980
			Access Door	**3.00 EA**	**63.1**	**5,723**	**20,032**				**8,585.02 /EA**	**25,755**	**19,660.06 /EA**	**58,980**
			08.10 Doors and Frames	3.00 EA	63.1	5,723	20,032				8,585.02 /EA	25,755	19,660.06 /EA	58,980
			08.0 Openings	1.00 LS	63.1	5,723	20,032				25,755.05 /LS	25,755	58,980.19 /LS	58,980
	26.0		Electrical Work											
		26.00	Electrical											
			Electrical and I&C											
			Electrical, Other											
			Electrical and I&C allowance	1.00 ls		-	-	101,172	-	-	101,171.86 /ls	101,172	241,805.31 /ls	241,805
			Electrical, Other	1.00 LS				101,172			101,171.86 /LS	101,172	241,805.31 /LS	241,805
			I&C, Flow / Mag Meter / Indicators & Transmitters											
			FE - Flow Element - Mag Flowtube (inline)	3.00 ea	7.9	636	152	-	-	-	262.70 /ea	788	627.86 /ea	1,884
			FT / FIT - Flow Transmitter - Magnetic,	3.00 ea	49.3	3,977	54,633	-	-	-	19,536.70 /ea	58,610	46,693.58 /ea	140,081
			I&C, Flow / Mag Meter / Indicators & Transmitters	3.00 EA	57.2	4,614	54,785				19,799.40 /EA	59,398	47,321.44 /EA	141,964
			Electrical and I&C	**1.00 LS**	**57.2**	**4,614**	**54,785**	**101,172**			**160,570.05 /LS**	**160,570**	**383,769.63 /LS**	**383,770**
			26.00 Electrical	1.00 LS	57.2	4,614	54,785	101,172			160,570.05 /LS	160,570	383,769.63 /LS	383,770
			26.0 Electrical Work	1.00 LS	57.2	4,614	54,785	101,172			160,570.05 /LS	160,570	383,769.63 /LS	383,770
	31.0		Earthwork											
		31.15	Site Preparation											
			Site Preparation											
			Site Preparation, Erosion Controls / Pre-construction											
			Silt Fence, Heavy-Duty, Subcontracted	250.00 lf	4.3		-	759	-	-	3.04 /lf	759	6.80 /lf	1,700
			Erosion control, hay bales, staked, Subcontracted, Install Only	20.00 ea	1.0		-	283	-	-	14.17 /ea	283	31.73 /ea	635
			Temp Seed	1.00 ls	5.3		-	506	-	-	505.85 /ls	506	1,133.14 /ls	1,133
			Temp Mulching	1.00 ls	0.5		-	506	-	-	505.86 /ls	506	1,133.13 /ls	1,133
			Inlet Protection, Subcontracted	8.00 ea	1.2		-	2,023	-	-	252.93 /ea	2,023	566.58 /ea	4,533
			Stabilized Construction Entrance, Clean Rock, 1-1/2" thru 3"	47.41 tn	12.5	908	959	-	1,028	-	61.07 /tn	2,895	136.80 /tn	6,485
			Filter Fabric under Stabilized Construction Entrance	88.89 sy	0.2		135	-		-	1.52 /sy	135	3.40 /sy	302
			Best Management Practice (BMP) Maintenance, Labor & Material	20.00 day	263.0	15,361	-	-	-	-	768.04 /day	15,361	1,720.44 /day	34,409
			Remove erosion control and dispose offsite	1.00 ls		-	3,541	-	-	-	3,541.02 /ls	3,541	7,932.03 /ls	7,932
			Site Preparation, Erosion Controls / Pre-construction	1.00 LS	288.0	16,269	4,635	4,077	1,028		26,009.07 /LS	26,009	58,261.49 /LS	58,261
			Site Preparation	**1.00 LS**	**288.0**	**16,269**	**4,635**	**4,077**	**1,028**		**26,009.07 /LS**	**26,009**	**58,261.49 /LS**	**58,261**
			31.15 Site Preparation	1.00 LS	288.0	16,269	4,635	4,077	1,028		26,009.07 /LS	26,009	58,261.49 /LS	58,261
		31.25	Earthworks, Structural											
			Structural Excavation											
			Site Preparation, Dewatering											
			Dewatering, pumping 24 hr, 8 hrs attended, 6" centrifugal pump	120.00 day	3,787.9	271,851	24,281	-	28,823	-	2,707.96 /day	324,955	6,065.95 /day	727,914
			Site Preparation, Dewatering	120.00 Day	3,787.9	271,851	24,281		28,823		2,707.96 /Day	324,955	6,065.95 /Day	727,914
			Earthworks, Sheeting and Shoring											
			Shoring, Sheet Piles, subcontracted	3,360.00 sf	1,176.0		-	254,953	-	-	75.88 /sf	254,953	169.97 /sf	571,106

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Earthworks, Sheeting and Shoring	**3,360.00 SF**	**1,176.0**			**254,953**			**75.88 /SF**	**254,953**	**169.97 /SF**	**571,106**
			Earthworks, Structural, Excavation											
			Fine grade, for slab on grade, by machine	900.00 sf	8.3	486	9	-	-	-	0.55 /sf	495	1.23 /sf	1,109
			Backfill from Select (Imported)	575.00 cy	47.3	3,262	20,361	-	3,583	-	47.31 /cy	27,206	105.99 /cy	60,942
			Compaction, vibratory plate, 8" lifts, common fill	575.00 cy	30.3	1,805	-	-	251	-	3.58 /cy	2,056	8.01 /cy	4,605
			Excav, Struct, common earth, hyd backhoe, 2 CY bkt	1,167.00 cy	122.8	8,548	-	-	34,563	-	36.94 /cy	43,111	82.75 /cy	96,570
			Load Excess Spoils for Off-Site Hauling, Excavator, Cat 320	1,167.00 cy	15.3	1,221	-	-	1,871	-	2.65 /cy	3,092	5.94 /cy	6,927
			Haul Excess Spoils Off-Site, 17 yd capacity, 50 miles RT	1,167.00 cy	148.0	9,911	-	-	20,112	-	25.73 /cy	30,023	57.63 /cy	67,253
			Excess Spoils (contaminated but not hazardous) Dump Charges for 17 yd end dumps, per cy	1,167.00 cy		-	141,681	-	-	-	121.41 /cy	141,681	271.96 /cy	317,372
			Earthworks, Structural, Excavation	**1,167.00 CY**	**372.0**	**25,233**	**162,051**		**60,380**		**212.22 /CY**	**247,664**	**475.39 /CY**	**554,778**
			Structural Excavation	**1,167.00 CY**	**5,335.8**	**297,084**	**186,332**	**254,953**	**89,203**		**709.15 /CY**	**827,572**	**1,588.52 /CY**	**1,853,798**
			Concrete Auger Cast Piles											
			Earthworks, Piling, Auger Cast											
			Mobilization for rig, average cost per vlf, add	600.00 vlf	5.9	456	-	-	2,855	-	5.52 /vlf	3,311	12.36 /vlf	7,417
			Uncasd drilld concrt piers,cast place augered piles,24"dm,priced using 40'lg,unless specifd otherws,excluds pile caps moblztn,casing rnfrcng	600.00 vlf	315.7	20,597	12,748	-	16,519	-	83.11 /vlf	49,864	186.16 /vlf	111,698
			Cast-in place adds for drilled concrete piers, for reinforcing steel, add	14,000.00 lb		-	17,705	-	-	-	1.27 /lb	17,705	2.83 /lb	39,660
			Pile Caps	15.00 ea		6,905	7,588	-	2,959	-	1,163.48 /ea	17,452	2,606.24 /ea	39,094
			Site Prep and Test Piles	1.00 ls	157.8	10,259		-	7,891	-	18,150.17 /ls	18,150	40,657.22 /ls	40,657
			Earthworks, Piling, Auger Cast	**600.00 LF**	**479.5**	**38,217**	**38,041**		**30,224**		**177.47 /LF**	**106,482**	**397.54 /LF**	**238,525**
			Concrete Auger Cast Piles	**15.00 EA**	**479.5**	**38,217**	**38,041**		**30,224**		**7,098.82 /EA**	**106,482**	**15,901.67 /EA**	**238,525**
			31.25 Earthworks, Structural	**1,167.00 CY**	**5,815.3**	**335,301**	**224,373**	**254,953**	**119,427**		**800.39 /CY**	**934,054**	**1,792.91 /CY**	**2,092,323**
			31.0 Earthwork	**1.00 LS**	**6,103.2**	**351,570**	**229,008**	**259,030**	**120,455**		**960,063.26 /LS**	**960,063**	**2,150,584.77 /LS**	**2,150,585**
	33.0		**Utilities**											
		33.05	**Buried Process Piping**											
			Yard Piping & Structures											
			Buried Pipe, Other											
			Miscellaneous Yard Piping	1.00 ls				101,172	-	-	101,171.86 /ls	101,172	231,688.10 /ls	231,688
			Buried Pipe, Other	**1.00 LS**				**101,172**			**101,171.86 /LS**	**101,172**	**231,688.10 /LS**	**231,688**
			Buried Structure, Concrete Junction Chamber											
			Allowance for concrete junction box including gates	1.00 ea				252,930	-	-	252,929.66 /ea	252,930	579,220.25 /ea	579,220
			Buried Structure, Concrete Junction Chamber	**1.00 EA**				**252,930**			**252,929.66 /EA**	**252,930**	**579,220.25 /EA**	**579,220**
			Yard Piping & Structures	**1.00 LS**				**354,102**			**354,101.52 /LS**	**354,102**	**810,908.35 /LS**	**810,908**
			Utility Relocation											
			Buried Pipe, Other											
			Miscellaneous utilities relocation at foot print of Dry Weather Pump Station	1.00 ls				75,879	-	-	75,878.89 /ls	75,879	173,766.05 /ls	173,766
			Buried Pipe, Other	**1.00 LS**				**75,879**			**75,878.89 /LS**	**75,879**	**173,766.05 /LS**	**173,766**
			Utility Relocation	**1.00 LS**				**75,879**			**75,878.89 /LS**	**75,879**	**173,766.05 /LS**	**173,766**
			Temporary Bypass Pumping											
			Buried Pipe Specials, Temporary Bypasses											
			Allowance for Bypass Pumping, System Operation	12.00 mon	315.7	27,302	48,562	-	1,578,281	-	137,845.47 /mon	1,654,146	315,672.31 /mon	3,788,068
			Buried Pipe Specials, Temporary Bypasses	**12.00 EA**	**315.7**	**27,302**	**48,562**		**1,578,281**		**137,845.47 /EA**	**1,654,146**	**315,672.31 /EA**	**3,788,068**
			Temporary Bypass Pumping	**12.00 MO**	**315.7**	**27,302**	**48,562**		**1,578,281**		**137,845.47 /MO**	**1,654,146**	**315,672.31 /MO**	**3,788,068**
			33.05 Buried Process Piping		**315.7**	**27,302**	**48,562**	**429,980**	**1,578,281**		**/LF**	**2,084,126**	**/LF**	**4,772,742**
			33.0 Utilities	**1.00 LS**	**315.7**	**27,302**	**48,562**	**429,980**	**1,578,281**		**2,084,126.04 /LS**	**2,084,126**	**4,772,742.10 /LS**	**4,772,742**
	40.0		**Process Pipe**											
		40.00	**Exposed Process Pipe**											
			12" DI Pipe											
			Process Pipe, Ductile Iron, 12"											
			Install 12" DI, flanged, spool <= 10'	16.00 ea	115.7	10,132	-	-	-	-	633.26 /ea	10,132	1,469.20 /ea	23,507
			12" Fabricated DI Spool, FxF, 1' 0" - FURNISH	3.00 ea		-	1,733	-	-	-	577.69 /ea	1,733	1,340.26 /ea	4,021
			12" Fabricated DI Spool, FxF, 2' 0" - FURNISH	3.00 ea		-	2,082	-	-	-	694.04 /ea	2,082	1,610.21 /ea	4,831
			12" Fabricated DI Spool, FxF, 3' 0" - FURNISH	4.00 ea		-	3,238	-	-	-	809.38 /ea	3,238	1,877.79 /ea	7,511
			12" Fabricated DI Spool, FxF, 3' 6" - FURNISH	3.00 ea		-	2,601	-	-	-	867.04 /ea	2,601	2,011.57 /ea	6,035
			12" Fabricated DI Spool, FxF, 8' 0" - FURNISH	3.00 ea		-	4,176	-	-	-	1,392.13 /ea	4,176	3,229.79 /ea	9,689
			12" DI, FL, Ell, 90	7.00 ea	50.6	4,433	3,287	-	-	-	1,102.85 /ea	7,720	2,558.67 /ea	17,911
			12" DI, FL, tee, 12" x 12"	1.00 ea	9.0	792	749	-	-	-	1,541.60 /ea	1,542	3,576.60 /ea	3,577
			12" DI, flanged coupling adapter	3.00 ea	20.2	1,769	801	-	-	-	856.60 /ea	2,570	1,987.34 /ea	5,962
			Process Pipe, Ductile Iron, 12"	**59.50 LF**	**195.6**	**17,126**	**18,668**				**601.58 /LF**	**35,794**	**1,395.68 /LF**	**83,043**
			12" DI Pipe	**59.50 LF**	**195.6**	**17,126**	**18,668**				**601.58 /LF**	**35,794**	**1,395.68 /LF**	**83,043**
			24" DI Pipe											
			Process Pipe, Ductile Iron, 24"											
			Install 24" DI, flanged, spool <= 10'	2.00 ea	31.5	2,759	-	-	-	-	1,379.36 /ea	2,759	3,200.16 /ea	6,400
			24" Fabricated DI Spool, FxF, 2' 0" - FURNISH	1.00 ea		-	2,095	-	-	-	2,095.27 /ea	2,095	4,861.12 /ea	4,861
			24" Fabricated DI Spool, FxF, 3' 0" - FURNISH	1.00 ea		-	2,380	-	-	-	2,379.57 /ea	2,380	5,520.74 /ea	5,521
			24" DI, FL, tee, red, 24" x 12"	1.00 ea	19.7	1,725	1,976	-	-	-	3,700.63 /ea	3,701	8,585.62 /ea	8,586

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Process Pipe, Ductile Iron, 24"											
			24" DI, FL, reducer, 24" x 12"	1.00 ea	15.8	1,379	1,285	-	-	-	2,664.85 /ea	2,665	6,182.57 /ea	6,183
			Process Pipe, Ductile Iron, 24"	**10.00 LF**	**67.0**	**5,863**	**7,736**				**1,359.90 /LF**	**13,599**	**3,155.04 /LF**	**31,550**
			24" DI Pipe	**5.00 LF**	**67.0**	**5,863**	**7,736**				**2,719.81 /LF**	**13,599**	**6,310.07 /LF**	**31,550**
			48" DI Pipe											
			Process Pipe, Ductile Iron, 48"											
			Install 48" DI, flanged, spool <= 10'	1.00 ea	32.7	2,861	-	-	-	-	2,861.22 /ea	2,861	6,638.16 /ea	6,638
			48" Fabricated DI Spool, FxF, 2' 0" - FURNISH	1.00 ea		-	9,081	-	-	-	9,081.18 /ea	9,081	21,068.74 /ea	21,069
			Process Pipe, Ductile Iron, 48"	**10.00 LF**	**32.7**	**2,861**	**9,081**				**1,194.24 /LF**	**11,942**	**2,770.69 /LF**	**27,707**
			48" DI Pipe	**2.00 LF**	**32.7**	**2,861**	**9,081**				**5,971.20 /LF**	**11,942**	**13,853.45 /LF**	**27,707**
			Valves											
			Process Pipe, Ductile Iron, 12"											
			Install gate valve, Flgd, DIP, 12"	3.00 ea	23.7	2,016	-	-	1,479	-	1,165.04 /ea	3,495	2,702.96 /ea	8,109
			Install gate valve, MJ, 12"	1.00 ea	5.5	470	-	-	345	-	815.52 /ea	816	1,892.03 /ea	1,892
			Gate valve, iron body, dbl disk, Flgd, 250#, HWO, 12"	3.00 ea		-	3,758	-	-	-	1,252.51 /ea	3,758	2,905.88 /ea	8,718
			Gate valve, iron body, dbl disk, MJ, 250#, NO, 12"	1.00 ea		-	1,253	-	-	-	1,252.50 /ea	1,253	2,905.87 /ea	2,906
			Install check valve, Flgd, DIP, 12"	3.00 ea	23.7	2,016	-	-	1,479	-	1,165.04 /ea	3,495	2,702.95 /ea	8,109
			Check valve, iron body, swing check, Flgd, 250#, 12"	3.00 ea		-	8,714	-	-	-	2,904.64 /ea	8,714	6,738.90 /ea	20,217
			Install magnetic flow meter, (material FBO), 24"	1.00 ea	16.3	1,428	-	-	-	-	1,427.72 /ea	1,428	3,312.37 /ea	3,312
			CI Valve Box & Cover, w/ Concrete Collar included	1.00 ea	3.9	336	152	-	247	-	734.29 /ea	734	1,703.58 /ea	1,704
			Flow Meters 24"	1.00 ea	0.0		24,281	-	-	-	24,281.25 /ea	24,281	56,333.60 /ea	56,334
			Flow Meter: Electrical Hookup Only, 24"	1.00 ea	16.4	1,326	-	-	-	-	1,325.82 /ea	1,326	3,075.96 /ea	3,076
			Process Pipe, Ductile Iron, 12"	**1.00 LF**	**89.6**	**7,591**	**38,157**		**3,551**		**49,298.82 /LF**	**49,299**	**114,375.48 /LF**	**114,375**
			Valves	**1.00 LS**	**89.6**	**7,591**	**38,157**		**3,551**		**49,298.82 /LS**	**49,299**	**114,375.48 /LS**	**114,375**
			Miscellaneous Piping											
			Process Pipe, Other											
			Miscellaneous Piping	1.00 ls				75,879	-	-	75,878.89 /ls	75,879	176,042.42 /ls	176,042
			Process Pipe, Other	**1.00 LS**				**75,879**			**75,878.89 /LS**	**75,879**	**176,042.42 /LS**	**176,042**
			Miscellaneous Piping	**1.00 LS**				**75,879**			**75,878.89 /LS**	**75,879**	**176,042.42 /LS**	**176,042**
			Odor Control											
			FRP Duct, Round, 30"											
			Allowance for Odor control	1.00 ls				65,762	-	-	65,761.71 /ls	65,762	152,570.13 /ls	152,570
			FRP Duct, Round, 30"					**65,762**			**/LF**	**65,762**	**/LF**	**152,570**
			Odor Control	**1.00 LS**				**65,762**			**65,761.71 /LS**	**65,762**	**152,570.13 /LS**	**152,570**
			40.00 Exposed Process Pipe	**66.50 LF**	**384.9**	**33,441**	**73,642**	**141,641**	**3,551**		**3,793.60 /LF**	**252,275**	**8,801.33 /LF**	**585,288**
			40.0 Process Pipe	**66.50 LF**	**384.9**	**33,441**	**73,642**	**141,641**	**3,551**		**3,793.60 /LF**	**252,275**	**8,801.33 /LF**	**585,288**
	44.0		**Process Equipment - Municipal**											
		44.05	**Furnish and Install Process Equipment**											
			90 HP Pumps											
			Submersible Pump: 51hp-100hp											
			Functional Testing, Pumps, 51-100 hp	3.00 ea	7.9	593	152	-	-	-	248.39 /ea	745	568.82 /ea	1,706
			Align Pump & Motor, 51-100 hp	3.00 ea	11.8	890	-	1,593	-	-	827.87 /ea	2,484	1,895.85 /ea	5,688
			Vibration Testing, Pumps, 51-100 hp	3.00 ea	3.9	297	-	531	-	-	275.96 /ea	828	631.96 /ea	1,896
			Witnessed factory test	3.00 ea		-	-	1,518	-	1,518	1,011.72 /ea	3,035	2,316.88 /ea	6,951
			Local panel	3.00 ea	23.7	1,780	4,553	-	-	-	2,111.00 /ea	6,333	4,834.30 /ea	14,503
			Pressure indicators	6.00 ea	11.8	890	1,518	-	-	-	401.29 /ea	2,408	918.96 /ea	5,514
			Sleeved anchor bolts - Medium	24.00 ea	11.0	831	510	-	-	-	55.86 /ea	1,341	127.93 /ea	3,070
			Non-Shrink Machine Grout	18.00 cuft	22.5	1,691	1,348	-	-	-	168.83 /cuft	3,039	386.63 /cuft	6,959
			Grease, Oil, and Lube Pumps, 51-100 hp	3.00 ea	15.8	1,187	228	-	-	-	471.51 /ea	1,415	1,079.77 /ea	3,239
			FURNISH Submersible Pump, 51 - 100 hp	3.00 EA		-	373,324	-	-	-	124,441.39 /EA	373,324	284,976.37 /EA	854,929
			Set pump assembly, 51 - 100 hp	3.00 ea	157.8	11,869	152	-	-	-	4,006.81 /ea	12,020	9,175.77 /ea	27,527
			Submersible Pump: 51hp-100hp	**3.00 EA**	**266.3**	**20,028**	**381,783**	**3,642**		**1,518**	**135,657.09 /EA**	**406,971**	**310,660.83 /EA**	**931,982**
			90 HP Pumps	**3.00 EA**	**266.3**	**20,028**	**381,783**	**3,642**		**1,518**	**135,657.09 /EA**	**406,971**	**310,660.83 /EA**	**931,982**
			44.05 Furnish and Install Process Equipment	**3.00 EA**	**266.3**	**20,028**	**381,783**	**3,642**		**1,518**	**135,657.09 /EA**	**406,971**	**310,660.83 /EA**	**931,982**
			44.0 Process Equipment - Municipal	**1.00 LS**	**266.3**	**20,028**	**381,783**	**3,642**		**1,518**	**406,971.28 /LS**	**406,971**	**931,982.48 /LS**	**931,982**
			0305 Dry Weather Pump Station	**1.00 LS**	**10,341.7**	**703,276**	**900,680**	**991,718**	**1,719,527**	**1,518**	**4,316,717.68 /LS**	**4,316,718**	**9,853,207.78 /LS**	**9,853,208**

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	3,382,071			11.68%
Material	5,525,039			19.07%
Subcontract	1,718,258			5.93%
Equipment	1,835,442			6.34%
Other	55,317			0.19%
Subtotal Raw Costs	**12,516,127**	**12,516,127**		**43.21**
Material Sales & Use Tax - %				
Construction Equip Tax - %				
Total Taxes		**12,516,127**		
Existing Conditions I,OH&P	138,222		15.000 %	0.48%
Concrete Work I,OH&P	79,047		15.000 %	0.27%
Masonry Work I,OH&P	1,395		15.000 %	0.00%
Metals Work I,OH&P	3,217		15.000 %	0.01%
Architectural (Div 6-12)I,OH&P	60,765		15.000 %	0.21%
Mechanical Work I,OH&P	9,776		20.000 %	0.03%
Electrical Work I,OH&P	825,760		25.000 %	2.85%
Site/Civil I,OH&P	98,315		10.000 %	0.34%
Buried Piping I,OH&P	312,619		15.000 %	1.08%
Process Piping I,OH&P	172,773		18.000 %	0.60%
Instruments & Controls I,OH&P	96,275		25.000 %	0.33%
Process Equipment I,OH&P	379,514		15.000 %	1.31%
Subtotal Subcontractor I,OH&P	**2,183,241**	**14,699,368**		**7.54**
Total Cost To Prime Contractor		**14,699,368**		
General Conditions	1,469,937		10.000 %	5.07%
Mobilization/Demobilization	646,772		4.000 %	2.23%
Subtotal Indirect Costs	**2,116,709**	**16,816,077**		**7.31**
Prime Contractor Home OfficeOH	1,345,286		8.000 %	4.64%
Prime Contractor Profit	1,816,136		10.000 %	6.27%
Bldr's Risk & Gen Liab Ins -%	362,104		1.250 %	1.25%
Payment & Performance Bonds	362,104		1.250 %	1.25%
Subtotal OH&P	**3,885,630**	**20,701,707**		**13.41**
Design Contingency	6,210,512		30.000 %	21.44%
Subtotal Contingency	**6,210,512**	**26,912,219**		21.44
Escal. to Midpoint Const 2020	2,056,094		7.640 %	7.10%
Subtotal Escalation	**2,056,094**	**28,968,313**		**7.10**
Total Prime Contractor Costs		**28,968,313**		

Intermediate-Term Improvements
Capacity Upgrade of Union Pump Station

Union Pump Station
Construction Cost Estimate for Concept Design

Project name	GNH Union Pump Station
Estimator	E.B. Smith/GNV, A. Frisch/PGH
Project Number	478874
Estimate Class 1-5	4
Design Stage	Conceptual
Rev No. / Date	Rev02 (10-3-2016)

Facility Summary

	Project:	GNH Union Pump Station	Estimator: E.B. Smith/GNV, A. Frisch/PGH
Job Size:	Project No.:	478874	Revision / Date: Rev02 (10-3-2016)
Duration:	Design Stage:	Conceptual	Estimate Class: 4

Facility	Description	Direct Amount	Grand Total w/Markups	Percent of Total
005	UNION PUMP STATION	4,299,242	10,036,007	71.035
006	FORCEMAIN AND PIPE BRIDGE REPLACEMENT	1,785,290	4,035,797	28.565
007	Submergence Chamber and 42-inch Rehabilitation	25,000	56,515	0.400

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	2,325,588			16.46%
Material	5,418,965			38.36%
Subcontract	4,866,501			34.45%
Equipment	1,458,848			10.33%
Other	58,416			0.41%
Total Prime Contractor Costs	**14,128,318**	**14,128,318**		**100.00**

Detail Report

Job Size:
Duration:

Project: GNH Union Pump Station
Project No.: 478874
Design Stage: Conceptual

Estimator: E.B. Smith/GNV, A. Frisch/PGH
Revision / Date: Rev02 (10-3-2016)
Estimate Class: 4

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
005			UNION PUMP STATION										
	02.0		Existing Conditions										
		02.40	Demolition										
			Selective Demolition										
			Structure/Building Demolition										
			Demo concrete walls, block, excludes disposal costs and dump fees - standard crew	66.67 cy	5,885	-	-	4,116	-	150.00 /cy	10,000	343.41 /cy	22,895
			Disposal only, urban buildings w/ salvage value allowed, conc frame	150.00 cy	3,156	-	-	4,344	-	50.00 /cy	7,500	115.06 /cy	17,259
			Rubbish handling, loading & trucking, hand loading truck, 50' haul	150.00 cy	6,230	-	-	7,685	-	92.76 /cy	13,915	213.29 /cy	31,993
			Demo access hatch	5.00 ea	4,512	0	-	-	-	902.40 /ea	4,512	2,039.95 /ea	10,200
			Demo small pumps	1.00 ea	2,406	25	-	-	-	2,431.40 /ea	2,431	5,498.13 /ea	5,498
			Demo large & Medium pumps	3.00 ea	13,536	150	-	-	-	4,562.00 /ea	13,686	10,316.28 /ea	30,949
			Demo Sluice Gates	8.00 ea	16,845	-	-	-	-	2,105.60 /ea	16,845	4,759.88 /ea	38,079
			Demo Bar Screen	2.00 ea	18,650	-	-	-	-	9,324.80 /ea	18,650	21,079.49 /ea	42,159
			Selective demolition, masonry, veneers, brick, soft old mortar, remove	1,075.00 sf	6,230	-	-	-	-	5.80 /sf	6,230	13.10 /sf	14,082
			Door demolition, single, remove	7.00 ea	209	-	-	-	-	29.83 /ea	209	67.43 /ea	472
			Door demolition, double, remove	3.00 ea	119	-	-	-	-	39.77 /ea	119	89.91 /ea	270
			Demolition Allowance	5.00 Days		-	12,500	-	-	2,500.00 /Days	12,500	5,651.46 /Days	28,257
			Demo windows	4.00 ea	159	-	-	-	-	39.77 /ea	159	89.90 /ea	360
			Demo Roll-Up Door	1.00 ea	477	-	-	-	-	477.24 /ea	477	1,078.85 /ea	1,079
			Structure/Building Demolition	**1.00 SF**	**78,414**	**175**	**12,500**	**16,144**		**107,232.83 /SF**	**107,233**	**243,551.09 /SF**	**243,551**
			Selective Demolition	**1.00 LS**	**78,414**	**175**	**12,500**	**16,144**		**107,232.83 /LS**	**107,233**	**243,551.09 /LS**	**243,551**
			Electrical Facility Demolition										
			Electrical Facility Demolition										
			Electrical demo, remove misc. electrical equipment, transformers, etc.	3,318.00 sf	203,756	-	-	-	-	61.41 /sf	203,756	138.82 /sf	460,607
			Electrical Facility Demolition	**3,318.00 SF**	**203,756**					**61.41 /SF**	**203,756**	**138.82 /SF**	**460,607**
			Electrical Facility Demolition	**1.00 LS**	**203,756**					**203,755.89 /LS**	**203,756**	**460,607.15 /LS**	**460,607**
			02.40 Demolition	**1.00 LS**	**282,170**	**175**	**12,500**	**16,144**		**310,988.72 /LS**	**310,989**	**704,158.24 /LS**	**704,158**
			02.0 Existing Conditions	**1.00 LS**	**282,170**	**175**	**12,500**	**16,144**		**310,988.72 /LS**	**310,989**	**704,158.24 /LS**	**704,158**
	03.0		Concrete Work										
		03.10	Cast-In-Place Concrete Work										
			Electrical Equipment Pads										
			Cast-In-Place Concrete, Equipment Pads, 13" thick										
			Edge forms, housekeeping pads >6" Deep	111.58 sf	2,087	167	-	-	-	20.21 /sf	2,255	45.78 /sf	5,108
			Reinforcing in place, A615 Gr 60, priced per lbs.	334.03 lb	-	167	134	-	-	0.90 /lb	301	2.07 /lb	691
			Concrete, ready mix, 4000 psi	4.45 CY	-	503	-	-	-	113.00 /CY	503	263.35 /CY	1,173
			Add for concrete waste, 4000 psi	0.22 cy	-	25	-	-	-	113.00 /cy	25	263.42 /cy	58
			Finish housekeeping pads	111.00 sf	307	3	-	-	-	2.80 /sf	311	6.33 /sf	703
			Curing, membrane spray	111.00 sf	13	4	-	-	-	0.16 /sf	17	0.36 /sf	40
			Cast-In-Place Concrete, Equipment Pads, 13" thick	**4.45 CY**	**2,407**	**871**	**134**			**766.66 /CY**	**3,412**	**1,746.79 /CY**	**7,773**
			Electrical Equipment Pads	**4.45 CY**	**2,407**	**871**	**134**			**766.66 /CY**	**3,412**	**1,746.79 /CY**	**7,773**
			Electrical Equipment Pad - Generator										
			Cast-In-Place Concrete, Equipment Pads, 24" thick										
			Equipment pad forms, large	102.00 sf	1,908	153	-	-	-	20.21 /sf	2,061	45.78 /sf	4,669
			Reinforcing in place, A615 Gr 60, priced per lbs.	750.00 lb	-	375	300	-	-	0.90 /lb	675	2.07 /lb	1,552
			Concrete, ready mix, 4000 psi	10.00 CY	-	1,130	-	-	-	113.00 /CY	1,130	263.36 /CY	2,634
			Add for concrete waste, 4000 psi	0.50 cy	-	57	-	-	-	113.00 /cy	57	263.36 /cy	132
			Finishing floors, monolithic, broom finish	135.00 sf	280	3	-	-	-	2.10 /sf	283	4.74 /sf	640
			Patch & plug tieholes	102.00 sf	90	2	-	-	-	0.90 /sf	92	2.03 /sf	207
			Sack rub	102.00 sf	239	3	-	-	-	2.37 /sf	242	5.37 /sf	548
			Curing, water	135.00 sf	26	7	-	-	-	0.25 /sf	33	0.56 /sf	75
			Cast-In-Place Concrete, Equipment Pads, 24" thick	**20.00 CY**	**2,543**	**1,729**	**300**			**228.62 /CY**	**4,572**	**522.87 /CY**	**10,457**
			Electrical Equipment Pad - Generator	**20.00 CY**	**2,543**	**1,729**	**300**			**228.62 /CY**	**4,572**	**522.87 /CY**	**10,457**
			12" CIP Wall										
			Cast-In-Place Concrete, Straight Walls, 12" thick										
			Concrete pumping, subcontract, all inclusive price	15.89 cy	-	-	238	-	-	15.00 /cy	238	33.91 /cy	539
			Forms in place, structural walls, to 8' high, hand set	858.00 sf	9,629	858	-	-	-	12.22 /sf	10,487	27.70 /sf	23,767
			Reinforcing in place, A615 Gr 60, priced per lbs.	2,780.56 lb	-	1,390	1,112	-	-	0.90 /lb	2,503	2.07 /lb	5,754
			Concrete, ready mix, 4000 psi	15.89 CY	-	1,795	-	-	-	113.00 /CY	1,795	263.36 /CY	4,184
			Add for concrete waste, 4000 psi	0.79 cy	-	90	-	-	-	113.00 /cy	90	263.36 /cy	209
			Add amount for Fuel Surcharges - per concrete truck load	2.00 load	-	30	-	-	-	15.00 /load	30	34.95 /load	70
			Add amount for Environmental Fee - per concrete truck load	2.00 load	-	12	-	-	-	6.00 /load	12	14.00 /load	28
			Placing concrete, concrete pump, for structural wall to 12" thick	15.89 cy	792	-	-	-	-	49.82 /cy	792	112.61 /cy	1,789
			Patch & plug tieholes	858.00 sf	754	17	-	-	-	0.90 /sf	771	2.03 /sf	1,745
			Sack rub	858.00 sf	2,011	26	-	-	-	2.37 /sf	2,037	5.37 /sf	4,607
			Curing, membrane spray	858.00 sf	101	34	-	-	-	0.16 /sf	135	0.36 /sf	307
			Cast-In-Place Concrete, Straight Walls, 12" thick	**15.89 CY**	**13,287**	**4,253**	**1,351**			**1,188.80 /CY**	**18,890**	**2,706.12 /CY**	**43,000**
			12" CIP Wall	**15.89 CY**	**13,287**	**4,253**	**1,351**			**1,188.80 /CY**	**18,890**	**2,706.12 /CY**	**43,000**
			Misc. Concrete Repairs										

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Concrete, Other										
			Misc. Concrete Repairs Allowance	1.00 LS			50,000	-	-	50,000.00 /LS	50,000	113,029.16 /LS	113,029
			Misc. Repair @ Joints Allowance	1.00 LS			25,000	-	-	25,000.00 /LS	25,000	56,514.58 /LS	56,515
			Concrete, Other	1.00 CY			75,000			75,000.00 /CY	75,000	169,543.74 /CY	169,544
			Misc. Concrete Repairs	**1.00 LS**			**75,000**			**75,000.00 /LS**	**75,000**	**169,543.74 /LS**	**169,544**
			03.10 Cast-In-Place Concrete Work	15.89 CY	18,238	6,852	76,784			6,411.21 /CY	101,874	14,523.25 /CY	230,774
			03.0 Concrete Work	15.89 CY	18,238	6,852	76,784			6,411.21 /CY	101,874	14,523.25 /CY	230,774
	04.0		Masonry										
		04.00	Masonry										
			4" Face Brick Veneer										
			Masonry Brick, 4"										
			Brick, standard 4" x 2 2/3" x 8"	1,075.00 SF	-	-	11,825	-	-	11.00 /SF	11,825	24.87 /SF	26,731
			Masonry Brick, 4"	1,075.00 SF			11,825			11.00 /SF	11,825	24.87 /SF	26,731
			4" Face Brick Veneer	**1,075.00 SF**			**11,825**			**11.00 /SF**	**11,825**	**24.87 /SF**	**26,731**
			8" CMU Wall w/ Brick Veneer										
			Masonry Concrete Masonry Units, 8"										
			Scaffolding, rented, 2 stories	1,305.00 sf	-	-	1,083	-	-	0.83 /sf	1,083	1.88 /sf	2,449
			Grout block cores, solid, 8" thick	1,305.00 sf	-	-	3,132	-	-	2.40 /sf	3,132	5.43 /sf	7,080
			Masonry reinforcing per square foot	1,305.00 sf	-	-	1,958	-	-	1.50 /sf	1,958	3.39 /sf	4,425
			Masonry anchor / ties per square foot	1,305.00 sf	-	-	1,305	-	-	1.00 /sf	1,305	2.26 /sf	2,950
			Brick, standard 4" x 2 2/3" x 8"	1,305.00 SF	-	-	14,355	-	-	11.00 /SF	14,355	24.87 /SF	32,451
			Concrete block, back-up, reinforced, 8" thick	1,305.00 SF	-	-	8,678	-	-	6.65 /SF	8,678	15.03 /SF	19,618
			Waterproof sealer, masonry, 2 coats	1,305.00 sf	-	-	1,305	-	-	1.00 /sf	1,305	2.26 /sf	2,950
			Paint exterior masonry walls, latex	1,305.00 sf	-	-	1,305	-	-	1.00 /sf	1,305	2.26 /sf	2,950
			Masonry Concrete Masonry Units, 8"	1,305.00 SF			33,121			25.38 /SF	33,121	57.37 /SF	74,873
			8" CMU Wall w/ Brick Veneer	**1,305.00 SF**			**33,121**			**25.38 /SF**	**33,121**	**57.37 /SF**	**74,873**
			8" CMU Wall @ Stair										
			Masonry Concrete Masonry Units, 8"										
			Scaffolding, rented, 2 stories	600.00 sf	-	-	498	-	-	0.83 /sf	498	1.88 /sf	1,126
			Grout block cores, solid, 8" thick	600.00 sf	-	-	1,440	-	-	2.40 /sf	1,440	5.43 /sf	3,255
			Masonry reinforcing per square foot	600.00 sf	-	-	900	-	-	1.50 /sf	900	3.39 /sf	2,035
			Concrete block, back-up, reinforced, 8" thick	600.00 SF	-	-	3,990	-	-	6.65 /SF	3,990	15.03 /SF	9,020
			Waterproof sealer, masonry, 2 coats	1,200.00 sf	-	-	1,200	-	-	1.00 /sf	1,200	2.26 /sf	2,713
			Paint exterior masonry walls, latex	1,200.00 sf	-	-	1,200	-	-	1.00 /sf	1,200	2.26 /sf	2,713
			Masonry Concrete Masonry Units, 8"	600.00 SF			9,228			15.38 /SF	9,228	34.77 /SF	20,861
			8" CMU Wall @ Stair	**600.00 SF**			**9,228**			**15.38 /SF**	**9,228**	**34.77 /SF**	**20,861**
			8" Interior CMU Wall										
			Masonry Concrete Masonry Units, 8"										
			Scaffolding, rented, 2 stories	576.00 sf	-	-	478	-	-	0.83 /sf	478	1.88 /sf	1,081
			Grout block cores, solid, 8" thick	576.00 sf	-	-	1,382	-	-	2.40 /sf	1,382	5.43 /sf	3,125
			Masonry reinforcing per square foot	576.00 sf	-	-	864	-	-	1.50 /sf	864	3.39 /sf	1,953
			Concrete block, back-up, reinforced, 8" thick	576.00 SF	-	-	3,830	-	-	6.65 /SF	3,830	15.03 /SF	8,659
			Waterproof sealer, masonry, 2 coats	1,152.00 sf	-	-	1,152	-	-	1.00 /sf	1,152	2.26 /sf	2,604
			Paint exterior masonry walls, latex	1,152.00 sf	-	-	1,152	-	-	1.00 /sf	1,152	2.26 /sf	2,604
			Masonry Concrete Masonry Units, 8"	576.00 SF			8,859			15.38 /SF	8,859	34.77 /SF	20,026
			8" Interior CMU Wall	**576.00 SF**			**8,859**			**15.38 /SF**	**8,859**	**34.77 /SF**	**20,026**
			8" Interior CMU Wall @ Stairwell										
			Masonry Concrete Masonry Units, 8"										
			Scaffolding, rented, 2 stories	276.00 sf	-	-	229	-	-	0.83 /sf	229	1.88 /sf	518
			Grout block cores, solid, 8" thick	276.00 sf	-	-	662	-	-	2.40 /sf	662	5.43 /sf	1,497
			Masonry reinforcing per square foot	276.00 sf	-	-	414	-	-	1.50 /sf	414	3.39 /sf	936
			Concrete block, back-up, reinforced, 8" thick	276.00 SF	-	-	1,835	-	-	6.65 /SF	1,835	15.03 /SF	4,149
			Waterproof sealer, masonry, 2 coats	552.00 sf	-	-	552	-	-	1.00 /sf	552	2.26 /sf	1,248
			Paint exterior masonry walls, latex	552.00 sf	-	-	552	-	-	1.00 /sf	552	2.26 /sf	1,248
			Masonry Concrete Masonry Units, 8"	276.00 SF			4,245			15.38 /SF	4,245	34.77 /SF	9,596
			8" Interior CMU Wall @ Stairwell	**276.00 SF**			**4,245**			**15.38 /SF**	**4,245**	**34.77 /SF**	**9,596**
			04.00 Masonry	3,832.00 SF			67,278			17.56 /SF	67,278	39.69 /SF	152,087
			04.0 Masonry	3,832.00 SF			67,278			17.56 /SF	67,278	39.69 /SF	152,087
	05.0		Metals										
		05.00	Metals										
			Railing										
			Metals, Handrailing, 3-Rail										
			Railing, pipe, aluminum, 3 rail, clear anodized	7.00 lf	150	420	-	19	-	84.07 /lf	589	194.44 /lf	1,361
			Metals, Handrailing, 3-Rail	7.00 LF	150	420		19		84.07 /LF	589	194.44 /LF	1,361
			Railing	**7.00 LF**	**150**	**420**		**19**		**84.07 /LF**	**589**	**194.44 /LF**	**1,361**
			05.00 Metals	1.00 LS	150	420		19		588.50 /LS	589	1,361.06 /LS	1,361
		05.10	Structural Steel										

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Modifications to Existing Monorail Beam										
			Metals, Structural Steel										
			Allowance to modify the existing monorail beam and all structural related works	1.00 ea			15,000	-	-	15,000.00 /ea	15,000	33,908.74 /ea	33,909
			Metals, Structural Steel				15,000			/TN	15,000	/TN	33,909
			Modifications to Existing Monorail Beam				**15,000**			**/LS**	**15,000**	**/LS**	**33,909**
			Misc. Metals										
			Metals, Structural Steel										
			Misc. Metals Allowance	1.00 LS			5,000	-	-	5,000.00 /LS	5,000	11,302.93 /LS	11,303
			Metals, Structural Steel	1.00 TN			5,000			5,000.00 /TN	5,000	11,302.93 /TN	11,303
			Misc. Metals	**1.00 LS**			**5,000**			**5,000.00 /LS**	**5,000**	**11,302.93 /LS**	**11,303**
			05.10 Structural Steel	1.00 LS			20,000			20,000.00 /LS	20,000	45,211.67 /LS	45,212
			05.0 Metals	1.00 LS	150	420	20,000	19		20,588.50 /LS	20,589	46,572.73 /LS	46,573
	06.0		Wood, Plastics and Composites										
		06.00	Wood, Plastics and Composites										
			FRP Grating										
			Wood & Plastics, FRP Fabrications, Gratings										
			Grating fbgls, molded, orange (hi crsv env), 2" sq mesh, 2" thk	90.00 sf	408	2,250	-	-	-	29.53 /sf	2,658	68.51 /sf	6,166
			Wood & Plastics, FRP Fabrications, Gratings	90.00 SF	408	2,250				29.53 /SF	2,658	68.51 /SF	6,166
			FRP Grating	**90.00 SF**	**408**	**2,250**				**29.53 /SF**	**2,658**	**68.51 /SF**	**6,166**
			06.00 Wood, Plastics and Composites	1.00 LS	408	2,250				2,657.94 /LS	2,658	6,166.00 /LS	6,166
			06.0 Wood, Plastics and Composites	1.00 LS	408	2,250				2,657.94 /LS	2,658	6,166.00 /LS	6,166
	07.0		Thermal and Moisture Protection										
		07.00	Thermal & Moisture Protection										
			Fire retardant Insulation										
			Thermal & Moisture Protection, Firerproofing										
			Fireproofing sprayed	2,481.00 sf	1,862	9,552	-	82	-	4.63 /sf	11,496	10.75 /sf	26,663
			Thermal & Moisture Protection, Firerproofing	1.00 LS	1,862	9,552		82		11,496.39 /LS	11,496	26,662.92 /LS	26,663
			Fire retardant Insulation	**1.00 LS**	**1,862**	**9,552**		**82**		**11,496.39 /LS**	**11,496**	**26,662.92 /LS**	**26,663**
			07.00 Thermal & Moisture Protection	1.00 LS	1,862	9,552		82		11,496.39 /LS	11,496	26,662.92 /LS	26,663
			07.0 Thermal and Moisture Protection	1.00 LS	1,862	9,552		82		11,496.39 /LS	11,496	26,662.92 /LS	26,663
	08.0		Openings										
		08.00	Openings										
			Doors										
			Openings, Doors, Frames and Hardware										
			Door hardware, average - H.M., wood, or aluminum	13.00 set	3,850	4,550	-	-	-	646.12 /set	8,400	1,485.12 /set	19,307
			Frames, steel, knock down, hollow metal, single, 16 ga., up to 5-3/4" deep, 7'-0" h x 3'-0" w	7.00 ea	534	1,085	-	-	-	231.26 /ea	1,619	533.63 /ea	3,735
			Frames, steel, knock down, hollow metal, double, 16 ga., up to 4-7/8" deep, 7'-0" h x 6'-0" w	3.00 ea	261	564	-	-	-	275.16 /ea	825	635.18 /ea	1,906
			Fiberglass, exterior, prehung door, 1-3/4", 3'-0" x 7'-0"	13.00 ea	1,057	5,980	-	-	-	541.35 /ea	7,037	1,255.96 /ea	16,327
			Openings, Doors, Frames and Hardware	13.00 EA	5,702	12,179				1,375.49 /EA	17,881	3,174.99 /EA	41,275
			Doors	**13.00 EA**	**5,702**	**12,179**				**1,375.49 /EA**	**17,881**	**3,174.99 /EA**	**41,275**
			08.00 Openings	1.00 LS	5,702	12,179				17,881.40 /LS	17,881	41,274.92 /LS	41,275
		08.30	Specialty Doors and Frames										
			Access Hatch 6' x 6'										
			Specialty Doors and Frames, Access Doors										
			Doors, specialty, access, floor, industrial, aluminum, double leaf, 6' x 6', 645 lb	5.00 opng	7,252	43,200	-	-	-	10,090.45 /opng	50,452	23,415.10 /opng	117,075
			Specialty Doors and Frames, Access Doors	5.00 EA	7,252	43,200				10,090.45 /EA	50,452	23,415.10 /EA	117,075
			Access Hatch 6' x 6'	**5.00 EA**	**7,252**	**43,200**				**10,090.45 /EA**	**50,452**	**23,415.10 /EA**	**117,075**
			Overhead Door										
			Specialty Doors and Frames, Sectional Overhead Doors										
			Doors, rolling service, steel, manual, fire, class A, 20 gauge, 20' x 10' high, incl. hardware	1.00 ea	1,813	4,550	-	-	-	6,363.06 /ea	6,363	14,702.72 /ea	14,703
			Doors, rolling service, steel, manual, motor operators for, to 14' x 14' opening	1.00 ea	290	1,175	-	-	-	1,465.09 /ea	1,465	3,394.22 /ea	3,394
			Specialty Doors and Frames, Sectional Overhead Doors	1.00 EA	2,103	5,725				7,828.15 /EA	7,828	18,096.94 /EA	18,097
			Overhead Door	**1.00 EA**	**2,103**	**5,725**				**7,828.15 /EA**	**7,828**	**18,096.94 /EA**	**18,097**
			08.30 Specialty Doors and Frames	1.00 EA	9,355	48,925				58,280.39 /EA	58,280	135,172.42 /EA	135,172
			08.0 Openings	1.00 LS	15,058	61,104				76,161.79 /LS	76,162	176,447.34 /LS	176,447
	09.0		Finishes										
		09.10	Finishes, Special Coatings										
			Electrical Equipment Pads										
			Finishes, Chemical Resistant Coatings										
			Concrete Coating, Chemical Resistant, CRC-2	111.00 sf	-	-	333	-	-	3.00 /sf	333	6.78 /sf	753

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Finishes, Chemical Resistant Coatings	**111.00 SF**			**333**			**3.00 /SF**	**333**	**6.78 /SF**	**753**
			Electrical Equipment Pads	**1.00 CY**			**333**			**333.00 /CY**	**333**	**752.78 /CY**	**753**
			Electrical Equipment Pad - Generator										
			Finishes, Chemical Resistant Coatings										
			Concrete Coating, Chemical Resistant, CRC-2	135.00 sf	-	-	405	-	-	3.00 /sf	405	6.78 /sf	916
			Finishes, Chemical Resistant Coatings	**135.00 SF**			**405**			**3.00 /SF**	**405**	**6.78 /SF**	**916**
			Electrical Equipment Pad - Generator	**1.00 CY**			**405**			**405.00 /CY**	**405**	**915.54 /CY**	**916**
			Finishes										
			Finishes, Chemical Resistant Coatings										
			Concrete Coating, @ wetwell	4,988.00 sf	-	-	24,940	-	-	5.00 /sf	24,940	11.30 /sf	56,379
			Concrete Coating, @top of roof	2,481.00 sf	-	-	12,405	-	-	5.00 /sf	12,405	11.30 /sf	28,043
			Concrete Coating, @screen room floor	402.00 sf	-	-	2,010	-	-	5.00 /sf	2,010	11.30 /sf	4,544
			Allowance for misc. coatings, prep & paint piping, equipment	1.00 LS	-	-	25,000	-	-	25,000.00 /LS	25,000	56,514.57 /LS	56,515
			Finishes, Chemical Resistant Coatings	**7,871.00 SF**			**64,355**			**8.18 /SF**	**64,355**	**18.48 /SF**	**145,480**
			Finishes	**1.00 LS**			**64,355**			**64,355.00 /LS**	**64,355**	**145,479.82 /LS**	**145,480**
			09.10 Finishes, Special Coatings	**1.00 LS**			**65,093**			**65,093.00 /LS**	**65,093**	**147,148.14 /LS**	**147,148**
			09.0 Finishes	**1.00 LS**			**65,093**			**65,093.00 /LS**	**65,093**	**147,148.14 /LS**	**147,148**
	10.0		**Specialties**										
		10.00	**Specialties**										
			Toilet Accessories										
			Specialties Toilet & Bath Accessories										
			Partitions, toilet, floor mounted, headrail braced, stainless steel	1.00 ea	203	1,175	-	-	-	1,378.39 /ea	1,378	3,198.23 /ea	3,198
			Toilet tissue dispenser, surface mounted, stainless, double roll	1.00 ea	25	23	-	-	-	47.89 /ea	48	109.82 /ea	110
			Toilet Accessories, grab bars, straight, stainless steel, 24" long	1.00 ea	27	31	-	-	-	57.03 /ea	57	131.07 /ea	131
			Toilet Accessories, grab bars, straight, stainless steel, 36" long	1.00 ea	31	37	-	-	-	67.50 /ea	68	155.18 /ea	155
			Toilet Accessories, mirror, 48" x 24", with stainless steel 3/4" square frame	1.00 ea	61	152	-	-	-	213.01 /ea	213	492.17 /ea	492
			Toilet Accessories, soap dispenser, stainless steel, recessed, liquid	1.00 ea	61	166	-	-	-	227.01 /ea	227	524.79 /ea	525
			Toilet Accessories, towel dispenser, stainless steel, surface mounted	1.00 ea	38	48	-	-	-	85.63 /ea	86	196.89 /ea	197
			Toilet Accessories, waste receptacle, stainless steel, w/top, 13 gallon	1.00 ea	61	315	-	-	-	376.01 /ea	376	872.05 /ea	872
			Specialties Toilet & Bath Accessories	**8.00 EA**	**507**	**1,946**				**306.56 /EA**	**2,452**	**710.03 /EA**	**5,680**
			Toilet Accessories	**1.00 LS**	**507**	**1,946**				**2,452.47 /LS**	**2,452**	**5,680.20 /LS**	**5,680**
			10.00 Specialties	**1.00 LS**	**507**	**1,946**				**2,452.47 /LS**	**2,452**	**5,680.20 /LS**	**5,680**
			10.0 Specialties	**1.00 LS**	**507**	**1,946**				**2,452.47 /LS**	**2,452**	**5,680.20 /LS**	**5,680**
	21.0		**Fire Suppression**										
		21.00	**Fire Suppression**										
			Sprinkler System										
			Mechanical, Fire Sprinklers System										
			Sprinkler System	928.00 SF	0	0	3,248	-	-	3.50 /SF	3,248	8.09 /SF	7,505
			Mechanical, Fire Sprinklers System	**1.00 LS**			**3,248**			**3,248.00 /LS**	**3,248**	**7,504.78 /LS**	**7,505**
			Sprinkler System	**938.00 SF**			**3,248**			**3.46 /SF**	**3,248**	**8.00 /SF**	**7,505**
			21.00 Fire Suppression	**1.00 LS**			**3,248**			**3,248.00 /LS**	**3,248**	**7,504.78 /LS**	**7,505**
			21.0 Fire Suppression	**1.00 LS**			**3,248**			**3,248.00 /LS**	**3,248**	**7,504.78 /LS**	**7,505**
	22.0		**Plumbing**										
		22.00	**Plumbing**										
			Plumbing Fixtures										
			Mechanical, Plumbing										
			Water closet, tank type, vitreous china, floor mounted, close coupled, two piece, includes seat, supply pipe with stop	1.00 ea	261	230	-	-	-	491.11 /ea	491	1,052.62 /ea	1,053
			Water closet, tank type, vitreous china, floor mounted, rough-in, supply, waste and vent, one piece	1.00 ea	454	325	-	-	-	778.73 /ea	779	1,666.33 /ea	1,666
			Lavatory, vanity top, stainless steel, self-rimming, ledge, round, single bowl, 18-3/4", includes trim	1.00 ea	216	800	-	-	-	1,016.23 /ea	1,016	2,200.85 /ea	2,201
			Lavatory, vanity top, rough-in, supply, waste and vent	1.00 ea	602	218	-	-	-	819.69 /ea	820	1,745.26 /ea	1,745
			Sink, service, stainless steel, self rimming, triple bowl, 22" x 43", includes faucet and drain	1.00 ea	315	1,125	-	-	-	1,439.52 /ea	1,440	3,116.99 /ea	3,117
			Sink, service, rough-in, supply, waste and vent	1.00 ea	647	247	-	-	-	893.68 /ea	894	1,903.47 /ea	1,903
			Industrial safety fixture, eyewash station, stainless steel, pedestal mounted, unmounted, excludes rough-in	2.00 ea	692	556	-	-	-	623.97 /ea	1,248	1,336.40 /ea	2,673
			Drinking fountain, wall mounted, non-recessed, aluminum, dual bubbler type, for connection to cold water supply	1.00 ea	222	2,475	-	-	-	2,696.85 /ea	2,697	5,865.18 /ea	5,865
			Mechanical, Plumbing	**1.00 LS**	**3,408**	**5,976**				**9,383.75 /LS**	**9,384**	**20,223.50 /LS**	**20,224**
			Plumbing Fixtures	**1.00 LS**	**3,408**	**5,976**				**9,383.75 /LS**	**9,384**	**20,223.50 /LS**	**20,224**
			22.00 Plumbing	**1.00 LS**	**3,408**	**5,976**				**9,383.75 /LS**	**9,384**	**20,223.50 /LS**	**20,224**
			22.0 Plumbing	**1.00 LS**	**3,408**	**5,976**				**9,383.75 /LS**	**9,384**	**20,223.50 /LS**	**20,224**
	23.0		**HVAC**										
		23.00	**HVAC**										

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			HVAC										
			Mechanical, HVAC										
			Condensing Unit, 3.5 ton	2.00 ea	2,801	12,000	-		-	7,400.67 /ea	14,801	16,039.74 /ea	32,079
			Fans, exhaust	1.00 ea	76	79	-	-	-	155.23 /ea	155	333.15 /ea	333
			Fans, wall exhauster, centrifugal, auto damper, direct drive, 1/8" S.P., 3307 CFM, 3/4 H.P.	3.00 ea	631	4,650	-	-	-	1,760.20 /ea	5,281	3,823.54 /ea	11,471
			Louver	16.00 sf	318	664	-	-	-	61.36 /sf	982	132.42 /sf	2,119
			AC-1 & AC2 Allowance	2.00 ea	6,151	41,800	-	-	-	23,975.27 /ea	47,951	52,064.81 /ea	104,130
			Misc. HVAC Allowance	1.00 LS			25,000	-	-	25,000.00 /LS	25,000	52,764.58 /LS	52,765
			Mechanical, HVAC	**1.00 LS**	**9,977**	**59,193**	**25,000**			**94,169.53 /LS**	**94,170**	**202,896.15 /LS**	**202,896**
			HVAC	**1.00 LS**	**9,977**	**59,193**	**25,000**			**94,169.53 /LS**	**94,170**	**202,896.15 /LS**	**202,896**
			HVAC Control Components/DDC Systems,										
			Mechanical, HVAC										
			Control Components/DDC Systems,	1.00 ls	-	-	-	-	25,000	25,000.00 /ls	25,000	52,764.58 /ls	52,765
			Mechanical, HVAC	**1.00 LS**					**25,000**	**25,000.00 /LS**	**25,000**	**52,764.58 /LS**	**52,765**
			HVAC Control Components/DDC Systems,	**1.00 LS**					**25,000**	**25,000.00 /LS**	**25,000**	**52,764.58 /LS**	**52,765**
			23.00 HVAC	**1.00 LS**	**9,977**	**59,193**	**25,000**		**25,000**	**119,169.53 /LS**	**119,170**	**255,660.73 /LS**	**255,661**
			23.0 HVAC	**1.00 LS**	**9,977**	**59,193**	**25,000**		**25,000**	**119,169.53 /LS**	**119,170**	**255,660.73 /LS**	**255,661**
	26.0		**Electrical Work**										
		26.10	**Site Electrical**										
			Electrical, Grounding										
			Site Electrical, Grounding										
			CU Bare Stranded #4/0	100.00 lf	363	401	-	-	-	7.64 /lf	764	18.32 /lf	1,832
			Hand Trench and Backfill, includes labor for layout	60.00 lf	968	-	-	-	-	16.13 /lf	968	38.07 /lf	2,284
			Copperclad Ground Rod 3/4" x 10'	4.00 E	258	128	-	-	-	96.45 /E	386	229.91 /E	920
			Compression Lug - 4/0	2.00 E	81	20	-	-	-	50.49 /E	101	119.90 /E	240
			Cadweld Cable to Rod - 250 Max	4.00 E	161	80	-	-	-	60.32 /E	241	143.79 /E	575
			Cadweld Cable to Cable - 250 Max	4.00 E	161	80	-	-	-	60.32 /E	241	143.79 /E	575
			Cadweld Cable to Steel - 250 Max	2.00 E	81	40	-	-	-	60.32 /E	121	143.80 /E	288
			Grounding Bolt and Nut Set	2.00 E	8	2	-	-	-	5.03 /E	10	11.94 /E	24
			Drill and Tap for Ground Connection	2.00 E	81	1	-	-	-	40.57 /E	81	95.79 /E	192
			Above Grade Ground Wire Supports	6.00 E	48	9	-	-	-	9.56 /E	57	22.68 /E	136
			Site Electrical, Grounding	**100.00 LF**	**2,210**	**761**				**29.70 /LF**	**2,970**	**70.65 /LF**	**7,065**
			Electrical, Grounding	**1.00 LS**	**2,210**	**761**				**2,970.30 /LS**	**2,970**	**7,064.90 /LS**	**7,065**
			26.10 Site Electrical	**1.00 LS**	**2,210**	**761**				**2,970.30 /LS**	**2,970**	**7,064.90 /LS**	**7,065**
		26.15	**Process Electrical**										
			Electrical, Conduit and Wire/Cable - Power										
			Process Electrical, Wire/Cable										
			THHN-THWN Copper Stranded 1/C # 12	10,880.00 lf	6,142	1,079	-	-	-	0.66 /lf	7,221	1.57 /lf	17,120
			THHN-THWN Copper Stranded 1/C # 8	425.00 lf	343	106	-	-	-	1.06 /lf	449	2.51 /lf	1,067
			THHN-THWN Copper Stranded 1/C # 6	85.00 lf	82	33	-	-	-	1.35 /lf	115	3.22 /lf	274
			THHN-THWN Copper Stranded 1/C # 2	1,530.00 lf	2,221	1,350	-	-	-	2.33 /lf	3,571	5.57 /lf	8,524
			THHN-THWN Copper Stranded 1/C # 2/0	255.00 lf	494	434	-	-	-	3.64 /lf	928	8.71 /lf	2,220
			THHN-THWN Copper Stranded 1/C # 3/0	1,200.00 lf	2,613	2,609	-	-	-	4.35 /lf	5,222	10.42 /lf	12,510
			THHN-THWN Copper Stranded 1/C # 350	3,600.00 lf	11,612	16,103	-	-	-	7.70 /lf	27,715	18.49 /lf	66,551
			THHN-THWN Copper Stranded 1/C # 500	765.00 lf	3,023	4,833	-	-	-	10.27 /lf	7,856	24.68 /lf	18,883
			Stakon Lug #12 - #10	256.00 E	2,064	64	-	-	-	8.31 /E	2,128	19.64 /E	5,029
			Compression Lug - # 8	10.00 E	121	23	-	-	-	14.40 /E	144	34.15 /E	341
			Compression Lug - # 6	2.00 E	24	4	-	-	-	14.29 /E	29	33.87 /E	68
			Compression Lug - # 2	36.00 E	726	204	-	-	-	25.83 /E	930	61.37 /E	2,209
			Compression Lug - 2/0	6.00 E	194	45	-	-	-	39.78 /E	239	94.42 /E	567
			Compression Lug - 3/0	24.00 E	774	220	-	-	-	41.42 /E	994	98.41 /E	2,362
			Compression Lug - 350 MCM	72.00 E	3,484	1,024	-	-	-	62.61 /E	4,508	148.78 /E	10,712
			Compression Lug - 500 MCM	18.00 E	1,016	370	-	-	-	76.99 /E	1,386	183.18 /E	3,297
			Motor Hook-up, single phase, 100 hp	1.00 E	645	135	-	-	-	780.38 /E	780	1,851.63 /E	1,852
			Motor Hook-up, 3 phase, 10 hp	32.00 E	4,645	1,816	-	-	-	201.90 /E	6,461	480.58 /E	15,379
			Motor Hook-up, 3 phase, 50 hp	2.00 E	629	231	-	-	-	430.15 /E	860	1,023.49 /E	2,047
			Equipmenmt Hook-up, 3 phase, 80A	3.00 E	944	347	-	-	-	430.15 /E	1,290	1,023.50 /E	3,070
			Motor Hook-up, 3 phase, 250 hp	3.00 E	3,387	531	-	-	-	1,305.82 /E	3,917	3,094.89 /E	9,285
			Motor Testing & Commissioning: 10HP / 480V / #12	32.00 E	1,806	-	-	-	-	56.45 /E	1,806	133.25 /E	4,264
			Motor Testing & Commissioning: 50HP / 480V / #4	2.00 E	177	-	-	-	-	88.71 /E	177	209.39 /E	419
			Equipment Testing & Commissioning: 80A / 480V / #4	3.00 E	266	-	-	-	-	88.71 /E	266	209.40 /E	628
			Motor Testing & Commissioning: 100 HP / 480v / 2/0	1.00 E	266	-	-	-	-	266.12 /E	266	628.22 /E	628
			Motor Testing & Commissioning: 250 HP / 480v / 500	3.00 E	1,427	-	-	-	-	475.78 /E	1,427	1,123.12 /E	3,369
			600V Megger Testing	212.00 E	4,274	-	-	-	-	20.16 /E	4,274	47.59 /E	10,089
			Wire Markers	424.00 E	342	21	-	-	-	0.86 /E	363	2.03 /E	859
			Process Electrical, Wire/Cable	**18,740.00 LF**	**53,740**	**31,583**				**4.55 /LF**	**85,323**	**10.87 /LF**	**203,623**
			Process Electrical, Conduit										
			GRC Conduit @ Level 2 3/4"	2,400.00 lf	17,031	3,497	-	-	-	8.55 /lf	20,528	20.29 /lf	48,703
			GRC Conduit @ Level 2 1-1/4"	375.00 lf	3,236	1,186	-	-	-	11.79 /lf	4,422	28.06 /lf	10,522

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Process Electrical, Conduit										
			GRC Conduit @ Level 2 2"	75.00 lf	907	333	-	-	-	16.54 /lf	1,240	39.35 /lf	2,951
			GRC Conduit @ Level 2 3"	1,225.00 lf	24,696	12,308	-	-	-	30.21 /lf	37,004	72.01 /lf	88,214
			GRC Elbow 3/4"	96.00 E	1,935	829	-	-	-	28.80 /E	2,765	68.59 /E	6,584
			GRC Elbow 1-1/4"	15.00 E	423	273	-	-	-	46.40 /E	696	110.80 /E	1,662
			GRC Elbow 2"	3.00 E	106	98	-	-	-	68.01 /E	204	162.83 /E	489
			GRC Elbow 3"	45.00 E	2,722	3,781	-	-	-	144.51 /E	6,503	347.01 /E	15,615
			GRC Couplng 3/4"	96.00 E	387	239	-	-	-	6.52 /E	626	15.56 /E	1,494
			GRC Couplng 1-1/4"	15.00 E	85	69	-	-	-	10.25 /E	154	24.51 /E	368
			GRC Couplng 2"	3.00 E	22	23	-	-	-	14.94 /E	45	35.79 /E	107
			GRC Couplng 3"	45.00 E	399	1,108	-	-	-	33.50 /E	1,508	80.81 /E	3,636
			Rigid Conduit Hub 3/4"	130.00 E	3,250	1,680	-	-	-	37.93 /E	4,930	90.43 /E	11,756
			Rigid Conduit Hub 1-1/4"	20.00 E	726	394	-	-	-	56.00 /E	1,120	133.57 /E	2,671
			Rigid Conduit Hub 2"	4.00 E	168	92	-	-	-	64.83 /E	259	154.63 /E	619
			Rigid Conduit Hub 3"	36.00 E	2,497	1,804	-	-	-	119.45 /E	4,300	285.49 /E	10,277
			Malleable LB Condulet - 3/4"	32.00 E	774	399	-	-	-	36.67 /E	1,174	87.44 /E	2,798
			Malleable LB Condulet - 1-1/4"	5.00 E	161	145	-	-	-	61.32 /E	307	146.78 /E	734
			Malleable LB Condulet - 2"	1.00 E	44	63	-	-	-	107.47 /E	107	258.08 /E	258
			Malleable LB Condulet - 3"	3.00 E	266	488	-	-	-	251.53 /E	755	605.15 /E	1,815
			Unistrut Straps 3/4"	320.00 E	774	591	-	-	-	4.27 /E	1,365	10.20 /E	3,264
			Unistrut Straps 1-1/4"	50.00 E	161	118	-	-	-	5.59 /E	279	13.36 /E	668
			Unistrut Straps 2"	10.00 E	32	31	-	-	-	6.29 /E	63	15.06 /E	151
			Unistrut Straps 3"	160.00 E	645	608	-	-	-	7.83 /E	1,253	18.75 /E	3,000
			Unistrut Conduit Hanger Allowance 3/4"	320.00 E	1,032	320	-	-	-	4.23 /E	1,352	10.04 /E	3,214
			Unistrut Conduit Hanger Allowance 1-1/4"	50.00 E	242	63	-	-	-	6.09 /E	304	14.46 /E	723
			Unistrut Conduit Hanger Allowance 2"	10.00 E	48	15	-	-	-	6.34 /E	63	15.07 /E	151
			Unistrut Conduit Hanger Allowance 3"	160.00 E	1,290	320	-	-	-	10.06 /E	1,610	23.90 /E	3,824
			EF Sealtite Flex 3/4"	32.00 lf	77	79	-	-	-	4.89 /lf	156	11.71 /lf	375
			EF Sealtite Flex 1-1/4"	5.00 lf	16	26	-	-	-	8.33 /lf	42	20.01 /lf	100
			EF Sealtite Flex 2"	1.00 lf	5	7	-	-	-	12.24 /lf	12	29.41 /lf	29
			EF Sealtite Flex 3"	11.00 lf	80	193	-	-	-	24.76 /lf	272	59.67 /lf	656
			LT Flex Connector Straight 3/4"	64.00 E	464	322	-	-	-	12.30 /E	787	29.38 /E	1,880
			LT Flex Connector Straight 1-1/4"	10.00 E	97	127	-	-	-	22.38 /E	224	53.72 /E	537
			LT Flex Connector Straight 2"	2.00 E	24	66	-	-	-	45.02 /E	90	108.57 /E	217
			LT Flex Connector Straight 3"	22.00 E	390	3,833	-	-	-	191.98 /E	4,224	465.38 /E	10,238
			Conduit Wall Penetration - 3"	8.00 E	194	40	-	-	-	29.19 /E	234	69.26 /E	554
			Fireproof Conduit Wall Penetration - 3"	8.00 E	387	117	-	-	-	63.04 /E	504	149.83 /E	1,199
			Process Electrical, Conduit	**4,075.00 LF**	**65,796**	**35,686**				**24.90 /LF**	**101,482**	**59.40 /LF**	**242,054**
			Electrical, Conduit and Wire/Cable - Power	**1.00 LS**	**119,537**	**67,268**				**186,804.71 /LS**	**186,805**	**445,676.85 /LS**	**445,677**
			Electrical, Conduit and Wire/Cable - Controls										
			Process Electrical, Wire/Cable										
			THHN-THWN Copper Stranded 1/C # 14	323,170.00 lf	156,365	20,889	-	-	-	0.55 /lf	177,254	1.30 /lf	419,884
			Shielded PLTC / Inst Cable 1 Pair #16	595.00 lf	960	268	-	-	-	2.06 /lf	1,227	4.90 /lf	2,916
			Unshielded Twisted Pair Cable, 4-Pair CAT 6 350Mhz Ultra II	680.00 lf	960	265	-	-	-	1.80 /lf	1,225	4.28 /lf	2,910
			UTP Cable Connector, RJ45 CAT 6 Mini-Jack TX-5e (568A/B)	16.00 E	323	70	-	-	-	24.51 /E	392	58.16 /E	931
			UTP Patch Cord, RJ45/RJ45 CAT 6E 350Mhz Data-Patch - 5ft	8.00 E	39	43	-	-	-	10.19 /E	82	24.43 /E	195
			UTP Wall Plate, 4-Port, CAT 6 350Mhz, RJ45/110 (568B), White	8.00 E	161	15	-	-	-	22.06 /E	176	52.21 /E	418
			4 Pair UTP Continuity Test	8.00 E	161		-	-	-	20.16 /E	161	47.59 /E	381
			4 Pair UTP Certification with Documentation	8.00 E	406		-	-	-	50.80 /E	406	119.93 /E	959
			UTP Cable Supports	48.00 E	194	24	-	-	-	4.53 /E	218	10.73 /E	515
			Termination Labor Only - # 16 - #14	979.00 E	7,895	-	-	-	-	8.06 /E	7,895	19.04 /E	18,636
			Control Wire Testing	486.00 E	3,919	-	-	-	-	8.06 /E	3,919	19.04 /E	9,251
			Wire Markers	979.00 E	789	49	-	-	-	0.86 /E	838	2.03 /E	1,983
			Process Electrical, Wire/Cable	**324,445.00 LF**	**172,171**	**21,623**				**0.60 /LF**	**193,794**	**1.41 /LF**	**458,979**
			Process Electrical, Conduit										
			GRC Conduit @ Level 2 3/4"	4,650.00 lf	32,998	6,775	-	-	-	8.55 /lf	39,773	20.29 /lf	94,363
			GRC Elbow 3/4"	186.00 E	3,750	1,607	-	-	-	28.80 /E	5,357	68.59 /E	12,757
			GRC Couplng 3/4"	186.00 E	750	462	-	-	-	6.52 /E	1,212	15.56 /E	2,894
			Rigid Conduit Hub 3/4"	124.00 E	3,100	1,603	-	-	-	37.93 /E	4,703	90.43 /E	11,213
			Malleable LB Condulet - 3/4"	62.00 E	1,500	774	-	-	-	36.67 /E	2,274	87.44 /E	5,421
			Unistrut Straps 3/4"	620.00 E	1,500	1,145	-	-	-	4.27 /E	2,645	10.20 /E	6,324
			Unistrut Conduit Hanger Allowance 3/4"	620.00 E	2,000	620	-	-	-	4.23 /E	2,620	10.05 /E	6,228
			EF Sealtite Flex 3/4"	62.00 lf	150	153	-	-	-	4.89 /lf	303	11.71 /lf	726
			LT Flex Connector Straight 3/4"	124.00 E	900	625	-	-	-	12.30 /E	1,525	29.38 /E	3,643
			Process Electrical, Conduit	**4,650.00 LF**	**46,648**	**13,764**				**12.99 /LF**	**60,411**	**30.88 /LF**	**143,570**
			Electrical, Conduit and Wire/Cable - Controls	**1.00 LS**	**218,819**	**35,386**				**254,204.89 /LS**	**254,205**	**602,548.84 /LS**	**602,549**
			Electrical, Grounding										
			Process Electrical, Grounding										
			Miscellaneous Grounding	1.00 ls	4,838	2,500	-	-	-	7,338.46 /ls	7,338	17,498.04 /ls	17,498
			Process Electrical, Grounding	**1.00 LF**	**4,838**	**2,500**				**7,338.46 /LF**	**7,338**	**17,498.04 /LF**	**17,498**
			Electrical, Grounding	**1.00 LS**	**4,838**	**2,500**				**7,338.46 /LS**	**7,338**	**17,498.04 /LS**	**17,498**

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			26.15 Process Electrical	**1.00 LS**	**343,194**	**105,155**				**448,348.06 /LS**	**448,348**	**1,065,723.73 /LS**	**1,065,724**
		26.20	**Facility Electrical**										
			Facility Electrical, Complete $/SF Cost										
			Facility Electrical, Complete $/SF Cost										
			PS Building, Electrical Subcontract, Division 16	3,318.00 sf	-	-	61,527	-	-	18.54 /sf	61,527	43.77 /sf	145,239
			Facility Electrical, Complete $/SF Cost	**3,318.00 SF**			**61,527**			**18.54 /SF**	**61,527**	**43.77 /SF**	**145,239**
			Facility Electrical, Complete $/SF Cost	**1.00 LS**			**61,527**			**61,526.78 /LS**	**61,527**	**145,239.09 /LS**	**145,239**
			26.20 Facility Electrical	**1.00 LS**			**61,527**			**61,526.78 /LS**	**61,527**	**145,239.09 /LS**	**145,239**
		26.25	**Electrical Equipment**										
			Electrical Equipment										
			Electrical, Testing										
			Megger/Check Elec Equipment	1.00 LS	4,838	-	-	-	-	4,838.46 /LS	4,838	11,421.61 /LS	11,422
			Electrical, Testing	**1.00 LS**	**4,838**					**4,838.46 /LS**	**4,838**	**11,421.61 /LS**	**11,422**
			Electrical Equipment, MCCs - General										
			LV MCC Vertical Sections - 1200A	9.00 E	5,806	24,750	-	-	-	3,395.13 /E	30,556	8,206.98 /E	73,863
			MCC Main Breaker - 1200A	1.00 E	564	8,625	-	-	-	9,189.49 /E	9,189	22,296.29 /E	22,296
			MCC FVNR Starter w/ Circuit Breaker - Size 1	7.00 E	452	2,324	-	-	-	396.51 /E	2,776	959.24 /E	6,715
			MCC Circuit Breaker - <30A	25.00 E	504	5,636	-	-	-	245.61 /E	6,140	595.57 /E	14,889
			MCC Circuit Breaker - 80A	1.00 E	60	248	-	-	-	307.98 /E	308	744.33 /E	744
			MCC Circuit Breaker - 90A	3.00 E	181	743	-	-	-	307.98 /E	924	744.34 /E	2,233
			MCC Circuit Breaker - 175A	1.00 E	101	486	-	-	-	586.80 /E	587	1,419.20 /E	1,419
			MCC Circuit Breaker - 400A	4.00 E	1,290	18,800	-	-	-	5,022.57 /E	20,090	12,185.19 /E	48,741
			Switchboard instruments, ground fault protection, ground return path	1.00 ea	239	6,750	-	-	-	6,988.94 /ea	6,989	16,970.46 /ea	16,970
			Voltage monitor systems, AC voltage remote, add-on det only, w/internal modem	1.00 ea	-	4,000	-	-	-	4,000.00 /ea	4,000	9,722.34 /ea	9,722
			Transformer, dry-type, ventilated, 3 phase 480 V primary 120/208 V secondary, 30 kVA	1.00 ea	143	1,475	-	-	-	1,618.38 /ea	1,618	3,923.57 /ea	3,924
			Panelboards, 3 phase 4 wire, main lugs, 120/208 V, 100 amp, 30 circuits, NQOD, incl 20 A 1 pole plug-in breakers	1.00 ea	122	1,125	-	-	-	1,246.69 /ea	1,247	3,021.67 /ea	3,022
			Electrical Equipment, MCCs - General	**1.00 LS**	**9,463**	**74,961**				**84,424.48 /LS**	**84,424**	**204,538.30 /LS**	**204,538**
			Electrical Equipment, Switches - General										
			Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 30 amp, NEMA 3R	25.00 ea	5,283	4,000	-	-	-	371.30 /ea	9,283	887.69 /ea	22,192
			Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 30 amp, NEMA 3R_HVAC	12.00 ea	2,536	1,920	-	-	-	371.30 /ea	4,456	887.69 /ea	10,652
			Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 100 amp, NEMA 3R	1.00 ea	364	390	-	-	-	753.91 /ea	754	1,806.98 /ea	1,807
			Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 200 amp, NEMA 3R	1.00 ea	546	475	-	-	-	1,020.86 /ea	1,021	2,443.07 /ea	2,443
			Electrical Equipment, Switches - General	**1.00 LS**	**8,728**	**6,785**				**15,512.91 /LS**	**15,513**	**37,094.46 /LS**	**37,094**
			Electrical Equipment, VFDs - General										
			Variable frequency drives, enclosed, 460 volt, 50 HP motor size, NEMA 1, FBO	2.00 ea	4,944	400	-	-	-	2,671.82 /ea	5,344	6,321.07 /ea	12,642
			Variable frequency drives, enclosed, 460 volt, 200 HP motor size, NEMA 1, FBO	3.00 ea	11,674	600	-	771	-	4,348.24 /ea	13,045	10,296.36 /ea	30,889
			Electrical Equipment, VFDs - General	**1.00 LS**	**16,617**	**1,000**		**771**		**18,388.35 /LS**	**18,388**	**43,531.21 /LS**	**43,531**
			Electrical Equipment, Generators - General										
			Generator set,diesel 1000 kva,incl battery,charger,enclosure,muffler,day tank,excl conduit,wiring,& concrete	1.00 ea	12,394	298,000	-	915	-	311,308.25 /ea	311,308	755,793.08 /ea	755,793
			Automatic transfer switches, enclosed, 3 pole, 480 volt, 1200 amp	1.00 ea	1,872	19,400	-	-	-	21,271.52 /ea	21,272	51,571.20 /ea	51,571
			Electrical Equipment, Generators - General	**1.00 LS**	**14,265**	**317,400**		**915**		**332,579.77 /LS**	**332,580**	**807,364.28 /LS**	**807,364**
			Electrical Equipment	**1.00 LS**	**53,912**	**400,146**		**1,686**		**455,743.97 /LS**	**455,744**	**1,103,949.86 /LS**	**1,103,950**
			26.25 Electrical Equipment	**1.00 LS**	**53,912**	**400,146**		**1,686**		**455,743.97 /LS**	**455,744**	**1,103,949.86 /LS**	**1,103,950**
			26.0 Electrical Work	**1.00 LS**	**399,315**	**506,062**	**61,527**	**1,686**		**968,589.11 /LS**	**968,589**	**2,321,977.58 /LS**	**2,321,978**
	32.0		**Exterior Improvements**										
		32.45	**Fencing**										
			Fencing										
			Fencing, Security										
			Fence, security fence	16.00 lf	1,573	1,088	-	709	-	210.65 /lf	3,370	473.53 /lf	7,576
			Fence, double swing gates	1.00 opng	1,873	1,350	-	341	-	3,563.67 /opng	3,564	7,996.16 /opng	7,996
			Fencing, Security	**16.00 LF**	**3,446**	**2,438**		**1,051**		**433.38 /LF**	**6,934**	**973.29 /LF**	**15,573**
			Fencing	**16.00 LF**	**3,446**	**2,438**		**1,051**		**433.38 /LF**	**6,934**	**973.29 /LF**	**15,573**
			32.45 Fencing	**16.00 LF**	**3,446**	**2,438**		**1,051**		**433.38 /LF**	**6,934**	**973.29 /LF**	**15,573**
		32.50	**Site, Improvements**										
			Site Improvements, Pipe Bollards										
			Site Improvements, Bollards										
			Pipe bollards, steel, concrete filled/paint, 8' L x 4' D hole, 12" dia	13.00 ea	2,129	4,420	-		-	503.76 /ea	6,549	1,137.40 /ea	14,786

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Site Improvements, Bollards	**13.00 EA**	**2,129**	**4,420**				**503.76 /EA**	**6,549**	**1,137.40 /EA**	**14,786**
			Site Improvements, Pipe Bollards	**1.00 LS**	**2,129**	**4,420**				**6,548.85 /LS**	**6,549**	**14,786.19 /LS**	**14,786**
			32.50 Site, Improvements	**1.00 LS**	**2,129**	**4,420**				**6,548.85 /LS**	**6,549**	**14,786.19 /LS**	**14,786**
			32.0 Exterior Improvements	**1.00 LS**	**5,574**	**6,858**		**1,051**		**13,482.97 /LS**	**13,483**	**30,358.82 /LS**	**30,359**
	33.0		**Utilities**										
		33.05	**Buried Process Piping**										
			Temporary Bypass Pumping										
			Buried Pipe Specials, Temporary Bypasses										
			Allowance for Bypass Pumping, System Operation	6.00 mon	10,379	24,000	-	600,000	-	105,729.86 /mon	634,379	246,291.15 /mon	1,477,747
			Buried Pipe Specials, Temporary Bypasses	**6.00 EA**	**10,379**	**24,000**		**600,000**		**105,729.86 /EA**	**634,379**	**246,291.15 /EA**	**1,477,747**
			Temporary Bypass Pumping	**6.00 MO**	**10,379**	**24,000**		**600,000**		**105,729.86 /MO**	**634,379**	**246,291.15 /MO**	**1,477,747**
			33.05 Buried Process Piping	**1.00 LS**	**10,379**	**24,000**		**600,000**		**634,379.16 /LS**	**634,379**	**1,477,746.91 /LS**	**1,477,747**
			33.0 Utilities	**1.00 LS**	**10,379**	**24,000**		**600,000**		**634,379.16 /LS**	**634,379**	**1,477,746.91 /LS**	**1,477,747**
	40.0		**Process Pipe**										
		40.00	**Exposed Process Pipe**										
			12" DI Pipe										
			Process Pipe, Ductile Iron, 12"										
			Install gate valve, Flgd, DIP, 12"	2.00 ea	1,022	-	-	507	-	764.54 /ea	1,529	1,769.00 /ea	3,538
			Gate valve, iron body, dbl disk, Flgd, 250#, NO, 12"	2.00 ea	-	2,888	-	-	-	1,444.00 /ea	2,888	3,408.68 /ea	6,817
			Install check valve, Flgd, DIP, 12"	2.00 ea	1,022	-	-	507	-	764.54 /ea	1,529	1,769.01 /ea	3,538
			Check valve, iron body, swing check, Flgd, 250#, 12"	2.00 ea	-	5,742	-	-	-	2,871.00 /ea	5,742	6,777.23 /ea	13,554
			Install magnetic flow meter, 12"	2.00 ea	1,051	-	-	-	-	525.25 /ea	1,051	1,203.13 /ea	2,406
			Install 12" DI, flanged, spool <= 10'	10.00 ea	4,815	-	-	-	-	481.48 /ea	4,815	1,102.87 /ea	11,029
			12" Fabricated DI Spool, FxF, 1' 6" - FURNISH	4.00 ea	-	2,516	-	-	-	629.00 /ea	2,516	1,484.81 /ea	5,939
			12" Fabricated DI Spool, FxF, 4' 0" - FURNISH	1.00 ea	-	914	-	-	-	914.00 /ea	914	2,157.57 /ea	2,158
			12" Fabricated DI Spool, FxF, 5' 0" - FURNISH	5.00 ea	-	5,165	-	-	-	1,033.00 /ea	5,165	2,438.48 /ea	12,192
			12" DI, FL, Ell, 90	4.00 ea	1,926	1,857	-	-	-	945.64 /ea	3,783	2,198.56 /ea	8,794
			12" DI, flanged coupling adapter	4.00 ea	1,793	1,056	-	-	-	712.22 /ea	2,849	1,649.87 /ea	6,599
			Pipe stand support, CS, 12"	2.00 ea	525	666	-	-	-	595.63 /ea	1,191	1,387.66 /ea	2,775
			Flow Meters 12"	2.00 ea		24,000	-	-	-	12,000.00 /ea	24,000	28,326.99 /ea	56,654
			Flow Meter: Electrical Hookup Only, 12"	2.00 ea	1,532	-	-	-	-	766.09 /ea	1,532	1,754.78 /ea	3,510
			Process Pipe, Ductile Iron, 12"	**35.00 LF**	**13,685**	**44,804**		**1,015**		**1,700.10 /LF**	**59,503**	**3,985.85 /LF**	**139,505**
			12" DI Pipe	**35.00 LF**	**13,685**	**44,804**		**1,015**		**1,700.10 /LF**	**59,503**	**3,985.85 /LF**	**139,505**
			16" DI Pipe										
			Process Pipe, Ductile Iron, 16"										
			Install gate valve, Flgd, DIP, 16"	4.00 ea	2,963	-	-	1,471	-	1,108.58 /ea	4,434	2,565.05 /ea	10,260
			Gate valve, iron body, dbl disk, Flgd, 250#, HWO, 16"	4.00 ea	-	31,352	-	-	-	7,838.00 /ea	31,352	18,502.24 /ea	74,009
			Install check valve, Flgd, DIP, 16"	3.00 ea	2,222	-	-	1,103	-	1,108.58 /ea	3,326	2,565.05 /ea	7,695
			Check valve, iron body, swing check, Flgd, 250#, 16"	3.00 ea	-	17,226	-	-	-	5,742.00 /ea	17,226	13,554.47 /ea	40,663
			Install magnetic flow meter, 16"	3.00 ea	2,285	-	-	-	-	761.62 /ea	2,285	1,744.55 /ea	5,234
			Install 16" DI, flanged, spool <= 10'	15.00 ea	11,332	-	-	-	-	755.49 /ea	11,332	1,730.51 /ea	25,958
			16" Fabricated DI Spool, FxF, 1' 0" - FURNISH	6.00 ea	-	6,114	-	-	-	1,019.00 /ea	6,114	2,405.44 /ea	14,433
			16" Fabricated DI Spool, FxF, 4' 0" - FURNISH	6.00 ea	-	9,174	-	-	-	1,529.00 /ea	9,174	3,609.33 /ea	21,656
			16" Fabricated DI Spool, FxF, 4' 6" - FURNISH	3.00 ea	-	4,842	-	-	-	1,614.00 /ea	4,842	3,809.98 /ea	11,430
			16" DI, FL, Ell, 90	7.00 ea	5,288	5,265	-	-	-	1,507.70 /ea	10,554	3,506.16 /ea	24,543
			16" DI, FL, reducer, 16" x 12"	1.00 ea	755	652	-	-	-	1,407.39 /ea	1,407	3,269.36 /ea	3,269
			16" DI, flanged coupling adapter	6.00 ea	3,939	2,112	-	-	-	1,008.57 /ea	6,051	2,334.84 /ea	14,009
			Pipe stand support, CS, 16"	3.00 ea	1,051	1,386	-	-	-	812.17 /ea	2,437	1,892.67 /ea	5,678
			Flow Meters 16"	3.00 ea		48,000	-	-	-	16,000.00 /ea	48,000	37,769.34 /ea	113,308
			Flow Meter: Electrical Hookup Only, 16"	3.00 ea	2,540	-	-	-	-	846.73 /ea	2,540	1,939.50 /ea	5,819
			Process Pipe, Ductile Iron, 16"	**43.50 LF**	**32,376**	**126,123**		**2,575**		**3,702.86 /LF**	**161,075**	**8,688.82 /LF**	**377,964**
			16" DI Pipe	**43.50 LF**	**32,376**	**126,123**		**2,575**		**3,702.86 /LF**	**161,075**	**8,688.82 /LF**	**377,964**
			20" DI Pipe										
			Process Pipe, Ductile Iron, 20"										
			Install gate valve, Flgd, DIP, 20"	2.00 ea	1,788	-	-	888	-	1,337.95 /ea	2,676	3,095.75 /ea	6,192
			Gate valve, iron body, dbl disk, Flgd, 250#, HWO, 20"	2.00 ea	-	24,750	-	-	-	12,375.00 /ea	24,750	29,212.21 /ea	58,424
			20" DI, FL, Ell, 90	2.00 ea	1,756	2,489	-	-	-	2,122.35 /ea	4,245	4,948.51 /ea	9,897
			20" DI, FL, reducer, 20" x 12"	1.00 ea	878	914	-	-	-	1,791.61 /ea	1,792	4,167.79 /ea	4,168
			20" DI, FL, reducer, 20" x 16"	1.00 ea	878	1,032	-	-	-	1,910.24 /ea	1,910	4,447.83 /ea	4,448
			Process Pipe, Ductile Iron, 20"	**1.00 LF**	**5,300**	**29,184**		**888**		**35,372.43 /LF**	**35,372**	**83,128.56 /LF**	**83,129**
			20" DI Pipe	**1.00 LF**	**5,300**	**29,184**		**888**		**35,372.43 /LF**	**35,372**	**83,128.56 /LF**	**83,129**
			24" DI Pipe										
			Process Pipe, Ductile Iron, 24"										
			Install gate valve, Flgd, DIP, 24"	2.00 ea	2,112	-	-	1,048	-	1,580.05 /ea	3,160	3,655.92 /ea	7,312
			Gate valve, iron body, dbl disk, Flgd, 250#, HWO, 24"	2.00 ea	-	33,000	-	-	-	16,500.00 /ea	33,000	38,949.62 /ea	77,899
			Install 24" DI, flanged, spool <= 10'	5.00 ea	5,244	-	-	-	-	1,048.75 /ea	5,244	2,402.26 /ea	12,011
			24" Fabricated DI Spool, FxF, 5' 0" - FURNISH	1.00 ea	-	2,905	-	-	-	2,905.00 /ea	2,905	6,857.50 /ea	6,858
			24" Fabricated DI Spool, FxF, 6' 0" - FURNISH	1.00 ea	-	3,181	-	-	-	3,181.00 /ea	3,181	7,509.02 /ea	7,509
			24" Fabricated DI Spool, FxF, 7' 0" - FURNISH	2.00 ea	-	6,924	-	-	-	3,462.00 /ea	6,924	8,172.34 /ea	16,345

Detail Report

Project: GNH Union Pump Station
Project No.: 478874
Design Stage: Conceptual

Estimator: E.B. Smith/GNV, A. Frisch/PGH
Revision / Date: Rev02 (10-3-2016)
Estimate Class: 4

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Process Pipe, Ductile Iron, 24"										
			24" Fabricated DI Spool, FxF, 9' 6" - FURNISH	1.00 ea	-	4,152	-	-	-	4,152.00 /ea	4,152	9,801.14 /ea	9,801
			24" DI, FL, Ell, 90	2.00 ea	2,098	4,102	-	-	-	3,099.86 /ea	6,200	7,244.05 /ea	14,488
			24" DI, FL, wye, red, 24" x 12"	2.00 ea	2,623	6,350	-	-	-	4,486.58 /ea	8,973	10,499.16 /ea	20,998
			24" DI, FL, wye, red, 24" x 16"	3.00 ea	3,934	15,005	-	-	-	6,313.04 /ea	18,939	14,810.66 /ea	44,432
			24" DI, FL, blind flange	1.00 ea	985	963	-	-	-	1,948.19 /ea	1,948	4,529.92 /ea	4,530
			24" DI, FL, reducer, 24" x 16"	2.00 ea	2,098	2,780	-	-	-	2,438.96 /ea	4,878	5,683.94 /ea	11,368
			Process Pipe, Ductile Iron, 24"	**34.50 LF**	**19,092**	**79,363**		**1,048**		**2,884.17 /LF**	**99,504**	**6,769.59 /LF**	**233,551**
			24" DI Pipe	**34.50 LF**	**19,092**	**79,363**		**1,048**		**2,884.17 /LF**	**99,504**	**6,769.59 /LF**	**233,551**
			40.00 Exposed Process Pipe	**35.00 LF**	**70,454**	**279,475**		**5,526**		**10,155.84 /LF**	**355,454**	**23,832.79 /LF**	**834,148**
			40.0 Process Pipe	**1.00 LF**	**70,454**	**279,475**		**5,526**		**355,454.26 /LF**	**355,454**	**834,147.62 /LF**	**834,148**
	40.9		**Instrumentation & Controls**										
		40.90	**Instrumentation & Controls**										
			Instrumentation & Controls										
			I&C, Flow / Mag Meter / Indicators & Transmitters										
			FE - Flow Element - Mag Flowtube (inline)	5.00 ea	806	250	-	-	-	211.28 /ea	1,056	502.25 /ea	2,511
			FT / FIT - Flow Transmitter - Magnetic, 12"	2.00 ea	1,532	18,000	-	-	-	9,766.09 /ea	19,532	23,683.67 /ea	47,367
			FT / FIT - Flow Transmitter - Magnetic, 16"	3.00 ea	2,540	36,000	-	-	-	12,846.73 /ea	38,540	31,165.77 /ea	93,497
			I&C, Flow / Mag Meter / Indicators & Transmitters	**10.00 EA**	**4,879**	**54,250**				**5,912.88 /EA**	**59,129**	**14,337.59 /EA**	**143,376**
			I&C, Level / Indicators & Transmitters										
			LE - Level Element / Sensor	2.00 ea	40	100	-	-	-	70.16 /ea	140	169.12 /ea	338
			LT / LIT - Level Transmitter	2.00 ea	363	2,550	-	-	-	1,456.44 /ea	2,913	3,527.30 /ea	7,055
			I&C, Level / Indicators & Transmitters	**4.00 EA**	**403**	**2,650**				**763.30 /EA**	**3,053**	**1,848.21 /EA**	**7,393**
			I&C, Pressure / Indicators & Transmitters										
			PI - Pressure Indicator - Stem Mounted	5.00 ea	202	1,625	-	-	-	365.32 /ea	1,827	885.12 /ea	4,426
			PE - Diaphragm Seal	5.00 ea	605	2,125	-	-	-	545.96 /ea	2,730	1,318.54 /ea	6,593
			I&C, Pressure / Indicators & Transmitters	**10.00 EA**	**806**	**3,750**				**455.64 /EA**	**4,556**	**1,101.83 /EA**	**11,018**
			I&C, Other / Switches										
			Control Stations	37.00 E	2,984	16,544	-	-	-	527.78 /E	19,528	1,277.17 /E	47,255
			I&C, Other / Switches	**37.00 EA**	**2,984**	**16,544**				**527.78 /EA**	**19,528**	**1,277.17 /EA**	**47,255**
			I&C, Panels & Stands										
			Instrument Stand-Single, Galv.	44.00 ea	4,435	2,200	-	-	-	150.80 /ea	6,635	359.48 /ea	15,817
			I&C, Panels & Stands	**44.00 EA**	**4,435**	**2,200**				**150.80 /EA**	**6,635**	**359.48 /EA**	**15,817**
			I&C, PLC, Control Panels, Network Hardware										
			Network Hardware	1.00 ls	645	5,000	-	-	-	5,645.13 /ls	5,645	13,675.82 /ls	13,676
			Ethernet Radio [Wireless] - SCADA	1.00 ea	3,226	25,000	-	-	-	28,225.64 /ea	28,226	68,378.95 /ea	68,379
			Local Control Panel, Odor Control, FBO	1.00 ea	1,210	200	-	-	-	1,409.62 /ea	1,410	3,341.54 /ea	3,342
			Local Control Panel, Sump Pump Controller, FBO	1.00 ea	1,210	200	-	-	-	1,409.62 /ea	1,410	3,341.53 /ea	3,342
			Local Control Panel, Generator Control, FBO	1.00 ea	1,210	200	-	-	-	1,409.62 /ea	1,410	3,341.53 /ea	3,342
			Union PS - PLC Cabinet	1.00 ea	3,226	30,000	-	-	-	33,225.64 /ea	33,226	80,531.88 /ea	80,532
			I&C, PLC, Control Panels, Network Hardware	**6.00 EA**	**10,725**	**60,600**				**11,887.55 /EA**	**71,325**	**28,768.54 /EA**	**172,611**
			I&C, Sotfware, Programming										
			SCADA Software Licenses	1.00 ea		3,500	-	-	-	3,500.00 /ea	3,500	8,507.05 /ea	8,507
			PLC / SCADA Software Development	184.00 pts	66,771		-	-	-	362.89 /pts	66,771	856.62 /pts	157,618
			I&C, Sotfware, Programming	**184.00 EA**	**66,771**	**3,500**				**381.91 /EA**	**70,271**	**902.85 /EA**	**166,125**
			I&C, Instrument Tubing, Piping, etc.										
			Press Gauge / Press Sw Installation Materials - Stainless	5.00 ea	1,048	750	-	-	-	359.67 /ea	1,798	859.52 /ea	4,298
			I&C, Instrument Tubing, Piping, etc.	**1.00 LF**	**1,048**	**750**				**1,798.33 /LF**	**1,798**	**4,297.59 /LF**	**4,298**
			I&C, Other										
			Receive & Store Instrument	50.00 ea	1,411	1	-	-	-	28.23 /ea	1,412	66.65 /ea	3,333
			Identification Tag - SS	50.00 ea	1,008	750	-	-	-	35.16 /ea	1,758	84.05 /ea	4,202
			Field Calibration - Simple	5.00 ea	202		-	-	-	40.32 /ea	202	95.18 /ea	476
			Field Calibration - Average	44.00 ea	10,645		-	-	-	241.92 /ea	10,645	571.08 /ea	25,127
			Field Calibration - Severe	1.00 ea	484		-	-	-	483.85 /ea	484	1,142.18 /ea	1,142
			Pre-Operation Check	50.00 ea	3,770		-	-	-	75.40 /ea	3,770	177.99 /ea	8,899
			Startup - Stand-By (Manhours)	49.00 ea	3,468		-	-	-	70.77 /ea	3,468	167.05 /ea	8,185
			Loop Check - Average	49.00 ea	6,935		-	-	-	141.53 /ea	6,935	334.10 /ea	16,371
			I&C, Other	**50.00 EA**	**27,922**	**751**				**573.45 /EA**	**28,672**	**1,354.72 /EA**	**67,736**
			Instrumentation & Controls	**1.00 LS**	**119,974**	**144,995**				**264,968.35 /LS**	**264,968**	**635,629.49 /LS**	**635,629**
			40.90 Instrumentation & Controls	**1.00 LS**	**119,974**	**144,995**				**264,968.35 /LS**	**264,968**	**635,629.49 /LS**	**635,629**
			40.9 Instrumentation & Controls	**1.00 LS**	**119,974**	**144,995**				**264,968.35 /LS**	**264,968**	**635,629.49 /LS**	**635,629**
	41.0		**Bulk Material Processing Equipment**										
		41.00	**Material Handling Equipment**										
			Monorail Crane										
			Material Handling, Monorail Cranes										
			Monorail Cranes, under hung hoist, electric operating, 7.5 ton,	1.00 ea	3,152	30,000	-	1,360	-	34,511.73 /ea	34,512	78,486.25 /ea	78,486
			Material Handling, Monorail Cranes	**1.00 EA**	**3,152**	**30,000**		**1,360**		**34,511.73 /EA**	**34,512**	**78,486.25 /EA**	**78,486**

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Monorail Crane	**1.00 EA**	**3,152**	**30,000**		**1,360**		**34,511.73 /EA**	**34,512**	**78,486.25 /EA**	**78,486**
			41.00 Material Handling Equipment	**1.00 LS**	**3,152**	**30,000**		**1,360**		**34,511.73 /LS**	**34,512**	**78,486.25 /LS**	**78,486**
			41.0 Bulk Material Processing Equipment	**1.00 LS**	**3,152**	**30,000**		**1,360**		**34,511.73 /LS**	**34,512**	**78,486.25 /LS**	**78,486**
	43.0		**Process Equipment - Industrial**										
		43.05	**Furnish and Install Process Equipment**										
			Wet Weather - 250 HP Flowserve Pump										
			Vertical Centrifugal Pump: 101hp-500hp										
			Functional Testing, Pumps, 101-500 hp	3.00 ea	902	300	-	-	-	400.80 /ea	1,202	913.04 /ea	2,739
			Align Pump & Motor, 101-500 hp	3.00 ea	1,354	-	3,150	-	-	1,501.20 /ea	4,504	3,393.59 /ea	10,181
			Vibration Testing, Pumps, 101-500 hp	3.00 ea	451	-	1,050	-	-	500.40 /ea	1,501	1,131.20 /ea	3,394
			Witnessed factory test	3.00 ea	-	-	1,500	-	1,500	1,000.00 /ea	3,000	2,260.58 /ea	6,782
			Local panel	3.00 ea	1,354	4,500	-	-	-	1,951.20 /ea	5,854	4,515.86 /ea	13,548
			Pressure indicators	6.00 ea	677	1,500	-	-	-	362.80 /ea	2,177	837.64 /ea	5,026
			Sleeved anchor bolts - Medium	24.00 ea	632	504	-	-	-	47.32 /ea	1,136	108.44 /ea	2,603
			Non-Shrink Machine Grout	24.00 cuft	1,715	1,776	-	-	-	145.44 /cuft	3,491	333.96 /cuft	8,015
			Grease, Oil, and Lube Pumps, 101-500 hp	3.00 ea	902	225	-	-	-	375.80 /ea	1,127	854.78 /ea	2,564
			FURNISH Vertical Centrifugal Pump, 101 - 500 hp	3.00 EA	-	450,000	-	-	-	150,000.00 /EA	450,000	349,587.49 /EA	1,048,762
			Set pump assembly, 101 - 500 hp	3.00 ea	13,536	150	-	-	-	4,562.00 /ea	13,686	10,316.28 /ea	30,949
			Vertical Centrifugal Pump: 101hp-500hp	**3.00 EA**	**21,522**	**458,955**	**5,700**		**1,500**	**162,559.08 /EA**	**487,677**	**378,187.29 /EA**	**1,134,562**
			Wet Weather - 250 HP Flowserve Pump	**3.00 EA**	**21,522**	**458,955**	**5,700**		**1,500**	**162,559.08 /EA**	**487,677**	**378,187.29 /EA**	**1,134,562**
			Dry Weather - 50 HP Flowserve Pump										
			Vertical Centrifugal Pump: 21hp-50hp										
			Functional Testing, Pumps, 21-50 hp	2.00 ea	301	100	-	-	-	200.40 /ea	401	456.53 /ea	913
			Align Pump & Motor, 21-50 hp	2.00 ea	451	-	1,050	-	-	750.60 /ea	1,501	1,696.80 /ea	3,394
			Vibration Testing, Pumps, 21-50 hp	2.00 ea	150	-	350	-	-	250.20 /ea	500	565.59 /ea	1,131
			Witnessed factory test	2.00 ea	-	-	1,000	-	1,000	1,000.00 /ea	2,000	2,260.60 /ea	4,521
			Local panel	2.00 ea	902	3,000	-	-	-	1,951.20 /ea	3,902	4,515.84 /ea	9,032
			Pressure indicators	4.00 ea	451	1,000	-	-	-	362.80 /ea	1,451	837.65 /ea	3,351
			Sleeved anchor bolts - Small	12.00 ea	271	144	-	-	-	34.56 /ea	415	78.96 /ea	948
			Non-Shrink Machine Grout	8.00 cuft	572	592	-	-	-	145.44 /cuft	1,164	333.96 /cuft	2,672
			Grease, Oil, and Lube Pumps, 21-50 hp	2.00 ea	301	150	-	-	-	225.40 /ea	451	514.79 /ea	1,030
			FURNISH Vertical Centrifugal Pump, 21 - 50 hp	2.00 EA	-	250,000	-	-	-	125,000.00 /EA	250,000	291,322.91 /EA	582,646
			Set pump assembly, 21 - 50 hp	2.00 ea	4,813	50	-	-	-	2,431.40 /ea	4,863	5,498.14 /ea	10,996
			Vertical Centrifugal Pump: 21hp-50hp	**2.00 EA**	**8,212**	**255,036**	**2,400**		**1,000**	**133,323.92 /EA**	**266,648**	**310,316.09 /EA**	**620,632**
			Dry Weather - 50 HP Flowserve Pump	**2.00 EA**	**8,212**	**255,036**	**2,400**		**1,000**	**133,323.92 /EA**	**266,648**	**310,316.09 /EA**	**620,632**
			Channel Grinders										
			Channel Grinders										
			Channel Grinders	2.00 ea	8,000	182,000	-	-	-	95,000.00 /ea	190,000	221,125.41 /ea	442,251
			Channel Grinders	**2.00 EA**	**8,000**	**182,000**				**95,000.00 /EA**	**190,000**	**221,125.41 /EA**	**442,251**
			Channel Grinders	**2.00 EA**	**8,000**	**182,000**				**95,000.00 /EA**	**190,000**	**221,125.41 /EA**	**442,251**
			42" x 42" Sluice Gate										
			Sluice Gates, Rectangular, 42"										
			42" Wide Rectangular Sluice Gate - FURNISH	5.00 ea	-	32,500	-	-	-	6,500.00 /ea	32,500	15,148.80 /ea	75,744
			42" Wide Rectangular Sluice Gate - Installation	5.00 ea	10,528	-	-	-	-	2,105.60 /ea	10,528	4,759.88 /ea	23,799
			Grout Behind Gate Frame	4.19 cf	472	151	-	-	-	148.80 /cf	623	338.90 /cf	1,419
			Sluice Gate Anchor Bolts	185.00 ea	2,782	1,388	-	-	-	22.54 /ea	4,170	51.48 /ea	9,524
			Sluice Gates, Rectangular, 42"	**5.00 EA**	**13,783**	**34,038**				**9,564.22 /EA**	**47,821**	**22,097.24 /EA**	**110,486**
			42" x 42" Sluice Gate	**5.00 EA**	**13,783**	**34,038**				**9,564.22 /EA**	**47,821**	**22,097.24 /EA**	**110,486**
			36" x 36" Sluice Gate										
			Sluice Gates, Rectangular, 36"										
			36" Wide Rectangular Sluice Gate - FURNISH	2.00 ea	-	10,400	-	-	-	5,200.00 /ea	10,400	12,119.04 /ea	24,238
			36" Wide Rectangular Sluice Gate - Installation	2.00 ea	3,610	-	-	-	-	1,804.80 /ea	3,610	4,079.90 /ea	8,160
			Grout Behind Gate Frame	1.45 cf	164	52	-	-	-	148.80 /cf	216	338.90 /cf	491
			Sluice Gate Anchor Bolts	64.00 ea	963	480	-	-	-	22.54 /ea	1,443	51.48 /ea	3,295
			Sluice Gates, Rectangular, 36"	**2.00 EA**	**4,736**	**10,932**				**7,833.96 /EA**	**15,668**	**18,091.95 /EA**	**36,184**
			36" x 36" Sluice Gate	**2.00 EA**	**4,736**	**10,932**				**7,833.96 /EA**	**15,668**	**18,091.95 /EA**	**36,184**
			Odor Control										
			Cast-In-Place Concrete, Slabs on Grade, 12" thick										
			Fine grade, for slab on grade, by hand	729.00 sf	299	22	-	-	-	0.44 /sf	321	1.00 /sf	727
			Fill, gravel subbase, under building slab on grade	13.50 cy	396	398	-	-	-	58.80 /cy	794	134.99 /cy	1,822
			Concrete pumping, subcontract, all inclusive price	27.00 cy	-	-	405	-	-	15.00 /cy	405	33.91 /cy	916
			Slab on grade edge forms, 7" to 12"	112.00 sf	1,508	112	-	-	-	14.47 /sf	1,620	32.77 /sf	3,671
			Reinforcing in place, A615 Gr 60, priced per lbs.	3,510.00 lb	-	1,755	1,404	-	-	0.90 /lb	3,159	2.07 /lb	7,264
			Concrete, ready mix, 4000 psi	27.00 CY	-	3,051	-	-	-	113.00 /CY	3,051	263.36 /CY	7,111
			Add for concrete waste, 4000 psi	1.35 cy	-	153	-	-	-	113.00 /cy	153	263.36 /cy	356
			Add amount for Fuel Surcharges - per concrete truck load	3.00 load	-	45	-	-	-	15.00 /load	45	34.96 /load	105
			Add amount for Environmental Fee - per concrete truck load	3.00 load	-	18	-	-	-	6.00 /load	18	13.98 /load	42
			Placing concrete, concrete pump	27.00 cy	1,187	-	-	-	-	43.95 /cy	1,187	99.36 /cy	2,683
			Finishing floors, monolithic, trowel finish (machine)	729.00 sf	1,009	15	-	-	-	1.40 /sf	1,024	3.18 /sf	2,315

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Cast-In-Place Concrete, Slabs on Grade, 12" thick										
			Curing, water	729.00 sf	142	36	-	-	-	0.25 /sf	179	0.56 /sf	407
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	27.00 CY	4,541	5,605	1,809			442.78 /CY	11,955	1,015.47 /CY	27,418
			Odor Control Equipment										
			Furnish Scrubber equipment associated accessories	1.00 ea	0	*179,000*	-	-	0	179,000.00 /ea	179,000	417,174.42 /ea	417,174
			Install Scrubber equipment and all associated accessories	1.00 ea	4,512	25,000	-	-	-	29,512.00 /ea	29,512	68,464.33 /ea	68,464
			30" FRP shop fabricated duct - FURNISH	51.00 LF	-	3,621	-	-	-	71.00 /LF	3,621	165.47 /LF	8,439
			30" FRP shop Ell, 90	1.00 ea	-	589	-	-	-	589.00 /ea	589	1,372.71 /ea	1,373
			30" FRP shop Tee	1.00 ea	-	884	-	-	-	883.50 /ea	884	2,059.07 /ea	2,059
			30" shop weld	6.00 ea	-	1,770	-	-	-	295.00 /ea	1,770	687.52 /ea	4,125
			36" FRP shop fabricated duct - FURNISH	20.00 LF	-	1,660	-	-	-	83.00 /LF	1,660	193.44 /LF	3,869
			36" shop weld	2.00 ea	-	660	-	-	-	330.00 /ea	660	769.09 /ea	1,538
			Odor Control Equipment	1.00 EA	4,512	213,184				217,695.50 /EA	217,696	507,041.65 /EA	507,042
			Odor Control	1.00 LS	9,053	218,788	1,809			229,650.60 /LS	229,651	534,459.47 /LS	534,459
			43.05 Furnish and Install Process Equipment	1.00 LS	65,306	1,159,750	9,909		2,500	1,237,464.68 /LS	1,237,465	2,878,574.44 /LS	2,878,574
			43.0 Process Equipment - Industrial	1.00 LS	65,306	1,159,750	9,909		2,500	1,237,464.68 /LS	1,237,465	2,878,574.44 /LS	2,878,574
			005 UNION PUMP STATION	**1.00 LS**	**1,005,931**	**2,298,606**	**341,339**	**625,867**	**27,500**	**4,299,242.06 /LS**	**4,299,242**	**10,036,006.89 /LS**	**10,036,007**
006			**FORCEMAIN AND PIPE BRIDGE REPLACEMENT**										
	33.0		Utilities										
		33.05	Buried Process Piping										
			Forcemain and Pipe Bridge Replacement (Lochner)										
			Buried Pipe, Other										
			Forcemain and pipe bridge replacement cost provided by (Lochner $2.5M less 30% contingency)	1.00 ls			1,785,290	-	-	1,785,290.00 /ls	1,785,290	4,035,796.75 /ls	4,035,797
			Buried Pipe, Other	1.00 LS			1,785,290			1,785,290.00 /LS	1,785,290	4,035,796.75 /LS	4,035,797
			Forcemain and Pipe Bridge Replacement (Lochner)	1.00 LS			1,785,290			1,785,290.00 /LS	1,785,290	4,035,796.75 /LS	4,035,797
			33.05 Buried Process Piping	1.00 LS			1,785,290			1,785,290.00 /LS	1,785,290	4,035,796.75 /LS	4,035,797
			33.0 Utilities	1.00 LS			1,785,290			1,785,290.00 /LS	1,785,290	4,035,796.75 /LS	4,035,797
			006 FORCEMAIN AND PIPE BRIDGE REPLACEMENT	**1.00 LS**			**1,785,290**			**1,785,290.00 /LS**	**1,785,290**	**4,035,796.75 /LS**	**4,035,797**
007			**Submergence Chamber and 42-inch Rehabilitation**										
	33.0		Utilities										
		33.15	Buried Structures										
			Submergence Chamber and 42-inch RCP Rehabilitation										
			Pipeline Specials, Other										
			Submergence Chamber and 42" RCP Rehabilitation	1.00 ls			25,000	-	-	25,000.00 /ls	25,000	56,514.56 /ls	56,515
			Pipeline Specials, Other	1.00 LS			25,000			25,000.00 /LS	25,000	56,514.56 /LS	56,515
			Submergence Chamber and 42-inch RCP Rehabilitation	1.00 EA			25,000			25,000.00 /EA	25,000	56,514.56 /EA	56,515
			33.15 Buried Structures	1.00 EA			25,000			25,000.00 /EA	25,000	56,514.56 /EA	56,515
			33.0 Utilities	1.00 LS			25,000			25,000.00 /LS	25,000	56,514.56 /LS	56,515
			007 Submergence Chamber and 42-inch Rehabilitation	**1.00 LS**			**25,000**			**25,000.00 /LS**	**25,000**	**56,514.56 /LS**	**56,515**

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	1,005,931			7.12%
Material	2,298,606			16.27%
Subcontract	2,151,629			15.23%
Equipment	625,867			4.43%
Other	27,500			0.19%
Subtotal Raw Costs	**6,109,533**	**6,109,533**		**43.24**
Material Sales & Use Tax - %	160.902		7.000 %	1.14%
Construction Equip Tax - %	43.811		7.000 %	0.31%
Total Taxes	**204,713**	**6,314,246**		**1.45**
Existing Conditions I,OH&P	46.648		15.000 %	0.33%
Concrete Work I,OH&P	15,281		15.000 %	0.11%
Masonry Work I,OH&P	10,092		15.000 %	0.07%
Metals Work I,OH&P	3,088		15.000 %	0.02%
Architectural (Div 6-12)I,OH&P	23,679		15.000 %	0.17%
Mechanical Work I,OH&P	650		20.000 %	0.00%
Electrical Work I,OH&P	242,147		25.000 %	1.71%
Site/Civil I,OH&P	1,348		10.000 %	0.01%
Process Piping I,OH&P	63,982		18.000 %	0.45%
Instruments & Controls I,OH&P	66,242		25.000 %	0.47%
Process Equipment I,OH&P	185,620		15.000 %	1.31%
Subtotal Subcontractor I,OH&P	**1,028,928**	**7,343,174**		**7.28**
Total Cost To Prime Contractor		**7,343,174**		
General Conditions	734,317		10.000 %	5.20%
Mobilization/Demobilization	220,295		3.000 %	1.56%
Subtotal Indirect Costs	**954,612**	**8,297,786**		**6.76**
Prime Contractor Home OfficeOH	663,823		8.000 %	4.70%
Prime Contractor Profit	829,779		10.000 %	5.87%
Blder's Risk & Gen Liab Ins -%	141,283		1.000 %	1.00%
Payment & Performance Bonds	163,888		1.160 %	1.16%
Subtotal OH&P	**1,798,773**	**10,096,559**		**12.73**
Design Contingency	3,028,968		30.000 %	21.44%
Subtotal Contingency	**3,028,968**	**13,125,527**		21.44
Escal. to Midpoint Const 2020	1,002,790		7.640 %	7.10%
Subtotal Escalation	**1,002,790**	**14,128,317**		**7.10**
Total Prime Contractor Costs		**14,128,317**		

Intermediate-Term Improvements
Capacity Upgrade of Boulevard Pump Station

Facility Summary

	Project:	Boulevard Pump Station	Estimator: E.B. Smith/GNV, A. Frisch/PGH
Job Size:	Project No.:	478874	Revision / Date: Rev03, (10-4-2016)
Duration:	Design Stage:	conceptual	Estimate Class: 4

Facility	Description	Direct Amount	Grand Total w/Markups	Percent of Total
0300	**Boulevard Pump Station**	**8,205,212**	**19,095,658**	**66.664**
0305	**Dry Weather Pump Station**	**4,179,720**	**9,549,065**	**33.336**

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	8,021,852			28.00%
Material	12,429,999			43.39%
Subcontract	3,874,229			13.53%
Equipment	4,199,798			14.66%
Other	118,846			0.41%
Total Prime Contractor Costs	**28,644,724**	**28,644,724**		**100.00**

Detail Report

Job Size:
Duration:

Project: Boulevard Pump Station
Project No.: 478874
Design Stage: conceptual

Estimator: E.B. Smith/GNV, A. Frisch/PGH
Revision / Date: Rev03, (10-4-2016)
Estimate Class: 4

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
0300			**Boulevard Pump Station**											
	01.0		General Requirements											
		01.06	Startup & Commissioning											
			Startup and Testing											
			General Conditions, Other											
			Startup, Testing, and Contractor Commissioning Allowance	1.00 ls		81,998		-	28,229	-	110,227.17 /ls	110,227	235,803.65 /ls	235,804
			General Conditions, Other	1.00 LS		81,998			28,229		110,227.17 /LS	110,227	235,803.65 /LS	235,804
			Startup and Testing	**1.00 LS**		**81,998**			**28,229**		**110,227.17 /LS**	**110,227**	**235,803.65 /LS**	**235,804**
			01.06 Startup & Commissioning	1.00 LS		81,998			28,229		110,227.17 /LS	110,227	235,803.65 /LS	235,804
			01.0 General Requirements	1.00 LS		81,998			28,229		110,227.17 /LS	110,227	235,803.65 /LS	235,804
	02.0		Existing Conditions											
		02.40	Demolition											
			Selective Demolition											
			Structure/Building Demolition											
			Roofing and siding demolition, roofing, built-up, 5-ply, excluding gravel	10,918.00 sf	366.8	22,115	-	-	-	-	2.03 /sf	22,115	4.64 /sf	50,627
			Door demolition, single, remove	15.00 ea	10.1	601	-	-	-	-	40.09 /ea	601	91.78 /ea	1,377
			Demo 17 skylights	17.00 ea	91.4	5,453	-	-	-	-	320.76 /ea	5,453	734.30 /ea	12,483
			Misc. Demo allowance	5.00 Days			-	12,925	-	-	2,585.07 /Days	12,925	5,917.86 /Days	29,589
			Misc. Concrete demo	1.00 LS		10,082	*7,755*	0	-	-	17,836.94 /LS	17,837	40,833.25 /LS	40,833
			Demo Tank	1.00 Days			-	2,585	-	-	2,585.08 /Days	2,585	5,917.91 /Days	5,918
			Repair cracked concrete	1.00 LS			2,585		-	-	2,585.06 /LS	2,585	5,917.86 /LS	5,918
			Demo grating, railings and exterior metal stair	1.00 Days			-	2,585	-	-	2,585.06 /Days	2,585	5,917.84 /Days	5,918
			Remove spalling concrete and patch surfaces Allowance	1.00 LS				15,510	-	-	15,510.39 /LS	15,510	35,507.18 /LS	35,507
			Demo toilet, service sink and accessories	1.00 LS	21.5	1,440		-	-	-	1,440.11 /LS	1,440	3,296.79 /LS	3,297
			Structure/Building Demolition	1.00 SF	489.8	39,691	10,340	33,606			83,637.54 /SF	83,638	191,467.40 /SF	191,467
			Pipe Demolition											
			Miscellaneous piping demolition and disposal	1.00 ls	1,075.4	94,527		-	-	-	94,526.52 /ls	94,527	216,394.98 /ls	216,395
			Pipe Demolition	1.00 LS	1,075.4	94,527					94,526.52 /LS	94,527	216,394.98 /LS	216,395
			Process Equipment Demolition											
			Demolish existing pump and all associated works	4.00 ea	430.2	32,617		-	10,611	-	10,806.99 /ea	43,228	24,739.91 /ea	98,960
			Demolish existing grit equipment and all associated works	1.00 ea	295.7	22,424		-	3,979	-	26,403.11 /ea	26,403	60,443.37 /ea	60,443
			Demolish existing existing sluice gates and all associated works	8.00 ea	258.1	19,570		-	15,917	-	4,435.87 /ea	35,487	10,154.83 /ea	81,239
			Demolish existing grit equipment and all associated works	1.00 ea	295.7	22,424		-	3,979	-	26,403.11 /ea	26,403	60,443.37 /ea	60,443
			Process Equipment Demolition	4.00 EA	1,279.7	97,034			34,487		32,880.29 /EA	131,521	75,271.25 /EA	301,085
			Selective Demolition	**1.00 LS**	**2,844.9**	**231,252**	**10,340**	**33,606**	**34,487**		**309,685.21 /LS**	**309,685**	**708,947.40 /LS**	**708,947**
			Electrical Facility Demolition											
			Electrical Facility Demolition											
			Electrical demo, remove misc. electrical equipment, transformers, etc.	8,855.00 sf	8,927.3	730,962	-	-	-	-	82.55 /sf	730,962	188.97 /sf	1,673,356
			Electrical Facility Demolition	8,855.00 SF	8,927.3	730,962					82.55 /SF	730,962	188.97 /SF	1,673,356
			Electrical Facility Demolition	**1.00 LS**	**8,927.3**	**730,962**					**730,962.11 /LS**	**730,962**	**1,673,356.21 /LS**	**1,673,356**
			02.40 Demolition	1.00 LS	11,772.3	962,214	10,340	33,606	34,487		1,040,647.32 /LS	1,040,647	2,382,303.61 /LS	2,382,304
			02.0 Existing Conditions	1.00 LS	11,772.3	962,214	10,340	33,606	34,487		1,040,647.32 /LS	1,040,647	2,382,303.61 /LS	2,382,304
	03.0		Concrete Work											
		03.10	Cast-In-Place Concrete Work											
			Electrical Equipment Pads											
			Cast-In-Place Concrete, Equipment Pads, 10" thick											
			Edge forms, housekeeping pads, up to 6"	242.00 lf	17.2	1,290	65	-	-	-	5.60 /lf	1,355	12.82 /lf	3,102
			Concrete, ready mix, 4000 psi	6.25 CY		-	776	-	-	-	124.08 /CY	776	284.06 /CY	1,776
			Add for concrete waste, 4000 psi	0.31 cy		-	39	-	-	-	124.07 /cy	39	284.07 /cy	89
			Finish housekeeping pads	506.25 sf	27.2	1,884	16	-	-	-	3.75 /sf	1,900	8.59 /sf	4,349
			Curing, membrane spray	506.25 sf	1.4	80	21	-	-	-	0.20 /sf	101	0.46 /sf	230
			Cast-In-Place Concrete, Equipment Pads, 10" thick	6.25 CY	45.8	3,254	916				667.18 /CY	4,170	1,527.36 /CY	9,546
			Electrical Equipment Pads	**6.25 CY**	**45.8**	**3,254**	**916**				**667.18 /CY**	**4,170**	**1,527.36 /CY**	**9,546**
			Electrical Equipment Pad - Generator, Xfmrs											
			Cast-In-Place Concrete, Equipment Pads, 24" thick											
			Equipment pad forms, large	212.00 sf	71.2	5,330	329	-	-	-	26.69 /sf	5,659	61.11 /sf	12,955
			Reinforcing in place, A615 Gr 60, priced per lbs.	1,300.00 lb		-	672	538	-	-	0.93 /lb	1,210	2.13 /lb	2,769
			Concrete, ready mix, 4000 psi	10.00 CY		-	1,241	-	-	-	124.08 /CY	1,241	284.06 /CY	2,841
			Concrete, ready mix, 4000 psi	2.00 CY		-	248	-	-	-	124.08 /CY	248	284.04 /CY	568
			Concrete, ready mix, 4000 psi	5.33 CY		-	662	-	-	-	124.08 /CY	662	284.06 /CY	1,515
			Add for concrete waste, 4000 psi	0.87 cy		-	108	-	-	-	124.10 /cy	108	284.08 /cy	246
			Finishing floors, monolithic, broom finish	135.00 sf	5.4	377	3	-	-	-	2.81 /sf	380	6.44 /sf	869
			Finishing floors, monolithic, broom finish	27.00 sf	1.1	75	1	-	-	-	2.82 /sf	76	6.44 /sf	174
			Finishing floors, monolithic, broom finish	72.00 sf	2.9	201	1	-	-	-	2.81 /sf	202	6.44 /sf	464
			Patch & plug tieholes	212.00 sf	4.3	251	4	-	-	-	1.20 /sf	255	2.75 /sf	584
			Sack rub	212.00 sf	11.4	668	7	-	-	-	3.18 /sf	675	7.29 /sf	1,544
			Curing, water	234.00 sf	1.0	62	12	-	-	-	0.32 /sf	74	0.72 /sf	169

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Cast-In-Place Concrete, Equipment Pads, 24" thick	17.33 CY	97.4	6,964	3,287	538			622.54 /CY	10,789	1,425.15 /CY	24,698
			Electrical Equipment Pad - Generator, Xfmrs	**17.33 CY**	**97.4**	**6,964**	**3,287**	**538**			**622.54 /CY**	**10,789**	**1,425.15 /CY**	**24,698**
			Concrete Wall - Floodproof Wall, 8" thick											
			Cast-In-Place Concrete, Straight Walls, 8" thick											
			Concrete pumping, subcontract, all inclusive price	31.61 cy		-	-	490	-	-	15.51 /cy	490	35.51 /cy	1,122
			Forms in place, structural walls, to 8' high, hand set	2,560.00 sf	516.2	38,619	2,647	-	-	-	16.12 /sf	41,266	36.90 /sf	94,469
			Speed Dowels, #5	320.00 ea		-	4,632	-	-	-	14.48 /ea	4,632	33.14 /ea	10,605
			Reinforcing in place, A615 Gr 60, priced per lbs.	5,688.89 lb		-	2,941	2,353	-	-	0.93 /lb	5,294	2.13 /lb	12,120
			Concrete, ready mix, 4000 psi	31.61 CY		-	3,693	-	-	-	116.85 /CY	3,693	267.49 /CY	8,454
			Add for concrete waste, 4000 psi	2.00 cy		-	234	-	-	-	116.84 /cy	234	267.48 /cy	535
			Placing concrete, concrete pump, for structural wall to 12" thick	31.61 cy	36.1	2,116	-	-	-	-	66.96 /cy	2,116	153.29 /cy	4,845
			Patch & plug tieholes	2,560.00 sf	51.6	3,025	53	-	-	-	1.20 /sf	3,078	2.75 /sf	7,045
			Sack rub	2,560.00 sf	137.7	8,067	79	-	-	-	3.18 /sf	8,147	7.29 /sf	18,650
			Curing, membrane spray	2,560.00 sf	6.9	403	106	-	-	-	0.20 /sf	509	0.46 /sf	1,166
			Cast-In-Place Concrete, Straight Walls, 8" thick	31.61 CY	748.4	52,231	14,386	2,843			2,197.39 /CY	69,459	5,030.37 /CY	159,010
			Concrete Wall - Floodproof Wall, 8" thick	**31.61 CY**	**748.4**	**52,231**	**14,386**	**2,843**			**2,197.39 /CY**	**69,459**	**5,030.37 /CY**	**159,010**
			Misc. Concrete & Brick repairs											
			Concrete, Other											
			Allowance for concrete and brick repairs	1.00 LS				77,552	-	-	77,551.95 /LS	77,552	177,535.93 /LS	177,536
			Concrete, Other	1.00 CY				77,552			77,551.95 /CY	77,552	177,535.93 /CY	177,536
			Misc. Concrete & Brick repairs	**1.00 LS**				**77,552**			**77,551.95 /LS**	**77,552**	**177,535.93 /LS**	**177,536**
			03.10 Cast-In-Place Concrete Work	6.25 CY	891.7	62,448	18,589	80,933			25,915.18 /CY	161,970	59,326.37 /CY	370,790
			03.0 Concrete Work	23.58 CY	891.7	62,448	18,589	80,933			6,868.95 /CY	161,970	15,724.76 /CY	370,790
	05.0		Metals											
		05.10	Structural Steel											
			Modifications to Existing Monorail Beam											
			Metals, Structural Steel											
			Allowance to modify the existing monorail beam and all structural related works	1.00 ea				15,510	-	-	15,510.39 /ea	15,510	35,507.19 /ea	35,507
			Metals, Structural Steel	1.00 LS				15,510			15,510.39 /LS	15,510	35,507.19 /LS	35,507
			Modifications to Existing Monorail Beam	**1.00 LS**				**15,510**			**15,510.39 /LS**	**15,510**	**35,507.19 /LS**	**35,507**
			05.10 Structural Steel	1.00 LS				15,510			15,510.39 /LS	15,510	35,507.19 /LS	35,507
			05.0 Metals	1.00 LS				15,510			15,510.39 /LS	15,510	35,507.19 /LS	35,507
	06.0		Wood, Plastics and Composites											
		06.00	Wood, Plastics and Composites											
			FRP Grating											
			Wood & Plastics, FRP Fabrications, Gratings											
			Grating fbgls, molded, orange (hi crsv env), 2" sq mesh, 2" thk	2,405.00 sf	161.6	14,653	62,171	-	-	-	31.94 /sf	76,824	73.13 /sf	175,869
			Wood & Plastics, FRP Fabrications, Gratings	2,405.00 SF	161.6	14,653	62,171				31.94 /SF	76,824	73.13 /SF	175,869
			FRP Grating	**2,405.00 SF**	**161.6**	**14,653**	**62,171**				**31.94 /SF**	**76,824**	**73.13 /SF**	**175,869**
			Misc. FRP Allowance											
			Wood & Plastics, FRP Fabrications, Gratings											
			Misc. FRP Allowance	1.00 LS		6,721	10,340	-	-	-	17,061.41 /LS	17,061	39,057.84 /LS	39,058
			Wood & Plastics, FRP Fabrications, Gratings	1.00 SF		6,721	10,340				17,061.41 /SF	17,061	39,057.84 /SF	39,058
			Misc. FRP Allowance	**1.00 LS**		**6,721**	**10,340**				**17,061.41 /LS**	**17,061**	**39,057.84 /LS**	**39,058**
			06.00 Wood, Plastics and Composites	1.00 LS	161.6	21,374	72,511				93,885.39 /LS	93,885	214,927.28 /LS	214,927
			06.0 Wood, Plastics and Composites	1.00 LS	161.6	21,374	72,511				93,885.39 /LS	93,885	214,927.28 /LS	214,927
	07.0		Thermal and Moisture Protection											
		07.50	Membrane Roofing											
			Roofing											
			Thermal & Moisture Protection, Built Up Roofing											
			Roof deck insulation, perlite, 1-1/2" thick R4.17	10,918.00 sf	146.7	10,672	5,419	-	-	-	1.47 /sf	16,090	3.37 /sf	36,835
			Roof deck insulation, polyisocyanurate 2#/CF density, 2-1/2" thick R16	10,918.00 sf	117.5	8,544	11,402	-	-	-	1.83 /sf	19,946	4.18 /sf	45,661
			Built up roof, asphalt base sheet, 3-plies #15 felt, mopped w/ gravel	109.18 sq	373.5	26,791	9,314	-	6,315	-	388.54 /sq	42,421	889.46 /sq	97,111
			Coping, aluminum to .019", duranodic finish, 12" wall	638.00 lf	75.5	5,488	5,179	-	-	-	16.72 /lf	10,667	38.28 /lf	24,420
			Roof hatches	1.00 ea	5.4	393	1,551	-	-	-	1,944.29 /ea	1,944	4,450.98 /ea	4,451
			Skylight, allowance	17.00 ea		-	-	43,946	-	-	2,585.07 /ea	43,946	5,917.87 /ea	100,604
			Misc. Roofing	1.00 LS		0	0	10,340	-	-	10,340.25 /LS	10,340	23,671.43 /LS	23,671
			Drain, roof, 6"	16.00 ea	64.5	5,694	16,396	-	-	-	1,380.57 /ea	22,089	3,160.47 /ea	50,568
			Vapor Retarders, building paper, asphalt felt sheathing paper, 15#	109.18 sq	31.7	2,420	598	-	-	-	27.65 /sq	3,018	63.29 /sq	6,910
			Thermal & Moisture Protection, Built Up Roofing	10,918.00 SF	814.8	60,002	49,859	54,286	6,315		15.61 /SF	170,462	35.74 /SF	390,231
			Roofing	**1.00 LS**	**814.8**	**60,002**	**49,859**	**54,286**	**6,315**		**170,462.33 /LS**	**170,462**	**390,231.18 /LS**	**390,231**
			07.50 Membrane Roofing	1.00 LS	814.8	60,002	49,859	54,286	6,315		170,462.33 /LS	170,462	390,231.18 /LS	390,231
			07.0 Thermal and Moisture Protection	1.00 LS	814.8	60,002	49,859	54,286	6,315		170,462.33 /LS	170,462	390,231.18 /LS	390,231
	08.0		Openings											
		08.00	Openings											

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Doors											
			Openings, Doors, Frames and Hardware											
			Coml st doors, 316 SST 3'-0" x 7'-0"	2.00 ea	2.5	193	2,140	-	-	-	1,166.69 /ea	2,333	2,670.85 /ea	5,342
			Door hardware, average - H.M., wood, or aluminum	2.00 set	10.8	796	724	-	-	-	759.94 /set	1,520	1,739.70 /set	3,479
			Frames, steel, knock down, hollow metal, single, 16 ga., up to 5-3/4" deep, 7'-0" h x 3'-0" w	12.00 ea	16.1	1,230	1,923	-	-	-	262.79 /ea	3,153	601.59 /ea	7,219
			Frames, steel, knock down, hollow metal, double, 16 ga., up to 4-7/8" deep, 7'-0" h x 6'-0" w	4.00 ea	6.1	469	778	-	-	-	311.58 /ea	1,246	713.28 /ea	2,853
			Fiberglass, exterior, prehung door, 1-3/4", 3'-0" x 7'-0"	20.00 ea	28.7	2,187	9,513	-	-	-	585.00 /ea	11,700	1,339.21 /ea	26,784
			Seal around doors & louvers	1.00 ea	1.1	0	0	5,170	-	-	5,170.13 /ea	5,170	11,835.73 /ea	11,836
			Openings, Doors, Frames and Hardware	**22.00 EA**	**65.3**	**4,875**	**15,078**	**5,170**			**1,141.96 /EA**	**25,123**	**2,614.23 /EA**	**57,513**
			Doors	**22.00 EA**	**65.3**	**4,875**	**15,078**	**5,170**			**1,141.96 /EA**	**25,123**	**2,614.23 /EA**	**57,513**
			08.00 Openings	**1.00 LS**	**65.3**	**4,875**	**15,078**	**5,170**			**25,123.11 /LS**	**25,123**	**57,513.12 /LS**	**57,513**
		08.30	**Specialty Doors and Frames**											
			Access Hatch 6' x 6'											
			Specialty Doors and Frames, Access Doors											
			Doors, specialty, access, floor, industrial, aluminum, double leaf, 6' x 6', 645 lb	2.00 opng	43.0	3,899	17,868	-	-	-	10,883.71 /opng	21,767	24,915.54 /opng	49,831
			Specialty Doors and Frames, Access Doors	**2.00 EA**	**43.0**	**3,899**	**17,868**				**10,883.71 /EA**	**21,767**	**24,915.54 /EA**	**49,831**
			Access Hatch 6' x 6'	**2.00 EA**	**43.0**	**3,899**	**17,868**				**10,883.71 /EA**	**21,767**	**24,915.54 /EA**	**49,831**
			08.30 Specialty Doors and Frames	**2.00 EA**	**43.0**	**3,899**	**17,868**				**10,883.71 /EA**	**21,767**	**24,915.54 /EA**	**49,831**
			08.0 Openings	**1.00 LS**	**108.3**	**8,774**	**32,946**	**5,170**			**46,890.52 /LS**	**46,891**	**107,344.21 /LS**	**107,344**
	09.0		**Finishes**											
		09.00	**Finishes**											
			Misc. Finishes											
			Finishes, Chemical Resistant Coatings											
			Misc. Finishes Allowance	1.00 LS		33,606	25,851	-	-	-	59,456.50 /LS	59,457	136,110.86 /LS	136,111
			Finishes, Chemical Resistant Coatings	**1.00 SF**		**33,606**	**25,851**				**59,456.50 /SF**	**59,457**	**136,110.86 /SF**	**136,111**
			Misc. Finishes	**1.00 LS**		**33,606**	**25,851**				**59,456.50 /LS**	**59,457**	**136,110.86 /LS**	**136,111**
			Special Coating											
			Finishes, Chemical Resistant Coatings											
			Concrete Coating, Chemical Resistant, CRC-2	641.25 sf		-	-	13,261	-	-	20.68 /sf	13,261	47.34 /sf	30,359
			Concrete Coating, Chemical Resistant, CRC-2	27.00 sf		-	-	558	-	-	20.68 /sf	558	47.34 /sf	1,278
			Concrete Coating, Chemical Resistant, CRC-2	200.00 sf		-	-	4,136	-	-	20.68 /sf	4,136	47.34 /sf	9,469
			Finishes, Chemical Resistant Coatings	**868.25 SF**				**17,956**			**20.68 /SF**	**17,956**	**47.34 /SF**	**41,105**
			Finishes, Special Coating											
			Special Coatings, high build epoxy, 50 mil, max, pump room floors and walls	5,824.00 sf	659.3	41,153	60,222	-	-	-	17.41 /sf	101,375	39.85 /sf	232,073
			Special Coatings, high build epoxy, 50 mil, max, wetwell floor and walls	3,731.00 sf	422.3	26,364	38,580	-	-	-	17.41 /sf	64,943	39.85 /sf	148,672
			Finishes, Special Coating	**5,824.00 SF**	**1,081.6**	**67,517**	**98,801**				**28.56 /SF**	**166,318**	**65.38 /SF**	**380,745**
			Special Coating	**6,692.25 SF**	**1,081.6**	**67,517**	**98,801**	**17,956**			**27.54 /SF**	**184,274**	**63.04 /SF**	**421,850**
			09.00 Finishes		**1,081.6**	**101,123**	**124,652**	**17,956**			**/LS**	**243,731**	**/LS**	**557,961**
			09.0 Finishes	**1.00 LS**	**1,081.6**	**101,123**	**124,652**	**17,956**			**243,730.81 /LS**	**243,731**	**557,961.15 /LS**	**557,961**
	10.0		**Specialties**											
		10.00	**Specialties**											
			Toilet Accessories											
			Specialties Toilet & Bath Accessories											
			Partitions, toilet, floor mounted, headrail braced, stainless steel	1.00 ea	3.6	273	1,215	-	-	-	1,488.38 /ea	1,488	3,407.27 /ea	3,407
			Toilet tissue dispenser, surface mounted, stainless, double roll	1.00 ea	0.4	34	23	-	-	-	57.43 /ea	57	131.48 /ea	131
			Toilet Accessories, grab bars, straight, stainless steel, 24" long	1.00 ea	0.5	36	32	-	-	-	67.15 /ea	67	153.73 /ea	154
			Toilet Accessories, grab bars, straight, stainless steel, 36" long	1.00 ea	0.5	41	38	-	-	-	79.20 /ea	79	181.30 /ea	181
			Toilet Accessories, mirror, 48" x 24", with stainless steel 3/4" square frame	1.00 ea	1.1	82	157	-	-	-	239.24 /ea	239	547.69 /ea	548
			Toilet Accessories, soap dispenser, stainless steel, recessed, liquid	1.00 ea	1.1	82	172	-	-	-	253.70 /ea	254	580.79 /ea	581
			Toilet Accessories, towel dispenser, stainless steel, surface mounted	1.00 ea	0.7	51	49	-	-	-	100.37 /ea	100	229.76 /ea	230
			Toilet Accessories, waste receptacle, stainless steel, w/top, 13 gallon	1.00 ea	1.1	82	326	-	-	-	407.78 /ea	408	933.52 /ea	934
			Specialties Toilet & Bath Accessories	**8.00 EA**	**8.9**	**682**	**2,012**				**336.66 /EA**	**2,693**	**770.69 /EA**	**6,166**
			Toilet Accessories	**1.00 LS**	**8.9**	**682**	**2,012**				**2,693.25 /LS**	**2,693**	**6,165.54 /LS**	**6,166**
			10.00 Specialties	**1.00 LS**	**8.9**	**682**	**2,012**				**2,693.25 /LS**	**2,693**	**6,165.54 /LS**	**6,166**
			10.0 Specialties	**1.00 LS**	**8.9**	**682**	**2,012**				**2,693.25 /LS**	**2,693**	**6,165.54 /LS**	**6,166**
	21.0		**Fire Suppression**											
		21.00	**Fire Suppression**											
			Sprinkler System											
			Mechanical, Fire Sprinklers System											
			Sprinkler System	3,180.00 SF	1,590.0			18,085	-	-	5.69 /SF	18,085	13.30 /SF	42,306
			Mechanical, Fire Sprinklers System	**1.00 LS**	**1,590.0**			**18,085**			**18,085.12 /LS**	**18,085**	**42,305.62 /LS**	**42,306**

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Sprinkler System	**3,180.00 SF**	**1,590.0**			**18,085**			**5.69 /SF**	**18,085**	**13.30 /SF**	**42,306**
			21.00 Fire Suppression	**1.00 LS**	**1,590.0**			**18,085**			**18,085.12 /LS**	**18,085**	**42,305.62 /LS**	**42,306**
			21.0 Fire Suppression	**1.00 LS**	**1,590.0**			**18,085**			**18,085.12 /LS**	**18,085**	**42,305.62 /LS**	**42,306**
	22.0		**Plumbing**											
		22.00	**Plumbing**											
			Misc. Plumbing											
			Mechanical, Plumbing											
			Misc. Plumbing Allowance	1.00 LS		33,606		25,851	-	-	59,456.49 /LS	59,456	127,192.42 /LS	127,192
			Mechanical, Plumbing	**1.00 LS**		**33,606**		**25,851**			**59,456.49 /LS**	**59,456**	**127,192.42 /LS**	**127,192**
			Misc. Plumbing	**1.00 LS**		**33,606**		**25,851**			**59,456.49 /LS**	**59,456**	**127,192.42 /LS**	**127,192**
			Plumbing Fixtures											
			Mechanical, Plumbing											
			Water closet, tank type, vitreous china, floor mounted, close coupled, two piece, includes seat, supply pipe with stop	1.00 ea	4.1	351	238	-	-	-	588.82 /ea	589	1,259.64 /ea	1,260
			Water closet, tank type, vitreous china, floor mounted, rough-in, supply, waste and vent, one piece	1.00 ea	7.1	610	336	-	-	-	946.01 /ea	946	2,023.75 /ea	2,024
			Lavatory, vanity top, stainless steel, self-rimming, ledge, round, single bowl, 18-3/4", includes trim	1.00 ea	3.4	291	827	-	-	-	1,117.86 /ea	1,118	2,391.37 /ea	2,391
			Lavatory, vanity top, rough-in, supply, waste and vent	1.00 ea	9.4	809	225	-	-	-	1,034.29 /ea	1,034	2,212.63 /ea	2,213
			Sink, service, stainless steel, self rimming, triple bowl, 22" x 43", includes faucet and drain	1.00 ea	4.9	423	1,163	-	-	-	1,586.06 /ea	1,586	3,392.96 /ea	3,393
			Sink, service, rough-in, supply, waste and vent	1.00 ea	10.1	869	255	-	-	-	1,124.75 /ea	1,125	2,406.13 /ea	2,406
			Industrial safety fixture, eyewash station, stainless steel, pedestal mounted, unmounted, excludes rough-in	3.00 ea	16.1	1,395	862	-	-	-	752.50 /ea	2,258	1,609.79 /ea	4,829
			Mechanical, Plumbing	**1.00 LS**	**54.9**	**4,748**	**3,908**				**8,655.30 /LS**	**8,655**	**18,515.86 /LS**	**18,516**
			Plumbing Fixtures	**1.00 LS**	**54.9**	**4,748**	**3,908**				**8,655.30 /LS**	**8,655**	**18,515.86 /LS**	**18,516**
			22.00 Plumbing	**1.00 LS**	**54.9**	**38,354**	**3,908**	**25,851**			**68,111.79 /LS**	**68,112**	**145,708.28 /LS**	**145,708**
			22.0 Plumbing	**1.00 LS**	**54.9**	**38,354**	**3,908**	**25,851**			**68,111.79 /LS**	**68,112**	**145,708.28 /LS**	**145,708**
	23.0		**HVAC**											
		23.00	**HVAC**											
			HVAC Control Components/DDC Systems,											
			Mechanical, HVAC											
			Control Components/DDC Systems,	1.00 ls		-	-	-	-	25,851	25,850.65 /ls	25,851	55,301.04 /ls	55,301
			Mechanical, HVAC	**1.00 LS**						**25,851**	**25,850.65 /LS**	**25,851**	**55,301.04 /LS**	**55,301**
			HVAC Control Components/DDC Systems,	**1.00**						**25,851**	**25,850.65**	**25,851**	**55,301.04**	**55,301**
			Misc. HVAC											
			Mechanical, HVAC											
			Misc. HVAC Allowance	1.00 ls		-	-	-	-	25,851	25,850.65 /ls	25,851	55,301.05 /ls	55,301
			Mechanical, HVAC	**1.00 LS**						**25,851**	**25,850.65 /LS**	**25,851**	**55,301.05 /LS**	**55,301**
			Misc. HVAC	**1.00 LS**						**25,851**	**25,850.65 /LS**	**25,851**	**55,301.05 /LS**	**55,301**
			23.00 HVAC	**1.00 LS**						**51,701**	**51,701.30 /LS**	**51,701**	**110,602.09 /LS**	**110,602**
			23.0 HVAC	**1.00 LS**						**51,701**	**51,701.30 /LS**	**51,701**	**110,602.09 /LS**	**110,602**
	26.0		**Electrical Work**											
		26.10	**Site Electrical**											
			Site Electrical, Buried Conduit											
			Site Electrical, Buried Conduit											
			PVC Sch 40 in Trench 2"	100.00 lf	5.9	477	89	-	-	-	5.66 /lf	566	13.53 /lf	1,353
			PVC Sch 40 90 deg Ell 2"	1.00 E	0.3	27	4	-	-	-	31.22 /E	31	74.60 /E	75
			PVC Coupling 2"	3.00 E	0.2	16	3	-	-	-	6.32 /E	19	15.10 /E	45
			PVC Female Adaptor 2"	2.00 E	0.4	28	3	-	-	-	15.41 /E	31	36.82 /E	74
			PVC Coated GRC in Trench 2"	10.00 lf	1.6	130	148	-	-	-	27.82 /lf	278	66.46 /lf	665
			PVC Coated GRC Elbow 36" Radius 2"	2.00 E	2.0	163	501	-	-	-	331.87 /E	664	792.92 /E	1,586
			PVC Base Spacers < 2"	20.00 E	1.3	108	21	-	-	-	6.45 /E	129	15.42 /E	308
			Duct Bank Warning Tape	100.00 lf	3.4	271	26	-	-	-	2.97 /lf	297	7.09 /lf	709
			PVC Solvent Cement - Qt	0.40 E	0.0	0	2	-	-	-	6.28 /E	3	14.95 /E	6
			Site Electrical, Buried Conduit	**100.00 LF**	**15.1**	**1,221**	**797**				**20.18 /LF**	**2,018**	**48.20 /LF**	**4,820**
			Site Electrical, Duct Bank											
			2500 psi Duct Bank Concrete	3.70 cy	3.2	261	402	-	-	-	179.05 /cy	663	427.81 /cy	1,585
			Add Color Die for Duct Bank Concrete	3.70 cy		-	69	-	-	-	18.61 /cy	69	44.47 /cy	165
			Duct Bank Concrete Forming	200.00 sf	80.7	6,504	414	-	-	-	34.59 /sf	6,918	82.64 /sf	16,528
			Duct Bank Reinforcing Re-bar #4	400.00 lf	5.4	434	207	-	-	-	1.60 /lf	641	3.83 /lf	1,531
			Duct Bank Reinforcing Re-bar #4 (Ties)	200.00 lf	6.7	542	108	-	-	-	3.25 /lf	650	7.76 /lf	1,553
			Site Electrical, Duct Bank		**96.0**	**7,741**	**1,200**				**/CY**	**8,941**	**/CY**	**21,361**
			Site Electrical, Trenching											
			Electrical Trench Excavation - Soil Type C	37.04 cy	16.4	1,325	-	-	326	-	44.58 /cy	1,651	106.52 /cy	3,945
			Electrical Trench Bedding - Crushed Gravel	7.41 cy	5.0	402	230	-	72	-	95.00 /cy	704	226.98 /cy	1,681
			Electrical Trench Backfill - Reuse Trench Spoils	25.93 cy	9.4	759	-	-	456	-	46.87 /cy	1,215	111.99 /cy	2,903
			Electrical Trench Spoils - Waste on Site	11.11 cy	2.2	181	-	-	130	-	27.99 /cy	311	66.87 /cy	743

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Site Electrical, Trenching		**33.1**	**2,667**	**230**		**984**		**/CY**	**3,881**	**/CY**	**9,273**
			Site Electrical, Grounding											
			CU Bare Stranded #4/0	100.00 lf	6.0	488	415	-	-	-	9.03 /lf	903	21.57 /lf	2,157
			Site Electrical, Grounding		**6.0**	**488**	**415**				**/LF**	**903**	**/LF**	**2,157**
			Site Electrical, Buried Conduit	**1.00 LF**	**150.2**	**12,116**	**2,641**		**984**		**15,741.74 /LF**	**15,742**	**37,610.99 /LF**	**37,611**
			Electrical, Grounding											
			Site Electrical, Grounding											
			CU Bare Stranded #4/0	100.00 lf	6.0	488	415	-	-	-	9.03 /lf	903	21.57 /lf	2,157
			CU Bare Stranded #4/0	70.00 lf	4.2	341	290	-	-	-	9.03 /lf	632	21.57 /lf	1,510
			CU Bare Stranded #4/0	75.00 lf	4.5	366	311	-	-	-	9.03 /lf	677	21.56 /lf	1,617
			Hand Trench and Backfill, includes labor for layout	135.00 lf	36.3	2,927	-	-	-	-	21.68 /lf	2,927	51.80 /lf	6,993
			Copperclad Ground Rod 3/4" x 10'	12.00 E	12.9	1,041	396	-	-	-	119.74 /E	1,437	286.10 /E	3,433
			Compression Lug - 4/0	6.00 E	4.0	325	63	-	-	-	64.71 /E	388	154.60 /E	928
			Cadweld Cable to Rod - 250 Max	4.00 E	2.7	217	83	-	-	-	74.90 /E	300	178.95 /E	716
			Cadweld Cable to Rod - 250 Max	4.00 E	2.7	217	83	-	-	-	74.90 /E	300	178.94 /E	716
			Cadweld Cable to Rod - 250 Max	4.00 E	2.7	217	83	-	-	-	74.90 /E	300	178.95 /E	716
			Cadweld Cable to Cable - 250 Max	4.00 E	2.7	217	83	-	-	-	74.90 /E	300	178.94 /E	716
			Cadweld Cable to Cable - 250 Max	4.00 E	2.7	217	83	-	-	-	74.90 /E	300	178.95 /E	716
			Cadweld Cable to Cable - 250 Max	4.00 E	2.7	217	83	-	-	-	74.90 /E	300	178.95 /E	716
			Cadweld Cable to Steel - 250 Max	6.00 E	4.0	325	124	-	-	-	74.87 /E	449	178.89 /E	1,073
			Grounding Bolt and Nut Set	4.00 E	0.3	22	4	-	-	-	6.43 /E	26	15.37 /E	61
			Grounding Bolt and Nut Set	2.00 E	0.1	11	2	-	-	-	6.44 /E	13	15.39 /E	31
			Drill and Tap for Ground Connection	6.00 E	4.0	325	2	-	-	-	54.45 /E	327	130.08 /E	780
			Above Grade Ground Wire Supports	18.00 E	2.4	195	28	-	-	-	12.40 /E	223	29.62 /E	533
			Site Electrical, Grounding		**95.1**	**7,667**	**2,132**				**/LF**	**9,799**	**/LF**	**23,411**
			Electrical, Grounding		**95.1**	**7,667**	**2,132**				**/LS**	**9,799**	**/LS**	**23,411**
			26.10 Site Electrical	**1.00 LS**	**245.3**	**19,783**	**4,773**		**984**		**25,540.25 /LS**	**25,540**	**61,022.09 /LS**	**61,022**
		26.15	**Process Electrical**											
			Electrical, Conduit and Wire/Cable - Power											
			Process Electrical, Wire/Cable											
			THHN-THWN Copper Stranded 1/C # 12	9,180.00 lf	86.4	6,966	941	-	-	-	0.86 /lf	7,907	2.06 /lf	18,893
			THHN-THWN Copper Stranded 1/C # 12	3,060.00 lf	28.8	2,322	314	-	-	-	0.86 /lf	2,636	2.06 /lf	6,298
			THHN-THWN Copper Stranded 1/C # 8	170.00 lf	2.3	184	44	-	-	-	1.34 /lf	228	3.21 /lf	545
			THHN-THWN Copper Stranded 1/C # 2	510.00 lf	12.3	995	465	-	-	-	2.86 /lf	1,461	6.84 /lf	3,490
			THHN-THWN Copper Stranded 1/C # 2	330.00 lf	8.0	644	301	-	-	-	2.86 /lf	945	6.84 /lf	2,258
			THHN-THWN Copper Stranded 1/C # 1/0	170.00 lf	5.0	405	239	-	-	-	3.79 /lf	644	9.05 /lf	1,539
			THHN-THWN Copper Stranded 1/C # 2/0	180.00 lf	5.8	468	317	-	-	-	4.36 /lf	785	10.42 /lf	1,876
			THHN-THWN Copper Stranded 1/C # 350	510.00 lf	27.4	2,211	2,359	-	-	-	8.96 /lf	4,570	21.41 /lf	10,919
			THHN-THWN Copper Stranded 1/C # 500	1,530.00 lf	100.8	8,127	9,995	-	-	-	11.85 /lf	18,122	28.30 /lf	43,298
			XHHW Copper Stranded 1/C # 6	240.00 lf	3.9	312	143	-	-	-	1.90 /lf	455	4.53 /lf	1,087
			XHHW Copper Stranded 1/C # 1/0	1,760.00 lf	52.0	4,197	3,903	-	-	-	4.60 /lf	8,099	11.00 /lf	19,351
			XHHW Copper Stranded 1/C # 1/0	1,920.00 lf	56.8	4,578	4,257	-	-	-	4.60 /lf	8,836	11.00 /lf	21,111
			5 KV Non Shielded XLP / PVC - 1/C #350 Copper	11,040.00 lf	905.3	73,003	86,302	-	-	-	14.43 /lf	159,305	34.48 /lf	380,620
			Copper XLP 133% Insulated 15 KV #1/0 Copper	720.00 lf	46.5	3,746	4,193	-	-	-	11.03 /lf	7,939	26.35 /lf	18,969
			Stakon Lug #12 - #10	288.00 E	38.7	3,122	74	-	-	-	11.10 /E	3,197	26.52 /E	7,637
			Compression Lug - # 8	4.00 E	0.8	65	10	-	-	-	18.65 /E	75	44.56 /E	178
			Compression Lug - # 6	4.00 E	0.8	65	9	-	-	-	18.54 /E	74	44.29 /E	177
			Compression Lug - # 2	18.00 E	6.0	488	106	-	-	-	32.96 /E	593	78.76 /E	1,418
			Compression Lug - 1/0	64.00 E	30.1	2,428	420	-	-	-	44.51 /E	2,848	106.34 /E	6,806
			Compression Lug - 1/0	4.00 E	1.9	152	26	-	-	-	44.53 /E	178	106.39 /E	426
			Compression Lug - 2/0	6.00 E	3.2	260	47	-	-	-	51.14 /E	307	122.20 /E	733
			Compression Lug - 350 MCM	12.00 E	9.7	780	176	-	-	-	79.74 /E	957	190.52 /E	2,286
			Compression Lug - 500 MCM	36.00 E	33.9	2,732	765	-	-	-	97.12 /E	3,496	232.04 /E	8,353
			Motor Hook-up, 3 phase, 10 hp	36.00 E	87.1	7,024	2,113	-	-	-	253.80 /E	9,137	606.39 /E	21,830
			Equipmenmt Hook-up, 3 phase, 80A	2.00 E	10.5	846	239	-	-	-	542.39 /E	1,085	1,295.89 /E	2,592
			Motor Hook-up, 3 phase, 250 hp	3.00 E	56.5	4,553	549	-	-	-	1,700.47 /E	5,101	4,062.87 /E	12,189
			Motor Testing & Commissioning: 10HP / 480V / #12	36.00 E	33.9	2,732	-	-	-	-	75.88 /E	2,732	181.29 /E	6,527
			Equipment Testing & Commissioning: 80A / 480V / #4	2.00 E	3.0	238	-	-	-	-	119.23 /E	238	284.88 /E	570
			Motor Testing & Commissioning: 250 HP / 480v / 500	3.00 E	23.8	1,919	-	-	-	-	639.56 /E	1,919	1,528.08 /E	4,584
			600V Megger Testing	218.00 E	73.3	5,908	-	-	-	-	27.10 /E	5,908	64.75 /E	14,115
			Wire Markers	32.00 E	0.4	35	2	-	-	-	1.14 /E	36	2.72 /E	87
			Wire Markers	4.00 E	0.1	4	0	-	-	-	1.13 /E	5	2.68 /E	11
			Wire Markers	336.00 E	4.5	364	17	-	-	-	1.14 /E	381	2.71 /E	911
			Wire Markers	12.00 E	0.2	13	1	-	-	-	1.14 /E	14	2.72 /E	33
			Wire Markers	4.00 E	0.1	4	0	-	-	-	1.13 /E	5	2.69 /E	11
			Wire Markers	32.00 E	0.4	35	2	-	-	-	1.14 /E	36	2.72 /E	87
			Wire Markers	12.00 E	0.2	13	1	-	-	-	1.14 /E	14	2.72 /E	33
			Wire Markers	4.00 E	0.1	4	0	-	-	-	1.13 /E	5	2.69 /E	11
			5 KV Compression Lug - # 350	192.00 E	232.3	18,732	2,615	-	-	-	111.18 /E	21,346	265.63 /E	51,002
			15 KV Indoor Termination Kit - 1/C # 1/0	6.00 E	16.1	1,301	310	-	-	-	268.49 /E	1,611	641.49 /E	3,849
			15 KV Outdoor Termination Kit - 1/C # 1/0	6.00 E	24.2	1,951	465	-	-	-	402.75 /E	2,417	962.28 /E	5,774
			15 KV Compression Lug - # 1/0	12.00 E	8.1	650	105	-	-	-	62.97 /E	756	150.44 /E	1,805

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Process Electrical, Wire/Cable											
			5 KV Motor Connect & Test - 1000 HP	4.00 E	53.8	4,336		-	-	-	1,084.02 /E	4,336	2,589.99 /E	10,360
			5 KV Motor Conn Insulating Boot - # 350	48.00 E	225.8	18,211	7,445	-	-	-	534.51 /E	25,656	1,277.07 /E	61,299
			5 KV Megger Testing	96.00 E	129.0	10,406	-	9,927	-	-	211.80 /E	20,333	506.05 /E	48,581
			15 KV Hi-Pot Testing	6.00 E	16.1	1,301	-	620	-	-	320.19 /E	1,921	765.01 /E	4,590
			MV Cable Tags	204.00 E	27.4	2,211	211	-	-	-	11.87 /E	2,422	28.37 /E	5,788
			Process Electrical, Wire/Cable		**2,493.1**	**201,044**	**129,480**	**10,547**			**/LF**	**341,071**	**/LF**	**814,904**
			Process Electrical, Conduit											
			GRC Conduit @ Level 2 3/4"	2,700.00 lf	319.4	25,755	4,068	-	-	-	11.05 /lf	29,823	26.39 /lf	71,255
			GRC Conduit @ Level 2 1-1/4"	150.00 lf	21.6	1,740	491	-	-	-	14.87 /lf	2,230	35.53 /lf	5,329
			GRC Conduit @ Level 2 1-1/2"	200.00 lf	32.0	2,580	771	-	-	-	16.76 /lf	3,351	40.03 /lf	8,007
			GRC Conduit @ Level 2 3"	1,600.00 lf	537.7	43,360	16,623	-	-	-	37.49 /lf	59,983	89.57 /lf	143,315
			GRC Conduit @ Level 2 3"	150.00 lf	50.4	4,065	1,558	-	-	-	37.49 /lf	5,623	89.57 /lf	13,436
			GRC Conduit @ Level 2 3"	1,900.00 lf	638.5	51,490	19,740	-	-	-	37.49 /lf	71,230	89.57 /lf	170,187
			GRC Conduit @ Level 2 3"	150.00 lf	50.4	4,065	1,558	-	-	-	37.49 /lf	5,623	89.57 /lf	13,436
			GRC Elbow 3/4"	108.00 E	36.3	2,927	965	-	-	-	36.03 /E	3,892	86.09 /E	9,298
			GRC Elbow 1-1/4"	6.00 E	2.8	228	113	-	-	-	56.74 /E	340	135.55 /E	813
			GRC Elbow 1-1/2"	6.00 E	3.2	260	140	-	-	-	66.67 /E	400	159.29 /E	956
			GRC Elbow 3"	48.00 E	48.4	3,902	4,171	-	-	-	168.19 /E	8,073	401.84 /E	19,288
			GRC Elbow 3"	9.00 E	9.1	732	782	-	-	-	168.19 /E	1,514	401.85 /E	3,617
			GRC Elbow 3"	57.00 E	57.5	4,634	4,953	-	-	-	168.19 /E	9,587	401.84 /E	22,905
			GRC Elbow 3"	6.00 E	6.0	488	521	-	-	-	168.20 /E	1,009	401.87 /E	2,411
			GRC Couplng 3/4"	108.00 E	7.3	585	278	-	-	-	7.99 /E	863	19.09 /E	2,061
			GRC Couplng 1-1/4"	6.00 E	0.6	45	29	-	-	-	12.34 /E	74	29.48 /E	177
			GRC Couplng 1-1/2"	6.00 E	0.6	52	36	-	-	-	14.70 /E	88	35.11 /E	211
			GRC Couplng 3"	48.00 E	7.1	572	1,223	-	-	-	37.39 /E	1,795	89.34 /E	4,288
			GRC Couplng 3"	9.00 E	1.3	107	229	-	-	-	37.39 /E	337	89.33 /E	804
			GRC Couplng 3"	48.00 E	7.1	572	1,223	-	-	-	37.40 /E	1,795	89.35 /E	4,289
			GRC Couplng 3"	15.00 E	2.2	179	382	-	-	-	37.39 /E	561	89.33 /E	1,340
			Rigid Conduit Hub 3/4"	144.00 E	60.0	4,839	1,925	-	-	-	46.97 /E	6,764	112.23 /E	16,161
			Rigid Conduit Hub 3/4"	6.00 E	2.5	202	80	-	-	-	46.97 /E	282	112.22 /E	673
			Rigid Conduit Hub 1-1/4"	8.00 E	4.8	390	163	-	-	-	69.17 /E	553	165.26 /E	1,322
			Rigid Conduit Hub 1-1/2"	4.00 E	2.5	199	89	-	-	-	72.12 /E	288	172.31 /E	689
			Rigid Conduit Hub 3"	64.00 E	74.0	5,966	3,316	-	-	-	145.03 /E	9,282	346.52 /E	22,177
			Rigid Conduit Hub 3"	12.00 E	13.9	1,119	622	-	-	-	145.04 /E	1,740	346.53 /E	4,158
			Rigid Conduit Hub 3"	64.00 E	74.0	5,966	3,316	-	-	-	145.03 /E	9,282	346.52 /E	22,177
			Rigid Conduit Hub 3"	12.00 E	13.9	1,119	622	-	-	-	145.03 /E	1,740	346.51 /E	4,158
			Rigid Conduit Hub 3"	4.00 E	4.6	373	207	-	-	-	145.03 /E	580	346.51 /E	1,386
			Malleable LB Condulet - 3/4"	36.00 E	14.5	1,171	465	-	-	-	45.42 /E	1,635	108.53 /E	3,907
			Malleable LB Condulet - 1-1/4"	2.00 E	1.1	87	60	-	-	-	73.44 /E	147	175.46 /E	351
			Malleable LB Condulet - 3"	3.00 E	4.4	358	505	-	-	-	287.60 /E	863	687.16 /E	2,061
			Malleable TB Condulet - 1-1/2"	2.00 E	1.3	108	94	-	-	-	101.37 /E	203	242.20 /E	484
			EYS Seal Fitting 3"	16.00 E	32.3	2,602	1,711	-	-	-	269.53 /E	4,313	643.98 /E	10,304
			Unistrut Straps 3/4"	360.00 E	14.5	1,171	688	-	-	-	5.16 /E	1,858	12.33 /E	4,440
			Unistrut Straps 1-1/4"	20.00 E	1.1	87	49	-	-	-	6.78 /E	136	16.19 /E	324
			Unistrut Straps 1-1/2"	14.00 E	0.8	61	42	-	-	-	7.34 /E	103	17.52 /E	245
			Unistrut Straps 3"	112.00 E	7.5	607	440	-	-	-	9.35 /E	1,047	22.33 /E	2,501
			Unistrut Straps 3"	21.00 E	1.4	114	82	-	-	-	9.35 /E	196	22.33 /E	469
			Unistrut Straps 3"	208.00 E	14.0	1,127	817	-	-	-	9.35 /E	1,944	22.33 /E	4,645
			Unistrut Straps 3"	39.00 E	2.6	211	153	-	-	-	9.35 /E	364	22.33 /E	871
			Unistrut Straps 3"	20.00 E	1.3	108	79	-	-	-	9.35 /E	187	22.33 /E	447
			Unistrut Conduit Hanger Allowance 3/4"	360.00 E	19.4	1,561	372	-	-	-	5.37 /E	1,933	12.83 /E	4,619
			Unistrut Conduit Hanger Allowance 1-1/4"	20.00 E	1.6	130	26	-	-	-	7.80 /E	156	18.63 /E	373
			Unistrut Conduit Hanger Allowance 1-1/2"	14.00 E	1.1	91	22	-	-	-	8.05 /E	113	19.24 /E	269
			Unistrut Conduit Hanger Allowance 3"	400.00 E	53.8	4,336	827	-	-	-	12.91 /E	5,164	30.84 /E	12,337
			EF Sealtite Flex 3/4"	36.00 lf	1.5	117	92	-	-	-	5.81 /lf	209	13.87 /lf	499
			EF Sealtite Flex 1-1/4"	2.00 lf	0.1	9	11	-	-	-	9.63 /lf	19	23.01 /lf	46
			EF Sealtite Flex 1-1/2"	2.00 lf	0.1	11	12	-	-	-	11.56 /lf	23	27.59 /lf	55
			EF Sealtite Flex 3"	16.00 lf	1.9	156	290	-	-	-	27.85 /lf	446	66.55 /lf	1,065
			EF Sealtite Flex 3"	3.00 lf	0.4	29	54	-	-	-	27.85 /lf	84	66.54 /lf	200
			EF Sealtite Flex 3"	16.00 lf	1.9	156	290	-	-	-	27.85 /lf	446	66.55 /lf	1,065
			EF Sealtite Flex 3"	3.00 lf	0.4	29	54	-	-	-	27.85 /lf	84	66.53 /lf	200
			LT Flex Connector Straight 3/4"	72.00 E	8.7	702	375	-	-	-	14.97 /E	1,078	35.76 /E	2,575
			LT Flex Connector Straight 1-1/4"	4.00 E	0.6	52	53	-	-	-	26.14 /E	105	62.46 /E	250
			LT Flex Connector Straight 1-1/2"	4.00 E	0.8	61	74	-	-	-	33.74 /E	135	80.61 /E	322
			LT Flex Connector Straight 3"	32.00 E	9.5	763	5,765	-	-	-	204.02 /E	6,529	487.45 /E	15,598
			LT Flex Connector Straight 3"	6.00 E	1.8	143	1,081	-	-	-	204.02 /E	1,224	487.44 /E	2,925
			LT Flex Connector Straight 3"	32.00 E	9.5	763	5,765	-	-	-	204.02 /E	6,529	487.45 /E	15,598
			LT Flex Connector Straight 3"	6.00 E	1.8	143	1,081	-	-	-	204.01 /E	1,224	487.44 /E	2,925
			Conduit Wall Penetration - 1-1/2"	2.00 E	0.7	54	5	-	-	-	29.68 /E	59	70.92 /E	142
			Conduit Wall Penetration - 3"	16.00 E	6.5	520	83	-	-	-	37.69 /E	603	90.05 /E	1,441
			Conduit Wall Penetration - 3"	19.00 E	7.7	618	98	-	-	-	37.69 /E	716	90.04 /E	1,711
			Fireproof Conduit Wall Penetration - 1-1/2"	2.00 E	1.3	108	20	-	-	-	64.12 /E	128	153.20 /E	306
			Fireproof Conduit Wall Penetration - 3"	16.00 E	12.9	1,041	242	-	-	-	80.19 /E	1,283	191.60 /E	3,066

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Process Electrical, Conduit											
			Fireproof Conduit Wall Penetration - 3"	3.00 E	2.4	195	45	-	-	-	80.20 /E	241	191.62 /E	575
			Fireproof Conduit Wall Penetration - 3"	16.00 E	12.9	1,041	242	-	-	-	80.19 /E	1,283	191.60 /E	3,066
			Conduit Floor Penetration - 3"	16.00 E	6.5	520	83	-	-	-	37.69 /E	603	90.05 /E	1,441
			Fireproof Conduit Floor Penetration - 3"	16.00 E	6.5	520	138	-	-	-	41.15 /E	658	98.32 /E	1,573
			Process Electrical, Conduit	**6,850.00 LF**	**2,358.6**	**190,197**	**92,576**				**41.28 /LF**	**282,772**	**98.63 /LF**	**675,614**
			Electrical, Conduit and Wire/Cable - Power		**4,851.6**	**391,240**	**222,056**	**10,547**				**623,843**		**1,490,518**
			Electrical, Conduit and Wire/Cable - Controls											
			Process Electrical, Wire/Cable											
			THHN-THWN Copper Stranded 1/C # 14	5,100.00 lf	41.2	3,319	341	-	-	-	0.72 /lf	3,660	1.71 /lf	8,744
			THHN-THWN Copper Stranded 1/C # 14	1,275.00 lf	10.3	830	85	-	-	-	0.72 /lf	915	1.71 /lf	2,186
			THHN-THWN Copper Stranded 1/C # 14	377,740.00 lf	3,048.4	245,823	25,247	-	-	-	0.72 /lf	271,070	1.71 /lf	647,655
			THHN-THWN Copper Stranded 1/C # 14	1,360.00 lf	11.0	885	91	-	-	-	0.72 /lf	976	1.71 /lf	2,332
			Shielded PLTC / Inst Cable 1 Pair #16	595.00 lf	16.0	1,290	277	-	-	-	2.63 /lf	1,567	6.29 /lf	3,744
			Unshielded Twisted Pair Cable, 4-Pair CAT 6 350Mhz Ultra II	765.00 lf	18.0	1,451	309	-	-	-	2.30 /lf	1,759	5.50 /lf	4,204
			UTP Cable Connector, RJ45 CAT 6 Mini-Jack TX-5e (568A/B)	18.00 E	6.0	488	81	-	-	-	31.60 /E	569	75.50 /E	1,359
			UTP Patch Cord, RJ45/RJ45 CAT 6E 350Mhz Data-Patch - 5ft	9.00 E	0.7	59	50	-	-	-	12.03 /E	108	28.74 /E	259
			UTP Wall Plate, 4-Port, CAT 6 350Mhz, RJ45/110 (568B), White	9.00 E	3.0	244	18	-	-	-	29.06 /E	262	69.43 /E	625
			4 Pair UTP Continuity Test	9.00 E	3.0	244		-	-	-	27.10 /E	244	64.74 /E	583
			4 Pair UTP Certification with Documentation	9.00 E	7.6	615		-	-	-	68.29 /E	615	163.15 /E	1,468
			UTP Cable Supports	54.00 E	3.6	293	28	-	-	-	5.94 /E	321	14.18 /E	766
			Termination Labor Only - # 16 - #14	1,185.00 E	159.3	12,846	-	-	-	-	10.84 /E	12,846	25.90 /E	30,692
			Control Wire Testing	589.00 E	79.2	6,385	-	-	-	-	10.84 /E	6,385	25.90 /E	15,255
			Wire Markers	1,118.00 E	15.0	1,212	58	-	-	-	1.14 /E	1,269	2.71 /E	3,033
			Wire Markers	49.00 E	0.7	53	3	-	-	-	1.13 /E	56	2.71 /E	133
			Wire Markers	18.00 E	0.2	20	1	-	-	-	1.14 /E	20	2.71 /E	49
			Process Electrical, Wire/Cable	**386,835.00 LF**	**3,423.2**	**276,054**	**26,587**				**0.78 /LF**	**302,641**	**1.87 /LF**	**723,087**
			Process Electrical, Conduit											
			GRC Conduit @ Level 2 3/4"	5,625.00 lf	665.4	53,657	8,475	-	-	-	11.05 /lf	62,132	26.39 /lf	148,448
			GRC Elbow 3/4"	198.00 E	66.5	5,366	1,769	-	-	-	36.03 /E	7,134	86.09 /E	17,046
			GRC Elbow 3/4"	27.00 E	9.1	732	241	-	-	-	36.03 /E	973	86.09 /E	2,324
			GRC Couplng 3/4"	45.00 E	3.0	244	116	-	-	-	7.99 /E	359	19.09 /E	859
			GRC Couplng 3/4"	132.00 E	8.9	716	339	-	-	-	7.99 /E	1,055	19.09 /E	2,520
			GRC Couplng 3/4"	21.00 E	1.4	114	54	-	-	-	7.99 /E	168	19.09 /E	401
			GRC Couplng 3/4"	27.00 E	1.8	146	69	-	-	-	7.99 /E	216	19.09 /E	515
			Rigid Conduit Hub 3/4"	118.00 E	49.2	3,965	1,577	-	-	-	46.97 /E	5,542	112.22 /E	13,242
			Rigid Conduit Hub 3/4"	32.00 E	13.3	1,075	428	-	-	-	46.97 /E	1,503	112.23 /E	3,591
			Malleable LB Condulet - 3/4"	59.00 E	23.8	1,919	761	-	-	-	45.42 /E	2,680	108.53 /E	6,403
			Malleable LB Condulet - 3/4"	16.00 E	6.5	520	206	-	-	-	45.42 /E	727	108.53 /E	1,736
			Unistrut Straps 3/4"	150.00 E	6.0	488	286	-	-	-	5.16 /E	774	12.33 /E	1,850
			Unistrut Straps 3/4"	440.00 E	17.7	1,431	840	-	-	-	5.16 /E	2,271	12.33 /E	5,427
			Unistrut Straps 3/4"	160.00 E	6.5	520	306	-	-	-	5.16 /E	826	12.33 /E	1,973
			Unistrut Conduit Hanger Allowance 3/4"	750.00 E	40.3	3,252	776	-	-	-	5.37 /E	4,027	12.83 /E	9,622
			EF Sealtite Flex 3/4"	15.00 lf	0.6	49	38	-	-	-	5.81 /lf	87	13.89 /lf	208
			EF Sealtite Flex 3/4"	60.00 lf	2.4	195	153	-	-	-	5.81 /lf	348	13.87 /lf	832
			LT Flex Connector Straight 3/4"	30.00 E	3.6	293	156	-	-	-	14.96 /E	449	35.75 /E	1,073
			LT Flex Connector Straight 3/4"	88.00 E	10.6	859	458	-	-	-	14.97 /E	1,317	35.76 /E	3,146
			LT Flex Connector Straight 3/4"	32.00 E	3.9	312	167	-	-	-	14.96 /E	479	35.74 /E	1,144
			Process Electrical, Conduit	**5,625.00 LF**	**940.6**	**75,852**	**17,216**				**16.55 /LF**	**93,068**	**39.53 /LF**	**222,363**
			Electrical, Conduit and Wire/Cable - Controls	**1.00 LS**	**4,363.9**	**351,906**	**43,803**				**395,709.38 /LS**	**395,709**	**945,449.31 /LS**	**945,449**
			Electrical, Grounding											
			Process Electrical, Grounding											
			Miscellaneous Grounding	1.00 ls	80.7	6,504	2,585	-	-	-	9,089.08 /ls	9,089	21,716.08 /ls	21,716
			Process Electrical, Grounding	**1.00 LF**	**80.7**	**6,504**	**2,585**				**9,089.08 /LF**	**9,089**	**21,716.08 /LF**	**21,716**
			Electrical, Grounding	**1.00 LS**	**80.7**	**6,504**	**2,585**				**9,089.08 /LS**	**9,089**	**21,716.08 /LS**	**21,716**
			26.15 Process Electrical	**1.00 LS**	**9,296.1**	**749,650**	**268,444**	**10,547**			**1,028,641.61 /LS**	**1,028,642**	**2,457,683.68 /LS**	**2,457,684**
		26.20	**Facility Electrical**											
			Facility Electrical, Complete $/SF Cost											
			Facility Electrical, Complete $/SF Cost											
			PS Building, Electrical Subcontract, Division 16	8,855.00 sf		-	-	509,365	-	-	57.52 /sf	509,365	137.44 /sf	1,217,001
			Facility Electrical, Complete $/SF Cost	**8,855.00 SF**				**509,365**			**57.52 /SF**	**509,365**	**137.44 /SF**	**1,217,001**
			Facility Electrical, Complete $/SF Cost	**1.00 LS**				**509,365**			**509,365.00 /LS**	**509,365**	**1,217,001.19 /LS**	**1,217,001**
			26.20 Facility Electrical	**1.00 LS**				**509,365**			**509,365.00 /LS**	**509,365**	**1,217,001.19 /LS**	**1,217,001**
		26.25	**Electrical Equipment**											
			Electrical Equipment											
			Electrical, Testing											
			Megger/Check Elec Equipment	1.00 LS	188.2	15,176	-	-	-	-	15,176.07 /LS	15,176	36,259.43 /LS	36,259
			Electrical, Testing	**1.00 LS**	**188.2**	**15,176**					**15,176.07 /LS**	**15,176**	**36,259.43 /LS**	**36,259**
			Electrical Equipment, MCCs - General											
			LV MCC Vertical Sections - 600A	6.00 E	64.5	5,203	13,959	-	-	-	3,193.75 /E	19,163	7,630.69 /E	45,784

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Electrical Equipment, MCCs - General											
			MCC Main Lug Only - 600A	1.00 E	3.4	271	1,396	-	-	-	1,666.90 /E	1,667	3,982.65 /E	3,983
			MCC FVNR Starter w/ Circuit Breaker - Size 1	9.00 E	9.7	780	3,090	-	-	-	430.02 /E	3,870	1,027.42 /E	9,247
			MCC Circuit Breaker - <30A	29.00 E	9.7	786	6,761	-	-	-	260.22 /E	7,546	621.74 /E	18,030
			MCC Circuit Breaker - 80A	2.00 E	2.0	163	512	-	-	-	337.21 /E	674	805.67 /E	1,611
			Switchboard instruments, ground fault protection, ground return path	1.00 ea	4.0	321	6,980	-	-	-	7,300.86 /ea	7,301	17,443.60 /ea	17,444
			Voltage monitor systems, AC voltage remote, add-on det only, w/internal modem	1.00 ea		-	4,136	-	-	-	4,136.10 /ea	4,136	9,882.16 /ea	9,882
			Transformer, dry-type, ventilated, 3 phase 480 V primary 120/208 V secondary, 30 kVA	1.00 ea	2.4	193	1,525	-	-	-	1,717.84 /ea	1,718	4,104.39 /ea	4,104
			Panelboards, 3 phase 4 wire, main lugs, 120/208 V, 100 amp, 30 circuits, NQOD, incl 20 A 1 pole plug-in breakers	1.00 ea	2.0	164	1,163	-	-	-	1,326.82 /ea	1,327	3,170.10 /ea	3,170
			Electrical Equipment, MCCs - General	**1.00 LS**	**97.7**	**7,881**	**39,522**				**47,402.05 /LS**	**47,402**	**113,255.46 /LS**	**113,255**
			Electrical Equipment, Switchgear - 5 KV											
			Med Volt Swgr Section NEMA 1 1200A	4.00 E	80.7	6,504	20,681	-	-	-	6,796.14 /E	27,185	16,237.68 /E	64,951
			Med Volt Swgr Section NEMA 1 1200A	2.00 E	40.3	3,252	10,340	-	-	-	6,796.13 /E	13,592	16,237.66 /E	32,475
			Med Volt Swgr Section NEMA 1 1200A	2.00 E	40.3	3,252	10,340	-	-	-	6,796.14 /E	13,592	16,237.68 /E	32,475
			Med Volt Swgr Main Breaker 1200A	1.00 E	2.7	217	51,701	-	-	-	51,918.06 /E	51,918	124,045.32 /E	124,045
			Med Volt Swgr Main Breaker 1200A	2.00 E	5.4	434	103,403	-	-	-	51,918.11 /E	103,836	124,045.44 /E	248,091
			Med Volt Swgr Main Breaker 1200A	1.00 E	2.7	217	51,701	-	-	-	51,918.05 /E	51,918	124,045.29 /E	124,045
			Med Volt Swgr Metering	1.00 E	2.7	217		-	-	-	216.84 /E	217	518.09 /E	518
			Med Volt Swgr Feed Breaker 1200A	5.00 E	13.4	1,084	258,507	-	-	-	51,918.11 /E	259,591	124,045.44 /E	620,227
			Med Volt Swgr Metering	1.00 E	2.7	217	51,701	-	-	-	51,918.06 /E	51,918	124,045.31 /E	124,045
			Med Voltage Switchgear Breaker Calibration	6.00 E	8.1	650	310	-	-	-	160.11 /E	961	382.54 /E	2,295
			Med Voltage Switchgear Breaker Calibration	4.00 E	5.4	434	207	-	-	-	160.10 /E	640	382.53 /E	1,530
			Switchboard instruments, ground fault protection, ground return path	1.00 ea	4.0	321	6,980	-	-	-	7,300.87 /ea	7,301	17,443.60 /ea	17,444
			Voltage monitor systems, AC voltage remote, add-on det only, w/internal modem	1.00 ea		-	4,136	-	-	-	4,136.10 /ea	4,136	9,882.18 /ea	9,882
			Electrical Equipment, Switchgear - 5 KV	**19.00 EA**	**208.3**	**16,798**	**570,007**				**30,884.47 /EA**	**586,805**	**73,790.77 /EA**	**1,402,025**
			Electrical Equipment, Switchgear - 480V											
			Low Volt Swgr Section NEMA 1 1200A	4.00 E	80.7	6,504	20,681	-	-	-	6,796.14 /E	27,185	16,237.69 /E	64,951
			Low Volt Swgr Main Breaker 1200A	1.00 E	2.7	217	51,701	-	-	-	51,918.06 /E	51,918	124,045.33 /E	124,045
			Low Volt Swgr Feeder Breakers 400AF 600V	4.00 E	5.4	434	103,403	-	-	-	25,959.06 /E	103,836	62,022.72 /E	248,091
			Low Volt Swgr Metering	1.00 E	2.0	163	25,851	-	-	-	26,013.21 /E	26,013	62,152.12 /E	62,152
			Low Voltage Switchgear Breaker Calibration	5.00 E	6.7	542	259	-	-	-	160.10 /E	800	382.51 /E	1,913
			Switchboard instruments, ground fault protection, ground return path	1.00 ea	4.0	321	6,980	-	-	-	7,300.86 /ea	7,301	17,443.59 /ea	17,444
			Voltage monitor systems, AC voltage remote, add-on det only, w/internal modem	1.00 ea		-	4,136	-	-	-	4,136.11 /ea	4,136	9,882.19 /ea	9,882
			Electrical Equipment, Switchgear - 480V	**17.00 EA**	**101.4**	**8,180**	**213,009**				**13,011.15 /EA**	**221,190**	**31,086.91 /EA**	**528,477**
			Electrical Equipment, Switches - General											
			Safety switches, heavy duty, 3 pole, nonfusible, 600 volt, 30 amp, NEMA 3R	34.00 ea	117.9	9,657	5,625	-	-	-	449.49 /ea	15,282	1,073.93 /ea	36,514
			Electrical Equipment, Switches - General	**1.00 LS**	**117.9**	**9,657**	**5,625**				**15,282.48 /LS**	**15,282**	**36,513.71 /LS**	**36,514**
			Electrical Equipment, VFDs - General											
			Variable frequency drives, enclosed, 480 volt, 215 HP motor size, NEMA 1, FBO	3.00 ea	192.0	15,692	620	-	1,410	-	5,907.45 /ea	17,722	14,114.39 /ea	42,343
			Variable frequency drives, enclosed, 4160 volt, 700 HP motor size, NEMA 1, FBO	4.00 ea	384.1	31,385	827	-	1,880	-	8,522.86 /ea	34,091	20,363.26 /ea	81,453
			Electrical Equipment, VFDs - General	**1.00 LS**	**576.1**	**47,077**	**1,448**		**3,289**		**51,813.79 /LS**	**51,814**	**123,796.18 /LS**	**123,796**
			Electrical Equipment, Transformers - General											
			Transformer, liquid-filled, 5 kV primary, 480 V secondary, 3 phase, 750 kVA, pad mounted	1.00 ea	70.7	5,781	27,815	-	519	-	34,116.02 /ea	34,116	81,511.76 /ea	81,512
			Transformer, liquid-filled, 15 kV primary, 4160 V secondary, 3 phase, 3000 kVA, pad mounted	1.00 ea	141.5	11,563	67,729	-	1,039	-	80,330.18 /ea	80,330	191,929.02 /ea	191,929
			Electrical Equipment, Transformers - General	**1.00 LS**	**212.2**	**17,344**	**95,544**		**1,558**		**114,446.20 /LS**	**114,446**	**273,440.78 /LS**	**273,441**
			Electrical Equipment, Generators - General											
			Generator set,diesel, 2.75MW,incl battery,charger,enclosure,muffler,day tank,excl conduit,wiring,& concrete	1.00 ea	468.8	37,351	186,125	-	1,672	-	225,148.20 /ea	225,148	537,935.72 /ea	537,936
			Electrical Equipment, Generators - General	**1.00 LS**	**468.8**	**37,351**	**186,125**		**1,672**		**225,148.20 /LS**	**225,148**	**537,935.72 /LS**	**537,936**
			Electrical Equipment	**1.00 LS**	**1,970.8**	**159,464**	**1,111,279**		**6,520**		**1,277,263.21 /LS**	**1,277,263**	**3,051,703.27 /LS**	**3,051,703**
			26.25 Electrical Equipment	**1.00 LS**	**1,970.8**	**159,464**	**1,111,279**		**6,520**		**1,277,263.21 /LS**	**1,277,263**	**3,051,703.27 /LS**	**3,051,703**
			26.0 Electrical Work	**1.00 LS**	**11,512.2**	**928,897**	**1,384,496**	**519,912**	**7,504**		**2,840,810.07 /LS**	**2,840,810**	**6,787,410.23 /LS**	**6,787,410**
	32.0		**Exterior Improvements**											
		32.50	**Site, Improvements**											
			Site Improvements, Pipe Bollards											
			Site Improvements, Bollards											
			Pipe bollards, steel, concrete filled/paint, 8' L x 4' D hole, 12" dia	13.00 ea	34.9	2,862	4,570	-		-	571.70 /ea	7,432	1,280.18 /ea	16,642
			Site Improvements, Bollards	**13.00 EA**	**34.9**	**2,862**	**4,570**				**571.70 /EA**	**7,432**	**1,280.18 /EA**	**16,642**
			Site Improvements, Pipe Bollards	**1.00 LS**	**34.9**	**2,862**	**4,570**				**7,432.07 /LS**	**7,432**	**16,642.28 /LS**	**16,642**

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			32.50 Site, Improvements	1.00 AC	34.9	2,862	4,570				7,432.07 /AC	7,432	16,642.28 /AC	16,642
			32.0 Exterior Improvements	1.00 LS	34.9	2,862	4,570				7,432.07 /LS	7,432	16,642.28 /LS	16,642
	40.0		Process Pipe											
		40.00	Exposed Process Pipe											
			12" DI Pipe											
			Process Pipe, Ductile Iron, 12"											
			Install 12" DI, flanged, spool <= 10'	4.00 ea	29.6	2,589	-	-	-	-	647.23 /ea	2,589	1,501.07 /ea	6,004
			12" Fabricated DI Spool, FxF, 5' 0" - FURNISH	4.00 ea		-	4,273	-	-	-	1,068.15 /ea	4,273	2,477.32 /ea	9,909
			12" DI, FL, Ell, 90	4.00 ea	29.6	2,589	1,920	-	-	-	1,127.18 /ea	4,509	2,614.21 /ea	10,457
			12" DI, flanged coupling adapter	8.00 ea	55.1	4,820	2,184	-	-	-	875.50 /ea	7,004	2,030.50 /ea	16,244
			Process Pipe, Ductile Iron, 12"	5.00 LF	114.2	9,998	8,376				3,674.84 /LF	18,374	8,522.88 /LF	42,614
			12" DI Pipe	5.00 LF	114.2	9,998	8,376				3,674.84 /LF	18,374	8,522.88 /LF	42,614
			24" DI Pipe											
			Process Pipe, Ductile Iron, 24"											
			Install 24" DI, flanged, spool <= 10'	8.00 ea	128.8	11,278	-	-	-	-	1,409.78 /ea	11,278	3,269.63 /ea	26,157
			24" Fabricated DI Spool, FxF, 1' 0" - FURNISH	4.00 ea		-	7,424	-	-	-	1,856.08 /ea	7,424	4,304.71 /ea	17,219
			24" Fabricated DI Spool, FxF, 7' 0" - FURNISH	4.00 ea		-	14,319	-	-	-	3,579.80 /ea	14,319	8,302.46 /ea	33,210
			24" DI, FL, Ell, 90	8.00 ea	128.8	11,278	16,967	-	-	-	3,530.67 /ea	28,245	8,188.50 /ea	65,508
			24" DI, FL, reducer, 24" x 12"	4.00 ea	64.4	5,639	5,255	-	-	-	2,723.57 /ea	10,894	6,316.65 /ea	25,267
			24" DI, FL, base Ell, 90	4.00 ea	70.9	6,204	11,277	-	-	-	4,370.19 /ea	17,481	10,135.57 /ea	40,542
			24" DI, flanged coupling adapter	4.00 ea	60.5	5,296	2,184	-	-	-	1,869.86 /ea	7,479	4,336.69 /ea	17,347
			Pipe support	1.00 ea	5.4	471	1,176	-	-	-	1,646.39 /ea	1,646	3,818.40 /ea	3,818
			Process Pipe, Ductile Iron, 24"	32.00 LF	458.8	40,166	58,602				3,086.50 /LF	98,768	7,158.37 /LF	229,068
			24" DI Pipe	32.00 LF	458.8	40,166	58,602				3,086.50 /LF	98,768	7,158.37 /LF	229,068
			Valves											
			Gate Valves, 12"											
			Install gate valve, Flgd, DIP, 12"	4.00 ea	32.3	2,747	-	-	2,016	-	1,190.74 /ea	4,763	2,761.62 /ea	11,046
			Gate valve, iron body, dbl disk, Flgd, 250#, HWO, 12"	4.00 ea		-	5,121	-	-	-	1,280.13 /ea	5,121	2,968.94 /ea	11,876
			Gate Valves, 12"	4.00 EA	32.3	2,747	5,121		2,016		2,470.87 /EA	9,883	5,730.56 /EA	22,922
			Gate Valves, 24"											
			Install gate valve, Flgd, DIP, 24"	4.00 ea	66.7	5,677	-	-	4,166	-	2,460.85 /ea	9,843	5,707.32 /ea	22,829
			CI Valve Box & Cover, w/ Concrete Collar included	4.00 ea	16.1	1,373	620	-	1,008	-	750.45 /ea	3,002	1,740.48 /ea	6,962
			FURNISH Gate valve, iron body, solid wedge, Flgd, 250#, HWO, 24"	4.00 ea		-	127,963	-	-	-	31,990.70 /ea	127,963	74,194.49 /ea	296,778
			Gate Valves, 24"	4.00 EA	82.8	7,050	128,583		5,174		35,202.00 /EA	140,808	81,642.29 /EA	326,569
			Gate Valves, 30"											
			Install gate valve, Flgd, DIP, 30"	4.00 ea	75.3	6,410	-	-	4,704	-	2,778.41 /ea	11,114	6,443.83 /ea	25,775
			Gate valve, iron body, dbl disk, Flgd, 250#, HWO, 30"	4.00 ea		-	127,963	-	-	-	31,990.70 /ea	127,963	74,194.48 /ea	296,778
			Gate Valves, 30"	4.00 EA	75.3	6,410	127,963		4,704		34,769.11 /EA	139,076	80,638.31 /EA	322,553
			Check Valves, 12"											
			Install check valve, Flgd, DIP, 12"	4.00 ea	32.3	2,747	-	-	2,016	-	1,190.74 /ea	4,763	2,761.63 /ea	11,047
			Check valve, iron body, swing check, Flgd, 250#, 12"	4.00 ea		-	11,875	-	-	-	2,968.69 /ea	11,875	6,885.13 /ea	27,541
			Check Valves, 12"	4.00 EA	32.3	2,747	11,875		2,016		4,159.43 /EA	16,638	9,646.76 /EA	38,587
			Flow Meter, 24"											
			Install magnetic flow meter, 24"	4.00 ea	66.7	5,837	-	-	-	-	1,459.22 /ea	5,837	3,384.30 /ea	13,537
			Flow Meters 24"	4.00 ea	0.0	0	99,266	-	-	-	24,816.62 /ea	99,266	57,555.99 /ea	230,224
			Flow Meter: Electrical Hookup Only, 24"	4.00 ea	67.2	5,420	-	-	-	-	1,355.01 /ea	5,420	3,142.61 /ea	12,570
			Flow Meter, 24"	4.00 EA	133.9	11,257	99,266				27,630.85 /EA	110,523	64,082.90 /EA	256,332
			Valves	1.00 LS	356.5	30,211	372,808		13,911		416,928.99 /LS	416,929	966,963.24 /LS	966,963
			30" DI Pipe											
			Process Pipe, Ductile Iron, 30"											
			Install 30" DI, flanged, spool <= 10'	3.00 ea	60.9	5,327	-	-	-	-	1,775.73 /ea	5,327	4,118.36 /ea	12,355
			Install 30" DI, flanged, spool > 10'	4.00 ea	101.4	8,878	-	-	-	-	2,219.39 /ea	8,878	5,147.32 /ea	20,589
			30" Fabricated DI Spool, FxF, 8' 6" - FURNISH	2.00 ea		-	13,639	-	-	-	6,819.40 /ea	13,639	15,815.90 /ea	31,632
			30" Fabricated DI Spool, FxF, 9' 6" - FURNISH	1.00 ea		-	7,342	-	-	-	7,341.59 /ea	7,342	17,027.00 /ea	17,027
			30" Fabricated DI Spool, FxF, 14' 6" - FURNISH	4.00 ea		-	39,827	-	-	-	9,956.64 /ea	39,827	23,091.95 /ea	92,368
			30" DI, FL, Ell, 90	8.00 ea	162.3	14,206	29,893	-	-	-	5,512.30 /ea	44,098	12,784.42 /ea	102,275
			30" DI, FL, wye, red, 30" x 24"	4.00 ea	101.4	8,878	37,595	-	-	-	11,618.05 /ea	46,472	26,945.18 /ea	107,781
			30" DI, FL, reducer, 30" x 18"	4.00 ea	81.1	7,103	9,560	-	-	-	4,165.73 /ea	16,663	9,661.37 /ea	38,645
			Process Pipe, Ductile Iron, 30"	69.50 LF	507.1	44,391	137,854				2,622.23 /LF	182,245	6,081.62 /LF	422,673
			30" DI Pipe	69.50 LF	507.1	44,391	137,854				2,622.23 /LF	182,245	6,081.62 /LF	422,673
			18" DI Pipe											
			Process Pipe, Ductile Iron, 12"											
			18" DI, FL, reducer, 18" x 14"	4.00 ea	48.7	4,265	3,151	-	-	-	1,853.97 /ea	7,416	4,299.82 /ea	17,199
			18" DI, flanged coupling adapter	4.00 ea	45.4	3,977	1,638	-	-	-	1,403.85 /ea	5,615	3,255.87 /ea	13,023
			Process Pipe, Ductile Iron, 12"	1.00 LF	94.2	8,242	4,789				13,031.26 /LF	13,031	30,222.76 /LF	30,223
			18" DI Pipe	1.00 LS	94.2	8,242	4,789				13,031.26 /LS	13,031	30,222.76 /LS	30,223
			40.00 Exposed Process Pipe		1,530.8	133,008	582,429		13,911		/LF	729,348	/LF	1,691,541
		40.30	Water Control Gates											

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Equipment Sluice Gate											
			Sluice Gates, Rectangular, 36"											
			36" Wide Rectangular Sluice Gate Wall Thimble - FURNISH	3.00 ea		-	5,041	-	-	-	1,680.29 /ea	5,041	3,897.03 /ea	11,691
			36" Wide Rectangular Sluice Gate Wall Thimble - Installation	3.00 ea	145.2	10,917	-	-	-	-	3,639.13 /ea	10,917	8,440.05 /ea	25,320
			36" Wide Rectangular Sluice Gate - FURNISH	3.00 ea		-	16,131	-	-	-	5,376.94 /ea	16,131	12,470.47 /ea	37,411
			36" Wide Rectangular Sluice Gate - Installation	3.00 ea	96.8	7,278	-	-	-	-	2,426.08 /ea	7,278	5,626.70 /ea	16,880
			Sluice Gates, Rectangular, 36"	**3.00 EA**	**242.0**	**18,196**	**21,172**				**13,122.44 /EA**	**39,367**	**30,434.25 /EA**	**91,303**
			Sluice Gates, Rectangular, 42"											
			42" Wide Rectangular Sluice Gate Wall Thimble - FURNISH	5.00 ea		-	11,762	-	-	-	2,352.41 /ea	11,762	5,455.83 /ea	27,279
			42" Wide Rectangular Sluice Gate Wall Thimble - Installation	5.00 ea	282.3	21,228	-	-	-	-	4,245.63 /ea	21,228	9,846.67 /ea	49,233
			42" Wide Rectangular Sluice Gate - FURNISH	5.00 ea		-	33,606	-	-	-	6,721.17 /ea	33,606	15,588.08 /ea	77,940
			42" Wide Rectangular Sluice Gate - Installation	5.00 ea	188.2	14,152	-	-	-	-	2,830.42 /ea	14,152	6,564.46 /ea	32,822
			Boxout Concrete at Sluice Gate Frame Invert	26.50 lf	7.1	536	37	-	-	-	21.61 /lf	573	50.12 /lf	1,328
			Grout Boxout at Sluice Gate Frame Invert	25.18 cf	50.8	3,817	937	-	-	-	188.86 /cf	4,754	438.00 /cf	11,027
			Sluice Gates, Rectangular, 42"	**5.00 EA**	**528.4**	**39,733**	**46,342**				**17,215.06 /EA**	**86,075**	**39,926.05 /EA**	**199,630**
			Equipment Sluice Gate	**8.00 EA**	**770.3**	**57,929**	**67,514**				**15,680.33 /EA**	**125,443**	**36,366.63 /EA**	**290,933**
			40.30 Water Control Gates	**7.00 EA**	**770.3**	**57,929**	**67,514**				**17,920.37 /EA**	**125,443**	**41,561.86 /EA**	**290,933**
			40.0 Process Pipe	**1.00 LF**	**2,301.1**	**190,937**	**649,943**		**13,911**		**854,790.22 /LF**	**854,790**	**1,982,473.64 /LF**	**1,982,474**
	40.9		**Instrumentation & Controls**											
		40.90	**Instrumentation & Controls**											
			Instrumentation & Controls											
			I&C, Flow / Mag Meter / Indicators & Transmitters											
			FE - Flow Element - Mag Flowtube (inline)	4.00 ea	10.8	867	207	-	-	-	268.50 /ea	1,074	641.52 /ea	2,566
			FT / FIT - Flow Transmitter - Magnetic,	4.00 ea	67.2	5,420	74,450	-	-	-	19,967.48 /ea	79,870	47,707.34 /ea	190,829
			I&C, Flow / Mag Meter / Indicators & Transmitters	**4.00 EA**	**78.0**	**6,287**	**74,657**				**20,235.98 /EA**	**80,944**	**48,348.86 /EA**	**193,395**
			I&C, Level / Indicators & Transmitters											
			LE - Level Element / Sensor	2.00 ea	0.7	54	103	-	-	-	78.80 /ea	158	188.26 /ea	377
			LT / LIT - Level Transmitter	2.00 ea	6.0	488	2,637	-	-	-	1,562.29 /ea	3,125	3,732.70 /ea	7,465
			I&C, Level / Indicators & Transmitters	**2.00 EA**	**6.7**	**542**	**2,740**				**1,641.08 /EA**	**3,282**	**3,920.95 /EA**	**7,842**
			I&C, Pressure / Indicators & Transmitters											
			PI - Pressure Indicator - Stem Mounted	8.00 ea	5.4	434	2,688	-	-	-	390.26 /ea	3,122	932.42 /ea	7,459
			PE - Diaphragm Seal	8.00 ea	16.1	1,301	3,516	-	-	-	602.07 /ea	4,817	1,438.51 /ea	11,508
			I&C, Pressure / Indicators & Transmitters	**8.00 EA**	**21.5**	**1,734**	**6,204**				**992.33 /EA**	**7,939**	**2,370.93 /EA**	**18,967**
			I&C, Other / Switches											
			Control Stations	44.00 E	59.1	4,770	4,420	-	-	-	208.85 /E	9,189	498.99 /E	21,955
			I&C, Other / Switches	**44.00 EA**	**59.1**	**4,770**	**4,420**				**208.85 /EA**	**9,189**	**498.99 /EA**	**21,955**
			I&C, Panels & Stands											
			Instrument Stand-Single, Galv.	6.00 ea	10.1	813	310	-	-	-	187.20 /ea	1,123	447.26 /ea	2,684
			Instrument Stand-Single, Galv.	2.00 ea	3.4	271	103	-	-	-	187.18 /ea	374	447.21 /ea	894
			Instrument Stand-Single, Galv.	44.00 ea	73.9	5,962	2,275	-	-	-	187.20 /ea	8,237	447.27 /ea	19,680
			I&C, Panels & Stands	**52.00 EA**	**87.4**	**7,046**	**2,688**				**187.20 /EA**	**9,734**	**447.27 /EA**	**23,258**
			I&C, PLC, Control Panels, Network Hardware											
			Network Hardware	1.00 ls	10.8	867	5,170	-	-	-	6,037.34 /ls	6,037	14,424.72 /ls	14,425
			Ethernet Radio [Wireless] - SCADA	1.00 ea	53.8	4,336	25,851	-	-	-	30,186.73 /ea	30,187	72,123.71 /ea	72,124
			Local Control Panel, Odor Control, FBO	1.00 ea	20.2	1,626	207	-	-	-	1,832.76 /ea	1,833	4,378.93 /ea	4,379
			Local Control Panel, Sump Pump Controller, FBO	1.00 ea	20.2	1,626	207	-	-	-	1,832.85 /ea	1,833	4,379.13 /ea	4,379
			Local Control Panel, Screen Control, FBO	3.00 ea	60.5	4,878	620	-	-	-	1,832.82 /ea	5,498	4,379.08 /ea	13,137
			Local Control Panel, Generator Control, FBO	1.00 ea	20.2	1,626	207	-	-	-	1,832.85 /ea	1,833	4,379.14 /ea	4,379
			Blvd PS - PLC Cabinet	1.00 ea	53.8	4,336	31,021	-	-	-	35,356.85 /ea	35,357	84,476.40 /ea	84,476
			I&C, PLC, Control Panels, Network Hardware	**8.00 EA**	**239.3**	**19,295**	**63,282**				**10,322.23 /EA**	**82,578**	**24,662.41 /EA**	**197,299**
			I&C, Sotfware, Programming											
			SCADA Software Licenses	1.00 ea	0.0		3,619	-	-	-	3,619.09 /ea	3,619	8,646.94 /ea	8,647
			PLC / SCADA Software Development	292.00 pts	1,766.3	142,438		-	-	-	487.80 /pts	142,438	1,165.48 /pts	340,320
			I&C, Sotfware, Programming	**292.00 EA**	**1,766.3**	**142,438**	**3,619**				**500.20 /EA**	**146,057**	**1,195.09 /EA**	**348,967**
			I&C, Instrument Tubing, Piping, etc.											
			Press Gauge / Press Sw Installation Materials - Stainless	8.00 ea	28.0	2,255	1,241	-	-	-	436.95 /ea	3,496	1,043.99 /ea	8,352
			I&C, Instrument Tubing, Piping, etc.	**1.00 LF**	**28.0**	**2,255**	**1,241**				**3,495.61 /LF**	**3,496**	**8,351.88 /LF**	**8,352**
			I&C, Other											
			Receive & Store Instrument	61.00 ea	28.7	2,314	1	-	-	-	37.95 /ea	2,315	90.67 /ea	5,531
			Identification Tag - SS	6.00 ea	2.0	163	93	-	-	-	42.61 /ea	256	101.80 /ea	611
			Identification Tag - SS	2.00 ea	0.7	54	31	-	-	-	42.61 /ea	85	101.81 /ea	204
			Identification Tag - SS	8.00 ea	2.7	217	124	-	-	-	42.61 /ea	341	101.82 /ea	815
			Identification Tag - SS	1.00 ea	0.3	27	16	-	-	-	42.60 /ea	43	101.77 /ea	102
			Identification Tag - SS	44.00 ea	14.8	1,192	682	-	-	-	42.61 /ea	1,875	101.81 /ea	4,479
			Field Calibration - Simple	8.00 ea	5.4	434		-	-	-	54.20 /ea	434	129.49 /ea	1,036
			Field Calibration - Average	52.00 ea	209.7	16,910		-	-	-	325.20 /ea	16,910	776.99 /ea	40,403
			Field Calibration - Severe	1.00 ea	8.1	650		-	-	-	650.45 /ea	650	1,554.10 /ea	1,554
			Pre-Operation Check	61.00 ea	76.3	6,152		-	-	-	100.85 /ea	6,152	240.96 /ea	14,698
			Startup - Stand-By (Manhours)	60.00 ea	69.9	5,637		-	-	-	93.95 /ea	5,637	224.47 /ea	13,468

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			I&C, Other											
			Loop Check - Average	60.00 ea	139.8	11,274		-	-	-	187.90 /ea	11,274	448.93 /ea	26,936
			I&C, Other	**1.00 EA**	**558.3**	**45,024**	**947**				**45,971.24 /EA**	**45,971**	**109,836.87 /EA**	**109,837**
			Instrumentation & Controls	**1.00 LS**	**2,844.6**	**229,392**	**159,798**				**389,190.24 /LS**	**389,190**	**929,873.44 /LS**	**929,873**
			40.90 Instrumentation & Controls	**1.00 LS**	**2,844.6**	**229,392**	**159,798**				**389,190.24 /LS**	**389,190**	**929,873.44 /LS**	**929,873**
			40.9 Instrumentation & Controls	**1.00 LS**	**2,844.6**	**229,392**	**159,798**				**389,190.24 /LS**	**389,190**	**929,873.44 /LS**	**929,873**
	41.0		**Bulk Material Processing Equipment**											
		41.00	**Material Handling Equipment**											
			Monorail Crane											
			Material Handling, Monorail Cranes											
			Monorail Cranes, under hung hoist, electric operating, 7.5 ton,	1.00 ea	45.7	4,237	51,701	-	200	-	56,137.73 /ea	56,138	125,706.51 /ea	125,707
			Material Handling, Monorail Cranes	**1.00 EA**	**45.7**	**4,237**	**51,701**		**200**		**56,137.73 /EA**	**56,138**	**125,706.51 /EA**	**125,707**
			Monorail Crane	**1.00 EA**	**45.7**	**4,237**	**51,701**		**200**		**56,137.73 /EA**	**56,138**	**125,706.51 /EA**	**125,707**
			41.00 Material Handling Equipment	**1.00 LS**	**45.7**	**4,237**	**51,701**		**200**		**56,137.73 /LS**	**56,138**	**125,706.51 /LS**	**125,707**
			41.0 Bulk Material Processing Equipment	**1.00 LS**	**45.7**	**4,237**	**51,701**		**200**		**56,137.73 /LS**	**56,138**	**125,706.51 /LS**	**125,707**
	43.0		**Process Equipment - Industrial**											
		43.05	**Furnish and Install Process Equipment**											
			Odor Control											
			Cast-In-Place Concrete, Slabs on Grade, 12" thick											
			Fine grade, for slab on grade, by hand	729.00 sf	6.9	402	23	-	-	-	0.58 /sf	425	1.33 /sf	972
			Fill, gravel subbase, under building slab on grade	13.50 cy	9.1	532	412	-	-	-	69.90 /cy	944	160.01 /cy	2,160
			Concrete pumping, subcontract, all inclusive price	27.00 cy		-	-	419	-	-	15.51 /cy	419	35.51 /cy	959
			Slab on grade edge forms, 7" to 12"	112.00 sf	27.1	2,028	116	-	-	-	19.14 /sf	2,143	43.81 /sf	4,907
			Reinforcing in place, A615 Gr 60, priced per lbs.	3,510.00 lb		-	1,815	1,452	-	-	0.93 /lb	3,266	2.13 /lb	7,478
			Concrete, ready mix, 4000 psi	27.00 CY		-	3,350	-	-	-	124.08 /CY	3,350	284.06 /CY	7,670
			Add for concrete waste, 4000 psi	1.35 cy		-	168	-	-	-	124.09 /cy	168	284.08 /cy	384
			Add amount for Fuel Surcharges - per concrete truck load	3.00 load		-	47	-	-	-	15.51 /load	47	35.50 /load	106
			Add amount for Environmental Fee - per concrete truck load	3.00 load		-	19	-	-	-	6.21 /load	19	14.20 /load	43
			Placing concrete, concrete pump	27.00 cy	27.2	1,595	-	-	-	-	59.09 /cy	1,595	135.26 /cy	3,652
			Finishing floors, monolithic, trowel finish (machine)	729.00 sf	19.6	1,356	15	-	-	-	1.88 /sf	1,371	4.31 /sf	3,140
			Curing, water	729.00 sf	3.3	191	38	-	-	-	0.31 /sf	229	0.72 /sf	524
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	**27.00 CY**	**93.1**	**6,105**	**6,001**	**1,871**			**517.62 /CY**	**13,976**	**1,184.96 /CY**	**31,994**
			Odor Control Equipment											
			Furnish Scrubber equipment associated accessories	1.00 ea			***185,091***	-	-		185,090.66 /ea	185,091	423,719.10 /ea	423,719
			Install Scrubber equipment and all associated accessories	1.00 ea	80.7	6,065	25,851	-	-	-	31,915.83 /ea	31,916	73,063.40 /ea	73,063
			30" FRP shop fabricated duct - FURNISH	51.00 LF		-	3,744	-	-	-	73.42 /LF	3,744	168.07 /LF	8,571
			30" FRP shop Ell, 90	1.00 ea		-	609	-	-	-	609.04 /ea	609	1,394.23 /ea	1,394
			30" FRP shop Tee	1.00 ea		-	914	-	-	-	913.56 /ea	914	2,091.39 /ea	2,091
			30" shop weld	6.00 ea		-	1,830	-	-	-	305.04 /ea	1,830	698.31 /ea	4,190
			36" FRP shop fabricated duct - FURNISH	20.00 LF		-	1,716	-	-	-	85.82 /LF	1,716	196.47 /LF	3,929
			36" shop weld	2.00 ea		-	682	-	-	-	341.23 /ea	682	781.16 /ea	1,562
			Odor Control Equipment	**1.00 EA**	**80.7**	**6,065**	**220,437**				**226,502.47 /EA**	**226,502**	**518,521.16 /EA**	**518,521**
			Odor Control	**1.00 LS**	**173.8**	**12,170**	**226,438**	**1,871**			**240,478.14 /LS**	**240,478**	**550,514.98 /LS**	**550,515**
			43.05 Furnish and Install Process Equipment	**1.00 LS**	**173.8**	**12,170**	**226,438**	**1,871**			**240,478.14 /LS**	**240,478**	**550,514.98 /LS**	**550,515**
			43.0 Process Equipment - Industrial	**1.00 LS**	**173.8**	**12,170**	**226,438**	**1,871**			**240,478.14 /LS**	**240,478**	**550,514.98 /LS**	**550,515**
	44.0		**Process Equipment - Municipal**											
		44.05	**Furnish and Install Process Equipment**											
			Furnish & Install 700 HP Pumps											
			Vertical Centrifugal Pump: 501hp-1000hp											
			Functional Testing, Pumps, 501-1000 hp	4.00 ea	43.0	3,235	414	-	-	-	912.10 /ea	3,648	2,088.03 /ea	8,352
			Align Pump & Motor, 501-1000 hp	4.00 ea	43.0	3,235	-	5,791	-	-	2,256.33 /ea	9,025	5,165.31 /ea	20,661
			Vibration Testing, Pumps, 501-1000 hp	4.00 ea	21.5	1,617	-	2,895	-	-	1,128.17 /ea	4,513	2,582.66 /ea	10,331
			Witnessed factory test	4.00 ea		-	-	2,068	-	2,068	1,034.03 /ea	4,136	2,367.14 /ea	9,469
			Local panel	4.00 ea	32.3	2,426	6,204	-	-	-	2,157.59 /ea	8,630	4,939.27 /ea	19,757
			Pressure indicators	8.00 ea	16.1	1,213	2,068	-	-	-	410.15 /ea	3,281	938.93 /ea	7,511
			Sleeved anchor bolts - Large	40.00 ea	26.9	2,022	1,158	-	-	-	79.50 /ea	3,180	181.99 /ea	7,280
			Non-Shrink Machine Grout	48.00 cuft	61.3	4,610	3,673	-	-	-	172.55 /cuft	8,282	395.01 /cuft	18,961
			Grease, Oil, and Lube Pumps, 501-1000 hp	4.00 ea	21.5	1,617	620	-	-	-	559.45 /ea	2,238	1,280.73 /ea	5,123
			FURNISH Vertical Centrifugal Pump, 501 - 1000 hp	4.00 EA		-	1,129,156	-	-	-	282,289.11 /EA	1,129,156	646,230.81 /EA	2,584,923
			Set pump assembly, 501 - 1000 hp	4.00 ea	387.1	29,113	414	-	-	-	7,381.64 /ea	29,527	16,898.42 /ea	67,594
			Vertical Centrifugal Pump: 501hp-1000hp	**4.00 EA**	**652.8**	**49,088**	**1,143,707**	**10,754**		**2,068**	**301,404.29 /EA**	**1,205,617**	**689,990.29 /EA**	**2,759,961**
			Furnish & Install 700 HP Pumps	**4.00 EA**	**652.8**	**49,088**	**1,143,707**	**10,754**		**2,068**	**301,404.29 /EA**	**1,205,617**	**689,990.29 /EA**	**2,759,961**
			Miscellaneous Euipment											
			Process Equipment											
			Miscellaneous process equipment including, Mechanical Bar Screen, Conveyors, Washer, Grinder & compactor	2.00 ea	1,209.8	90,736	454,971	-	41,134	-	293,420.42 /ea	586,841	671,713.19 /ea	1,343,426
			Process Equipment	**1.00 EA**	**1,209.8**	**90,736**	**454,971**		**41,134**		**586,840.84 /EA**	**586,841**	**1,343,426.37 /EA**	**1,343,426**

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Miscellaneous Euipment	**1.00 LS**	**1,209.8**	**90,736**	**454,971**		**41,134**		**586,840.84 /LS**	**586,841**	**1,343,426.37 /LS**	**1,343,426**
			44.05 Furnish and Install Process Equipment	**1.00 EA**	**1,862.6**	**139,824**	**1,598,679**	**10,754**	**41,134**	**2,068**	**1,792,458.01 /EA**	**1,792,458**	**4,103,387.52 /EA**	**4,103,388**
			44.0 Process Equipment - Municipal	**1.00 LS**	**1,862.6**	**139,824**	**1,598,679**	**10,754**	**41,134**	**2,068**	**1,792,458.01 /LS**	**1,792,458**	**4,103,387.52 /LS**	**4,103,388**
			0300 Boulevard Pump Station	**1.00 LS**	**35,259.1**	**2,845,287**	**4,390,442**	**783,934**	**131,780**	**53,769**	**8,205,211.75 /LS**	**8,205,212**	**19,095,658.23 /LS**	**19,095,658**
0305			**Dry Weather Pump Station**											
	01.0		**General Requirements**											
		01.06	**Startup & Commissioning**											
			Startup and Testing											
			General Conditions, Other											
			Startup, Testing, and Contractor Commissioning Allowance	1.00 ls		39,858		-	13,286	-	53,144.34 /ls	53,144	113,689.12 /ls	113,689
			General Conditions, Other	**1.00 LS**		**39,858**			**13,286**		**53,144.34 /LS**	**53,144**	**113,689.12 /LS**	**113,689**
			Startup and Testing	**1.00 LS**		**39,858**			**13,286**		**53,144.34 /LS**	**53,144**	**113,689.12 /LS**	**113,689**
			01.06 Startup & Commissioning	**1.00 LS**		**39,858**			**13,286**		**53,144.34 /LS**	**53,144**	**113,689.12 /LS**	**113,689**
			01.0 General Requirements	**1.00 LS**		**39,858**			**13,286**		**53,144.34 /LS**	**53,144**	**113,689.12 /LS**	**113,689**
	02.0		**Existing Conditions**											
		02.40	**Demolition**											
			Demolition											
			General Site Demolition											
			Miscellaneous site demo	1.00 ls				25,550	-	-	25,550.14 /ls	25,550	58,490.70 /ls	58,491
			General Site Demolition	**1.00 LS**				**25,550**			**25,550.14 /LS**	**25,550**	**58,490.70 /LS**	**58,491**
			General Site Demolition, Aspalt Pavement											
			Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	277.78 sy	35.1	2,353	-	-	1,216	-	12.85 /sy	3,570	29.42 /sy	8,172
			load and haul pavement material for offsite disposal 15 miles	46.30 cy	6.5	434	-	-	707	-	24.64 /cy	1,141	56.40 /cy	2,611
			Dumping fees	46.30 cy				1,183	-	-	25.55 /cy	1,183	58.49 /cy	2,708
			General Site Demolition, Aspalt Pavement	**278.00 SY**	**41.6**	**2,787**		**1,183**	**1,923**		**21.20 /SY**	**5,893**	**48.53 /SY**	**13,491**
			General Site Demolition, Saw Cutting Asphalt											
			Selective demolition, saw cutting, each additional inch of depth over 3"	750.00 lf	65.2	4,562	226	-	2,206	-	9.33 /lf	6,994	21.35 /lf	16,010
			General Site Demolition, Saw Cutting Asphalt	**750.00 LF**	**65.2**	**4,562**	**226**		**2,206**		**9.33 /LF**	**6,994**	**21.35 /LF**	**16,010**
			Demolition	**1.00 LS**	**106.9**	**7,349**	**226**	**26,733**	**4,129**		**38,437.04 /LS**	**38,437**	**87,992.04 /LS**	**87,992**
			02.40 Demolition	**1.00 LS**	**106.9**	**7,349**	**226**	**26,733**	**4,129**		**38,437.04 /LS**	**38,437**	**87,992.04 /LS**	**87,992**
			02.0 Existing Conditions	**1.00 LS**	**106.9**	**7,349**	**226**	**26,733**	**4,129**		**38,437.04 /LS**	**38,437**	**87,992.04 /LS**	**87,992**
	03.0		**Concrete Work**											
		03.10	**Cast-In-Place Concrete Work**											
			36" Slab on Grade: 40' x 20' x 36" Thk											
			Cast-In-Place Concrete, Slabs on Grade, 36" thick											
			Fine grade, for slab on grade, by hand	800.00 sf	7.4	436	25	-	-	-	0.58 /sf	461	1.32 /sf	1,054
			Fill, gravel subbase, under building slab on grade	29.63 cy	19.7	1,154	893	-	-	-	69.08 /cy	2,047	158.14 /cy	4,686
			Concrete pumping, subcontract, all inclusive price	88.89 cy		-	-	1,363	-	-	15.33 /cy	1,363	35.09 /cy	3,120
			Slab on grade edge forms, > 24"	360.00 sf	119.6	8,946	460	-	-	-	26.13 /sf	9,406	59.81 /sf	21,533
			Waterstop, PVC, center bulb, 6" wide	160.00 lf	17.0	1,273	327	-	-	-	10.00 /lf	1,600	22.89 /lf	3,662
			Reinforcing in place, A615 Gr 60, priced per lbs.	14,222.22 lb		-	7,268	5,814	-	-	0.92 /lb	13,082	2.11 /lb	29,947
			Concrete, ready mix, 4000 psi	88.89 CY		-	10,901	-	-	-	122.64 /CY	10,901	280.76 /CY	24,956
			Add for concrete waste, 4000 psi	4.44 cy		-	545	-	-	-	122.64 /cy	545	280.75 /cy	1,248
			Placing concrete, concrete pump	88.89 cy	88.6	5,191	-	-	-	-	58.40 /cy	5,191	133.69 /cy	11,883
			Finishing floors, monolithic, trowel finish (machine)	800.00 sf	21.3	1,472	16	-	-	-	1.86 /sf	1,488	4.26 /sf	3,407
			Curing, membrane spray	800.00 sf	2.1	125	33	-	-	-	0.20 /sf	157	0.45 /sf	360
			Polyethelene vapor barrier, 10 mil thick	8.00 sq	2.3	173	87	-	-	-	32.47 /sq	260	74.34 /sq	595
			Cast-In-Place Concrete, Slabs on Grade, 36" thick	**88.89 CY**	**278.0**	**18,769**	**20,555**	**7,177**			**523.12 /CY**	**46,500**	**1,197.56 /CY**	**106,451**
			36" Slab on Grade: 40' x 20' x 36" Thk	**88.89 CY**	**278.0**	**18,769**	**20,555**	**7,177**			**523.12 /CY**	**46,500**	**1,197.56 /CY**	**106,451**
			12" SOG @ Valve Vault											
			Cast-In-Place Concrete, Slabs on Grade, 12" thick											
			Fine grade, for slab on grade, by hand	378.00 sf	3.5	206	12	-	-	-	0.58 /sf	217	1.32 /sf	498
			Concrete pumping, subcontract, all inclusive price	14.00 cy		-	-	215	-	-	15.33 /cy	215	35.09 /cy	491
			Slab on grade edge forms, 7" to 12"	78.00 sf	18.7	1,396	80	-	-	-	18.91 /sf	1,475	43.30 /sf	3,377
			Reinforcing in place, A615 Gr 60, priced per lbs.	1,820.00 lb		-	930	744	-	-	0.92 /lb	1,674	2.11 /lb	3,832
			Concrete, ready mix, 4000 psi	14.00 CY		-	1,717	-	-	-	122.64 /CY	1,717	280.76 /CY	3,931
			Add for concrete waste, 4000 psi	0.70 cy		-	86	-	-	-	122.64 /cy	86	280.77 /cy	197
			Add amount for Fuel Surcharges - per concrete truck load	2.00 load		-	31	-	-	-	15.34 /load	31	35.10 /load	70
			Add amount for Environmental Fee - per concrete truck load	2.00 load		-	12	-	-	-	6.13 /load	12	14.03 /load	28
			Placing concrete, concrete pump	14.00 cy	13.9	818	-	-	-	-	58.40 /cy	818	133.68 /cy	1,872
			Finishing floors, monolithic, trowel finish (machine)	378.00 sf	10.0	695	8	-	-	-	1.86 /sf	703	4.26 /sf	1,610
			Curing, water	378.00 sf	1.7	98	19	-	-	-	0.31 /sf	117	0.71 /sf	269
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	**14.00 CY**	**47.8**	**3,212**	**2,894**	**959**			**504.66 /CY**	**7,065**	**1,155.29 /CY**	**16,174**
			12" SOG @ Valve Vault	**14.00 CY**	**47.8**	**3,212**	**2,894**	**959**			**504.66 /CY**	**7,065**	**1,155.29 /CY**	**16,174**
			24" Exterior Concrete Walls: 120' L x 20' H x 24" Thk											
			Cast-In-Place Concrete, Straight Walls, 24" thick											

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Cast-In-Place Concrete, Straight Walls, 24" thick											
			Concrete pumping, subcontract, all inclusive price	177.78 cy		-	-	2,725	-	-	15.33 /cy	2,725	35.09 /cy	6,239
			Forms in place, structural walls, > 16' high, hand set	4,800.00 sf	1,084.1	81,112	6,623	-	-	-	18.28 /sf	87,735	41.84 /sf	200,847
			Waterstop, PVC, center bulb, 6" wide	240.00 lf	25.5	1,909	491	-	-	-	10.00 /lf	2,399	22.88 /lf	5,492
			Reinforcing in place, A615 Gr 60, priced per lbs.	32,000.00 lb		-	16,352	13,082	-	-	0.92 /lb	29,434	2.11 /lb	67,381
			Concrete, ready mix, 4000 psi	177.78 CY		-	21,803	-	-	-	122.64 /CY	21,803	280.76 /CY	49,912
			Add for concrete waste, 4000 psi	8.89 cy		-	1,090	-	-	-	122.64 /cy	1,090	280.76 /cy	2,496
			Placing concrete, concrete pump, for structural wall >12" - 24" thick	177.78 cy	177.1	10,382	-	-	-	-	58.40 /cy	10,382	133.69 /cy	23,767
			Patch & plug tieholes	4,800.00 sf	95.7	5,609	98	-	-	-	1.19 /sf	5,707	2.72 /sf	13,066
			Sack rub	4,800.00 sf	255.1	14,949	147	-	-	-	3.15 /sf	15,096	7.20 /sf	34,558
			Curing, membrane spray	4,800.00 sf	12.8	748	196	-	-	-	0.20 /sf	944	0.45 /sf	2,161
			Below grade damproofing, Bituminous Asphalt	2,400.00 sf		-	2,453	-	-	-	1.02 /sf	2,453	2.34 /sf	5,615
			Cast-In-Place Concrete, Straight Walls, 24" thick		**1,650.3**	**114,708**	**49,253**	**15,807**			**/CY**	**179,768**	**/CY**	**411,534**
			24" Exterior Concrete Walls: 120' L x 20' H x 24" Thk	**177.78 CY**	**1,650.3**	**114,708**	**49,253**	**15,807**			**1,011.18 /CY**	**179,768**	**2,314.85 /CY**	**411,534**
			12" Walls @ Valve Vault											
			Cast-In-Place Concrete, Straight Walls, 12" thick											
			Concrete pumping, subcontract, all inclusive price	23.70 cy		-	-	363	-	-	15.33 /cy	363	35.09 /cy	832
			Forms in place, structural walls, to 8' high, hand set	1,280.00 sf	255.1	19,084	1,308	-	-	-	15.93 /sf	20,393	36.47 /sf	46,684
			Reinforcing in place, A615 Gr 60, priced per lbs.	3,204.10 lb		-	1,637	1,310	-	-	0.92 /lb	2,947	2.11 /lb	6,747
			Concrete, ready mix, 4000 psi	23.70 CY		-	2,907	-	-	-	122.64 /CY	2,907	280.76 /CY	6,655
			Add for concrete waste, 4000 psi	1.19 cy		-	145	-	-	-	122.63 /cy	145	280.73 /cy	333
			Add amount for Fuel Surcharges - per concrete truck load	3.00 load		-	46	-	-	-	15.33 /load	46	35.10 /load	105
			Add amount for Environmental Fee - per concrete truck load	3.00 load		-	18	-	-	-	6.13 /load	18	14.05 /load	42
			Placing concrete, concrete pump, for structural wall to 12" thick	23.70 cy	26.8	1,569	-	-	-	-	66.18 /cy	1,569	151.51 /cy	3,591
			Patch & plug tieholes	1,280.00 sf	25.5	1,496	26	-	-	-	1.19 /sf	1,522	2.72 /sf	3,484
			Sack rub	1,280.00 sf	68.0	3,986	39	-	-	-	3.15 /sf	4,026	7.20 /sf	9,216
			Curing, membrane spray	1,280.00 sf	3.4	199	52	-	-	-	0.20 /sf	252	0.45 /sf	576
			Cast-In-Place Concrete, Straight Walls, 12" thick	**23.70 CY**	**378.8**	**26,335**	**6,180**	**1,673**			**1,442.53 /CY**	**34,188**	**3,302.32 /CY**	**78,265**
			12" Walls @ Valve Vault	**23.70 CY**	**378.8**	**26,335**	**6,180**	**1,673**			**1,442.53 /CY**	**34,188**	**3,302.32 /CY**	**78,265**
			12" Elevated Slab: 40' L x 20' W x 12" Thk											
			Cast-In-Place Concrete, Elevated Decks, 12" thick											
			Concrete pumping, subcontract, all inclusive price	29.63 cy		-	-	454	-	-	15.33 /cy	454	35.10 /cy	1,040
			Forms in place, elevated slab, soffit	800.00 sf	212.6	15,905	1,022	-	-	-	21.16 /sf	16,927	48.44 /sf	38,749
			Forms in place, elevated slab, edge form	120.00 sf	39.9	2,982	153	-	-	-	26.13 /sf	3,136	59.82 /sf	7,178
			Slab shoring	16,000.00 cf	148.6	11,121	818	-	-	-	0.75 /cf	11,939	1.71 /cf	27,330
			Waterstop, PVC, center bulb, 6" wide	240.00 lf	25.5	1,909	491	-	-	-	10.00 /lf	2,399	22.88 /lf	5,492
			Reinforcing in place, A615 Gr 60, priced per lbs.	6,518.52 lb		-	3,331	2,665	-	-	0.92 /lb	5,996	2.11 /lb	13,726
			Concrete, ready mix, 4000 psi	29.63 CY		-	3,634	-	-	-	122.64 /CY	3,634	280.76 /CY	8,319
			Add for concrete waste, 4000 psi	1.48 cy		-	182	-	-	-	122.64 /cy	182	280.75 /cy	416
			Placing concrete, concrete pump, for elevated slab to 12" thick	29.63 cy	19.7	1,154	-	-	-	-	38.93 /cy	1,154	89.13 /cy	2,641
			Curing, membrane spray	800.00 sf	2.1	125	33	-	-	-	0.20 /sf	157	0.45 /sf	360
			Cast-In-Place Concrete, Elevated Decks, 12" thick	**14.67 CY**	**448.4**	**33,194**	**9,663**	**3,119**			**3,134.02 /CY**	**45,976**	**7,174.57 /CY**	**105,251**
			12" Elevated Slab: 40' L x 20' W x 12" Thk	**29.63 CY**	**448.4**	**33,194**	**9,663**	**3,119**			**1,551.68 /CY**	**45,976**	**3,552.17 /CY**	**105,251**
			12" Elevated Slab @ Valve Vault											
			Cast-In-Place Concrete, Elevated Decks, 12" thick											
			Concrete pumping, subcontract, all inclusive price	14.00 cy		-	-	215	-	-	15.33 /cy	215	35.10 /cy	491
			Forms in place, elevated slab, soffit	378.00 sf	100.4	7,515	483	-	-	-	21.16 /sf	7,998	48.44 /sf	18,309
			Forms in place, elevated slab, edge form	78.00 sf	25.9	1,938	100	-	-	-	26.13 /sf	2,038	59.81 /sf	4,666
			Slab shoring	3,024.00 cf	28.1	2,102	155	-	-	-	0.75 /cf	2,256	1.71 /cf	5,165
			Reinforcing in place, A615 Gr 60, priced per lbs.	1,892.42 lb		-	967	774	-	-	0.92 /lb	1,741	2.11 /lb	3,985
			Concrete, ready mix, 4000 psi	14.00 CY		-	1,717	-	-	-	122.64 /CY	1,717	280.75 /CY	3,931
			Add for concrete waste, 4000 psi	0.70 cy		-	86	-	-	-	122.64 /cy	86	280.76 /cy	197
			Add amount for Fuel Surcharges - per concrete truck load	2.00 load		-	31	-	-	-	15.33 /load	31	35.09 /load	70
			Add amount for Environmental Fee - per concrete truck load	2.00 load		-	12	-	-	-	6.13 /load	12	14.04 /load	28
			Placing concrete, concrete pump, for elevated slab to 12" thick	14.00 cy	9.3	545	-	-	-	-	38.93 /cy	545	89.13 /cy	1,248
			Curing, membrane spray	378.00 sf	1.0	59	15	-	-	-	0.20 /sf	74	0.45 /sf	170
			Cast-In-Place Concrete, Elevated Decks, 12" thick	**14.00 CY**	**164.7**	**12,159**	**3,565**	**988**			**1,193.76 /CY**	**16,713**	**2,732.82 /CY**	**38,259**
			12" Elevated Slab @ Valve Vault	**14.00 CY**	**164.7**	**12,159**	**3,565**	**988**			**1,193.76 /CY**	**16,713**	**2,732.82 /CY**	**38,259**
			8" Baffle Wall @ Wetwell											
			Cast-In-Place Concrete, Straight Walls, 8" thick											
			Concrete pumping, subcontract, all inclusive price	3.75 cy		-	-	58	-	-	15.33 /cy	58	35.10 /cy	132
			Forms in place, structural walls, > 8' to 16' high, hand set	304.00 sf	80.8	6,044	388	-	-	-	21.16 /sf	6,432	48.44 /sf	14,725
			Reinforcing in place, A615 Gr 60, priced per lbs.	760.97 lb		-	389	311	-	-	0.92 /lb	700	2.11 /lb	1,602
			Concrete, ready mix, 4000 psi	3.75 CY		-	460	-	-	-	122.64 /CY	460	280.76 /CY	1,054
			Add for concrete waste, 4000 psi	0.19 cy		-	23	-	-	-	122.60 /cy	23	280.69 /cy	53
			Add amount for Fuel Surcharges - per concrete truck load	1.00 load		-	15	-	-	-	15.32 /load	15	35.07 /load	35
			Add amount for Environmental Fee - per concrete truck load	1.00 load		-	6	-	-	-	6.14 /load	6	14.06 /load	14
			Placing concrete, concrete pump, for structural wall to 12" thick	3.75 cy	4.2	248	-	-	-	-	66.20 /cy	248	151.54 /cy	569
			Patch & plug tieholes	304.00 sf	6.1	355	6	-	-	-	1.19 /sf	361	2.72 /sf	827
			Sack rub	304.00 sf	16.2	947	9	-	-	-	3.14 /sf	956	7.20 /sf	2,188
			Curing, membrane spray	304.00 sf	0.8	47	12	-	-	-	0.20 /sf	60	0.45 /sf	137

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Cast-In-Place Concrete, Straight Walls, 8" thick	3.75 CY	108.0	7,641	1,310	369			2,485.26 /CY	9,320	5,689.37 /CY	21,335
			8" Baffle Wall @ Wetwell	**3.75 CY**	**108.0**	**7,641**	**1,310**	**369**			**2,485.26 /CY**	**9,320**	**5,689.37 /CY**	**21,335**
			03.10 Cast-In-Place Concrete Work	351.75 CY	3,076.1	216,019	93,419	30,092			965.26 /CY	339,530	2,209.72 /CY	777,270
			03.0 Concrete Work	351.75 CY	3,076.1	216,019	93,419	30,092			965.26 /CY	339,530	2,209.72 /CY	777,270
	08.0		Openings											
		08.10	Doors and Frames											
			Access Door											
			Specialty Doors and Frames, Access Doors											
			Floor, industrial, steel 300 psf L.L., dbl leaf, 6' x 4' opening, 645#	3.00 opng	63.8	5,781	20,236	-	-	-	8,672.32 /opng	26,017	19,853.12 /opng	59,559
			Specialty Doors and Frames, Access Doors	3.00 EA	63.8	5,781	20,236				8,672.32 /EA	26,017	19,853.12 /EA	59,559
			Access Door	**1.00 EA**	**63.8**	**5,781**	**20,236**				**26,016.95 /EA**	**26,017**	**59,559.35 /EA**	**59,559**
			08.10 Doors and Frames	3.00 EA	63.8	5,781	20,236				8,672.32 /EA	26,017	19,853.12 /EA	59,559
			08.0 Openings	1.00 LS	63.8	5,781	20,236				26,016.95 /LS	26,017	59,559.35 /LS	59,559
	26.0		Electrical Work											
		26.00	Electrical											
			Electrical and I&C											
			Electrical, Other											
			Electrical and I&C allowance	1.00 ls		-	-	102,201	-	-	102,200.63 /ls	102,201	244,183.02 /ls	244,183
			Electrical, Other	1.00 LS				102,201			102,200.63 /LS	102,201	244,183.02 /LS	244,183
			I&C, Flow / Mag Meter / Indicators & Transmitters											
			FE - Flow Element - Mag Flowtube (inline)	3.00 ea	8.0	643	153	-	-	-	265.36 /ea	796	634.02 /ea	1,902
			FT / FIT - Flow Transmitter - Magnetic,	3.00 ea	49.8	4,018	55,188	-	-	-	19,735.35 /ea	59,206	47,152.71 /ea	141,458
			I&C, Flow / Mag Meter / Indicators & Transmitters	3.00 EA	57.8	4,660	55,342				20,000.71 /EA	60,002	47,786.73 /EA	143,360
			Electrical and I&C	**1.00 LS**	**57.8**	**4,660**	**55,342**	**102,201**			**162,202.76 /LS**	**162,203**	**387,543.21 /LS**	**387,543**
			26.00 Electrical	1.00 LS	57.8	4,660	55,342	102,201			162,202.76 /LS	162,203	387,543.21 /LS	387,543
			26.0 Electrical Work	1.00 LS	57.8	4,660	55,342	102,201			162,202.76 /LS	162,203	387,543.21 /LS	387,543
	31.0		Earthwork											
		31.15	Site Preparation											
			Site Preparation											
			Site Preparation, Erosion Controls / Pre-construction											
			Silt Fence, Heavy-Duty, Subcontracted	250.00 lf	4.3		-	767	-	-	3.07 /lf	767	6.87 /lf	1,716
			Erosion control, hay bales, staked, Subcontracted, Install Only	20.00 ea	1.0		-	286	-	-	14.31 /ea	286	32.04 /ea	641
			Temp Seed	1.00 ls	5.3		-	511	-	-	511.00 /ls	511	1,144.26 /ls	1,144
			Temp Mulching	1.00 ls	0.5		-	511	-	-	511.01 /ls	511	1,144.29 /ls	1,144
			Inlet Protection, Subcontracted	8.00 ea	1.2		-	2,044	-	-	255.50 /ea	2,044	572.13 /ea	4,577
			Stabilized Construction Entrance, Clean Rock, 1-1/2" thru 3"	47.41 tn	12.6	917	969	-	1,038	-	61.69 /tn	2,925	138.14 /tn	6,549
			Filter Fabric under Stabilized Construction Entrance	88.89 sy	0.2		136	-		-	1.53 /sy	136	3.43 /sy	305
			Best Management Practice (BMP) Maintenance, Labor & Material	20.00 day	265.7	15,517	-	-	-	-	775.85 /day	15,517	1,737.32 /day	34,746
			Remove erosion control and dispose offsite	1.00 ls		-	3,577	-	-	-	3,577.02 /ls	3,577	8,009.83 /ls	8,010
			Site Preparation, Erosion Controls / Pre-construction	1.00 LS	290.8	16,434	4,682	4,119	1,038		26,273.46 /LS	26,273	58,832.87 /LS	58,833
			Site Preparation	**1.00 LS**	**290.8**	**16,434**	**4,682**	**4,119**	**1,038**		**26,273.46 /LS**	**26,273**	**58,832.87 /LS**	**58,833**
			31.15 Site Preparation	1.00 LS	290.8	16,434	4,682	4,119	1,038		26,273.46 /LS	26,273	58,832.87 /LS	58,833
		31.25	Earthworks, Structural											
			Structural Excavation											
			Site Preparation, Dewatering											
			Dewatering, pumping 24 hr, 8 hrs attended, 6" centrifugal pump	120.00 day	2,550.9	183,075	-	-	7,279	-	1,586.28 /day	190,354	3,552.09 /day	426,251
			Site Preparation, Dewatering	120.00 Day	2,550.9	183,075			7,279		1,586.28 /Day	190,354	3,552.09 /Day	426,251
			Earthworks, Sheeting and Shoring											
			Shoring, soldier beams & lagging with tie-backs and walers, subcontracted	3,360.00 sf	1,176.0		-	137,358	-	-	40.88 /sf	137,358	91.54 /sf	307,578
			Earthworks, Sheeting and Shoring	3,360.00 SF	1,176.0			137,358			40.88 /SF	137,358	91.54 /SF	307,578
			Earthworks, Structural, Excavation											
			Fine grade, for slab on grade, by machine	900.00 sf	8.4	490	9	-	-	-	0.56 /sf	499	1.24 /sf	1,118
			Backfill from Select (Imported)	575.00 cy	8.5	586	8,815	-	1,072	-	18.21 /cy	10,472	40.78 /cy	23,450
			Compaction, vibratory plate, 8" lifts, common fill	575.00 cy	30.6	1,823	-	-	254	-	3.61 /cy	2,076	8.09 /cy	4,650
			Excav, Struct, common earth, hyd backhoe, 2 CY bkt	1,167.00 cy	124.0	8,635	-	-	34,914	-	37.32 /cy	43,549	83.56 /cy	97,517
			Load Excess Spoils for Off-Site Hauling, Excavator, Cat 320	1,167.00 cy	12.4	987	-	-	1,512	-	2.14 /cy	2,499	4.80 /cy	5,596
			Haul Excess Spoils Off-Site, 17 yd capacity, 50 miles RT	1,167.00 cy	149.5	10,012	-	-	15,029	-	21.46 /cy	25,041	48.05 /cy	56,073
			Excess Spoils (contaminated but not hazardous) Dump Charges for 17 yd end dumps, per cy	1,167.00 cy		-	143,122	-	-	-	122.64 /cy	143,122	274.62 /cy	320,486
			Earthworks, Structural, Excavation	1,167.00 CY	333.4	22,532	151,946		52,781		194.74 /CY	227,259	436.07 /CY	508,890
			Structural Excavation	**1,167.00 CY**	**4,060.3**	**205,607**	**151,946**	**137,358**	**60,060**		**475.55 /CY**	**554,970**	**1,064.88 /CY**	**1,242,719**
			Concrete Auger Cast Piles											
			Earthworks, Piling, Auger Cast											
			Mobilization for rig, average cost per vlf, add	600.00 vlf	6.0	461	-	-	2,884	-	5.57 /vlf	3,345	12.48 /vlf	7,489
			Uncasd drilld concrt piers,cast place augered piles,24"dm,priced using 40'lg,unless specifd otherws,excluds pile caps moblztn,casing rnfrcng	600.00 vlf	318.9	20,804	12,877	-	16,687	-	83.95 /vlf	50,368	187.98 /vlf	112,788

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Earthworks, Piling, Auger Cast											
			Cast-in place adds for drilled concrete piers, for reinforcing steel, add	14,000.00 lb		-	17,885	-	-	-	1.28 /lb	17,885	2.86 /lb	40,049
			Pile Caps	15.00 ea		6,975	7,665	-	2,989	-	1,175.31 /ea	17,630	2,631.81 /ea	39,477
			Site Prep and Test Piles	1.00 ls	159.4	10,363		-	7,972	-	18,334.75 /ls	18,335	41,056.11 /ls	41,056
			Earthworks, Piling, Auger Cast	**600.00 LF**	**484.3**	**38,603**	**38,427**		**30,532**		**179.27 /LF**	**107,563**	**401.43 /LF**	**240,859**
			Concrete Auger Cast Piles	**15.00 EA**	**484.3**	**38,603**	**38,427**		**30,532**		**7,170.83 /EA**	**107,563**	**16,057.30 /EA**	**240,859**
			31.25 Earthworks, Structural	**1,167.00 CY**	**4,544.6**	**244,211**	**190,373**	**137,358**	**90,592**		**567.72 /CY**	**662,533**	**1,271.28 /CY**	**1,483,578**
			31.0 Earthwork	**1.00 LS**	**4,835.3**	**260,645**	**195,056**	**141,476**	**91,630**		**688,806.44 /LS**	**688,806**	**1,542,410.97 /LS**	**1,542,411**
	33.0		**Utilities**											
		33.05	**Buried Process Piping**											
			Yard Piping & Structures											
			Buried Pipe, Other											
			Miscellaneous Yard Piping	1.00 ls				102,201	-	-	102,200.62 /ls	102,201	233,962.94 /ls	233,963
			Buried Pipe, Other					**102,201**			**/LS**	**102,201**	**/LS**	**233,963**
			Buried Structure, Concrete Junction Chamber											
			Allowance for concrete junction box including gates	1.00 ea				255,502	-	-	255,501.58 /ea	255,502	584,907.43 /ea	584,907
			Buried Structure, Concrete Junction Chamber					**255,502**			**/EA**	**255,502**	**/EA**	**584,907**
			Yard Piping & Structures	**1.00 LS**				**357,702**			**357,702.20 /LS**	**357,702**	**818,870.37 /LS**	**818,870**
			Utility Relocation											
			Buried Pipe, Other											
			Miscellaneous utilities relocation at foot print of Dry Weather Pump Station	1.00 ls				76,650	-	-	76,650.48 /ls	76,650	175,472.23 /ls	175,472
			Buried Pipe, Other					**76,650**			**/LS**	**76,650**	**/LS**	**175,472**
			Utility Relocation	**1.00 LS**				**76,650**			**76,650.48 /LS**	**76,650**	**175,472.23 /LS**	**175,472**
			Temporary Bypass Pumping											
			Buried Pipe Specials, Temporary Bypasses											
			Allowance for Bypass Pumping, System Operation	12.00 mon	318.9	27,580	49,056	-	1,594,330	-	139,247.15 /mon	1,670,966	318,771.76 /mon	3,825,261
			Buried Pipe Specials, Temporary Bypasses	**12.00 EA**	**318.9**	**27,580**	**49,056**		**1,594,330**		**139,247.15 /EA**	**1,670,966**	**318,771.76 /EA**	**3,825,261**
			Temporary Bypass Pumping	**12.00 MO**	**318.9**	**27,580**	**49,056**		**1,594,330**		**139,247.15 /MO**	**1,670,966**	**318,771.76 /MO**	**3,825,261**
			33.05 Buried Process Piping	**1.00 LS**	**318.9**	**27,580**	**49,056**	**434,353**	**1,594,330**		**2,105,318.43 /LS**	**2,105,318**	**4,819,603.75 /LS**	**4,819,604**
			33.0 Utilities	**1.00 LS**	**318.9**	**27,580**	**49,056**	**434,353**	**1,594,330**		**2,105,318.43 /LS**	**2,105,318**	**4,819,603.75 /LS**	**4,819,604**
	40.0		**Process Pipe**											
		40.00	**Exposed Process Pipe**											
			12" DI Pipe											
			Process Pipe, Ductile Iron, 12"											
			Install 12" DI, flanged, spool <= 10'	16.00 ea	116.9	10,235	-	-	-	-	639.70 /ea	10,235	1,483.64 /ea	23,738
			12" Fabricated DI Spool, FxF, 1' 0" - FURNISH	3.00 ea		-	1,751	-	-	-	583.57 /ea	1,751	1,353.45 /ea	4,060
			12" Fabricated DI Spool, FxF, 2' 0" - FURNISH	3.00 ea		-	2,103	-	-	-	701.09 /ea	2,103	1,626.01 /ea	4,878
			12" Fabricated DI Spool, FxF, 3' 0" - FURNISH	4.00 ea		-	3,270	-	-	-	817.61 /ea	3,270	1,896.24 /ea	7,585
			12" Fabricated DI Spool, FxF, 3' 6" - FURNISH	3.00 ea		-	2,628	-	-	-	875.86 /ea	2,628	2,031.34 /ea	6,094
			12" Fabricated DI Spool, FxF, 8' 0" - FURNISH	3.00 ea		-	4,219	-	-	-	1,406.28 /ea	4,219	3,261.51 /ea	9,785
			12" DI, FL, Ell, 90	7.00 ea	51.2	4,478	3,321	-	-	-	1,114.08 /ea	7,799	2,583.83 /ea	18,087
			12" DI, FL, tee, 12" x 12"	1.00 ea	9.1	800	757	-	-	-	1,557.28 /ea	1,557	3,611.71 /ea	3,612
			12" DI, flanged coupling adapter	3.00 ea	20.4	1,787	809	-	-	-	865.33 /ea	2,596	2,006.93 /ea	6,021
			Process Pipe, Ductile Iron, 12"	**55.50 LF**	**197.6**	**17,300**	**18,858**				**651.49 /LF**	**36,158**	**1,510.98 /LF**	**83,859**
			12" DI Pipe	**55.50 LF**	**197.6**	**17,300**	**18,858**				**651.49 /LF**	**36,158**	**1,510.98 /LF**	**83,859**
			24" DI Pipe											
			Process Pipe, Ductile Iron, 24"											
			Install 24" DI, flanged, spool <= 10'	2.00 ea	31.8	2,787	-	-	-	-	1,393.36 /ea	2,787	3,231.55 /ea	6,463
			24" Fabricated DI Spool, FxF, 2' 0" - FURNISH	1.00 ea		-	2,117	-	-	-	2,116.57 /ea	2,117	4,908.86 /ea	4,909
			24" Fabricated DI Spool, FxF, 3' 0" - FURNISH	1.00 ea		-	2,404	-	-	-	2,403.76 /ea	2,404	5,574.91 /ea	5,575
			24" DI, FL, tee, red, 24" x 12"	1.00 ea	19.9	1,742	1,996	-	-	-	3,738.24 /ea	3,738	8,669.95 /ea	8,670
			24" DI, FL, reducer, 24" x 12"	1.00 ea	15.9	1,393	1,299	-	-	-	2,691.83 /ea	2,692	6,243.03 /ea	6,243
			Process Pipe, Ductile Iron, 24"	**5.00 LF**	**67.7**	**5,922**	**7,815**				**2,747.42 /LF**	**13,737**	**6,371.97 /LF**	**31,860**
			24" DI Pipe	**5.00 LF**	**67.7**	**5,922**	**7,815**				**2,747.42 /LF**	**13,737**	**6,371.97 /LF**	**31,860**
			48" DI Pipe											
			Process Pipe, Ductile Iron, 48"											
			Install 48" DI, flanged, spool <= 10'	1.00 ea	33.0	2,890	-	-	-	-	2,890.29 /ea	2,890	6,703.30 /ea	6,703
			48" Fabricated DI Spool, FxF, 2' 0" - FURNISH	1.00 ea		-	9,174	-	-	-	9,173.54 /ea	9,174	21,275.73 /ea	21,276
			Process Pipe, Ductile Iron, 48"	**2.00 LF**	**33.0**	**2,890**	**9,174**				**6,031.92 /LF**	**12,064**	**13,989.52 /LF**	**27,979**
			48" DI Pipe	**2.00 LF**	**33.0**	**2,890**	**9,174**				**6,031.92 /LF**	**12,064**	**13,989.52 /LF**	**27,979**
			Valves											
			Gate Valves, 12"											
			Install gate valve, Flgd, DIP, 12"	3.00 ea	23.9	2,036	-	-	1,494	-	1,176.87 /ea	3,531	2,729.47 /ea	8,188
			Install gate valve, MJ, 12"	1.00 ea	5.6	475	-	-	349	-	823.93 /ea	824	1,910.89 /ea	1,911
			Gate valve, iron body, dbl disk, Flgd, 250#, HWO, 12"	3.00 ea		-	3,796	-	-	-	1,265.24 /ea	3,796	2,934.41 /ea	8,803
			Gate valve, iron body, dbl disk, MJ, 250#, NO, 12"	1.00 ea		-	1,265	-	-	-	1,265.25 /ea	1,265	2,934.43 /ea	2,934

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Gate Valves, 12"											
			CI Valve Box & Cover, w/ Concrete Collar included	1.00 ea	4.0	339	153	-	249	-	741.79 /ea	742	1,720.39 /ea	1,720
			Gate Valves, 12"	**4.00 EA**	**33.5**	**2,851**	**5,214**		**2,092**		**2,539.33 /EA**	**10,157**	**5,889.34 /EA**	**23,557**
			Check Valves, 12"											
			Install check valve, Flgd, DIP, 12"	3.00 ea	23.9	2,036	-	-	1,494	-	1,176.87 /ea	3,531	2,729.45 /ea	8,188
			Check valve, iron body, swing check, Flgd, 250#, 12"	3.00 ea		-	8,803	-	-	-	2,934.18 /ea	8,803	6,805.11 /ea	20,415
			Check Valves, 12"	**3.00 EA**	**23.9**	**2,036**	**8,803**		**1,494**		**4,111.05 /EA**	**12,333**	**9,534.56 /EA**	**28,604**
			Valves	**1.00 LS**	**57.4**	**4,887**	**14,017**		**3,587**		**22,490.45 /LS**	**22,490**	**52,161.03 /LS**	**52,161**
			Miscellaneous Piping											
			Process Pipe, Other											
			Miscellaneous Piping	1.00 ls				76,650	-	-	76,650.47 /ls	76,650	177,771.73 /ls	177,772
			Process Pipe, Other	**1.00 LS**				**76,650**			**76,650.47 /LS**	**76,650**	**177,771.73 /LS**	**177,772**
			Miscellaneous Piping	**1.00 LS**				**76,650**			**76,650.47 /LS**	**76,650**	**177,771.73 /LS**	**177,772**
			Odor Control											
			FRP Duct, Round, 30"											
			Allowance for Odor control	1.00 ls				66,430	-	-	66,430.41 /ls	66,430	154,068.83 /ls	154,069
			FRP Duct, Round, 30"	**150.00 LF**				**66,430**			**442.87 /LF**	**66,430**	**1,027.13 /LF**	**154,069**
			Odor Control	**1.00 LS**				**66,430**			**66,430.41 /LS**	**66,430**	**154,068.83 /LS**	**154,069**
			40.00 Exposed Process Pipe	**62.50 LF**	**355.7**	**30,999**	**49,863**	**143,081**	**3,587**		**3,640.48 /LF**	**227,530**	**8,443.20 /LF**	**527,700**
			40.0 Process Pipe	**62.50 LF**	**355.7**	**30,999**	**49,863**	**143,081**	**3,587**		**3,640.48 /LF**	**227,530**	**8,443.20 /LF**	**527,700**
	44.0		**Process Equipment - Municipal**											
		44.05	**Furnish and Install Process Equipment**											
			Furnish & Install 215 HP Pumps											
			Submersible Pump: 51hp-100hp											
			Functional Testing, Pumps, 101-500 hp	3.00 ea	15.9	1,199	307	-	-	-	501.84 /ea	1,506	1,148.84 /ea	3,447
			Align Pump & Motor, 101-500 hp	3.00 ea	23.9	1,798	-	3,219	-	-	1,672.55 /ea	5,018	3,828.87 /ea	11,487
			Vibration Testing, Pumps, 101-500 hp	3.00 ea	8.0	599	-	1,073	-	-	557.51 /ea	1,673	1,276.29 /ea	3,829
			Witnessed factory test	3.00 ea		-	-	1,533	-	1,533	1,022.01 /ea	3,066	2,339.63 /ea	7,019
			Local panel	3.00 ea	23.9	1,798	4,599	-	-	-	2,132.46 /ea	6,397	4,881.72 /ea	14,645
			Pressure indicators	6.00 ea	12.0	899	1,533	-	-	-	405.36 /ea	2,432	927.98 /ea	5,568
			Sleeved anchor bolts - Medium	24.00 ea	11.2	839	515	-	-	-	56.43 /ea	1,354	129.17 /ea	3,100
			Non-Shrink Machine Grout	24.00 cuft	30.3	2,278	1,815	-	-	-	170.54 /cuft	4,093	390.42 /cuft	9,370
			Grease, Oil, and Lube Pumps, 101-500 hp	3.00 ea	15.9	1,199	230	-	-	-	476.29 /ea	1,429	1,090.34 /ea	3,271
			FURNISH Submersible Pump, 101 - 500 hp	3.00 EA		-	493,629	-	-	-	164,543.01 /EA	493,629	376,680.37 /EA	1,130,041
			Set pump assembly, 101 - 500 hp	3.00 ea	239.1	17,984	153	-	-	-	6,045.76 /ea	18,137	13,840.26 /ea	41,521
			Submersible Pump: 51hp-100hp	**3.00 EA**	**380.2**	**28,594**	**502,781**	**5,825**		**1,533**	**179,577.91 /EA**	**538,734**	**411,099.03 /EA**	**1,233,297**
			Furnish & Install 215 HP Pumps	**3.00 EA**	**380.2**	**28,594**	**502,781**	**5,825**		**1,533**	**179,577.91 /EA**	**538,734**	**411,099.03 /EA**	**1,233,297**
			44.05 Furnish and Install Process Equipment	**3.00 EA**	**380.2**	**28,594**	**502,781**	**5,825**		**1,533**	**179,577.91 /EA**	**538,734**	**411,099.03 /EA**	**1,233,297**
			44.0 Process Equipment - Municipal	**1.00 LS**	**380.2**	**28,594**	**502,781**	**5,825**		**1,533**	**538,733.73 /LS**	**538,734**	**1,233,297.09 /LS**	**1,233,297**
			0305 Dry Weather Pump Station	**1.00 LS**	**9,194.7**	**621,486**	**965,978**	**883,761**	**1,706,962**	**1,533**	**4,179,719.98 /LS**	**4,179,720**	**9,549,065.15 /LS**	**9,549,065**

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	3,466,774			12.10%
Material	5,356,420			18.70%
Subcontract	1,667,694			5.82%
Equipment	1,838,741			6.42%
Other	55,302			0.19%
Subtotal Raw Costs	**12,384,931**	**12,384,931**		**43.24**
Material Sales & Use Tax - %				
Construction Equip Tax - %				
Total Taxes		**12,384,931**		
Existing Conditions I,OH&P	161,863		15.000 %	0.57%
Concrete Work I,OH&P	75,225		15.000 %	0.26%
Architectural (Div 6-12)I,OH&P	87,552		15.000 %	0.31%
Mechanical Work I,OH&P	3,617		20.000 %	0.01%
Electrical Work I,OH&P	750,753		25.000 %	2.62%
Site/Civil I,OH&P	69,624		10.000 %	0.24%
Buried Piping I,OH&P	315,798		15.000 %	1.10%
Process Piping I,OH&P	194,818		18.000 %	0.68%
Instruments & Controls I,OH&P	97,298		25.000 %	0.34%
Process Equipment I,OH&P	385,750		15.000 %	1.35%
Subtotal Subcontractor I,OH&P	**2,150,239**	**14,535,170**		**7.51**
Contractor Contingency				
Subtotal Contingency		**14,535,170**		
Total Cost To Prime Contractor		**14,535,170**		
General Conditions	1,453,517		10.000 %	5.07%
Mobilization/Demobilization	639,547		4.000 %	2.23%
Subtotal Indirect Costs	**2,093,064**	**16,628,234**		**7.31**
Prime Contractor Home OfficeOH	1,330,259		8.000 %	4.64%
Prime Contractor Profit	1,795,849		10.000 %	6.27%
Bldr's Risk & Gen Liab Ins -%	358,059		1.250 %	1.25%
Payment & Performance Bonds	358,059		1.250 %	1.25%
Subtotal OH&P	**3,842,226**	**20,470,460**		**13.41**
Design Contingency	6,141,138		30.000 %	21.44%
Subtotal Contingency	**6,141,138**	**26,611,598**		21.44
Escalation	2,033,126		7.640 %	7.10%
Subtotal Escalation	**2,033,126**	**28,644,724**		**7.10**
Total Prime Contractor Costs		**28,644,724**		

Intermediate-Term Improvements
Yale Campus Trumbull Street Area
Phase 2A Project Sewer Separation

Yale Campus / Trumbull Street Sewer Separation Project - Phase 2A
Cost Estimate - July 30, 2013
CWF 2012-04
DTC# 09-405-116

SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
201.01	1	LS Clearing and Grubbing	$ 75,000.00	$ 75,000.00
201.02	1	EA Removal of Existing Tree (3" to 6" Caliper)	$ 500.00	$ 500.00
201.03	1	EA Removal of Existing Tree (6" to 10" Caliper)	$ 800.00	$ 800.00
201.04	1	EA Removal of Existing Tree (10" to 16" Caliper)	$ 1,500.00	$ 1,500.00
201.05	3	EA Removal of Existing Tree (16" to 24" Caliper)	$ 2,200.00	$ 6,600.00
201.06	2	EA Removal of Existing Tree (24" to 36" Caliper)	$ 3,600.00	$ 7,200.00
205.01	11,917	CY Trench Excavation - Earth	$ 60.00	$ 715,020.00
205.02	1,192	CY Trench Excavation - Rock	$ 150.00	$ 178,800.00
205.03	1,000	CY Trench Excavation - Unsuitable	$ 60.00	$ 60,000.00
205.05	400	CY Test Pit Excavation	$ 110.00	$ 44,000.00
205.06	40	EA Test Pit by Vacuum Method, Complete	$ 1,500.00	$ 60,000.00
205.07	1,559	SY Removal of Concrete Pavement	$ 30.00	$ 46,770.00
209	5,255	SY Formation of Subgrade	$ 8.00	$ 42,040.00
210	1	LS Temporary Soil Erosion and Water Pollution Control	$ 90,000.00	$ 90,000.00
210.1	485	DAY Mechanical Street Sweeping	$ 220.00	$ 106,700.00
213	1,000	CY Gravel Fill	$ 55.00	$ 55,000.00
304	1,473	CY Processed Aggregate Base	$ 65.00	$ 95,745.00
305.01	2,703	CY Bedding Material - Select Fill	$ 45.00	$ 121,635.00

SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
305.02	792	CY Bedding Material - 3/4" Crushed Stone	$ 50.00	$ 39,600.00
407.01	6,384	SY 2" Class 2 Temporary Pavement Trench in Roadways	$ 20.00	$ 127,680.00
407.02	254	SY Temporary Pavement for Sidewalk and Driveway, 2" Class 2 on Compacted Trench Backfill	$ 20.00	$ 5,080.00
407.1	1,574	SY Bituminous Concrete Trench Repair Class 1, Thickness 1.5" (Base Bid)	$ 20.70	$ 32,581.80
407.11	3,681	SY Bituminous Concrete Trench Repair Class 1, Thickness 2" (Base Bid)	$ 27.60	$ 101,595.60
407.2	1,574	SY Bituminous Concrete Trench Repair Class 2, Thickness 1.5" (Base Bid)	$ 31.05	$ 48,872.70
407.21	3,681	SY Bituminous Concrete Trench Repair Class 2, Thickness 2" (Base Bid)	$ 41.40	$ 152,393.40
407.4	1,574	SY Bituminous Concrete Trench Repair Class 4, Thickness 6" (2-3" lifts) (Base Bid)	$ 66.00	$ 103,884.00
407.51	500	TON Bituminous Concrete Skim Coat, Class 2, 1-inch Thickness	$ 150.00	$ 75,000.00
407.6	1,000	SY Bituminous Concrete Cold Patch, (Class 5)	$ 25.00	$ 25,000.00
407.7	2,000	SY Hybrid Asphalt (2" thickness)	$ 35.00	$ 70,000.00
407.82	23	SY Utility Bit. Conc. Trench Repair Class 1, Thickness 1.5" (Base Bid)	$ 20.70	$ 476.10
407.83	1,130	SY Utility Bit. Conc Trench Repair Class 1, Thickness 2" (Base Bid)	$ 27.60	$ 31,188.00
407.84	23	SY Utility Bit. Conc Trench Repair Class 2, Thickness 1.5" (Base Bid)	$ 31.05	$ 714.15
407.85	1,130	SY Utility Bit. Conc Trench Repair Class 2, Thickness 2" (Base Bid)	$ 41.40	$ 46,782.00
407.86	23	SY Utility Bit. Conc Trench Repair Class 4, Thickness 6" (2-3" lifts) (Base Bid)	$ 66.00	$ 1,518.00
507.01	225	VF Catch Basin, Type "C" or "CL"	$ 550.00	$ 123,750.00
507.02.1	266	VF Manhole - 4ft Dia. (Also Catch Basin Manhole)	$ 475.00	$ 126,350.00

SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
507.02.2	131	VF Manhole - 5ft Dia. (Also Catch Basin Manhole)	$ 500.00	$ 65,500.00
507.02.3	66	VF Manhole - 6ft Dia. (Also Catch Basin Manhole)	$ 550.00	$ 36,300.00
507.07C	33	EACH Frame Grate or Cover - Sanitary (Convert Ex. Combined MH)	$ 1,700.00	$ 56,100.00
512.01	299	LF Sanitary Sewer 12" PVC	$ 120.00	$ 35,880.00
512.05	100	CY Concrete Cradles and Encasement	$ 400.00	$ 40,000.00
518.01.1	1,202	LF Sanitary Sewer Hydraulic Cleaning (Light) 12" VCP	$ 3.00	$ 3,606.00
518.01.2	1,904	LF Sanitary Sewer Hydraulic Cleaning (Light) 15" VCP	$ 3.00	$ 5,712.00
518.01.3	450	LF Sanitary Sewer Hydraulic Cleaning (Light) 18"x10" RCP Horseshoe	$ 4.50	$ 2,025.00
518.01.4	298	LF Sanitary Sewer Hydraulic Cleaning (Light) 24"x15" RCP Egg	$ 4.50	$ 1,341.00
518.01.5	1,139	LF Sanitary Sewer Hydraulic Cleaning (Light) 32"x24" Brick Horseshoe	$ 7.00	$ 7,973.00
518.01.6	41	LF Sanitary Sewer Hydraulic Cleaning (Light) 18" RCP	$ 5.00	$ 205.00
518.02.1	200	LF Sanitary Sewer Hydraulic Cleaning (Heavy) 12" VCP	$ 6.00	$ 1,200.00
518.02.2	700	LF Sanitary Sewer Hydraulic Cleaning (Heavy) 15" VCP	$ 6.00	$ 4,200.00
518.02.3	500	LF Sanitary Sewer Hydraulic Cleaning (Heavy) 18"x10" RCP Horseshoe	$ 9.00	$ 4,500.00
518.02.4	300	LF Sanitary Sewer Hydraulic Cleaning (Heavy) 24"x15" RCP Egg	$ 11.00	$ 3,300.00
518.02.5	450	LF Sanitary Sewer Hydraulic Cleaning (Heavy) 32"x24" Brick Horseshoe	$ 15.00	$ 6,750.00
518.04	29	EACH Lateral Connection Cleaning	$ 500.00	$ 14,500.00
520.01.1	1,202	LF 12" VCP Sanitary Sewer CIPP Lining	$ 80.00	$ 96,160.00

SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
520.01.2	1,904	LF 15" VCP Sanitary Sewer CIPP Lining	$ 90.00	$ 171,360.00
520.01.3	450	LF 18"x10" RCP Horseshoe Sanitary Sewer CIPP Lining	$ 150.00	$ 67,500.00
520.01.4	298	LF 24"x15" RCP Egg Sanitary Sewer CIPP Lining	$ 190.00	$ 56,620.00
520.01.5	1,139	LF 32"x24" Brick Horseshoe Sanitary Sewer CIPP Lining	$ 225.00	$ 256,275.00
520.01.6	41	LF 18" RCP Sanitary Sewer CIPP Lining	$ 130.00	$ 5,330.00
520.1	143	EACH Re-establish House Service Connection	$ 300.00	$ 42,900.00
520.11.1	61	EACH Cut Protruding (Clay/Plastic) Taps	$ 250.00	$ 15,250.00
520.12	27	EACH Sewer Lateral / Sewer Main Connection Lining	$ 5,000.00	$ 135,000.00
521.01	20	LF Sanitary Sewer Point Repairs 12" VCP	$ 200.00	$ 4,000.00
521.02	60	LF Sanitary Sewer Point Repairs 15" VCP	$ 205.00	$ 12,300.00
521.03	40	LF Sanitary Sewer Point Repairs 32"x24" Brick Horseshoe	$ 800.00	$ 32,000.00
522.01	1,202	LF Sanitary Sewer CCTV Inspection 12" VCP	$ 2.00	$ 2,404.00
522.02	1,904	LF Sanitary Sewer CCTV Inspection 15" VCP	$ 2.00	$ 3,808.00
522.03	450	LF Sanitary Sewer CCTV Inspection 18"x10" RCP Egg	$ 3.00	$ 1,350.00
522.04	298	LF Sanitary Sewer CCTV Inspection 24"x15" RCP Egg	$ 3.00	$ 894.00
522.05	1,139	LF Sanitary Sewer CCTV Inspection 32"x24" Brick Horseshoe	$ 3.00	$ 3,417.00
522.06	41	LF Sanitary Sewer CCTV Inspection 18" RCP	$ 2.50	$ 102.50
523.01	32	VF Sanitary Sewer Manhole	$ 475.00	$ 15,200.00

SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
523.06	1	EACH Proposed Connection at Existing Structure (Pearl Stub)	$ 15,000.00	$ 15,000.00
601.05	50	CY Miscellaneous Concrete	$ 400.00	$ 20,000.00
601.06	50	CY Miscellaneous Structural Concrete	$ 400.00	$ 20,000.00
651.02	1,743	LF 15" RCP Storm Culvert	$ 105.00	$ 183,015.00
651.03	317	LF 18" RCP Storm Culvert	$ 125.00	$ 39,625.00
651.04	904	LF 24" RCP Storm Culvert	$ 180.00	$ 162,720.00
651.05	397	LF 30" RCP Storm Culvert	$ 260.00	$ 103,220.00
651.06	1,205	LF 36" RCP Storm Culvert	$ 300.00	$ 361,500.00
651.07	957	LF 42" RCP Storm Culvert	$ 450.00	$ 430,650.00
651.08	75	LF 18" DIP Storm Culvert	$ 180.00	$ 13,500.00
651.09	-	LF 24" DIP Storm Culvert	$ 200.00	$ -
651.1	31	LF 30" DIP Storm Culvert	$ 280.00	$ 8,680.00
651.11	435	LF 36" DIP Storm Culvert	$ 340.00	$ 147,900.00
714	38,474	SF Temporary Wood Sheet Piling Left-in-Place	$ 37.00	$ 1,423,538.00
813.1	260	LF Granite Stone Curbing (Straight)	$ 40.00	$ 10,400.00
813.2	162	LF Granite Stone Curbing (Curved)	$ 50.00	$ 8,100.00
814	33	LF Reset Stone Curbing	$ 20.00	$ 660.00
921.01	846	SF Concrete Sidewalk	$ 15.00	$ 12,690.00

SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
921.02	-	SF Concrete Driveway	$ 20.00	$ -
921.03	1,439	SF Concrete Handicapped Ramp	$ 20.00	$ 28,780.00
942	100	TONS Calcium Chloride for Dust Control	$ 40.00	$ 4,000.00
944	14	CY Furnishing and Placing Topsoil 4" Thickness	$ 75.00	$ 1,050.00
945	40	SY Fertilizing, Seeding and Mulching	$ 5.00	$ 200.00
945.01	1	LS Tree Preservation	$ 100,000.00	$ 100,000.00
949.01.1	7	EACH Planting Deciduous Tree (Trident Maple) (3" Cal.)	$ 600.00	$ 4,200.00
949.01.2	7	EACH Planting Deciduous Tree (American Elm) (3" Cal.)	$ 600.00	$ 4,200.00
949.01.3	7	EACH Planting Deciduous Tree (Hedge Maple) (3" Cal.)	$ 600.00	$ 4,200.00
949.01.4	8	EACH Planting Deciduous Tree (Kwanzan Cherry) (3" Cal.)	$ 600.00	$ 4,800.00
949.01.5	7	EACH Planting Deciduous Tree (Columnar Sargent Cherry) (3" Cal.)	$ 600.00	$ 4,200.00
949.01.6	7	EACH Planting Deciduous Tree (Japanese Treet Lilac) (3" Cal.)	$ 600.00	$ 4,200.00
969.02	24	MONTH Engineer's Field Office (Type B)	$ 5,000.00	$ 120,000.00
971	1	LS Maintenance and Protection of Traffic	$ 350,000.00	$ 350,000.00
975	1	LS Mobilization (Not to exceed 3% of total price excluding mobilization)	$ 290,000.00	$ 290,000.00
985	1	LS Project Survey and Stakeout	$ 100,000.00	$ 100,000.00
1208.1	240	SF Sign Face - Sheet Aluminum	$ 40.00	$ 9,600.00
1208.2	240	SF Temporary Signage (Building)	$ 30.00	$ 7,200.00

SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
1208.3	240	SF Temporary Signage (Miscellaneous)	$ 30.00	$ 7,200.00
1209.1	6,542	LF Pavement Markings (Thermoplastic), 4" Wide, White or Yellow	$ 4.00	$ 26,168.00
1209.11	357	LF Pavement Markings (Thermoplastic), 12" Wide, White or Yellow	$ 8.00	$ 2,856.00
1209.12	42	SF Pavement Markings (Thermoplastic), Symbols, Legends	$ 9.00	$ 378.00
1209.13	12	EA Pavement Markings (Thermoplastic), White Stop Bars and Crosswalk Bars	$ 900.00	$ 10,800.00
1209.4	2,867	LF Temporary Pavement Markings (Fast-drying Paint), 4" or 12" Wide	$ 1.50	$ 4,300.50
1209.41	2,867	LF Temporary Pavement Markings (Tape) 4" or 12" Wide	$ 2.50	$ 7,167.50
1209.42	3,024	SF Temporary Pavement Markings (Fast-drying Paint), Symbols, Legends	$ 4.50	$ 13,608.00
1209.43	26	EA Temp Pvmt Markings (Fast-drying Paint), White Stop Bars and White Crosswalk Bars	$ 600.00	$ 15,600.00
1209.5	6,300	SF Power Washing for Removal of Paint Marks from Concrete/Brick	$ 1.00	$ 6,300.00
1210.01	6,221	LF Pavement Markings (Epoxy Resin), 4" Wide, White or Yellow	$ 2.50	$ 15,552.50
1210.02	956	LF Pavement Markings (Epoxy Resin), 12" Wide, White or Yellow	$ 7.50	$ 7,170.00
1210.03	1,008	SF Pavement Markings (Epoxy Resin), Symbols, Legends	$ 7.50	$ 7,560.00
1210.04	9	EA Pavement Markings (Epoxy Resin) White Stop Bars and White Crosswalk Bars	$ 900.00	$ 8,100.00
1210.1	18,661	LF Temporary Pavement Markings (Epoxy Resin) 4" Wide, White or Yellow	$ 1.75	$ 32,656.75
1210.11	2,867	LF Temporary Pavement Markings (Epoxy Resin) 12" Wide, White or Yellow	$ 5.25	$ 15,051.75
1210.12	3,024	SF Temporary Pavement Markings (Epoxy Resin) Symbols, Legends	$ 5.25	$ 15,876.00
1210.13	26	EA Temp Pvmt Markings (Epoxy Resin) White Stop Bars and White Crosswalk Bars	$ 750.00	$ 19,500.00

SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
1500	1	ALLOWANCE Uniformed Police Officers	$ 873,000.00	$ 873,000.00
1505.1	1	LS Special Precast Concrete Structure No.1	$ 40,000.00	$ 40,000.00
1506.1	300	LF Abandoning Pipe in Place (4" to 10" I.D.)	$ 20.00	$ 6,000.00
1506.2	242	LF Abandoning Pipe in Place (12" to 15" I.D.)	$ 25.00	$ 6,050.00
1506.3	20	LF Abandoning Pipe in Place (18" to 24" I.D.)	$ 30.00	$ 600.00
1506.4	3	EA Abandon Existing Catch Basin or Manhole Structure	$ 1,000.00	$ 3,000.00
1507.1	1,304	LF 6" PVC Storm Lateral	$ 95.00	$ 123,880.00
1507.2	112	LF 12" PVC Storm Lateral	$ 100.00	$ 11,200.00
1507.3	21	LF 15" RCP Storm Lateral	$ 105.00	$ 2,205.00
1507.4	103	EA Connection of New or Existing Storm Pipe/Lateral (6" to 15")	$ 500.00	$ 51,500.00
1508.1	100	CY Controlled Low Strength Material (Miscellaneous)	$ 250.00	$ 25,000.00
1508.2	100	CY Controlled Low Strength Material (Trench Backfill)	$ 250.00	$ 25,000.00
1510.1	4	EA Alter Existing Manhole, Catch Basin, or Drop Inlet	$ 1,000.00	$ 4,000.00
1513	1	LS Arborist Supervision During Construction	$ 50,000.00	$ 50,000.00
1514	5,820	HR Uniformed Trafficman (Flagger)	$ 25.00	$ 145,500.00
1516	53	SF Remove and Reset / Replace Brick Sidewalk	$ 20.00	$ 1,060.00
1520	1,050	SY Pervious Concrete Sidewalk	$ 175.00	$ 183,750.00
1521.1	1	EACH Tree Box Filter / Bioswale 'A'	$ 18,000.00	$ 18,000.00

Yale Campus / Trumbull Street Sewer Separation Project - Phase 2A
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SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
1521.2	1	EACH Tree Box Filter / Bioswale 'B'	$ 18,000.00	$ 18,000.00
1521.3	1	EACH Tree Box Filter / Bioswale 'C'	$ 18,000.00	$ 18,000.00
1521.4	1	EACH Tree Box Filter / Bioswale 'D'	$ 18,000.00	$ 18,000.00
1521.5	1	EACH Tree Box Filter / Bioswale 'E'	$ 18,000.00	$ 18,000.00
1521.6	1	EACH Tree Box Filter / Bioswale 'F'	$ 18,000.00	$ 18,000.00
1521.7	1	EACH Tree Box Filter / Bioswale 'G'	$ 18,000.00	$ 18,000.00
102-16-19	10	EA Temporary Utility Pole Support	$ 1,800.00	$ 18,000.00
102-16-19	1	EA Traffic Signal Span Pole Support	$ 20,000.00	$ 20,000.00

TOTAL $ 9,960,156.25

Yale Campus / Trumbull Street Sewer Separation Project - Phase 2A
Cost Estimate - July 30, 2013
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SPEC NUMBER	ESTIMATED QUANTITY	ITEM	UNIT PRICE DOLLARS	EXTENDED PRICE DOLLARS
BID ALTERNATIVE #1 MILL & OVERLAY				
405.02	23,604	SY Bituminous Concrete Milling 0"-2"	$ 4.00	$ 94,416.00
407.41	3,681	SY Bituminous Concrete Base (Local), Class 4, Thickness 4" (single lift)	$ 44.00	$ 161,964.00
407.42	1,574	SY Bituminous Concrete Base (Collector), Class 4, 8" Thickness (2 -4" lifts)	$ 88.00	$ 138,512.00
407.5	23,604	SY Bituminous Concrete Overlay, Class 2, 2" Thick	$ 13.80	$ 325,735.20
407.8	1,130	SY Utility Trench Base Course (Local), Class 4, 4" thickness (single lift)	$ 44.00	$ 49,720.00
407.81	23	SY Utility Trench Base Course (Collector), Class 4, 8" thickness (2-4" lifts)	$ 88.00	$ 2,024.00

TOTAL ALTERNATIVE #1 $ 772,371.20

Long-Term Improvements
Phase II East Shore WPAF
Wet Weather Capacity Improvements
Preliminary Treatment and Odor Control

Project: GNHWPCA Long Term Control Plan Update
Facility: Preliminary Treatment
Estimate Type: Conceptual
Prepared By: J.Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 1 - General Requirements				
Included in percentages below				
Div. 1 Subtotal:				
Division 2 - Site Work				
Demolition				
Existing Garage	3,000	SF	$5	$18,144
Existing Maintenance Facility	7,500	SF	$8	$68,040
Ecavation				
Preliminary Treatment Bldg	6,963	CY	$30	$252,673
Dewatering				
Preliminary Treatment Bldg	12,000	SF	$30	$435,457
Yard Piping				
Twin 72 inch Effluent Pipes	850	FT	$1,275	$1,310,907
Site Work				
Grading and Drainage	1	ALLOWANCE	$10,000	$12,096
Roads & paved areas	1,333	SQYDS	$45	$72,558
Floodplain Compensation	1	Estimate	$300,000	$362,881
Div. 2 Subtotal:				$2,532,756
Division 3 - Concrete				
Truck Bay				
Stone Base 6" Thick	80	CY	$25	$2,419
Base Slab	470	CY	$500	$284,257
3rd Floor Slab	310	CY	$1,000	$374,977
Fine Screening				
Stone Base 6" Thick	75	CY	$25	$2,268
Base Slab	430	CY	$500	$260,065
2nd Floor Slab	220	CY	$1,000	$266,113
3rd Floor Slab	35	CY	$1,000	$42,336
Elec, Control, and HVAC				
Stone Base 6" Thick	30	CY	$25	$907
Base Slab	180	CY	$500	$108,864
2nd Floor Slab	90	CY	$1,000	$108,864
3rd Floor Slab	90	CY	$1,000	$108,864
Channels				
Screening Influent and Effluent	125	CY	$1,000	$151,200
Fine Screen Channels	70	CY	$1,000	$84,672
Grit Removal Channels	330	CY	$1,000	$399,169
Grit Removal				
Stone Base 6" Thick	160	CY	$25	$4,838
Base Slab	950	CY	$500	$574,561
1st Floor Slab	475	CY	$1,000	$574,561
Pista Grit	390	CY	$1,000	$471,745
Below Grade Wall	360	CY	$750	$326,593
Div. 3 Subtotal:				$4,147,275
Division 4 - Masonry				
Included in Div 10				
Div. 4 Subtotal:				

Project: GNHWPCA Long Term Control Plan Update
Facility: Preliminary Treatment
Estimate Type: Conceptual
Prepared By: J.Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 5 - Metals				
Other Metals Included in percentages below				
Div. 5 Subtotal:				
Division 6 - Wood & Plastics				
Included in Div 10				
Div. 6 Subtotal:				
Division 7 - Thermal & Moisture Protection				
Included in Div 10				
Div. 7 Subtotal:				
Division 8 - Doors & Windows				
Included in Div 10				
Div. 8 Subtotal:				
Division 9 - Finishes				
Included in percentages below				
Div. 9 Subtotal:				
Division 10 - Specialties				
Truck Bay Superstructure	8,450	SF	$250	$2,555,286
Fine Screens Superstructure	3,900	SF	$250	$1,179,363
Elec, Control, HVAC Superstructure	4,875	SF	$250	$1,474,203
Div. 10 Subtotal:				$5,208,852
Division 11 - Equipment				
Fine Screens				
Fine Screens (70 MGD, 6mm)	3	EA	$290,000	$1,052,354
Screen Presses	3	EA	$85,000	$308,449
Transfer Screws (60' long, 15 deg)	3	EA	$70,000	$254,017
Sluice Gates	6	EA	$55,400	$402,072
Grit Removal				
Pista Grit Equipment	3	EA	$90,000	$326,593
Grit Pumps	6	EA	$20,000	$145,152
Classifier and Concentrator	3	EA	$60,000	$217,729
Sluice Gates	6	EA	$33,300	$241,679
Truck Bay				
Leveling Screws	3	EA	$70,000	$254,017
Hoppers with Load Cells	6	EA	$100,000	$725,762
Equipment Installation	1	PERCENT	30%	$1,178,347
Div. 11 Subtotal:				$5,106,169
Division 12 - Furnishings				
Not Used				
Div. 12 Subtotal:				
Division 13 - Special Construction				
Included in Percentages Below				
Div. 13 Subtotal:				
Division 14 - Conveying Systems				

Project: GNHWPCA Long Term Control Plan Update
Facility: Preliminary Treatment
Estimate Type: Conceptual
Prepared By: J.Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Included in Div 11				
Div. 14 Subtotal:				
Division 15 - Mechanical				
Included in Percentages Below				
Div. 15 Subtotal:				
Division 16 - Electrical				
Included in Percentages Below				
Div. 16 Subtotal:				
Subtotal Division 1 - 11 (54%)				**$16,995,052**
Percentage of Costs				
Metals	3%		$31,472,318	$944,170
Finishes	0%			
Process Mechanical Piping	15%		$31,472,318	$4,720,848
I&C	6%		$31,472,318	$1,888,339
Electrical	10%		$31,472,318	$3,147,232
Facility Subtotal:				$27,695,640
General Requirements	10%		$2,769,564	
Overhead	8%		$2,437,216	
Profit	10%		$3,046,520	
Mobilization/Demolization	3%		$913,956	
Bond/Insurance	3%		$913,956	
Subtotal:				$37,776,853
Contingency	20%		$7,555,371	$7,555,371
Total Facility Cost:				**$45,332,223**

Long-Term Improvements
Phase II East Shore WPAF
Wet Weather Capacity Improvements
Primary Clarifiers with CEPT

Project: GNHWPCA Long Term Control Plan Update
Facility: Primary Clarifiers
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 1 - General Requirements				
Included in percentages below				
Div. 1 Subtotal:				
Division 2 - Site Work				
Demolition				
Demolition of Primary Influent Channel	148	CY		
Demolition of Primary Clarifiers Wall and Footing	281	CY		
Demolition of Primary Clarifier Floor	329	CY		
Demolition of Primary Sludge Pits (3 exist, 2 older)	121	CY		
Demolition of Primary Effluent Structure, clarifier 3	18	CY		
Demolition I Subtotal:	878	CY	$150	$159,315
Demolition of Primaries chain and flight collectors	9	EA		
Demolition of Primaries scum collectors	9	EA		
Demolition of Primaries sludge screw conveyors	3	EA		
Demolition of Primary Sludge Pumps	6	EA		
Demolition II Subtotal:	1	ALLOWANCE	$250,000	$302,401
Excavation				
Primary Clarifier 4	9,293	CY	$30	$337,237
Primary Clarifier 4 Gallery	2,292	CY	$30	$83,167
Gallery Clarifier 1-3	2,095	CY	$30	$76,017
Dewatering	1	ALLOWANCE	$500,000	$604,801
Yard Piping				
Effluent piping, 84 inch dia	320	FT	$335	$129,669
Sludge piping	640	FT	$150	$116,122
Scum piping 18 inch dia	260	FT	$85	$26,732
Site Work				
Grading and Drainage	1	ALLOWANCE	$50,000	$60,480
Roads (22 ft wide)	489	SQYDS	$45	$26,611
Div. 2 Subtotal:				$1,922,553
Division 3 - Concrete				
Primary Clarifier 4				
Stone Base 6" thick	310	CY	$25	$9,368
Effluent Structure Walls	28	CY	$750	$25,200
Effluent Structure Floor	19	CY	$500	$11,290
Primary Clarifier Walls	628	CY	$750	$569,723
Primary Clarifier Floor	1,859	CY	$500	$1,124,124
Primary Clarifier Footings	244	CY	$500	$147,706
Influent Pipe Encasement	1,048	CY	$500	$633,549
Primary Clarifier Gallery (1-4)				
Stone Base 6" thick	175	CY	$25	$5,292
Gallery Walls	756	CY	$750	$686,046
Gallery Floor	1,042	CY	$500	$630,337
Gallery Roof	521	CY	$1,000	$630,337
Gallery Footings	131	CY	$500	$79,498
Div. 3 Subtotal:				$4,552,471

Project: GNHWPCA Long Term Control Plan Update
Facility: Primary Clarifiers
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 4 - Masonry				
Not used				
Div. 4 Subtotal:				
Division 5 - Metals				
Primary Tank Covers	16,728	SF	$50	$1,011,712
Hand Railing	500	LF	$120	$72,576
Other Metals Included in percentages below				
Div. 5 Subtotal:				$1,084,288
Division 6 - Wood & Plastics				
Not used				
Div. 6 Subtotal:				
Division 7 - Thermal & Moisture Protection				
Not used				
Div. 7 Subtotal:				
Division 8 - Doors & Windows				
Not used				
Div. 8 Subtotal:				
Division 9 - Finishes				
Included in percentages below				
Div. 9 Subtotal:				
Division 10 - Specialties				
Gallery Exits -2 (stairwells)	700	SF	$150	$127,008
Div. 10 Subtotal:				$127,008
Division 11 - Equipment				
Primary Clarifier Mechanism	4	EA	$414,900	$2,007,457
Clarifier influent slide gates	24	EA	$6,800	$197,407
Clarifier channel isolation gates	3	EA	$8,800	$31,934
Primary Sludge Pumps	12	EA	$27,000	$391,911
Primary Sludge Pump Drives	12	EA	$10,000	$145,152
PSD line 6" flow meters	12	EA	$3,000	$43,546
48" Mag Meter	4	EA	$38,500	$186,279
48" Butterfly Valves	4	EA	$18,000	$87,091
Equipment Installation	1	PERCENT	30%	$927,233
Div. 11 Subtotal:				$4,018,010
Division 12 - Furnishings				
Not used				
Div. 12 Subtotal:				
Division 13 - Special Construction				
Not used				
Div. 13 Subtotal:				

Project: GNHWPCA Long Term Control Plan Update
Facility: Primary Clarifiers
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 14 - Conveying Systems				
Not used				
Div. 14 Subtotal:				
Division 15 - Mechanical				
Included in percentages below				
Div. 15 Subtotal:				
Division 16 - Electrical				
Included in percentages below				
Div. 16 Subtotal:				
Subtotal Division 1 - 11 (62%)				**$11,704,330**
Percentage of Costs				
Metals	3%		$18,877,952	$566,339
Finishes	2%		$18,877,952	$377,559
Process Mechanical Piping	15%		$18,877,952	$2,831,693
I&C	6%		$18,877,952	$1,132,677
Electrical	10%		$18,877,952	$1,887,795
Facility Subtotal:				$18,500,393
General Requirements	10%		$1,850,039	
Overhead	8%		$1,628,035	
Profit	10%		$2,035,043	
Mobilization/Demolization	3%		$610,513	
Bond/Insurance	3%		$610,513	
Subtotal:				$25,234,536
Contingency	20%		$5,046,907	$5,046,907
Total Facility Cost:				**$30,281,443**

Long-Term Improvements
Phase II East Shore WPAF
Wet Weather Capacity Improvements
Head Works with CEPT and Septage

Project: GNHWPCA Long Term Control Plan Update
Facility: Head Works with CEPT & Septage
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 1 - General Requirements				
Included in percentages below				
Div. 1 Subtotal:				
Division 2 - Site Work				
Demolition				
Demolition of existing grit removal equipment	1	ALLOWANCE	$150,000	$181,440
Excavation				
CEPT Chemical Containment	259	CY	$25	$7,840
Dewatering	1	ALLOWANCE	$5,000	$6,048
Yard Piping				
$FeCl_3$ Pipes, 2" PVC	300	FT	$65	$23,587
PO Pipes, 2" PVC	300	FT	$65	$23,587
Site Work				
Grading and Drainage	1	ALLOWANCE	$10,000	$12,096
Roads (22 ft wide)	222	SQYDS	$45	$12,096
Div. 2 Subtotal:				$266,695
Division 3 - Concrete				
Basement				
Screen channel covers	11	CY	$1,000	$13,440
Grit channel covers	59	CY	$1,000	$71,680
Grit channel benching	237	CY	$500	$143,360
Grit channel modifications at gates	1	ALLOWANCE	$100,000	$120,960
Chemical containment				
Stone Base 6" thick	19	CY	$25	$560
base slab	111	CY	$500	$67,200
walls	39	CY	$750	$34,944
Div. 3 Subtotal:				$452,145
Division 4 - Masonry				
Not used				
Div. 4 Subtotal:				
Division 5 - Metals				
Included in percentages below				
Div. 5 Subtotal:				
Division 6 - Wood & Plastics				
Not used				
Div. 6 Subtotal:				
Division 7 - Thermal & Moisture Protection				
Not used				
Div. 7 Subtotal:				
Division 8 - Doors & Windows				
Not used				
Div. 8 Subtotal:				

Project: GNHWPCA Long Term Control Plan Update
Facility: Head Works with CEPT & Septage
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 9 - Finishes				
Included in percentages below				
Div. 9 Subtotal:				
Division 10 - Specialties				
Headworks Bldg.				
Life Safety (egress, fire protcection, NFPA, etc)	10,080	SQFT	$75	$914,460
Change of use & Upgrades (doors, windows, thermal protection, etc)	10,080	SQFT	$75	$914,460
Chemical containment super structure	1,000	SQFT	$250	$302,401
Div. 10 Subtotal:				$2,131,320
Division 11 - Equipment				
Screening Compactors	2	EA	$50,000	$120,960
Screen isolation gates	4	EA	$50,000	$241,921
Septage receiving tank	1	EA	$50,000	
Septage grinder	1	EA	$13,000	
Septage control valve	1	EA	$5,000	
$FeCl_3$ Metering Pumps	5	EA	$9,500	$57,456
Polymer Metering Pumps	5	EA	$6,000	$36,288
Polymer Blending Units	4	EA	$15,000	$72,576
$FeCl_3$ Storage Tank	2	EA	$21,500	$52,013
NaOCl Metering Pumps	4	EA	$9,500	$45,965
Equipment Installation	1	PERCENT	30%	$188,154
Div. 11 Subtotal:				$815,333
Division 12 - Furnishings				
Not used				
Div. 12 Subtotal:				
Division 13 - Special Construction				
Not used				
Div. 13 Subtotal:				
Division 14 - Conveying Systems				
Not used				
Div. 14 Subtotal:				
Division 15 - Mechanical				
Included in percentages below				
Div. 15 Subtotal:				
Division 16 - Electrical				
Included in percentages below				
Div. 16 Subtotal:				
Subtotal Division 1 - 11 (62%)				**$3,665,493**
Percentage of Costs				
Metals	3%		$5,912,086	$177,363
Finishes	2%		$5,912,086	$118,242
Process Mechanical Piping	15%		$5,912,086	$886,813

Project: GNHWPCA Long Term Control Plan Update
Facility: Head Works with CEPT & Septage
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
I&C	6%		$5,912,086	$354,725
Electrical	12%		$5,912,086	$709,450
Facility Subtotal:				$5,912,086
General Requirements	10%		$591,209	
Overhead	8%		$520,264	
Profit	10%		$650,329	
Mobilization/Demolization	3%		$195,099	
Bond/Insurance	3%		$195,099	
Subtotal:				$8,064,085
Contingency	20%		$1,612,817	$1,612,817
Total Facility Cost:				**$9,676,902**

Long-Term Improvements
Phase II East Shore WPAF
Wet Weather Capacity Improvements
Disinfection

Project: GNHWPCA Long Term Control Plan Update
Facility: Disinfection
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 1 - General Requirements				
Included in percentages below				
Div. 1 Subtotal:				
Division 2 - Site Work				
Demolition				
Existing CCT1 baffle walls	318	CY	$150	$57,607
Effluent channel wall to beach gate	12	CY	$150	$2,150
Ecavation				
Dry/Wet Weather Flow Split	356	CY	$30	$12,902
Chlorine Contact Tanks	8,889	CY	$30	$322,561
Wet Weather Conduit	10,276	CY	$30	$372,880
Dewatering				
Dry/Wet Weather Flow Split	1	ALLOWANCE	$50,000	$60,480
Chlorine Contact Tanks	1	ALLOWANCE	$150,000	$181,440
Wet Weather Conduit	1	ALLOWANCE	$100,000	$120,960
Yard Piping				
NaOCl Pipes, 2" PVC	1,200	FT	$65	$94,349
Site Work				
Grading and Drainage	1	ALLOWANCE	$100,000	$120,960
Roads (22 ft wide)	1,333	SQYDS	$45	$72,576
Div. 2 Subtotal:				$1,418,867
Division 3 - Concrete				
Primary Effluent Conduit				
84 inch dia RCP	600	FT	$335	$243,130
84 inch fittings	2	EA	$5,500	$13,306
Dry/Wet Weather Flow Split				
Stone Base 6" thick	15	CY	$25	$448
Footings	47	CY	$500	$28,224
Base slab	89	CY	$500	$53,760
Walls	213	CY	$750	$193,536
Wet Weather Chlorine Contact Tanks				
Stone Base 6" thick	296	CY	$25	$8,960
Base slab	1,778	CY	$500	$1,075,203
Footings	202	CY	$500	$122,304
Baffle walls	428	CY	$750	$387,879
Wet Weather Effluent Conduit				
New CCT to plant effluent Conduit	1,445	FT	$1,292	$2,257,995
Dry Weather UV				
Channel walls	415	CY	$750	$376,321
Channel covers (50%)	117	CY	$1,000	$141,120
Div. 3 Subtotal:				$4,902,187

Project: GNHWPCA Long Term Control Plan Update
Facility: Disinfection
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 4 - Masonry				
Not used				
Div. 4 Subtotal:				
Division 5 - Metals				
Chlorine Contact Tank Covers	16,000	SF	$50	$967,682
Included in percentages below				
Div. 5 Subtotal:				$967,682
Division 6 - Wood & Plastics				
Not used				
Div. 6 Subtotal:				
Division 7 - Thermal & Moisture Protection				
Not used				
Div. 7 Subtotal:				
Division 8 - Doors & Windows				
Not used				
Div. 8 Subtotal:				
Division 9 - Finishes				
Not used				
Div. 9 Subtotal:				
Division 10 - Specialties				
UV Canopy	3,150	SF	$150	$571,537
Div. 10 Subtotal:				$571,537
Division 11 - Equipment				
Mechanical Constant Level Gates	3	EA	$39,500	$143,338
UV Equipment	1	EA	$1,600,000	$1,935,365
Slide Gate, 48" w/ operator	1	EA	$6,800	$8,225
42" Butterfly Valves, Flow Split Box	3	EA	$18,000	$65,319
Partial Flume (dry weather)	1	EA	$9,600	$11,612
Partial Flume (wet weather)	1	EA	$33,300	$40,280
Equipment Installation	1	PERCENT	30%	$661,241
Div. 11 Subtotal:				$2,865,380
Division 12 - Furnishings				
Not used				
Div. 12 Subtotal:				
Division 13 - Special Construction				
Included in percentages below				
Div. 13 Subtotal:				
Division 14 - Conveying Systems				
Not used				
Div. 14 Subtotal:				

Project: GNHWPCA Long Term Control Plan Update
Facility: Disinfection
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 15 - Mechanical				
Included in percentages below				
Div. 15 Subtotal:				
Division 16 - Electrical				
Included in percentages below				
Div. 16 Subtotal:				
Subtotal Division 1 - 11 (81%)				**$10,725,654**
Percentage of Costs				
Metals	1.5%		$13,241,548	$198,623
Finishes	1%		$13,241,548	$132,415
Process Mechanical Piping	7.5%		$13,241,548	$993,116
I&C	3%		$13,241,548	$397,246
Electrical	6%		$13,241,548	$794,493
Facility Subtotal:				$13,241,548
General Requirements	10%		$1,324,155	
Overhead	8%		$1,165,256	
Profit	10%		$1,456,570	
Mobilization/Demolization	3%		$436,971	
Bond/Insurance	3%		$436,971	
Subtotal:				$18,061,472
Contingency	20%		$3,612,294	$3,612,294
Total Facility Cost:				**$21,673,766**

Long-Term Improvements
Phase II East Shore WPAF
Wet Weather Capacity Improvements
Power Distribution

Project: GNHWPCA Long Term Control Plan Update
Facility: Electrical Upgrade
Estimate Type: Conceptual - Capital Improvements Planning
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 1 - General Requirements				
Included in percentages below				
Div. 1 Subtotal:				
Division 2 - Site Work				
Duct Banks to existing facilities				
Main Building	0	LF	$50	
Aeration Tanks	0	LF	$50	
Sludge Bldg.	0	LF	$50	
Influent Bldg	0	LF	$50	
Duct Banks to new facilities				
Preliminary Treatment	600	LF	$350	$210,000
South Odor Control	50	LF	$350	$17,500
Div. 2 Subtotal:				$227,500
Division 3 - Concrete				
Generator pad	0	CY	$500	
Switch Gear Bldg.	0	CY	$500	
Div. 3 Subtotal:				
Division 4 - Masonry				
Not used				
Div. 4 Subtotal:				
Division 5 - Metals				
Not used				
Div. 5 Subtotal:				
Division 6 - Wood & Plastics				
Not used				
Div. 6 Subtotal:				
Division 7 - Thermal & Moisture Protection				
Not used				
Div. 7 Subtotal:				
Division 8 - Doors & Windows				
Not used				
Div. 8 Subtotal:				
Division 9 - Finishes				
Not used				
Div. 9 Subtotal:				
Division 10 - Specialties				
Switch Gear Bldg. Suoerstructure	0	SF	$250	
Div. 10 Subtotal:				
Division 11 - Equipment				
Main Building				

Project: GNHWPCA Long Term Control Plan Update
Facility: Electrical Upgrade
Estimate Type: Conceptual - Capital Improvements Planning
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
MCC-M1	0	EA	$10,000	
MCC-M2	0	EA	$10,000	
MCC-M3 (ABANDONED-2002)	0	EA	$10,000	
MCC-M4(MODIFIED 2002)	0	EA	$10,000	
MCC-M5	0	EA	$10,000	
MCC-M6	0	EA	$10,000	
MCC-M7	0	EA	$10,000	
MCC-M8(FIND DRAWINGS)	0	EA	$10,000	
MCC-M10 (INSTALLED 1986)	0	EA	$10,000	
MCC-M11 (INSTALLED 1997)	0	EA	$10,000	
MCC-Z1	0	EA	$10,000	
MCC-T1	0	EA	$10,000	
SWBD-M1 (INSTALLED 2002)		EA		
SWBD-M2 (INSTALLED 2002)		EA		
SUB NO.1 FEEDER BRKR	0	EA	$25,000	
SUB NO.1 MAIN/TIE BRKR	0	EA	$75,000	
SUB NO.1 XFMR (2000 KVA)	0	EA	$100,000	
SUB NO.1 HV SWITCH	0	EA	$50,000	
Aeration tanks				
MCC-A5 (INSTALLED 1996)	0	EA	$10,000	
MCC-A6 (INSTALLED 1996)	0	EA	$10,000	
MCC-A7 (INSTALLED 1996)	0	EA	$10,000	
MCC-A8 (INSTALLED 1996)	0	EA	$10,000	
MCC-A9 (INSTALLED 1996)	0	EA	$10,000	
SUB NO.2 FEEDER BRKR	0	EA	$25,000	
SUB NO.2 MAIN/TIE BRKR	0	EA	$75,000	
SUB NO.2 XFMR (2000 KVA)	0	EA	$100,000	
SUB NO.2 HV SWITCH	0	EA	$50,000	
Sludge Building				
MCC-S3	0	EA	$10,000	
MCC-S4	0	EA	$10,000	
MCC-S5 (INSTALLED 1998)	0	EA	$10,000	
MCC-S6 (INSTALLED 1998)	0	EA	$10,000	
SUB NO.3 FEEDER BRKR	0	EA	$25,000	
SUB NO.3 MAIN/TIE BRKR	0	EA	$75,000	
SUB NO.3 XFMR (2000 KVA)	0	EA	$100,000	
SUB NO.3 HV SWITCH	0	EA	$50,000	
Head Works Building				
MCC-PW	0	EA	$10,000	
MCC-PW2 (INSTALLED 1997)	0	EA	$10,000	
Generator Building				
MCC-GEN BLDG	6		$10,000	$72,576
SUB GEN BLDG FEEDER BRKR	2		$25,000	$60,480
SUB GEN BLDG MAIN/TIE BRKR	3		$75,000	$272,161
SUB GEN BLDG XFMR (750 KVA)	2		$75,000	$181,440
SUB GEN BLDG HV SWITCH	2		$50,000	$120,960
Grit Building				
MCC-Grit BLDG	10		$10,000	$120,960
SUB GRIT BLDG FEEDER BRKR	2		$25,000	$60,480

Project: GNHWPCA Long Term Control Plan Update
Facility: Electrical Upgrade
Estimate Type: Conceptual - Capital Improvements Planning
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
SUB GRIT BLDG MAIN/TIE BRKR	3		$75,000	$272,161
SUB GRIT BLDG XFMR (750 KVA)	2		$75,000	$181,440
SUB GRIT BLDG HV SWITCH	2		$50,000	$120,960
Generator with outdoor enclosure	0	EA	$600,000	
Main Switch Gear	0	EA	$1,000,000	
Electrical Installation	1	PERCENT	30%	$439,086
Div. 11 Subtotal:				$1,902,705
Division 12 - Furnishings				
Not used				
Div. 12 Subtotal:				
Division 13 - Special Construction				
Not used				
Div. 13 Subtotal:				
Division 14 - Conveying Systems				
Not used				
Div. 14 Subtotal:				
Division 15 - Mechanical				
Not used				
Div. 15 Subtotal:				
Division 16 - Electrical				
Included in percentages below				
Div. 16 Subtotal:				
Subtotal Division 1 - 11 (65%)				**$2,130,205**
Percentage of Costs				
Metals	0%		$3,550,342	$0
Finishes	0%		$3,550,342	$0
I&C	0%		$3,550,342	$0
Electrical	20%		$3,550,342	$710,068
Facility Subtotal:				$2,840,274
General Requirements	10%		$284,027	
Overhead	8%		$249,944	
Profit	10%		$312,430	
Mobilization/Demolization	3%		$93,729	
Bond/Insurance	3%		$93,729	
Subtotal:				$3,874,133
Contingency	20%		$774,827	$774,827
Total Facility Cost:				**$4,648,960**

Long-Term Improvements
Phase II East Shore WPAF
Wet Weather Capacity Improvements
Nitrogen Removal (IFAS)

Project: GNHWPCA Long Term Control Plan Update
Facility: IFAS
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 1 - General Requirements				
Included in percentages below				
Div. 1 Subtotal:				
Division 2 - Site Work				
Not Used				
Div. 2 Subtotal:				
Baffle walls	652	CY	$750	$591,361
Channel	296	CY	$1,000	$358,401
Div. 3 Subtotal:				$949,762
Division 4 - Masonry				
Not Used				
Div. 4 Subtotal:				
Division 5 - Metals				
other items included in percentages below				
Div. 5 Subtotal:				
Division 6 - Wood & Plastics				
Not Used				
Div. 6 Subtotal:				
Division 7 - Thermal & Moisture Protection				
Not Used				
Div. 7 Subtotal:				
Division 8 - Doors & Windows				
Not Used				
Div. 8 Subtotal:				
Division 9 - Finishes				
Included in percentages below				
Div. 9 Subtotal:				
Division 10 - Specialties				
Not Used				
Div. 10 Subtotal:				
Division 11 - Equipment				
Media	1	EA	$4,150,000	$5,019,852
Reactor Sieves	1	EA	$500,000	$604,801
Weir Gates	12	EA	$12,500	$181,440
Aeration basin diffuser grid modifications				
Remove diffuser grid in IFAS zone	16,000	SQFT	$3	$48,384
Add diffusers in IFAS zone	16,000	SQFT	$30	$580,609
Blower and Air Distribution Modifications				
Capacity controls and piping	1	ALLOWANCE	$0	
Equipment Installation	1	PERCENT	30%	$1,930,526
Div. 11 Subtotal:				$8,365,613

Project: GNHWPCA Long Term Control Plan Update
Facility: IFAS
Estimate Type: Conceptual
Prepared By: J. Ososkie/HRT
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Division 12 - Furnishings				
Not Used				
Div. 12 Subtotal:				
Division 13 - Special Construction				
Not Used				
Div. 13 Subtotal:				
Division 14 - Conveying Systems				
Not Used				
Div. 14 Subtotal:				
Division 15 - Mechanical				
Included in percentages below				
Div. 15 Subtotal:				
Division 16 - Electrical				
Included in percentages below				
Div. 16 Subtotal:				
Subtotal Division 1 - 11 (64%)				**$9,315,375**
Percentage of Costs				
Metals	3%		$14,555,274	$436,658
Finishes	0%		$14,555,274	
Process Mechanical Piping	15%		$14,555,274	$2,183,291
I&C	6%		$14,555,274	$873,316
Electrical	12%		$14,555,274	$1,746,633
Facility Subtotal:				$14,555,274
General Requirements	10%		$1,455,527	
Overhead	8%		$1,280,864	
Profit	10%		$1,601,080	
Mobilization/Demolization	3.0%		$480,324	
Bond/Insurance	3%		$480,324	
Subtotal:				$19,853,394
Contingency	20%		$3,970,679	$3,970,679
Total Facility Cost:				**$23,824,073**

Long-Term Improvements Fair Haven Sewer Separation

Project: GNHWPCA Long Term Control Plan Update
Facility: Fair Haven Sewer Separation
Estimate Type: Conceptual
Prepared By: J. Ososkie
Date: 10/4/2016

Item of Work	Qty	Unit	Unit Cost	Total Cost
Sewer Separation				
15" Storm	55,487	LF	450	$24,969,150
18" Storm	4,132	LF	500	$2,066,000
21" Storm	1,754	LF	600	$1,052,400
24" Storm	1,928	LF	700	$1,349,600
27" Storm	1,261	LF	1,000	$1,261,000
30" Storm	2,535	LF	1,250	$3,168,750
36" Storm	1,564	LF	1,500	$2,346,000
42" Storm	646	LF	1,800	$1,162,800
48" Storm	1,749	LF	1,900	$3,323,100
54" Storm	1,390	LF	2,000	$2,780,000
Subtototal				**$43,478,800**
General Requirements	10%			$4,347,880.00
Overhead	8%			$3,478,304.00
Profit	10%			$4,347,880.00
Mobilization/Demolization	3%			$1,304,364.00
Bond/Insurance	3%			$1,304,364.00
Subtototal				**$58,261,592**
Contingency	35%			$20,391,557.20
Total Cost:				**$78,653,149**

Long-Term Improvements CSO Storage Tanks

Great New Haven WWTP Master Plan
Storage Tank Estimate
Construction Cost Estimate for Conceptual Design

Project name	GNH WWTP Master Plan
Estimator	Tweneboa-Kodua, A/WDC
Project Number	478874
Estimate Class 1-5	4
Design Stage	Concept
Project Manager	John Ososkie/HRT
Rev No. / Date	R04/(11-30-2016)

Facility Summary

	Project: GNH WWTP Master Plan	Estimator:	Tweneboa-Kodua, A/WDC
Job Size: 1 LS	Project No.: 478874	Revision / Date:	R04/(11-30-2016)
Duration: 1 LS	Design Stage: Concept	Estimate Class:	4

Facility	Description	Direct Amount	Grand Total w/Markups	Percent of Total
003	CSO 003 Storage Tank	1,079,209	1,995,205	4.005
004	CSO 004 Storage Tank	3,299,209	6,172,411	12.389
005	CSO 005 Storage Tank	6,999,209	13,134,419	26.363
012	CSO 006 StorageTank	5,852,209	10,976,197	22.031
014	CSO 011 StorageTank	5,630,209	10,558,476	21.193
016	CSO 015 StorageTank	2,152,209	4,014,188	8.057
018	CSO 016 StorageTank	1,597,209	2,969,887	5.961

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	12,057,956			24.20%
Material	30,940,144			62.10%
Subcontract	4,389,447			8.81%
Equipment	1,890,198			3.79%
Other	543,037			1.09%
Total Prime Contractor Costs	**49,820,782**	**49,820,782**		**100.00**

Detail Report

Job Size: 1 LS
Duration: 1 LS

Project: GNH WWTP Master Plan
Project No.: 478874
Design Stage: Concept

Estimator: Tweneboa-Kodua, A/WDC
Revision / Date: R04/(11-30-2016)
Estimate Class: 4

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
003			CSO 003 Storage Tank										
	13.0		Effluent Pump Station										
		13-10	Buildings Complete										
			Effluent Pump Station										
			Masonry Building										
			Pump Building Masonry 20' x 20'	400.00 sf	28,638	28,000	-	105,072	-	404.27 /sf	161,710	740.48 /sf	296,191
			Masonry Building	400.00 SF	28,638	28,000		105,072		404.27 /SF	161,710	740.48 /SF	296,191
			Mechanical, Other										
			Miscelleneous piping allowance	1.00 ls	-	-	200,000	-	-	200,000.00 /ls	200,000	366,324.80 /ls	366,325
			Mechanical, Other	400.00 SF			200,000			500.00 /SF	200,000	915.81 /SF	366,325
			Mechanical, HVAC										
			Condensing unit, air cooled, compressor, 4 ton, includes standard controls	1.00 ea	3,095	8,500	-	-	-	11,595.04 /ea	11,595	21,237.76 /ea	21,238
			Mechanical, HVAC	400.00 SF	3,095	8,500				28.99 /SF	11,595	53.09 /SF	21,238
			Electrical, Other										
			Miscellaneous electrical and I&C	1.00 ls	-	-	100,000	-	-	100,000.00 /ls	100,000	183,162.40 /ls	183,162
			Electrical, Other	400.00 SF			100,000			250.00 /SF	100,000	457.91 /SF	183,162
			Electrical Equipment, Generators - >300 to 400 KW										
			Emergency Generator 400 KW	1.00 E	7,541	120,000	-	-	-	127,540.92 /E	127,541	233,606.99 /E	233,607
			Electrical Equipment, Generators - >300 to 400 KW	1.00 EA	7,541	120,000				127,540.92 /EA	127,541	233,606.99 /EA	233,607
			I&C, Flow / Mag Meter / Indicators & Transmitters										
			Pump Flow Meter including transmitter	2.00 ea	1,194	20,400	-	-	-	10,796.99 /ea	21,594	19,776.03 /ea	39,552
			I&C, Flow / Mag Meter / Indicators & Transmitters	2.00 EA	1,194	20,400				10,796.99 /EA	21,594	19,776.03 /EA	39,552
			I&C, Level / Switches										
			Float switch	8.00 ea	1,203	-	-	-	-	150.40 /ea	1,203	275.48 /ea	2,204
			Float switch bracket	2.00 ea	602	300	-	-	-	450.80 /ea	902	825.70 /ea	1,651
			I&C, Level / Switches	10.00 EA	1,805	300				210.48 /EA	2,105	385.52 /EA	3,855
			I&C, Panels & Stands										
			System panel	2.00 ea	1,203	12,000	-	-	-	6,601.60 /ea	13,203	12,091.65 /ea	24,183
			I&C, Panels & Stands	2.00 EA	1,203	12,000				6,601.60 /EA	13,203	12,091.65 /EA	24,183
			Submersible Pump: 35Hp										
			Functional Testing, Submersible Pumps, 21 - 50 hp	2.00 ea	602	100	-	-	-	350.80 /ea	702	642.54 /ea	1,285
			FURNISH Submersible Pump, 35 hp	2.00 EA	-	63,000	-	-	-	31,500.00 /EA	63,000	57,696.15 /EA	115,392
			Set base elbow / pump assembly, 35 hp	2.00 ea	5,414	100	-	-	-	2,757.20 /ea	5,514	5,050.15 /ea	10,100
			Stainless steel guide rails, 3",	40.00 lf	1,306	694	-	-	-	50.00 /lf	2,000	91.58 /lf	3,663
			Install upper guide rail bracket	2.00 ea	226	20	-	-	-	122.80 /ea	246	224.92 /ea	450
			Submersible Pump: 35Hp	2.00 EA	7,547	63,914				35,730.80 /EA	71,462	65,445.39 /EA	130,891
			Effluent Pump Station	1.00 EA	51,023	253,114	300,000	105,072		709,209.14 /EA	709,209	1,299,004.46 /EA	1,299,004
			13-10 Buildings Complete	400.00 SF	51,023	253,114	300,000	105,072		1,773.02 /SF	709,209	3,247.51 /SF	1,299,004
			13.0 Effluent Pump Station	400.00 SF	51,023	253,114	300,000	105,072		1,773.02 /SF	709,209	3,247.51 /SF	1,299,004
	33.5		Tank Construction										
		33.90	Tanks										
			Cast-In-Place Concrete Storage Tank										
			Tanks, Other										
			Storage Tanks construction, below grade, cast-in-place concrete, 100,000 gaillons, incluidng sitework, miscellaneous piping excludiing pump station	100,000.00 gal	105,714	264,286		-		3.70 /gal	370,000	6.96 /gal	696,201
			Tanks, Other	100,000.00 GAL	105,714	264,286				3.70 /GAL	370,000	6.96 /GAL	696,201
			Cast-In-Place Concrete Storage Tank	100,000.00 GAL	105,714	264,286				3.70 /GAL	370,000	6.96 /GAL	696,201
			33.90 Tanks	100,000.00 GAL	105,714	264,286				3.70 /GAL	370,000	6.96 /GAL	696,201
			33.5 Tank Construction	100,000.00 GAL	105,714	264,286				3.70 /GAL	370,000	6.96 /GAL	696,201
			003 CSO 003 Storage Tank	0.10 MG	156,737	517,400	300,000	105,072		10,792,091.40 /MG	1,079,209	19,952,053.40 /MG	1,995,205
004			CSO 004 Storage Tank										
	13.0		Effluent Pump Station										
		13-10	Buildings Complete										
			Effluent Pump Station										
			Masonry Building										
			Pump Building Masonry 20' x 20'	400.00 sf	28,638	28,000	-	105,072	-	404.27 /sf	161,710	740.48 /sf	296,191
			Masonry Building	400.00 SF	28,638	28,000		105,072		404.27 /SF	161,710	740.48 /SF	296,191
			Mechanical, Other										
			Miscelleneous piping allowance	1.00 ls	-	-	200,000	-	-	200,000.00 /ls	200,000	366,324.80 /ls	366,325
			Mechanical, Other	400.00 SF			200,000			500.00 /SF	200,000	915.81 /SF	366,325
			Mechanical, HVAC										
			Condensing unit, air cooled, compressor, 4 ton, includes standard controls	1.00 ea	3,095	8,500	-	-	-	11,595.04 /ea	11,595	21,237.75 /ea	21,238

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Mechanical, HVAC	**400.00 SF**	**3,095**	**8,500**				**28.99 /SF**	**11,595**	**53.09 /SF**	**21,238**
			Electrical, Other										
			Miscellaneous electrical and I&C	1.00 ls	-	-	100,000	-	-	100,000.00 /ls	100,000	183,162.39 /ls	183,162
			Electrical, Other	**400.00 SF**			**100,000**			**250.00 /SF**	**100,000**	**457.91 /SF**	**183,162**
			Electrical Equipment, Generators - >300 to 400 KW										
			Emergency Generator 400 KW	1.00 E	7,541	120,000	-	-	-	127,540.92 /E	127,541	233,607.02 /E	233,607
			Electrical Equipment, Generators - >300 to 400 KW	**1.00 EA**	**7,541**	**120,000**				**127,540.92 /EA**	**127,541**	**233,607.02 /EA**	**233,607**
			I&C, Flow / Mag Meter / Indicators & Transmitters										
			Pump Flow Meter including transmitter	2.00 ea	1,194	20,400	-	-	-	10,796.99 /ea	21,594	19,776.01 /ea	39,552
			I&C, Flow / Mag Meter / Indicators & Transmitters	**2.00 EA**	**1,194**	**20,400**				**10,796.99 /EA**	**21,594**	**19,776.01 /EA**	**39,552**
			I&C, Level / Switches										
			Float switch	8.00 ea	1,203	-	-	-	-	150.40 /ea	1,203	275.48 /ea	2,204
			Float switch bracket	2.00 ea	602	300	-	-	-	450.80 /ea	902	825.70 /ea	1,651
			I&C, Level / Switches	**10.00 EA**	**1,805**	**300**				**210.48 /EA**	**2,105**	**385.52 /EA**	**3,855**
			I&C, Panels & Stands										
			System panel	2.00 ea	1,203	12,000	-	-	-	6,601.60 /ea	13,203	12,091.65 /ea	24,183
			I&C, Panels & Stands	**2.00 EA**	**1,203**	**12,000**				**6,601.60 /EA**	**13,203**	**12,091.65 /EA**	**24,183**
			Submersible Pump: 35Hp										
			Functional Testing, Submersible Pumps, 21 - 50 hp	2.00 ea	602	100	-	-	-	350.80 /ea	702	642.54 /ea	1,285
			FURNISH Submersible Pump, 35 hp	2.00 EA	-	63,000	-	-	-	31,500.00 /EA	63,000	57,696.16 /EA	115,392
			Set base elbow / pump assembly, 35 hp	2.00 ea	5,414	100	-	-	-	2,757.20 /ea	5,514	5,050.15 /ea	10,100
			Stainless steel guide rails, 3",	40.00 lf	1,306	694	-	-	-	50.00 /lf	2,000	91.58 /lf	3,663
			Install upper guide rail bracket	2.00 ea	226	20	-	-	-	122.80 /ea	246	224.93 /ea	450
			Submersible Pump: 35Hp	**2.00 EA**	**7,547**	**63,914**				**35,730.80 /EA**	**71,462**	**65,445.39 /EA**	**130,891**
			Effluent Pump Station	**1.00 EA**	**51,023**	**253,114**	**300,000**	**105,072**		**709,209.14 /EA**	**709,209**	**1,299,004.45 /EA**	**1,299,004**
			13-10 Buildings Complete	**400.00 SF**	**51,023**	**253,114**	**300,000**	**105,072**		**1,773.02 /SF**	**709,209**	**3,247.51 /SF**	**1,299,004**
			13.0 Effluent Pump Station	**400.00 SF**	**51,023**	**253,114**	**300,000**	**105,072**		**1,773.02 /SF**	**709,209**	**3,247.51 /SF**	**1,299,004**
	33.5		**Tank Construction**										
		33.90	**Tanks**										
			Cast-In-Place Concrete Storage Tank										
			Tanks, Other										
			Storage Tanks construction, below grade, cast-in-place concrete, 700,000 gaillons, incluidng sitework, miscellaneous piping excludiing pump station	700,000.00 gal	740,000	1,850,000		-		3.70 /gal	2,590,000	6.96 /gal	4,873,406
			Tanks, Other	**700,000.00 GAL**	**740,000**	**1,850,000**				**3.70 /GAL**	**2,590,000**	**6.96 /GAL**	**4,873,406**
			Cast-In-Place Concrete Storage Tank	**700,000.00 GAL**	**740,000**	**1,850,000**				**3.70 /GAL**	**2,590,000**	**6.96 /GAL**	**4,873,406**
			33.90 Tanks	**700,000.00 GAL**	**740,000**	**1,850,000**				**3.70 /GAL**	**2,590,000**	**6.96 /GAL**	**4,873,406**
			33.5 Tank Construction	**700,000.00 GAL**	**740,000**	**1,850,000**				**3.70 /GAL**	**2,590,000**	**6.96 /GAL**	**4,873,406**
			004 CSO 004 Storage Tank	**0.70 MG**	**791,023**	**2,103,114**	**300,000**	**105,072**		**4,713,155.91 /MG**	**3,299,209**	**8,817,729.34 /MG**	**6,172,411**
005			**CSO 005 Storage Tank**										
	13.0		**Effluent Pump Station**										
		13-10	**Buildings Complete**										
			Effluent Pump Station										
			Masonry Building										
			Pump Building Masonry 20' x 20'	400.00 sf	28,638	28,000	-	105,072	-	404.27 /sf	161,710	740.48 /sf	296,191
			Masonry Building	**400.00 SF**	**28,638**	**28,000**		**105,072**		**404.27 /SF**	**161,710**	**740.48 /SF**	**296,191**
			Mechanical, Other										
			Miscelleneous piping allowance	1.00 ls	-	-	200,000	-	-	200,000.00 /ls	200,000	366,324.80 /ls	366,325
			Mechanical, Other	**400.00 SF**			**200,000**			**500.00 /SF**	**200,000**	**915.81 /SF**	**366,325**
			Mechanical, HVAC										
			Condensing unit, air cooled, compressor, 4 ton, includes standard controls	1.00 ea	3,095	8,500	-	-	-	11,595.04 /ea	11,595	21,237.75 /ea	21,238
			Mechanical, HVAC	**400.00 SF**	**3,095**	**8,500**				**28.99 /SF**	**11,595**	**53.09 /SF**	**21,238**
			Electrical, Other										
			Miscellaneous electrical and I&C	1.00 ls	-	-	100,000	-	-	100,000.00 /ls	100,000	183,162.40 /ls	183,162
			Electrical, Other	**400.00 SF**			**100,000**			**250.00 /SF**	**100,000**	**457.91 /SF**	**183,162**
			Electrical Equipment, Generators - >300 to 400 KW										
			Emergency Generator 400 KW	1.00 E	7,541	120,000	-	-	-	127,540.92 /E	127,541	233,607.00 /E	233,607
			Electrical Equipment, Generators - >300 to 400 KW	**1.00 EA**	**7,541**	**120,000**				**127,540.92 /EA**	**127,541**	**233,607.00 /EA**	**233,607**
			I&C, Flow / Mag Meter / Indicators & Transmitters										
			Pump Flow Meter including transmitter	2.00 ea	1,194	20,400	-	-	-	10,796.99 /ea	21,594	19,776.03 /ea	39,552
			I&C, Flow / Mag Meter / Indicators & Transmitters	**2.00 EA**	**1,194**	**20,400**				**10,796.99 /EA**	**21,594**	**19,776.03 /EA**	**39,552**
			I&C, Level / Switches										
			Float switch	8.00 ea	1,203	-	-	-	-	150.40 /ea	1,203	275.48 /ea	2,204
			Float switch bracket	2.00 ea	602	300	-	-	-	450.80 /ea	902	825.70 /ea	1,651

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			I&C, Level / Switches	10.00 EA	1,805	300				210.48 /EA	2,105	385.52 /EA	3,855
			I&C, Panels & Stands										
			System panel	2.00 ea	1,203	12,000	-	-	-	6,601.60 /ea	13,203	12,091.65 /ea	24,183
			I&C, Panels & Stands	2.00 EA	1,203	12,000				6,601.60 /EA	13,203	12,091.65 /EA	24,183
			Submersible Pump: 35Hp										
			Functional Testing, Submersible Pumps, 21 - 50 hp	2.00 ea	602	100	-	-	-	350.80 /ea	702	642.54 /ea	1,285
			FURNISH Submersible Pump, 35 hp	2.00 EA	-	63,000	-	-	-	31,500.00 /EA	63,000	57,696.14 /EA	115,392
			Set base elbow / pump assembly, 35 hp	2.00 ea	5,414	100	-	-	-	2,757.20 /ea	5,514	5,050.16 /ea	10,100
			Stainless steel guide rails, 3",	40.00 lf	1,306	694	-	-	-	50.00 /lf	2,000	91.58 /lf	3,663
			Install upper guide rail bracket	2.00 ea	226	20	-	-	-	122.80 /ea	246	224.91 /ea	450
			Submersible Pump: 35Hp	2.00 EA	7,547	63,914				35,730.80 /EA	71,462	65,445.39 /EA	130,891
			Effluent Pump Station	1.00 EA	51,023	253,114	300,000	105,072		709,209.14 /EA	709,209	1,299,004.45 /EA	1,299,004
			13-10 Buildings Complete	400.00 SF	51,023	253,114	300,000	105,072		1,773.02 /SF	709,209	3,247.51 /SF	1,299,004
			13.0 Effluent Pump Station	400.00 SF	51,023	253,114	300,000	105,072		1,773.02 /SF	709,209	3,247.51 /SF	1,299,004
	33.5		Tank Construction										
		33.90	Tanks										
			Cast-In-Place Concrete Storage Tank										
			Tanks, Other										
			Storage Tanks construction, below grade, cast-in-place concrete, 1,700,000 gaillons, incluidng sitework, miscellaneous piping excludiing pump station	1,700,000.00 gal	1,797,143	4,492,857		-		3.70 /gal	6,290,000	6.96 /gal	11,835,415
			Tanks, Other	1,700,000.00 GAL	1,797,143	4,492,857				3.70 /GAL	6,290,000	6.96 /GAL	11,835,415
			Cast-In-Place Concrete Storage Tank	1,700,000.00 GAL	1,797,143	4,492,857				3.70 /GAL	6,290,000	6.96 /GAL	11,835,415
			33.90 Tanks	1,700,000.00 GAL	1,797,143	4,492,857				3.70 /GAL	6,290,000	6.96 /GAL	11,835,415
			33.5 Tank Construction	1,700,000.00 GAL	1,797,143	4,492,857				3.70 /GAL	6,290,000	6.96 /GAL	11,835,415
			005 CSO 005 Storage Tank	**1.70 MG**	**1,848,166**	**4,745,972**	**300,000**	**105,072**		**4,117,181.85 /MG**	**6,999,209**	**7,726,128.97 /MG**	**13,134,419**
012			**CSO 006 StorageTank**										
	13.0		Effluent Pump Station										
		13-10	Buildings Complete										
			Effluent Pump Station										
			Masonry Building										
			Pump Building Masonry 20' x 20'	400.00 sf	28,638	28,000	-	105,072	-	404.27 /sf	161,710	740.48 /sf	296,191
			Masonry Building	400.00 SF	28,638	28,000		105,072		404.27 /SF	161,710	740.48 /SF	296,191
			Mechanical, Other										
			Miscelleneous piping allowance	1.00 ls	-	-	200,000	-	-	200,000.00 /ls	200,000	366,324.78 /ls	366,325
			Mechanical, Other	400.00 SF			200,000			500.00 /SF	200,000	915.81 /SF	366,325
			Mechanical, HVAC										
			Condensing unit, air cooled, compressor, 4 ton, includes standard controls	1.00 ea	3,095	8,500	-	-	-	11,595.04 /ea	11,595	21,237.76 /ea	21,238
			Mechanical, HVAC	400.00 SF	3,095	8,500				28.99 /SF	11,595	53.09 /SF	21,238
			Electrical, Other										
			Miscellaneous electrical and I&C	1.00 ls	-	-	100,000	-	-	100,000.00 /ls	100,000	183,162.41 /ls	183,162
			Electrical, Other	400.00 SF			100,000			250.00 /SF	100,000	457.91 /SF	183,162
			Electrical Equipment, Generators - >300 to 400 KW										
			Emergency Generator 400 KW	1.00 E	7,541	120,000	-	-	-	127,540.92 /E	127,541	233,607.00 /E	233,607
			Electrical Equipment, Generators - >300 to 400 KW	1.00 EA	7,541	120,000				127,540.92 /EA	127,541	233,607.00 /EA	233,607
			I&C, Flow / Mag Meter / Indicators & Transmitters										
			Pump Flow Meter including transmitter	2.00 ea	1,194	20,400	-	-	-	10,796.99 /ea	21,594	19,776.03 /ea	39,552
			I&C, Flow / Mag Meter / Indicators & Transmitters	2.00 EA	1,194	20,400				10,796.99 /EA	21,594	19,776.03 /EA	39,552
			I&C, Level / Switches										
			Float switch	8.00 ea	1,203	-	-	-	-	150.40 /ea	1,203	275.48 /ea	2,204
			Float switch bracket	2.00 ea	602	300	-	-	-	450.80 /ea	902	825.70 /ea	1,651
			I&C, Level / Switches	10.00 EA	1,805	300				210.48 /EA	2,105	385.52 /EA	3,855
			I&C, Panels & Stands										
			System panel	2.00 ea	1,203	12,000	-	-	-	6,601.60 /ea	13,203	12,091.66 /ea	24,183
			I&C, Panels & Stands	2.00 EA	1,203	12,000				6,601.60 /EA	13,203	12,091.66 /EA	24,183
			Submersible Pump: 35Hp										
			Functional Testing, Submersible Pumps, 21 - 50 hp	2.00 ea	602	100	-	-	-	350.80 /ea	702	642.53 /ea	1,285
			FURNISH Submersible Pump, 35 hp	2.00 EA	-	63,000	-	-	-	31,500.00 /EA	63,000	57,696.15 /EA	115,392
			Set base elbow / pump assembly, 35 hp	2.00 ea	5,414	100	-	-	-	2,757.20 /ea	5,514	5,050.15 /ea	10,100
			Stainless steel guide rails, 3",	40.00 lf	1,306	694	-	-	-	50.00 /lf	2,000	91.58 /lf	3,663
			Install upper guide rail bracket	2.00 ea	226	20	-	-	-	122.80 /ea	246	224.94 /ea	450
			Submersible Pump: 35Hp	2.00 EA	7,547	63,914				35,730.80 /EA	71,462	65,445.39 /EA	130,891
			Effluent Pump Station	1.00 EA	51,023	253,114	300,000	105,072		709,209.14 /EA	709,209	1,299,004.47 /EA	1,299,004
			13-10 Buildings Complete	400.00 SF	51,023	253,114	300,000	105,072		1,773.02 /SF	709,209	3,247.51 /SF	1,299,004

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			13.0 Effluent Pump Station	400.00 SF	51,023	253,114	300,000	105,072		1,773.02 /SF	709,209	3,247.51 /SF	1,299,004
	33.5		Tank Construction										
		33.90	Tanks										
			Cast-In-Place Concrete Storage Tank										
			Tanks, Other										
			Storage Tanks construction, below grade, cast-in-place concrete, 3,200,000 gaillons, incluidng sitework, miscellaneous piping excludiing pump station	1,390,000.00 gal	1,469,429	3,673,571		-		3.70 /gal	5,143,000	6.96 /gal	9,677,192
			Tanks, Other	1,390,000.00 GAL	1,469,429	3,673,571				3.70 /GAL	5,143,000	6.96 /GAL	9,677,192
			Cast-In-Place Concrete Storage Tank	1,390,000.00 GAL	1,469,429	3,673,571				3.70 /GAL	5,143,000	6.96 /GAL	9,677,192
			33.90 Tanks	1,390,000.00 GAL	1,469,429	3,673,571				3.70 /GAL	5,143,000	6.96 /GAL	9,677,192
			33.5 Tank Construction	1,390,000.00 GAL	1,469,429	3,673,571				3.70 /GAL	5,143,000	6.96 /GAL	9,677,192
			012 CSO 006 StorageTank	**1.39 MG**	**1,520,452**	**3,926,686**	**300,000**	**105,072**		**4,210,222.40 /MG**	**5,852,209**	**7,896,544.27 /MG**	**10,976,197**
014			**CSO 011 StorageTank**										
	13.0		Effluent Pump Station										
		13-10	Buildings Complete										
			Effluent Pump Station										
			Masonry Building										
			Pump Building Masonry 20' x 20'	400.00 sf	28,638	28,000	-	105,072	-	404.27 /sf	161,710	740.48 /sf	296,191
			Masonry Building	400.00 SF	28,638	28,000		105,072		404.27 /SF	161,710	740.48 /SF	296,191
			Mechanical, Other										
			Miscelleneous piping allowance	1.00 ls	-	-	200,000	-	-	200,000.00 /ls	200,000	366,324.79 /ls	366,325
			Mechanical, Other	400.00 SF			200,000			500.00 /SF	200,000	915.81 /SF	366,325
			Mechanical, HVAC										
			Condensing unit, air cooled, compressor, 4 ton, includes standard controls	1.00 ea	3,095	8,500	-	-	-	11,595.04 /ea	11,595	21,237.76 /ea	21,238
			Mechanical, HVAC	400.00 SF	3,095	8,500				28.99 /SF	11,595	53.09 /SF	21,238
			Electrical, Other										
			Miscellaneous electrical and I&C	1.00 ls	-	-	100,000	-	-	100,000.00 /ls	100,000	183,162.39 /ls	183,162
			Electrical, Other	400.00 SF			100,000			250.00 /SF	100,000	457.91 /SF	183,162
			Electrical Equipment, Generators - >300 to 400 KW										
			Emergency Generator 400 KW	1.00 E	7,541	120,000	-	-	-	127,540.92 /E	127,541	233,607.01 /E	233,607
			Electrical Equipment, Generators - >300 to 400 KW	1.00 EA	7,541	120,000				127,540.92 /EA	127,541	233,607.01 /EA	233,607
			I&C, Flow / Mag Meter / Indicators & Transmitters										
			Pump Flow Meter including transmitter	2.00 ea	1,194	20,400	-	-	-	10,796.99 /ea	21,594	19,776.03 /ea	39,552
			I&C, Flow / Mag Meter / Indicators & Transmitters	2.00 EA	1,194	20,400				10,796.99 /EA	21,594	19,776.03 /EA	39,552
			I&C, Level / Switches										
			Float switch	8.00 ea	1,203	-	-	-	-	150.40 /ea	1,203	275.48 /ea	2,204
			Float switch bracket	2.00 ea	602	300	-	-	-	450.80 /ea	902	825.69 /ea	1,651
			I&C, Level / Switches	10.00 EA	1,805	300				210.48 /EA	2,105	385.52 /EA	3,855
			I&C, Panels & Stands										
			System panel	2.00 ea	1,203	12,000	-	-	-	6,601.60 /ea	13,203	12,091.66 /ea	24,183
			I&C, Panels & Stands	2.00 EA	1,203	12,000				6,601.60 /EA	13,203	12,091.66 /EA	24,183
			Submersible Pump: 35Hp										
			Functional Testing, Submersible Pumps, 21 - 50 hp	2.00 ea	602	100	-	-	-	350.80 /ea	702	642.53 /ea	1,285
			FURNISH Submersible Pump, 35 hp	2.00 EA	-	63,000	-	-	-	31,500.00 /EA	63,000	57,696.15 /EA	115,392
			Set base elbow / pump assembly, 35 hp	2.00 ea	5,414	100	-	-	-	2,757.20 /ea	5,514	5,050.16 /ea	10,100
			Stainless steel guide rails, 3",	40.00 lf	1,306	694	-	-	-	50.00 /lf	2,000	91.58 /lf	3,663
			Install upper guide rail bracket	2.00 ea	226	20	-	-	-	122.80 /ea	246	224.92 /ea	450
			Submersible Pump: 35Hp	2.00 EA	7,547	63,914				35,730.80 /EA	71,462	65,445.38 /EA	130,891
			Effluent Pump Station	1.00 EA	51,023	253,114	300,000	105,072		709,209.14 /EA	709,209	1,299,004.46 /EA	1,299,004
			13-10 Buildings Complete	400.00 SF	51,023	253,114	300,000	105,072		1,773.02 /SF	709,209	3,247.51 /SF	1,299,004
			13.0 Effluent Pump Station	400.00 SF	51,023	253,114	300,000	105,072		1,773.02 /SF	709,209	3,247.51 /SF	1,299,004
	33.5		Tank Construction										
		33.90	Tanks										
			Cast-In-Place Concrete Storage Tank										
			Tanks, Other										
			Storage Tanks construction, below grade, cast-in-place concrete, 3,200,000 gaillons, incluidng sitework, miscellaneous piping excludiing pump station	1,330,000.00 gal	1,406,000	3,515,000		-		3.70 /gal	4,921,000	6.96 /gal	9,259,472
			Tanks, Other	1,330,000.00 GAL	1,406,000	3,515,000				3.70 /GAL	4,921,000	6.96 /GAL	9,259,472
			Cast-In-Place Concrete Storage Tank	1,330,000.00 GAL	1,406,000	3,515,000				3.70 /GAL	4,921,000	6.96 /GAL	9,259,472
			33.90 Tanks	1,330,000.00 GAL	1,406,000	3,515,000				3.70 /GAL	4,921,000	6.96 /GAL	9,259,472
			33.5 Tank Construction	1,330,000.00 GAL	1,406,000	3,515,000				3.70 /GAL	4,921,000	6.96 /GAL	9,259,472

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			014 CSO 011 StorageTank	**1.33 MG**	**1,457,023**	**3,768,114**	**300,000**	**105,072**		**4,233,239.96 /MG**	**5,630,209**	**7,938,703.79 /MG**	**10,558,476**
016			**CSO 015 StorageTank**										
	13.0		Effluent Pump Station										
		13-10	Buildings Complete										
			Effluent Pump Station										
			Masonry Building										
			Pump Building Masonry 20' x 20'	400.00 sf	28,638	28,000	-	105,072	-	404.27 /sf	161,710	740.48 /sf	296,191
			Masonry Building	**400.00 SF**	**28,638**	**28,000**		**105,072**		**404.27 /SF**	**161,710**	**740.48 /SF**	**296,191**
			Mechanical, Other										
			Miscelleneous piping allowance	1.00 ls	-	-	200,000	-	-	200,000.00 /ls	200,000	366,324.79 /ls	366,325
			Mechanical, Other	**400.00 SF**			**200,000**			**500.00 /SF**	**200,000**	**915.81 /SF**	**366,325**
			Mechanical, HVAC										
			Condensing unit, air cooled, compressor, 4 ton, includes standard controls	1.00 ea	3,095	8,500	-	-	-	11,595.04 /ea	11,595	21,237.75 /ea	21,238
			Mechanical, HVAC	**400.00 SF**	**3,095**	**8,500**				**28.99 /SF**	**11,595**	**53.09 /SF**	**21,238**
			Electrical, Other										
			Miscellaneous electrical and I&C	1.00 ls	-	-	100,000	-	-	100,000.00 /ls	100,000	183,162.40 /ls	183,162
			Electrical, Other	**400.00 SF**			**100,000**			**250.00 /SF**	**100,000**	**457.91 /SF**	**183,162**
			Electrical Equipment, Generators - >300 to 400 KW										
			Emergency Generator 400 KW	1.00 E	7,541	120,000	-	-	-	127,540.92 /E	127,541	233,607.00 /E	233,607
			Electrical Equipment, Generators - >300 to 400 KW	**1.00 EA**	**7,541**	**120,000**				**127,540.92 /EA**	**127,541**	**233,607.00 /EA**	**233,607**
			I&C, Flow / Mag Meter / Indicators & Transmitters										
			Pump Flow Meter including transmitter	2.00 ea	1,194	20,400	-	-	-	10,796.99 /ea	21,594	19,776.03 /ea	39,552
			I&C, Flow / Mag Meter / Indicators & Transmitters	**2.00 EA**	**1,194**	**20,400**				**10,796.99 /EA**	**21,594**	**19,776.03 /EA**	**39,552**
			I&C, Level / Switches										
			Float switch	8.00 ea	1,203	-	-	-	-	150.40 /ea	1,203	275.48 /ea	2,204
			Float switch bracket	2.00 ea	602	300	-	-	-	450.80 /ea	902	825.70 /ea	1,651
			I&C, Level / Switches	**10.00 EA**	**1,805**	**300**				**210.48 /EA**	**2,105**	**385.52 /EA**	**3,855**
			I&C, Panels & Stands										
			System panel	2.00 ea	1,203	12,000	-	-	-	6,601.60 /ea	13,203	12,091.65 /ea	24,183
			I&C, Panels & Stands	**2.00 EA**	**1,203**	**12,000**				**6,601.60 /EA**	**13,203**	**12,091.65 /EA**	**24,183**
			Submersible Pump: 35Hp										
			Functional Testing, Submersible Pumps, 21 - 50 hp	2.00 ea	602	100	-	-	-	350.80 /ea	702	642.53 /ea	1,285
			FURNISH Submersible Pump, 35 hp	2.00 EA	-	63,000	-	-	-	31,500.00 /EA	63,000	57,696.15 /EA	115,392
			Set base elbow / pump assembly, 35 hp	2.00 ea	5,414	100	-	-	-	2,757.20 /ea	5,514	5,050.15 /ea	10,100
			Stainless steel guide rails, 3",	40.00 lf	1,306	694	-	-	-	50.00 /lf	2,000	91.58 /lf	3,663
			Install upper guide rail bracket	2.00 ea	226	20	-	-	-	122.80 /ea	246	224.94 /ea	450
			Submersible Pump: 35Hp	**2.00 EA**	**7,547**	**63,914**				**35,730.80 /EA**	**71,462**	**65,445.40 /EA**	**130,891**
			Effluent Pump Station	**1.00 EA**	**51,023**	**253,114**	**300,000**	**105,072**		**709,209.14 /EA**	**709,209**	**1,299,004.47 /EA**	**1,299,004**
			13-10 Buildings Complete	**400.00 SF**	**51,023**	**253,114**	**300,000**	**105,072**		**1,773.02 /SF**	**709,209**	**3,247.51 /SF**	**1,299,004**
			13.0 Effluent Pump Station	**400.00 SF**	**51,023**	**253,114**	**300,000**	**105,072**		**1,773.02 /SF**	**709,209**	**3,247.51 /SF**	**1,299,004**
	33.5		Tank Construction										
		33.90	Tanks										
			Cast-In-Place Concrete Storage Tank										
			Tanks, Other										
			Storage Tanks construction, below grade, cast-in-place concrete, 390,000 gaillons, incluidng sitework, miscellaneous piping excludiing pump station	390,000.00 gal	288,600	288,600	288,600	288,600	288,600	3.70 /gal	1,443,000	6.96 /gal	2,715,183
			Tanks, Other	**390,000.00 GAL**	**288,600**	**288,600**	**288,600**	**288,600**	**288,600**	**3.70 /GAL**	**1,443,000**	**6.96 /GAL**	**2,715,183**
			Cast-In-Place Concrete Storage Tank	**390,000.00 GAL**	**288,600**	**288,600**	**288,600**	**288,600**	**288,600**	**3.70 /GAL**	**1,443,000**	**6.96 /GAL**	**2,715,183**
			33.90 Tanks	**390,000.00 GAL**	**288,600**	**288,600**	**288,600**	**288,600**	**288,600**	**3.70 /GAL**	**1,443,000**	**6.96 /GAL**	**2,715,183**
			33.5 Tank Construction	**390,000.00 GAL**	**288,600**	**288,600**	**288,600**	**288,600**	**288,600**	**3.70 /GAL**	**1,443,000**	**6.96 /GAL**	**2,715,183**
			016 CSO 015 StorageTank	**0.39 MG**	**339,623**	**541,714**	**588,600**	**393,672**	**288,600**	**5,518,484.97 /MG**	**2,152,209**	**10,292,789.33 /MG**	**4,014,188**
018			**CSO 016 StorageTank**										
	13.0		Effluent Pump Station										
		13-10	Buildings Complete										
			Effluent Pump Station										
			Masonry Building										
			Pump Building Masonry 20' x 20'	400.00 sf	28,638	28,000	-	105,072	-	404.27 /sf	161,710	740.48 /sf	296,191
			Masonry Building	**400.00 SF**	**28,638**	**28,000**		**105,072**		**404.27 /SF**	**161,710**	**740.48 /SF**	**296,191**
			Mechanical, Other										
			Miscelleneous piping allowance	1.00 ls	-	-	200,000	-	-	200,000.00 /ls	200,000	366,324.80 /ls	366,325
			Mechanical, Other	**400.00 SF**			**200,000**			**500.00 /SF**	**200,000**	**915.81 /SF**	**366,325**
			Mechanical, HVAC										

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Mechanical, HVAC										
			Condensing unit, air cooled, compressor, 4 ton, includes standard controls	1.00 ea	3,095	8,500	-	-	-	11,595.04 /ea	11,595	21,237.74 /ea	21,238
			Mechanical, HVAC	**400.00 SF**	**3,095**	**8,500**				**28.99 /SF**	**11,595**	**53.09 /SF**	**21,238**
			Electrical, Other										
			Miscellaneous electrical and I&C	1.00 ls	-	-	100,000	-	-	100,000.00 /ls	100,000	183,162.41 /ls	183,162
			Electrical, Other	**400.00 SF**			**100,000**			**250.00 /SF**	**100,000**	**457.91 /SF**	**183,162**
			Electrical Equipment, Generators - >300 to 400 KW										
			Emergency Generator 400 KW	1.00 E	7,541	120,000	-	-	-	127,540.92 /E	127,541	233,607.00 /E	233,607
			Electrical Equipment, Generators - >300 to 400 KW	**1.00 EA**	**7,541**	**120,000**				**127,540.92 /EA**	**127,541**	**233,607.00 /EA**	**233,607**
			I&C, Flow / Mag Meter / Indicators & Transmitters										
			Pump Flow Meter including transmitter	2.00 ea	1,194	20,400	-	-	-	10,796.99 /ea	21,594	19,776.02 /ea	39,552
			I&C, Flow / Mag Meter / Indicators & Transmitters	**2.00 EA**	**1,194**	**20,400**				**10,796.99 /EA**	**21,594**	**19,776.02 /EA**	**39,552**
			I&C, Level / Switches										
			Float switch	8.00 ea	1,203	-	-	-	-	150.40 /ea	1,203	275.48 /ea	2,204
			Float switch bracket	2.00 ea	602	300	-	-	-	450.80 /ea	902	825.70 /ea	1,651
			I&C, Level / Switches	**10.00 EA**	**1,805**	**300**				**210.48 /EA**	**2,105**	**385.52 /EA**	**3,855**
			I&C, Panels & Stands										
			System panel	2.00 ea	1,203	12,000	-	-	-	6,601.60 /ea	13,203	12,091.65 /ea	24,183
			I&C, Panels & Stands	**2.00 EA**	**1,203**	**12,000**				**6,601.60 /EA**	**13,203**	**12,091.65 /EA**	**24,183**
			Submersible Pump: 35Hp										
			Functional Testing, Submersible Pumps, 21 - 50 hp	2.00 ea	602	100	-	-	-	350.80 /ea	702	642.54 /ea	1,285
			FURNISH Submersible Pump, 35 hp	2.00 EA	-	63,000	-	-	-	31,500.00 /EA	63,000	57,696.16 /EA	115,392
			Set base elbow / pump assembly, 35 hp	2.00 ea	5,414	100	-	-	-	2,757.20 /ea	5,514	5,050.15 /ea	10,100
			Stainless steel guide rails, 3",	40.00 lf	1,306	694	-	-	-	50.00 /lf	2,000	91.58 /lf	3,663
			Install upper guide rail bracket	2.00 ea	226	20	-	-	-	122.80 /ea	246	224.93 /ea	450
			Submersible Pump: 35Hp	**2.00 EA**	**7,547**	**63,914**				**35,730.80 /EA**	**71,462**	**65,445.40 /EA**	**130,891**
			Effluent Pump Station	**1.00 EA**	**51,023**	**253,114**	**300,000**	**105,072**		**709,209.14 /EA**	**709,209**	**1,299,004.48 /EA**	**1,299,004**
			13-10 Buildings Complete	**400.00 SF**	**51,023**	**253,114**	**300,000**	**105,072**		**1,773.02 /SF**	**709,209**	**3,247.51 /SF**	**1,299,004**
			13.0 Effluent Pump Station	**400.00 SF**	**51,023**	**253,114**	**300,000**	**105,072**		**1,773.02 /SF**	**709,209**	**3,247.51 /SF**	**1,299,004**
	33.5		**Tank Construction**										
		33.90	**Tanks**										
			Cast-In-Place Concrete Storage Tank										
			Tanks, Other										
			Storage Tanks construction, below grade, cast-in-place concrete, 240,000 gaillons, incluidng sitework, miscellaneous piping excludiing pump station	240,000.00 gal	253,714	634,286		-		3.70 /gal	888,000	6.96 /gal	1,670,882
			Tanks, Other	**240,000.00 GAL**	**253,714**	**634,286**				**3.70 /GAL**	**888,000**	**6.96 /GAL**	**1,670,882**
			Cast-In-Place Concrete Storage Tank	**240,000.00 GAL**	**253,714**	**634,286**				**3.70 /GAL**	**888,000**	**6.96 /GAL**	**1,670,882**
			33.90 Tanks	**240,000.00 GAL**	**253,714**	**634,286**				**3.70 /GAL**	**888,000**	**6.96 /GAL**	**1,670,882**
			33.5 Tank Construction	**240,000.00 GAL**	**253,714**	**634,286**				**3.70 /GAL**	**888,000**	**6.96 /GAL**	**1,670,882**
			018 CSO 016 StorageTank	**0.24 MG**	**304,737**	**887,400**	**300,000**	**105,072**		**6,655,038.08 /MG**	**1,597,209**	**12,374,527.29 /MG**	**2,969,887**

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	6,417,762			12.88%
Material	16,490,401			33.10%
Subcontract	2,388,600			4.79%
Equipment	1,024,101			2.06%
Other	288,600			0.58%
Subtotal Raw Costs	**26,609,464**	**26,609,464**		**53.41**
Material Sales & Use Tax - %				
Construction Equip Tax - %				
Total Taxes		**26,609,464**		
Tank Construction I,OH&P	4,329,000		20.000 %	8.69%
Subtotal Subcontractor I,OH&P	**5,073,670**	**31,683,134**		**10.18**
Subtotal Contingency		**31,683,134**		
Total Cost To Prime Contractor		**31,683,134**		
General Conditions	3,168,313		10.000 %	6.36%
Mobilization/Demobilization	950,494		3.000 %	1.91%
Subtotal Indirect Costs	**4,118,807**	**35,801,941**		**8.27**
Prime Contractor Home OfficeOH	2,864,155		8.000 %	5.75%
Prime Contractor Profit	3,580,194		10.000 %	7.19%
Blder's Risk & Gen Liab Ins -%	498,208		1.000 %	1.00%
Payment & Performance Bonds	577,921		1.160 %	1.16%
Subtotal OH&P	**7,520,478**	**43,322,419**		**15.10**
Design Contingency	6,498,363		15.000 %	13.04%
Subtotal Contingency	**6,498,363**	**49,820,782**		13.04
Escalation				
Subtotal Escalation		**49,820,782**		
Total Prime Contractor Costs		**49,820,782**		