Wilroy Pressure Reducing Station and Off-Line Storage Facility Preliminary Engineering Report

Prepared for

HRSD

Virginia Beach, Virginia

September 2022

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301 Bendix Road, Suite 400

Virginia Beach, VA 23452

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List of Abbreviations

AACE - American Association for the Advancement of Cost Estimating
ach - Air Changes per Hour
ACI - American Concrete Institute
adf - Average Daily Flow
AFT - Applied Flow Technology
AIS - American Iron & Steel
AMWA - Association of Metropolitan Water Agencies
ANSI - American National Standards Institute
ANSI/HI - American National Standards Institute Hydraulic Institute
AOR – Acceptable Operating Region
APE - Area of Potential Effects
ARVs - Air Release Valves
ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM - American Society for Testing and Materials
ats- Automatic Transfer Switch
AWWA - American Water Works Association
BABAA - Build America, Buy America Act
bgs - Below Ground Surface
bmp - Best Management Practice
BTFs - Biotrickling Filters
CAC - Calcium Aluminate Cement
CBPA - Chesapeake Bay Preservation Area
cfm - Cubic Feet Per Minute
cfm/ft^2 - Cubic Feet Per Minute per Square Foot
CIP - Capital Improvement Program
CIP - Cast in Place
CMAR - Construction Management At Risk
cmu - Concrete Masonry Unit
CWFAP - Clean Water Financing and Assistance Program
D/T - Dilutions-to-Threshold
DCR - Department of Conservation and Recreation
DE - Dominion Energy
DEQ - Department of Environmental Quality
Dia - Diameter
DIP - Ductile Iron Pipe
dmts - Dilatometers
EBUs - Emergency Battery Units
EL - Elevation
EPA - Environmental Protection Agency
F – Fahrenheit
FM – Force Main
Fps – Feet per Second
ft - Feet
GC/MS - Gas Chromatograph/Mass Spectrometry
GFI - Ground Fault Interrupter
GMP - Guaranteed Maximum Price
gpd- Gallons per Day
gph - Gallons per Hour
gpm - Gallons per Minute
H_2S - Hydrogen Sulfide

HART - Hydraulic Analysis Review Team
HDPE - High-Density Polyethylene
HGL - Hydraulic Grade Line
HI - Hydraulic Institute
HMI - Human Machine Interface
HOA - HAND-OFF-AUTO
HP – Horsepower
hrs - Hours
HVAC - Heating, Ventilating, and Air Conditioning
I&C - Instrumentation and Control
IDAs - Intensely Developed Areas
IFM – Interceptor Force Main
IPaC - Information for Planning and Consultation
ISI - Institute for Sustainable Infrastructure
LED - Light Emitting Diode
LEED - Leadership in Energy and Environmental Design
lf - Linear Feet
LPI - Lightning Protection Standards
MBE/WBE - Minority and Women's Business Enterprise Goals
MCA - Mechanical Contractors Association
MG - Million Gallons
MGD - Million Gallons per Day
MoP - Manual of Practice
mph - Miles per Hour
mts - Manual Transfer Switch
MW - Megawatt
NECA - National Electrical Contractors Association
NEPA - National Environmental Policy Act
NFPA - National Fire Protection association
NPSH - Net Positive Suction Head
NPSHa -Net Positive Suction Head available
NPSHr - Net Positive Suction Head required
NPW - Net Present Worth
NTP - Notice to Proceed
O&M - Operations and Maintenance
OIT - Operator Interface Terminal
OLSF - Offline Storage Facility
OMB - Office of Management and Budget
ORP- Oxidation-Reduction Potential
P&IDs - Process and Instrumentation Diagrams
PCCP - Prestressed Concrete Cylinder Pipe
PEP - Preliminary Engineering Proposal
PER - Preliminary Engineering Report
pH - potential Hydrogen
PID - Photoionization Detector
PLC - Programmable Logic Controller
POR - Preferred Operating Region
ppm - Parts per Million
ppmv - Parts per Million by Volume
PRS - Pressure Reducing Station
PS - Pump Station
psf – Pounds per Square Feet
psi – Pounds per Square Inch
PVC - Polyvinyl Chloride
R/T - Recognition-to-Threshold
RHM - Regional Hydraulic Model
RI - Color Rendering Index
RPA - Resource Protection Area
rpm - Revolutions per Minute
RSCs - Reduced Sulfur Compounds
RTU - Remote Terminal Unit
RWWMP - Regional Wet Weather Management Plan
SCADA - Supervisory Control and Data Acquisition
SCAT - Sewage Collection and Treatment
SDS - Safety Data Sheet
sf - Square Feet
SPT - Standard Penetration Test
SRF - State Revolving Fund
SSO - Sanitary Sewer Overflows
SWCB - State Water Control Board
SWD - Side Water Depth
SWPPP - Stormwater Pollution Prevention Plan
TDH - Total Dynamic Head
THW - Thermoplastic Heat and Water-resistant
THWN - Thermoplastic Heat-and Moisture-resistant Nylon coated wire
TMDL - Total Maximum Daily Load
UL – Underwriters Laboratory

USFWS - U.S. Fish and Wildlife Service
USGS - United States Geological Survey
V - Volt
DMME - Department of Mines, Minerals, and Energy
V-CRIS - Virginia Cultural Resource Information System
VCWRLF - Virginia Clean Water Revolving Loan Fund
VDOT DM - Virginia Department of Transportation Drainage manual
VDOT - Virginia Department of Transportation
VESCH - Virginia Erosion and Sediment Control Handbook
vfd - Variable Frequency Drive
VOCs - Volatile Organic Compounds
VRA - Virginia Resources Authority
VSMP - Virginia Stormwater Management Program
WEF - Water Environmental Federation
WIFIA - Water Infrastructure Finance and Innovation Act
WSE - Water Surface Elevation
WTP - Water Treatment Plant
WW - Wastewater
XHHW - Cross-linked High Heat Water Resistant Insulated Wire

Executive Summary

EX.1 Background and Purpose

The Wilroy Pressure Reducing Station (PRS) and Offline Storage Facility (OLSF) Capital Improvements Program (CIP) project (NP014000) is intended to provide pressure relief and increase system capacity for areas of Suffolk and Isle of Wight County during wet weather events. Since 2009, there have been numerous weather-related sanitary sewer overflow events reported by the City of Suffolk and HRSD.

A pressure reducing station in the vicinity of Wilroy Road has been planned by HRSD for many years, and HRSD even owns a small parcel of land with branches off the existing 30-inch force main with this thought in mind.

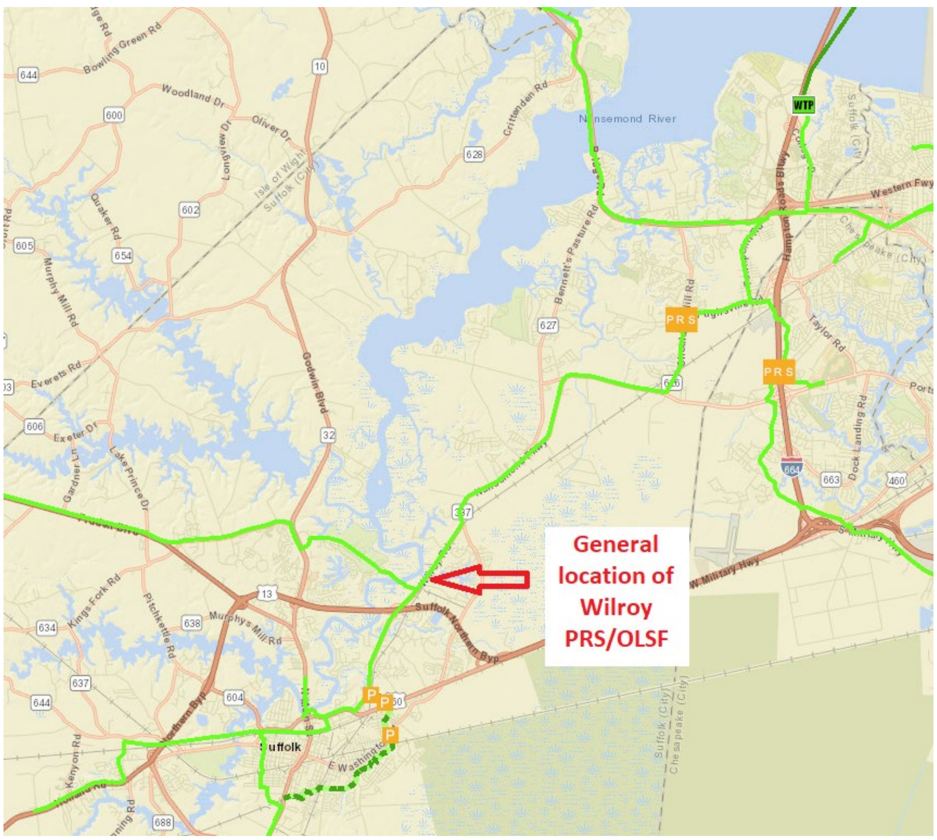


Figure EX-1. Wilroy PRS/OLSF General Location

The Wilroy PRS and OLSF project was identified as a Phase 1 High Priority Project in the Regional Wet Weather Management Plan (RWWMP) solution set submitted to the United States Environmental Protection Agency (EPA) and Virginia Department of Environmental Quality (DEQ) as part of the HRSD's Consent Decree. This project has a regulatory completion date of December 31, 2030.

EX.2 Facility Overview & Considerations

At this stage of the project, a final site has not been selected; however, significant effort has been made to narrow the list of candidate locations. Three sites, all located on Wilroy Road just south of the HRSD’s SF-214 connection (from Windsor and Isle of Wight County), have been identified as ideal candidates for the location of the new Wilroy PRS and OLSF. The three sites range in size from 3.3 to 5.4 acres (Sites 25, 26, and 27 below in Figure EX-2 would be combined into one site). All three sites are currently zoned for B-2 and would require re-zoning to either A, M-1, or M-2 to allow the OLSF.

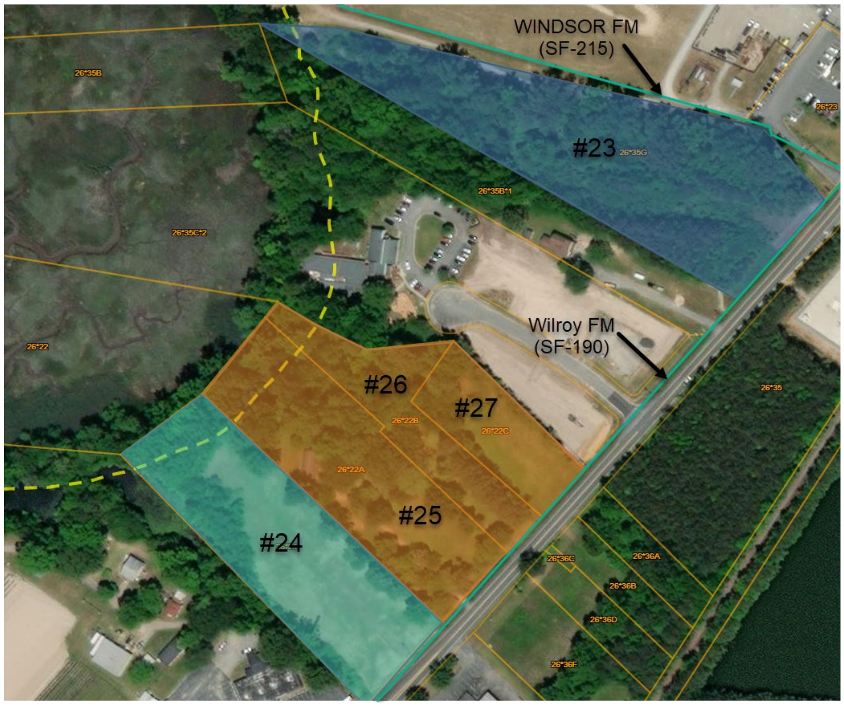


Figure EX-2. Refined Candidate Site Locations

From the HART Report provided by HRSD, the design parameters for the Wilroy PRS/OLSF are as follows:

Table EX-1. Design Parameters	
PRS	
Pump Flow Range	4,000-7,000 gpm
Min.-Max. Pressure Relief (TDH)	40-80 ft
Suction Set Point	30 ft
OLSF	
Storage Volume	3 MG

Using data from the HART Report, four flow scenarios exist for the Wilroy PRS and OLSF:

1. Dry weather flow scenario – During dry weather flow will bypass the PRS through the station bypass piping. Dry weather operation will occur whenever the hydraulic grade line (HGL) is below the PRS initiation setpoint. Dry weather operation will resume once the HGL drops below the PRS off setpoint, set below the initiation setpoint to avoid cycling.
2. PRS operating flow scenario – Once the HGL increases above the initiation setpoint the PRS will turn on and the bypass will close. The PRS will remain in operation until the shutdown setpoint is reached. The PRS pumps will turn on and off and ramp up and down to maintain a

desired suction HGL. Appropriate setpoints and minimum run times will be identified to provide smooth operation and avoid cycling.

3. PRS and OLSF operating flow scenario – Once the PRS reaches the maximum capacity of 7,000 gpm, the valve to the OLSF will begin to open allowing flow to be directed to the OLSF at a rate required to maintain the desired suction HGL, the setpoint will be adjustable and set above the PRS operating setpoint. If the HGL begins to fall the valve will close reducing flow directed to the OLSF. If the suction side HGL continues to fall the valve will close and the system will revert back to the PRS operating flow scenario. The valve to the OLSF will close once it reaches maximum operating level.
4. Drain flow scenario – Once the OLSF is no longer filling and the discharge side HGL is below a set point the OLSF will begin to drain.

The flow and HGL conditions for each scenario have been determined to be as shown in Table EX-2.

Table EX-2. Design Flows and Boundary Conditions

Scenario	Description	Flow Range (gpm)	Upstream HGL (ft)	Downstream HGL (ft)
1	Dry weather	<3,908[a]	<70	<70
2	PRS Operating	4,000 to 7,000	30	70 to 104[d]
3	PRS and OLSF Operating	7,000 to 15,462[b]	30	104[d]
4	Drain	2,083[c]	--	30 to 65[e]

a. *DW Max from HART Report.*
b. *WW Max from HART Report.*
c. *Flow required to drain the OLSF in 24-hrs*
d. *Max simulated discharge HGL from HART Report.*
e. *Downstream HGL when the OLSF control valve closes from HART Report.*

Multiple alternatives were considered for layout and configuration of the PRS and OLSF. With a suction set point of 30 feet, and an existing approximate site elevation of 23 feet, the option of filling the tank using influent line pressure (as would typically be preferred) would require burying the tank and the drain pumps more than 25 feet below grade. In addition to considering whether to fill the tank with line pressure, options were considered for filling the tank with the PRS pumps and drain pumps.

Various pump options were evaluated including dry and wet pit submersible, screw centrifugal, and extended shaft pumps. Pump efficiencies, life-cycle costs, ease of operation and maintenance were considered in the pump evaluation.

An evaluation of various tank styles, sizes, configuration, and construction methods was performed. This included prestressed concrete, cast-in-place, and post-tensioned concrete. A review of cover options and corrosion protection was also conducted.

Based on direction from HRSD, the OLSF will be used intermittently for wet weather flow management and not be used on a regular basis for diurnal peak shaving. This is an important factor in selection of both the tank cleaning system and also odor control. Various options were considered for cleaning including hose/water cannon washdown, mixing, deluge, tipping buckets, and two-types of flushing systems.

Odor control design is affected by both the frequency of use as well as the strength and composition of the influent flow. Various options for odor control as well as a planned sampling program are provided in this report that will inform the final design.

This document also details the evaluation and recommendations for electrical, instrumentation and controls, structural, civil site design, building mechanical, and architectural options.

EX.3 Additional Evaluations

BC conducted several evaluations beyond the technical details of the PRS and OLSF design. Many of these efforts are preliminary plans to be implemented as part of final design:

- An initial plan was developed for the Environmental Evaluation upon selection of the final site. This includes wetland delineation, protected species, invasive species, and historic and cultural resources.
- A Permitting Plan was developed to identify the necessary permits and process for this project.
- A Community Outreach Plan was reviewed to identify project stakeholders and develop and approach for coordination.
- An Envision workshop was held on May 23, 2022, with HRSD staff to determine the likely certification level that could be achieved as well as identify action items to maintain and improve the certification level for the project. Although HRSD may not apply for Envision certification, this process helps identify opportunities for making the project more sustainable.

EX.4 Recommendations

Based on the evaluations described in Section EX.2, Brown and Caldwell has made the following recommendations for the Wilroy PRS and OLSF:

- Following survey, geotechnical evaluation, and preliminary environmental assessment, the JTF Properties (Sites 25, 26, and 27) appear to be the preferred option for locating the new PRS and OLSF
- Design and construct a PRS building (approximately 11,375 SF) with a lower level approximately 10 feet below grade that will house:
    - Four (4) dry pit submersible PRS pumps (3 duty, 1 standby) –185 HP (each) with a firm capacity of 15,462 GPM @ 81 TDH
        - The pumps are sized to meet PRS pumping requirements and to fill the OLSF
    - Three (3) dry pit submersible drain pumps (2 duty, 1 standby) – 25 HP (each) with a firm capacity of 2,083 GPM @ 48 TDH
    - Generator (1.5MW, 480/277V, 3-phase, 4-wire generator)
    - Electrical Room
    - Bathroom
    - Bridge Crane
- Design and construct a single round 3 MG prestressed concrete tank
    - Approximately 130 feet in diameter and 35 feet in height and set at grade
    - Vacuum flushing system and perimeter collection trough
    - No tank lining

    - Dome cover
    - Odor control unit utilizing activated carbon (with room left for additional system if needed for future)
- Architectural style will be reviewed with HRSD and either the contemporary option or barn option is acceptable

A full set of conceptual drawings is included in Appendix F.

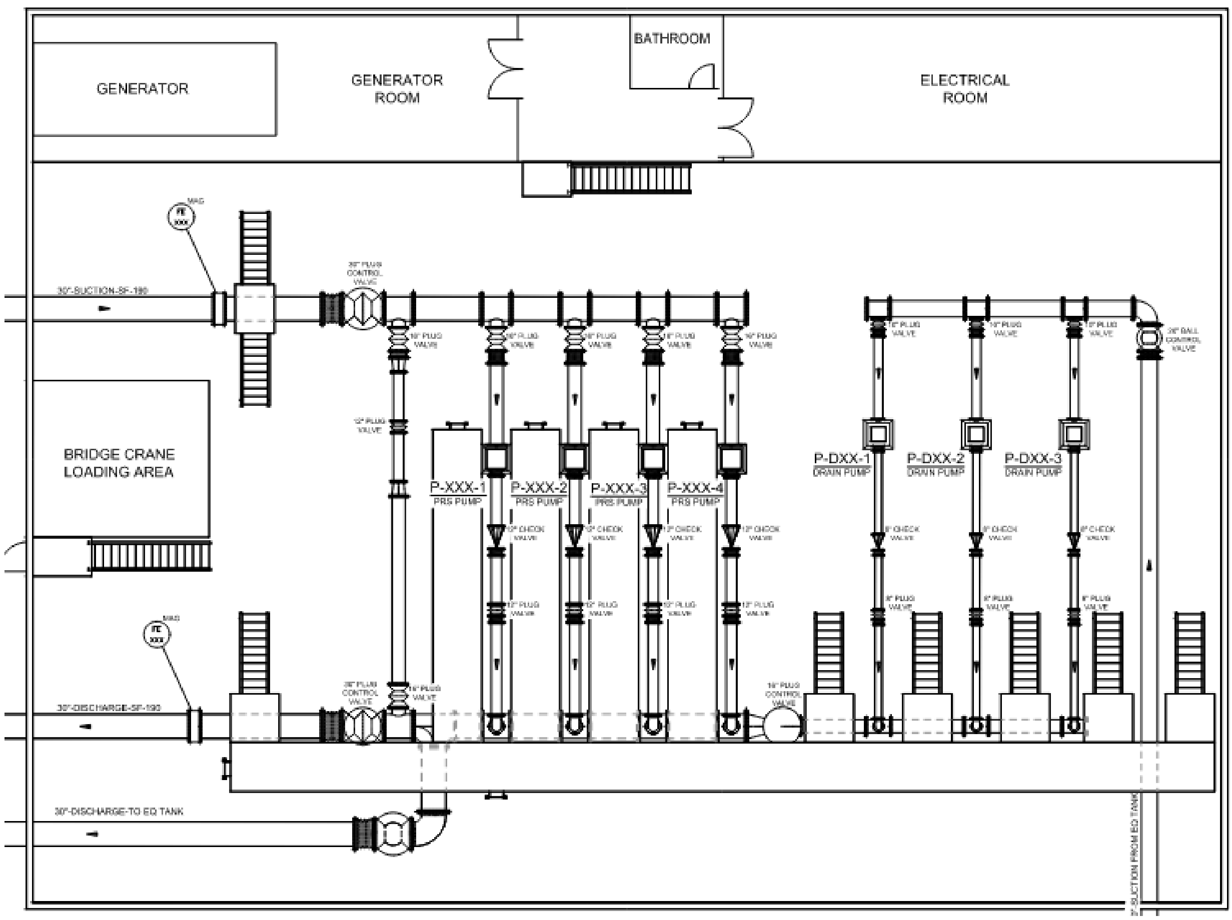


Figure EX-3. PRS Plan View

Preliminary Opinion of Probable Construction Cost

Based on the typical accuracy of a Class 4 estimate, the expected range of costs are shown in Table EX-3 below.

Table EX-3. Opinion of Probable Construction Cost		
Upper Range	Estimated Cost	Lower Range
+50%		-30%
$72,598,551	$48,399,034	$33,879,324

The cost opinion has been developed by BC's cost estimating professionals and subjected to review by senior staff. It includes a 30% contingency (appropriate based on current level of design and unknown site conditions), an additional CMAR fee, BC's construction services, and a mid-point escalation cost.

Section 11.3 provides a review of potential project funding requirements including significant impacts of the Buy America, Build America Act.

Schedule:

The proposed preliminary project schedule is shown in Table EX-4 below.

Table EX-4. Project Schedule

Task	Completion date
Final PER	Sept 2022
CMAR Selection	Dec 2022
Final Design	Sept 2023
Construction Start	Dec 2023
Substantial Completion	Sept 2025
Project Completion	Dec 2025

Section 1

Introduction

The Wilroy Pressure Reducing Station (PRS) and Offline Storage Facility (OLSF) Capital Improvements Program (CIP) project (NP014000) is intended to provide pressure relief and increase system capacity for areas of Suffolk and Isle of Wight County during wet weather events. This preliminary engineering report (PER) will document the results from the following activities:

- Site selection
- Development of design alternatives and a recommendation on design approach
- Identify design standards and codes
- Develop conceptual design drawings
- Develop architectural renderings
- Permitting plan
- Environmental evaluation
- Community outreach plan
- Contractor procurement options
- List of specifications
- Risk Register
- Project Schedule

1.1 Background

A pressure reducing station in the vicinity of Wilroy Road has been planned by HRSD for many years, and HRSD even owns a small parcel of land with branches off the existing 30-inch force main with this thought in mind. The Wilroy PRS and OLSF project was formally identified in the Regional Wet Weather Management Plan (RWWMP) solution set submitted to the United States Environmental Protection Agency (EPA) and Virginia Department of Environmental Quality (DEQ) as part of the HRSD's Consent Decree. In 2017, HRSD submitted to the EPA/DEQ, after amendments of the Consent Decree, an Integrated Plan (IP) with a list of high priority projects which included the Wilroy project. This plan was revised again in 2020 and finally approved in 2022.

The Wilroy PRS and OLSF as defined in the RWWMP was evaluated using the Regional Hydraulic Model (RHM) with a 5-year peak flow recurrence event as an input flow to the model. The modeling efforts are documented in the Hydraulic Analysis for Wilroy PRS and Offline Storage Tank Facilities (CIP NP014000) (Hydraulic Analysis Review Team (HART) Report included as Appendix B).

1.2 Purpose

The purpose of the Wilroy PRS and OLSF is to reduce sanitary sewer overflows (SSOs) during wet weather events. As documented in the HART Report, since 2009 there have been approximately 196 capacity weather related overflows events report in the City of Suffolk representing approximately 33 distinct locations within the City's sanitary sewer system. The reported estimated total volume of wastewater spilled during those events was approximately 3 million gallons (MG). Also, HRSD reported approximately 6 SSO events since 2009 with an estimated total volume of 0.6 MG and all of them occurred around the Shingle Creek gravity interceptor or at the receiving station, HRSD Suffolk Pump Station (PS) #135.

As a Phase 1 High Priority Project in the RWWMP, HRSD must complete the Wilroy PRS/OLSF by December 31, 2030; however, HRSD is constructing two new pumping stations to replace the existing Suffolk PS which will greatly benefit from the completion of the Wilroy project.

1.3 Workshops

A series of workshops were held with HRSD staff that were used in the development of this Preliminary Engineering Report (PER).

- A Hydraulics and Facility Configuration Workshop was held on April 20, 2022. The meeting included a review of alternatives for the process mechanical design criteria and preliminary facility layouts.
- An Envision Workshop was held on June 23, 2022. BC and HRSD walked through the Envision online tool and developed a preliminary Envision Score.
- An Electrical and Process Control/SCADA Workshop was held on June 26, 2022. The meeting included discussion of SCADA integration, process controls, and electrical design criteria.

1.4 Design Requirements

The Wilroy PRS and OLSF will be located along the Suffolk IFM Section V (SF-190) 30-inch prestressed concrete cylinder pipe (PCCP) following Wilroy Road and Nansemond Parkway in Suffolk, VA. In order for it to provide relief to Windsor, it must connect downstream of the 24-inch Hillpoint Rd IFM (SF-214). The HART Report identified two potential locations for the Wilroy PRS/OLSF shown in Figure 1-1. The report recommended Alternative 2 as the location of the PRS/OLSF.

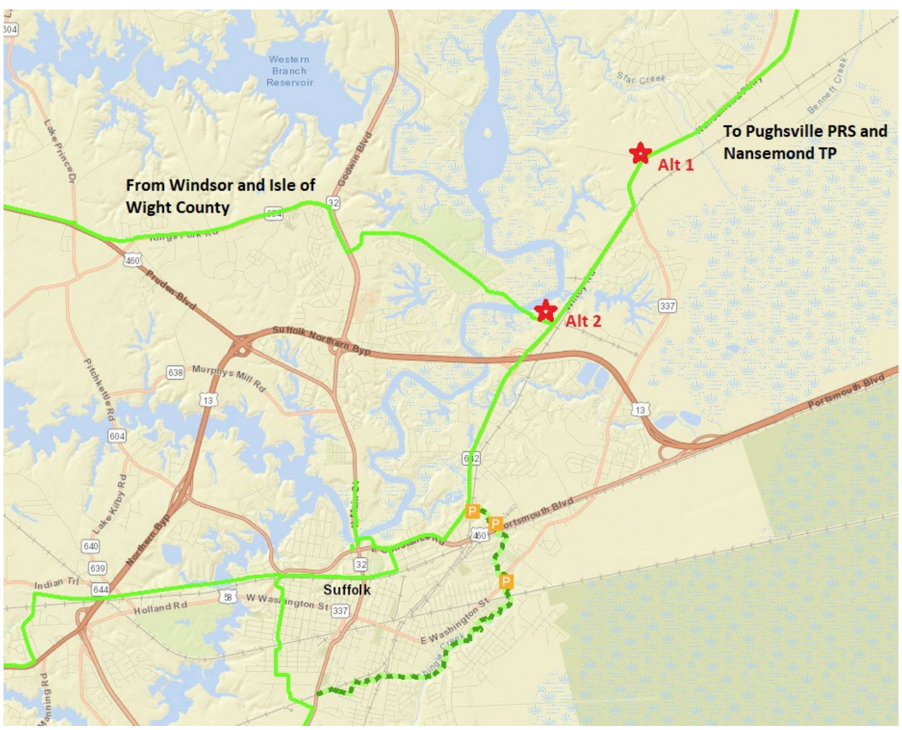


Figure 1-1. Potential Locations for Wilroy PRS/OLSF

The HART Report documented the following design parameters for the Wilroy PRS/OLSF:

Table 1-1. Design Parameters

PRS	
Pump Flow Range	4,000-7,000 gpm
Min.-Max. Pressure Relief (TDH)	40-80 ft
Suction Set Point	30 ft
OLSF	
Storage Volume	3 MG

Section 2

Site Selection

HRSD's HART report conducted analysis of two alternative site locations for the PRS and OLSF. The two alternative site locations can be seen on Figure 2-1. Alternative 1 location is in the vicinity of the Nansemond Parkway and Upton Lane intersection. Alternative 2 location is located near the connection of the Windsor Line (SF-214) and Wilroy Road Line (SF-190). In the HART analysis, it was determined that the closer the PRS/OLSF is to the Windsor line tie-in, the more benefit and relief that is provided to the system. This would mean that Alternative 2 location provides maximum relief in the upstream parts of the interceptor system. Note that if a connection point is upstream of the Windsor Line, an extension would be required to tie-in to the new PRS and OLSF. This tie-in is important to ensure that the new PRS provides the relief to the Windsor system.

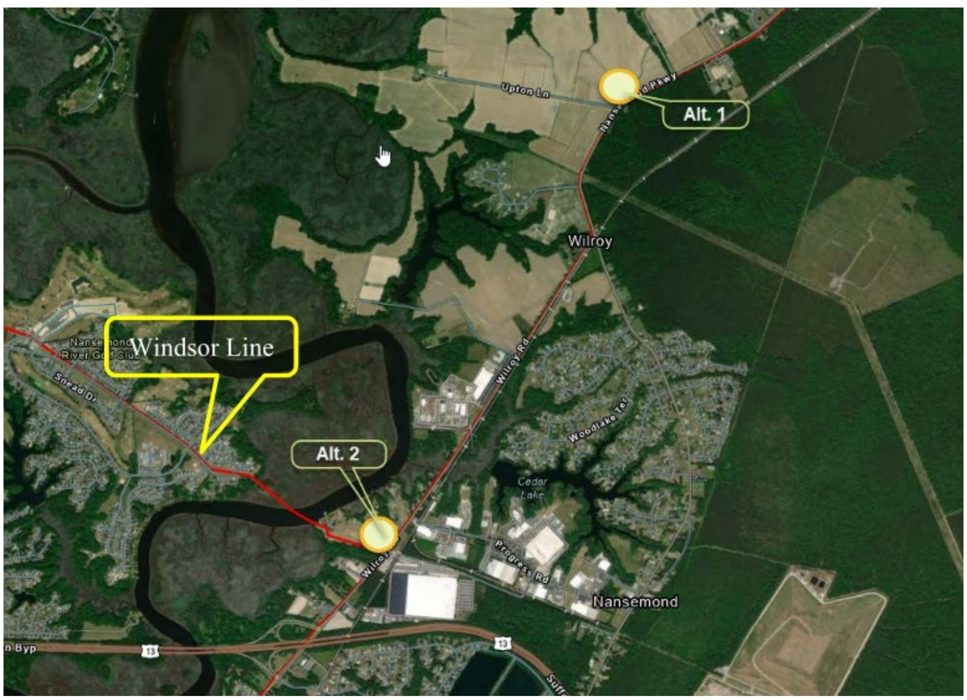


Figure 2-1. HART Report Alternative Site Locations

2.1 Alternatives

BC evaluated 27 different properties in the area located within proximity of both alternatives listed in the HART report, see Figure 2-2. In this evaluation, BC reviewed and ranked the properties based on multiple criteria found within the Institute for Sustainable Infrastructure (ISI) Envision categories. These categories include the natural world, climate and resilience, quality of life, resource allocation and leadership. Table 2-1 (in Appendix C) describes category criteria and defines the rank scores. A detailed site selection analysis with ranking can be found in Appendix C.

Figure 2-2. Potential Site Locations from BC Evaluation

2.2 Selection

After significant effort to identify properties that both satisfy HRSD's needs for a site and also are likely able to be acquired in a timely manner, BC has identified three property owners that are potentially open to selling their property to HRSD for this project. All these sites are on the upstream portion of the SF-190 line just upstream of the connection of the Windsor line (SF-214) and would all provide significant hydraulic relief for the Suffolk and Isle of Wight systems. These three sites are identified as site numbers 23 through 27 from Table 2-2 (in Appendix C). Property information for these individual sites is listed in Table 2-3. While sites 25, 26, and 27 are all under the minimum three acres required to build the PRS/OLSF they are all owned by the same company who has indicated they are willing to sell them together.

Table 2-3. Property Information

Site #	Parcel ID	Owner	Zone Classification	Lot Size (ac)	Site Map Color (Figure 2-2)
23	304649300	CITY OF CHESAPEAKE	B-2	4.6	Blue
24	303392500	MARK WAHLSTROM & DEBORAH J TR	B-2	3.31	Green
25	301260000	JTF PROPERTIES LLC	B-2	2.82	Orange
26	304324200	JTF PROPERTIES LLC	B-2	1.47	Orange
27	304324300	JTF PROPERTIES LLC	B-2	1.08	Orange

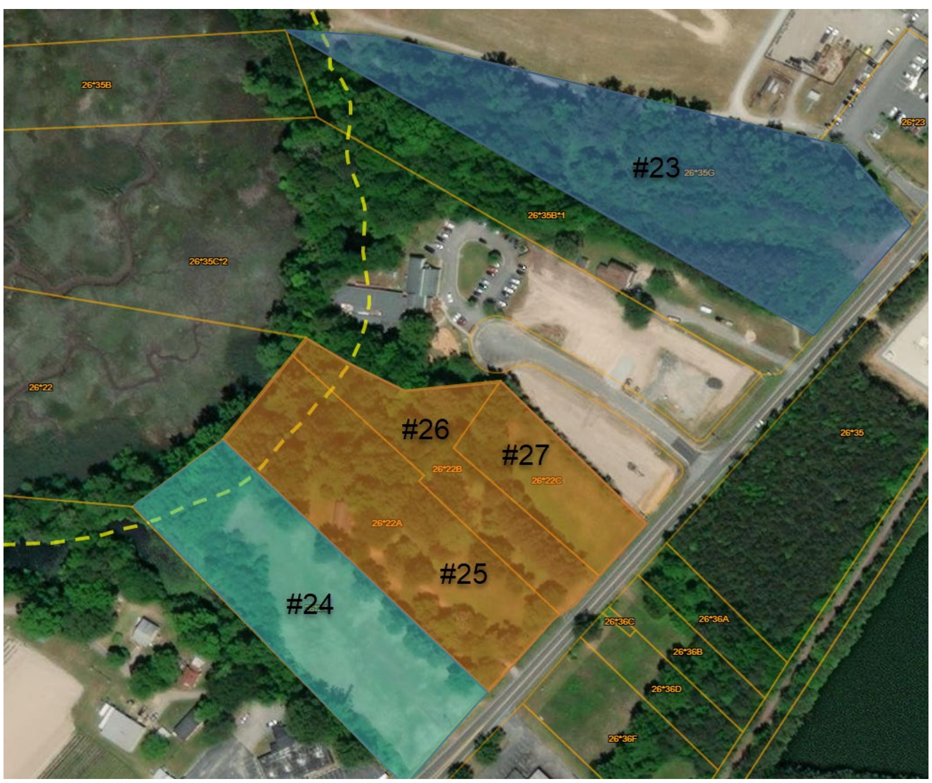


Figure 2-3. Refined Candidate Site Locations

As of the draft date of this report, HRSD and BC are performing due diligence survey, geotechnical borings, and environmental assessment and will likely be moving forward to acquire property from one of these three properties owners which are listed in order of preference:

1. Sites 25, 26, and 27 (referred to as JTF Properties)
2. Site 24
3. Site 23 (referred to as the Chesapeake property)

2.3 Existing Conditions

All three sites are included in the Chesapeake Bay Preservation Area (CBPA) with a small portion, near the back of each of the properties, included in the resource protection boundary line or Resource Protection Area (RPA). New construction is allowed in the CBPA but should not encroach on the RPA (50-foot seaward portion). None of the properties are identified in the City of Suffolk's Intensely Developed Areas (IDAs). See Figure 2-3 for properties and the RPA boundary. The RPA boundary is shown as the yellow dashed line on Figure 2-3.

2.3.1 JTF Properties

The JTF Properties locations consist of three sites all zoned for B-2 classification that have a total lot size of 5.37 acres. These properties are bordered by Wilroy Road to the east, the Nansemond River to the west, the Children's Center to the north and Site 24 lot to the south. The properties are mostly wooded with a few small structures on them. The HRSD 30-inch IFM runs along Wilroy right in front of the property for close tie-in. The Windsor Line (SF-214) is located approximately 1000 feet to the north and would need to be extended south to the new PRS/OLSF.

2.3.2 Site 24

Site 24, owned the Wahlstroms Trust, consists of a total lot size of 3.31 acres and is zoned for B-2 classification. This property is bordered by Wilroy Road to the east, the Nansemond River to the west, JTF Properties to the north, and Evans Farms to the south. Evans Farms is a family owned and operated local produce farm with a farmers' market open to the public. Site 24 is mostly maintained grass with woods in the rear near the RPA. The HRSD 30-inch IFM runs along Wilroy right in front of the property for close tie-in. The Windsor Line (SF-214) is located approximately 1500 feet to the north and would need to be extended south to the new PRS/OLSF.

2.3.3 Chesapeake Site

The Chesapeake site, owned by the City of Chesapeake to install their new 36" raw water transmission main, consists of a total lot size of 4.6 acres and is currently zoned for B-2 classification. This property is bordered by Wilroy Road to the east, the Nansemond River to the west, the Ryan Construction the north and the Children's Center to the south. The HRSD 30-inch IFM runs along Wilroy right in front of the property for close tie-in. The Winsor Line (SF-214) is located along the north property line shared with Ryan Construction. The site is mostly woods with some wetlands identified onsite. Also, the site elevation starts to drop-off in the middle of the property, leaving less than two acres of useable development.

2.4 Geotechnical

On July 7, 2022, Schnabel Engineering, LLC (Schnabel) performed a preliminary exploration of 1941-1949 Wilroy Road (JTF properties), Suffolk Virginia. Schnabel performed a subsurface exploration and field-testing program to identify the subsurface stratigraphy underlying the site. The full report can be found Appendix A. Boring location map can be seen on Figure 2-4.

The project sites are located within the Coastal Plain Province of Virginia. A review of existing geologic data and information in the area, and the Geologic Map and Generalized Cross Sections of the Coastal Plain and Adjacent Parts of the Piedmont, Virginia (VA DMME, 1989) shows that the project site is underlain by Pleistocene Age alluvial soils of the Tabb Formation and the Miocene Age marine soils of the Yorktown Formation.

Groundwater was observed in the boring at a depth of 6 ft, about EL 14. At this time no long-term water level readings were taken. The final design should anticipate the fluctuation of the hydrostatic water table depending on variations in precipitation, surface runoff, pumping, tidal action, evaporation, leaking utilities, stream levels, and similar factors.

Schnabel recommends the final geotechnical engineering study include one day of in-situ testing, such as Dilatometers (DMTs), and several supplemental SPT borings to obtain soil samples for laboratory testing and to install at least one temporary groundwater monitoring well. Laboratory testing should include gradations, Atterberg limits, moisture contents, natural density, one-dimensional consolidation, and corrosion tests.

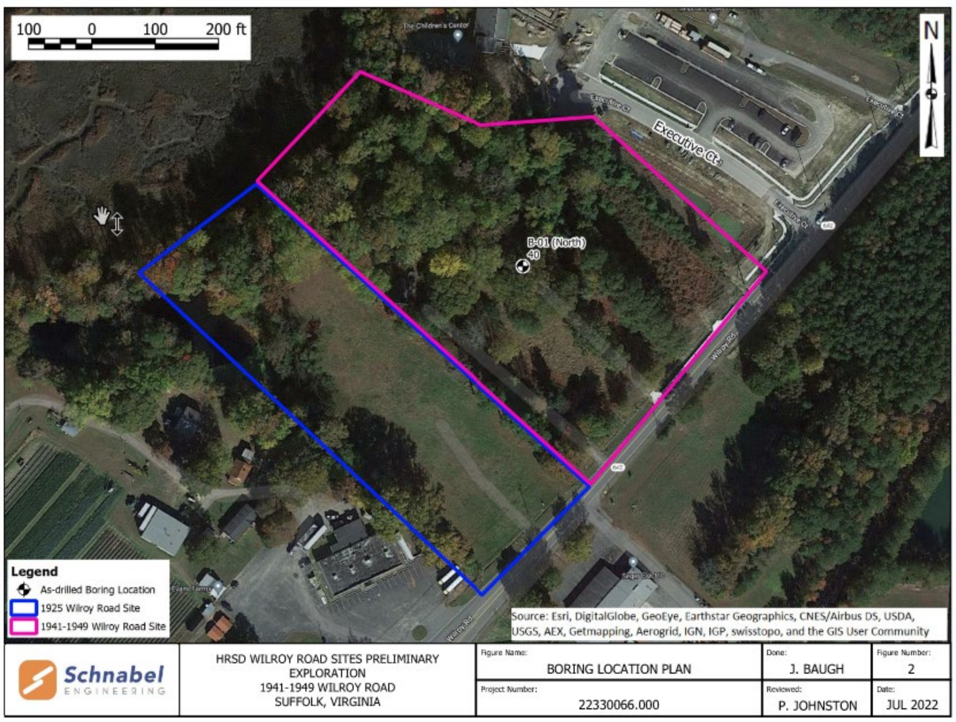


Figure 2-4. Boring Location Plan

2.5 Zoning

Table 2-4 identifies the zoning classes that under the City of Suffolk zoning ordinance allow for above ground storage tanks up to 65 feet tall. All the candidate properties being investigated during the site section portion are classified as B-2, which currently prohibits above ground storage tanks.

Table 2-4. Zoning Classes	
Zone Class	Permitted, Conditional, or Prohibited Use
A	Conditional
M-1	Conditional
M-2	Permitted
All Others	Prohibited Use

Once the land is acquired by HRSD the rezoning process can be started. An application for rezoning will be required. BC has initiated discussion with the City of Suffolk on this topic and at this time the City has no objections to the land being rezoned to M-1 and obtaining a conditional use permit for the OLSF. The city did state that rezoning to M-2 (heavy industrial) would not be possible due to the other zoning classes in the area. BC presented the project to the City of Suffolk Department of Economic Development "Friday morning meeting" on May 6, 2022, to discuss the project, potential property acquisition, and the necessary rezoning. The rezoning process takes approximately six or more months to complete according to the City, and the application requires the following analysis/reports (an exemption wavier can be acquired for any of these with approval of the director):

- Public facilities report
  - Water level of service
  - Sewer level of service
  - Stormwater management drainage data
- Traffic impact study
- Fiscal impact analysis
- Major water quality impact assessment
- Soils report
- Phase I environmental site assessment

Section 3

Hydraulic Evaluation

3.1 Design Flows and Boundary Conditions

The Wilroy PRS/OLSF will provide pressure relief and increase system capacity during wet weather events; and based on discussions with HRSD staff, diurnal use ("peak shaving") is not anticipated at this time. The Wilroy PRS/OLSF will have four main flow scenarios. A description of the scenarios, design flows, and boundary conditions used in this PER are provided below:

1. Dry weather flow scenario – During dry weather flow will bypass the PRS through the station bypass piping. Dry weather operation will occur whenever the hydraulic grade line (HGL) is below the PRS initiation setpoint. Dry weather operation will resume once the HGL drops below the PRS off setpoint, set below the initiation setpoint to avoid cycling.
2. PRS operating flow scenario – Once the HGL increases above the initiation setpoint the PRS will turn on and the bypass will close. The PRS will remain in operation until the shutdown setpoint is reached. The PRS pumps will turn on and off and ramp up and down to maintain a desired suction HGL. Appropriate setpoints and minimum run times will be identified to provide smooth operation and avoid cycling.
3. PRS and OLSF operating flow scenario – Once the PRS reaches the maximum capacity of 7,000 gpm, the valve to the OLSF will begin to open allowing flow to be directed to the OLSF at a rate required to maintain the desired suction HGL, the setpoint will be adjustable and set above the PRS operating setpoint. If the HGL begins to fall the valve will close reducing flow directed to the OLSF. If the suction side HGL continues to fall the valve will close and the system will revert back to the PRS operating flow scenario. The valve to the OLSF will close once it reaches maximum operating level.
4. Drain flow scenario – Once the OLSF is no longer filling and the discharge side HGL is below a set point the OLSF will begin to drain.

Table 3-1. Design Flows and Boundary Conditions

Scenario	Description	Flow Range (gpm)	Upstream HGL (ft)	Downstream HGL (ft)
1	Dry weather	<3,908[a]	<70	<70
2	PRS Operating	4,000 to 7,000	30	70 to 104[d]
3	PRS and OLSF Operating	7,000 to 15,462[b]	30	104[d]
4	Drain	2,083[c]	--	30 to 65[e]

f. *DW Max from HART Report.*
g. *WW Max from HART Report.*
h. *Flow required to drain the OLSF in 24-hrs*
i. *Max simulated discharge HGL from HART Report.*
j. *Downstream HGL when the OLSF control valve closes from HART Report.*

Brown AND Caldwell

3.2 Design Standards

Below is a list of standards used in preparation of the PER and will be used in the design of the PRS and OLSF:

- HRSD Design and Construction Standards, January 2022 (or the most current version available at the start of design)
- Virginia Administrative Code Chapter 790, Sewage Collection and Treatment Regulations.
- Pump NPSH Margin will follow ANSI/HI 9.6.1 Rotodynamic Pumps Guideline for NPSH Margin
- Pump operating range will follow ANSI/HI 9.6.3 Rotodynamic (Centrifugal and Vertical) Pumps – Guidelines for Allowable Operating Region
- Piping layout and sizing will follow ANSI/HI 9.6.6 Rotodynamic Pumps for Pump Piping
- Pump intake design will follow ANSI/HI 9.8 Pump Intake Design

Section 4

Design Alternatives

The following section provides details on the alternatives evaluated for the PRS/OLSF and recommends a selected alternative. The alternatives were discussed during the Hydraulics and Facility Configuration Workshop with HRSD staff on April 20, 2022. The alternatives can be categorized as the following:

- OLSF fill alternatives
- PRS and drain pump types
- Drain pump location
- PRS layout
- OLSF tank alternatives
- OLSF cleaning

The various alternatives for each process were compared to determine a preferred overall system to meet the design requirements.

Costs presented in Section 4 are for comparison purposes and do not include all construction costs and markups. These totals do not include costs associated with architecture, HVAC, plumbing, electrical, or I&C. The costs only include differences between the various alternatives and focus on the relative sizes of the PRS and OLSF, amount of excavation, shoring and dewatering required for the different alternatives, and the pump costs of the different alternatives. A full opinion of probable cost of the selected alternative is presented in Section 10.

4.1 PRS Alternatives

4.1.1 OLSF Fill Design

A preliminary, localized hydraulic model was built to evaluate the various options. For hydraulic modeling of the three options, BC used AFT Fathom 12, a hydraulic modeling software developed by Applied Flow Technology. Modeling was limited to the new PRS and associated piping alone using HGL values from the HART report to establish boundary conditions for the surrounding interceptor system.

Elevations used in development of OLSF fill alternatives are presented in Table 4-1.

Table 4-1. Site Elevations

Location	Elevation (ft)
Grade	23
Suction HGL during filling	30
Existing FM	18

The difference between the grade and suction side HGL during filling is only 7 feet. In order to fill the tank with the upstream line pressure (30 ft), this would require a very short tank or for the tank to be partially buried. For this reason, additional alternatives were explored for filling the OLSF.

A tank wall height of 30 ft was assumed in the development of alternatives, this value matched the assumption from the HART report. This height was also discussed with representatives from the Crom Corporation (tank construction company) and was agreed that it is an economical selection for a 3 MG circular AWWA D110 prestressed concrete tank. Although tanks can be constructed to almost any dimension, but the recommended heights are between 15'-10" and 63'-11" for a 3 MG round tank with the most economical heights between 32'-9" and 42'-3". The final selected height will be further refined during detailed design but for the purpose of comparing alternatives a height of 30 ft was used.

Three options were evaluated for filling the OLSF:

1. Fill using upstream line pressure
2. Fill using PRS pumps
3. Fill using drain pumps

4.1.1.1 Fill using upstream line pressure

The preferred approach to filling the OLSF would be to use upstream line pressure to fill the tank without the need for additional pumping. This would require the suction side HGL to be above the high-water level of the OLSF. Per the HART report, the OLSF would only come online if the PRS is operating at full capacity and unable to maintain a suction side HGL of 30 ft. At that point, a control valve would open to allow flow into the OLSF. The control valve would modulate to maintain the suction side HGL set point of 30 ft. Therefore, the HGL used in filling the OLSF would be 30 ft, minus losses from the control valve and feed piping. As discussed above, grade at the proposed site is approximately at elevation of 23 ft. To fill the OLSF using line pressure, and assuming a tank height of 30 ft, would require the tank to be nearly completely buried to allow for the HGL on the fill side to be above the high-water level in the tank. Figure 4-1 shows a preliminary hydraulic profile of filling the OLSF under Option 1.

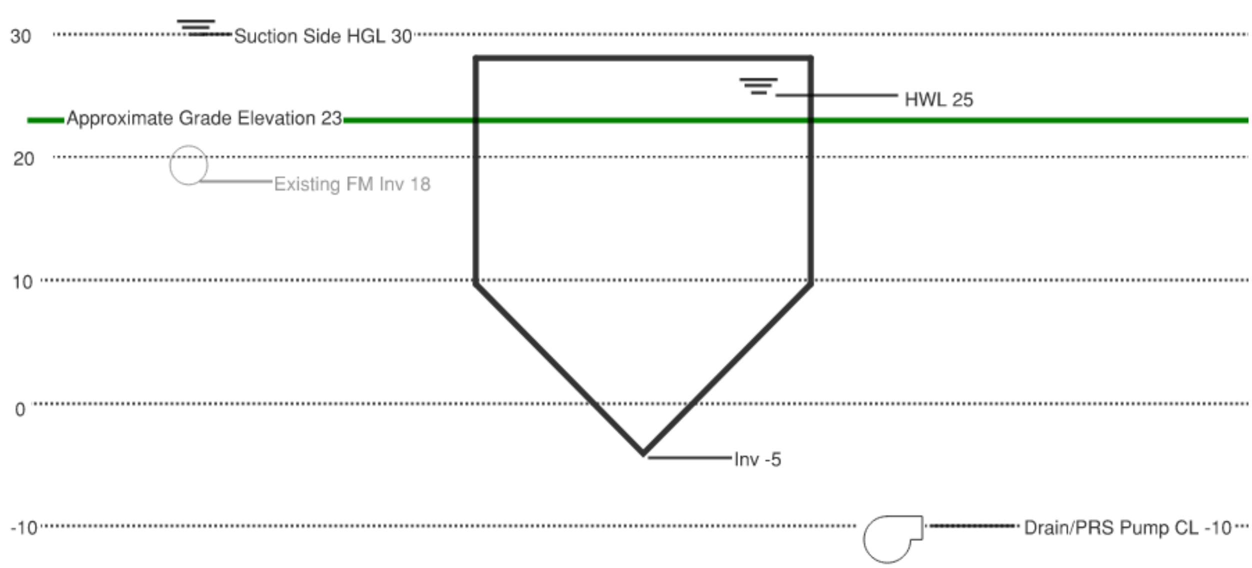


Figure 4-1. Option 1 Hydraulic Profile

Figure 4-2 shows a flow diagram for Option 1 with the drain pumps shown within the PRS. Locating the drain pumps within the PRS would require the finished floor of the PRS to be below the bottom of the OLSF to ensure adequate NPSHa (Net Positive Suction Head Available) is provided for the drain pumps. An alternative would be to use submersible pumps for the drain pumps and locate them within the OLSF. A sump would be provided within the OLSF to ensure the drain pumps have adequate NPSHa and submergence. This would allow the PRS to be smaller to house only the PRS pumps and would allow the PRS to be located closer to grade. The suction side HGL would provide adequate NPSHa for PRS operation.

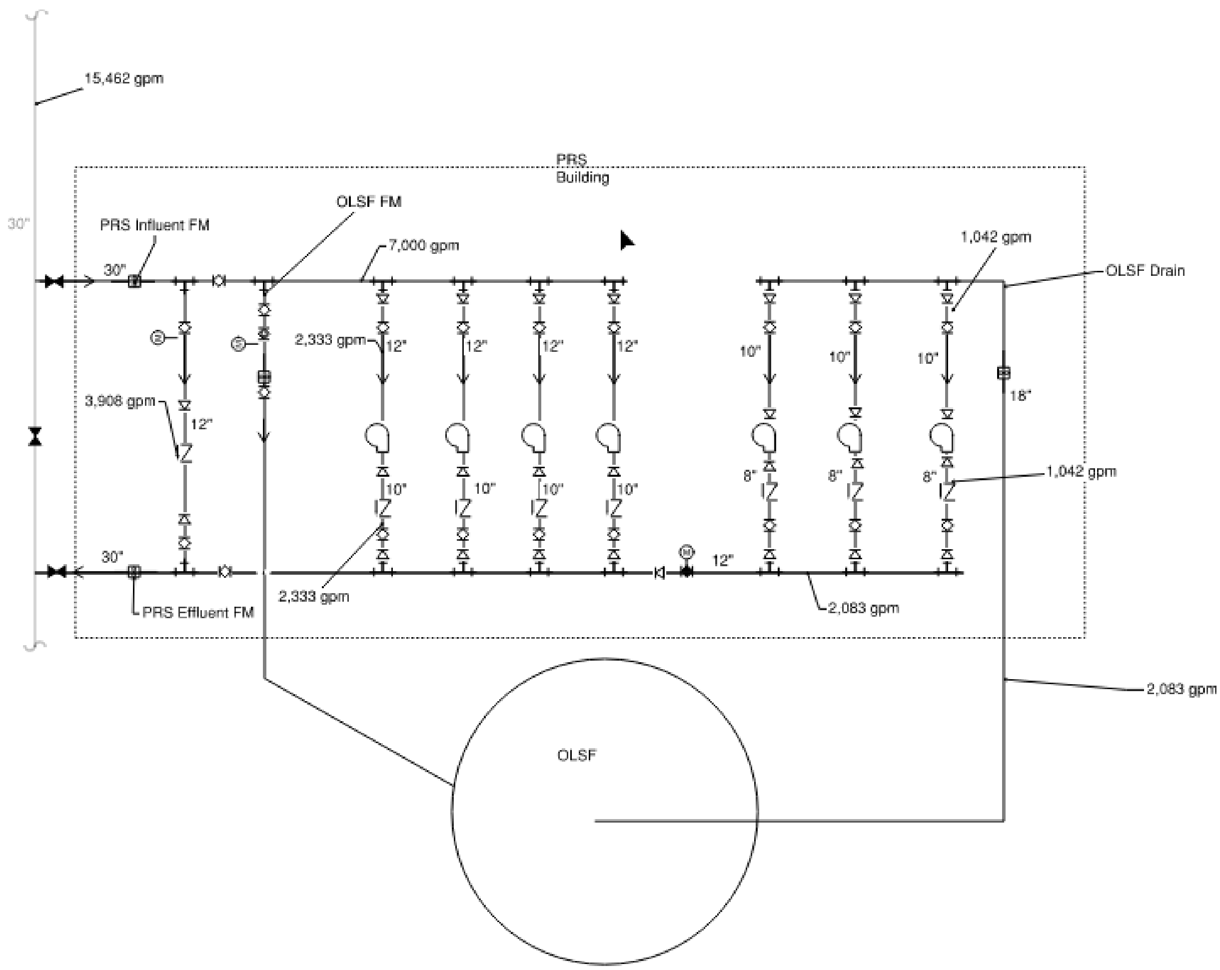


Figure 4-2. Option 1 Flow Diagram

Option 1 summary:

- OLSF is filled off upstream line pressure
- OLSF is nearly completely buried
- Control valve controls flow into the OLSF
- PRS pumps sized for PRS operation
- Drain pumps sized for OLSF draining
- Drain pumps can be located in the PRS (shown in Figure 4-2) or in the OLSF (submersible – not shown)

4.1.1.2 Fill using PRS Pumps

The second option would be to locate the OLSF at grade and fill the tank using the PRS pumps. A hydraulic profile of Option 2 is presented in Figure 4-3.

Figure 4

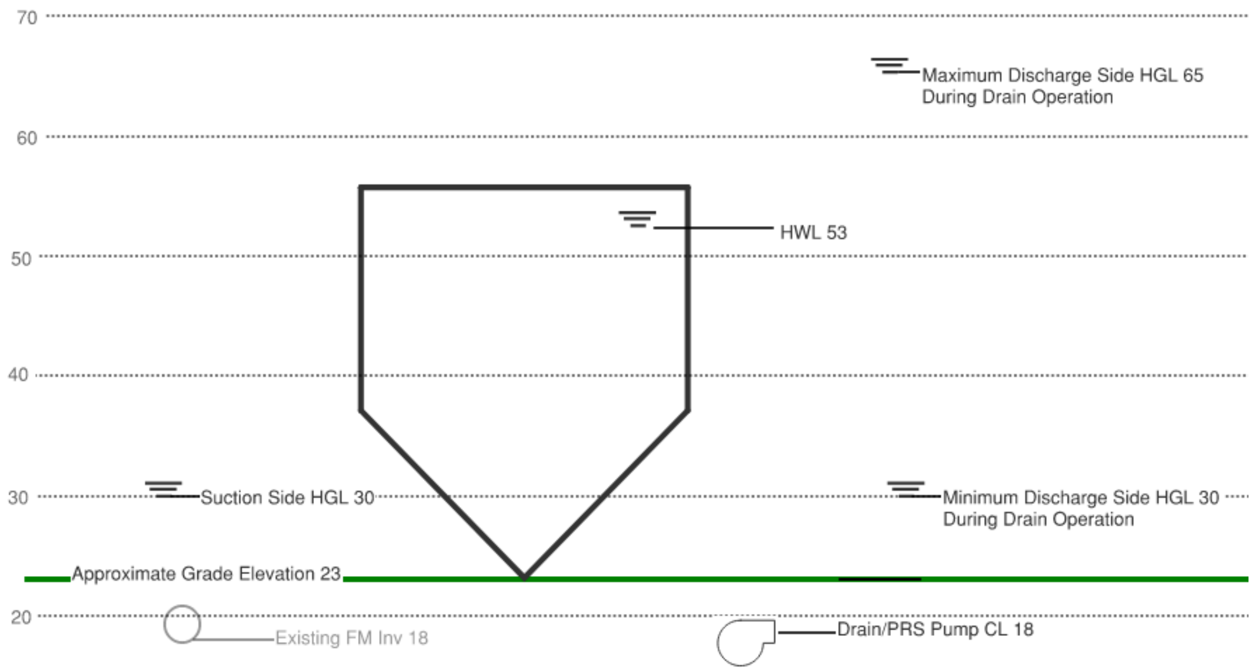


Figure 4-3. Option 2 Hydraulic Profile

The pumping capacity of the PRS would be increased to meet the maximum wet weather flow presented in the HART Report of 15,462 gpm. Once a flow of 7,000 gpm is reached, a control valve would open to allow additional flow to be directed towards the OLSF. The control valve will modulate to maintain the upstream HGL of 30 ft. Figure 4-4 shows a flow diagram for the option with the drain pumps within the PRS. An alternative would be to use submersible pumps for the drain pumps and locate them within the OLSF. A sump would be provided within the OLSF to ensure the drain pumps have adequate NPSHa and submergence. This would allow the PRS to be smaller to house only the PRS pumps.

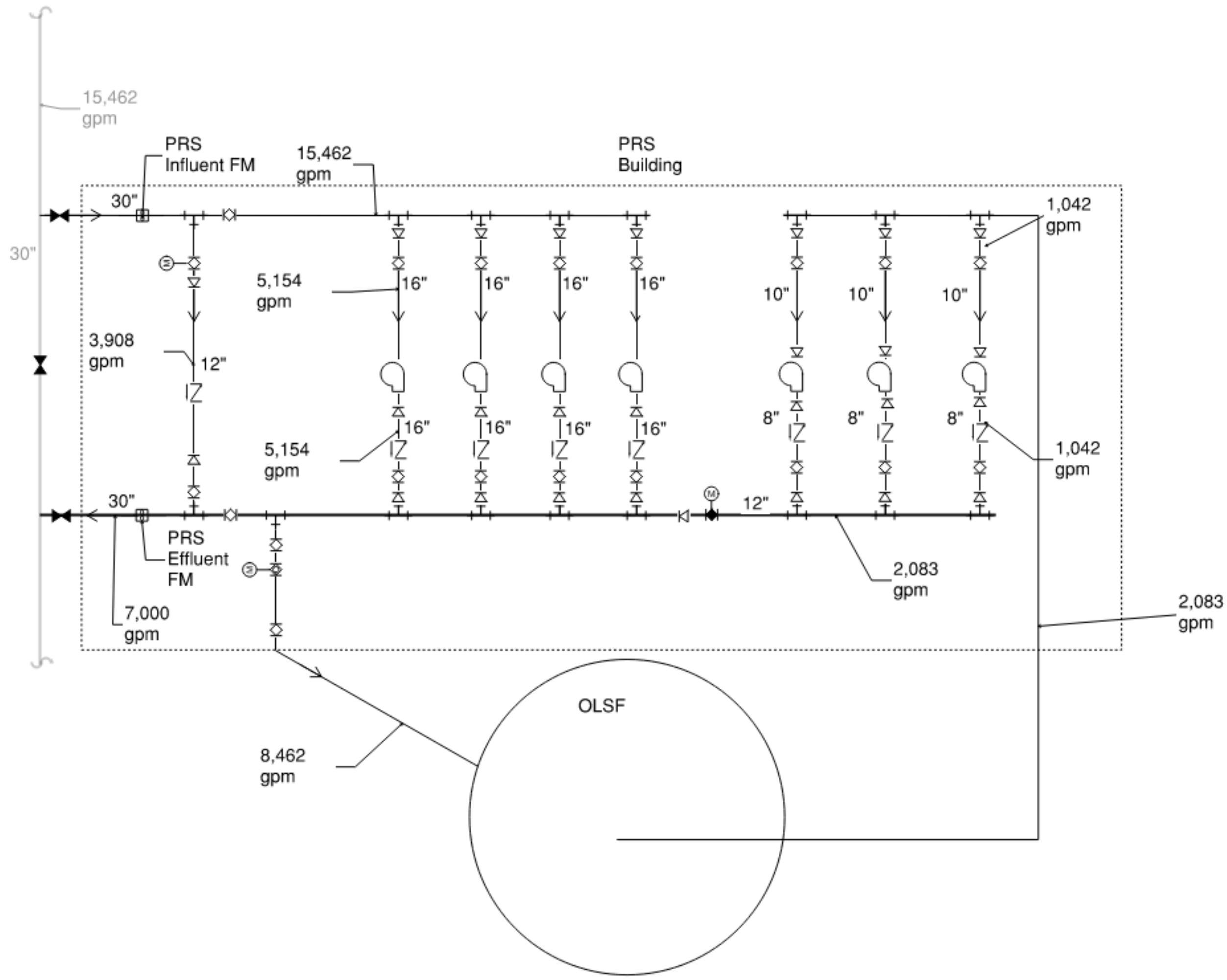


Figure 4-4. Option 2 Flow Diagram

Raising the OLSF to grade requires a control valve on the pump discharge during draining. Grade is assumed to be at elevation 23 ft, so a tank with a 30-ft side water depth (SWD) would have a high-water surface elevation (WSE) of 53 ft. This would be 23 ft higher than the dry weather downstream HGL of 30-ft. When the static head is negative or zero, tank WSE >= discharge HGL, a control valve is necessary to add enough head to raise the system curve into a preferred operating region for the selected pump. When the static head is high enough the valve can open fully.

Option 2 summary:

- OLSF is filled off PRS pumps
- OLSF is located at grade
- Control valve splits flow between the existing FM and the OLSF
- PRS pumps sized for PRS and OLSF filling operation
- Drain pumps sized for draining
- Drain pumps can be located in the PRS (shown in Figure 4-4) or in the OLSF (submersible)
- Drain pumps require a control valve during tank draining

4.1.1.3 Fill using Drain Pumps

The second alternative approach to filling the OLSF would be to locate the OLSF at grade and fill the tank using the drain pumps. The pumping capacity of the drain pumps would be increased to meet the additional flow above the PRS capacity of 7,000 gpm. For this scenario, the drain pumps capacity would be 8,462 gpm. Once the PRS is operating at full capacity and unable to maintain a suction side HGL of 30 ft, the drain pumps would turn on and pump into the OLSF. The pump speed would be adjusted to maintain the suction side HGL of 30 ft. The hydraulic profile would be the same as shown for Option 2.

Using the drain pumps to fill the OLSF has an advantage over using the PRS pumps because it does not rely on balancing flow with a control valve; however, the wide range of design points makes it difficult to find a good pump selection. Preliminary design points for a three pump (two duty) arrangement are provided below in Table 4-2.

Table 4-2. Preliminary Drain Pump Design

Operation	Total Flow	Flow per Pump	TDH
Filling OLSF, High Head	8462	4213	83
Filling OLSF, Low Head	8462	4213	53
Draining OLSF, High Head	2083	2083	55
Draining OLSF, High Head	2083	2083	20

Preliminary pumps could be identified to meet the filling conditions and pumps could be identified to meet the draining condition, but a pump that could meet both conditions within the preferred operating range (POR) could not be found.. For this reason, the option to fill the OLSF using the drain pumps was eliminated and not considered for further evaluation. Figure 4-5 shows a flow diagram for the option with the drain pumps shown within the PRS. Locating the drain pumps within the OLSF would not work for this option since the pumps are also used to fill the OLSF.

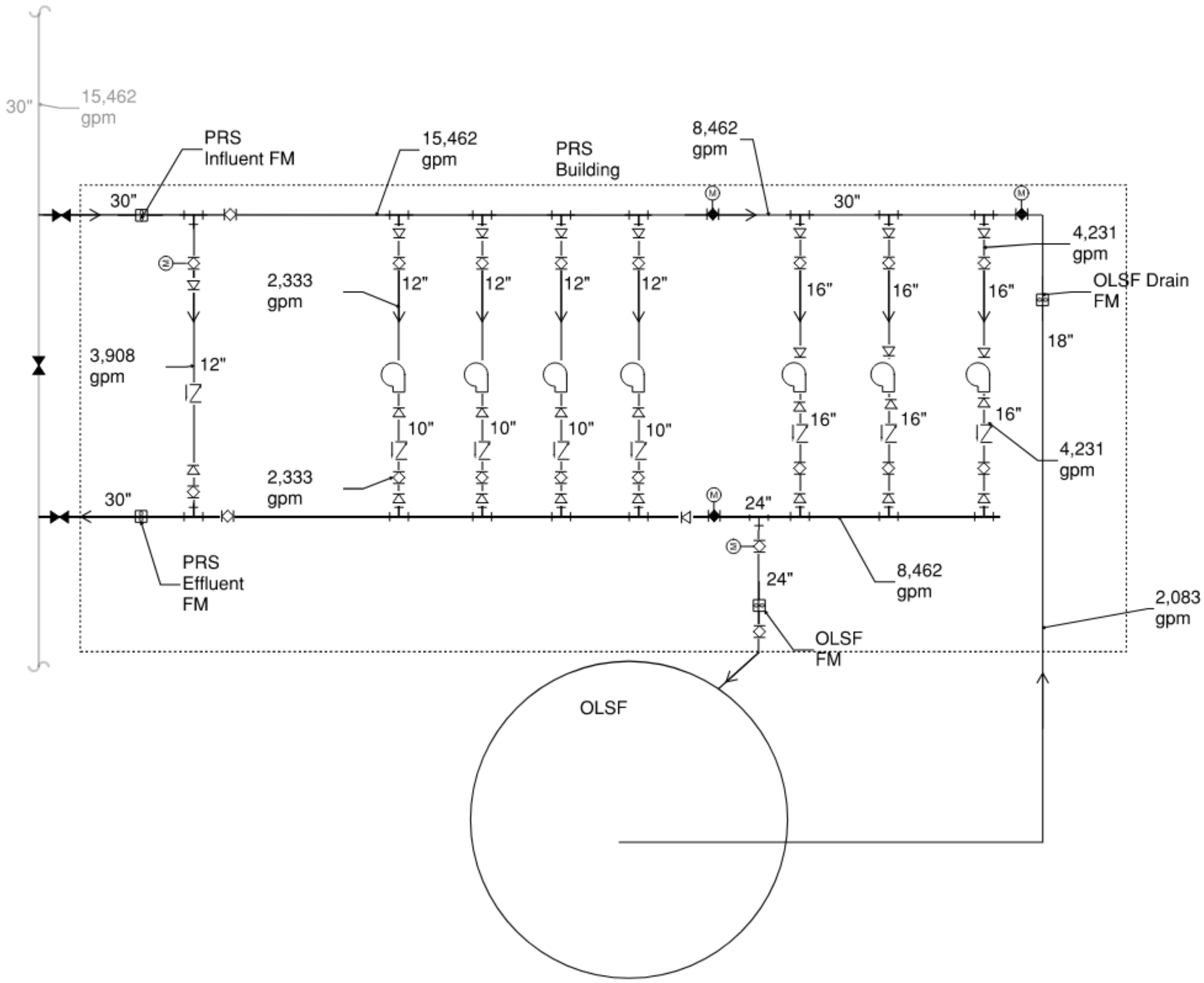


Figure 4-5. Option 3 Flow Diagram

A control valve on the drain discharge is required as described in Section 4.1.1.2.

Option 3 summary:

- OLSF is filled off tank drain pumps
- OLSF is located at grade
- PRS pumps sized for PRS operation
- Drain pumps sized for OLSF filling and draining
- Drain pumps located in the PRS
- Drain pumps require a control valve during tank draining

4.1.2 Pump Type

There will be two sets of pumps for the Wilroy PRS and OLSF.

- PRS Pumps
- OLSF Drain Pumps

For the PRS pumps, the following pumps were considered for use.

- Dry Pit Submersible
- Screw Centrifugal
- Extended Shaft Non-clog centrifugal

For the OLSF drain pumps, the same three pumps were considered in addition to wet pit submersible pumps installed in the OLSF.

Dry Pit Submersible. Dry pit submersible pumps are currently used extensively throughout the HRSD system. Below is a picture of two dry pit submersible pumps installed at the Woodstock Off-Line Storage Facility.

Figure 4-6. Dry Pit Submersible Pumps Installed at Woodstock OLSF

Dry pit submersible pumps are a variant of submersible pumps that have been modified to operate in a dry condition. These designs are the same submersible pump that would be used for the same application, but either mounted on a baseplate in a horizontal configuration or a vertical design supported by a combination inlet elbow and pump support. Since the pumps are not submerged during normal operation, motor cooling is necessary. Pumps can be provided with a closed loop cooling system using a glycol solution to avoid inefficiencies and maintenance issues related to using pumped water to cool the motor.

Advantages include the following:

- Ability to monitor pump health signs because the pump is not immersed in wastewater
- Not susceptible to water damage should the dry well flood. Dry pit pumps are capable of pumping with a fully submerged dry well
- Do not need a seal water system
- Compact design limits alignment and vibration issues. Vibration sensors can be included to shutdown circuits should displacement exceed the manufacturer’s recommendations
- Elimination of shafting and coupling

Disadvantages include the following:

- Mechanical seal failure can lead to moisture in the motor housing
- Motor cooling system failure can lead to overheating
- Limited to small and medium sized pumps

Wet Pit Submersible. Submersible pumps are comprised of a sealed motor direct connected to a pump volute. The pump impeller is mounted on the motor shaft and a double seal is provided to protect the motor windings from leakage along the shaft. The seal chamber can be either air-filled or oil-filled, with the latter more common. The pump is raised from or lowered to its pumping position on a guide rail system. The surrounding water can cool smaller pumps, but larger pumps typically use a closed loop cooling system using a glycol solution similar to the dry pit variation.

Figure 4-7. Submersible Pumps (Courtesy of Xylem)

Advantages include the following:

- No dry well required
- No seal system
- No suction piping or valves

Disadvantages include the following:

- Limited access for maintenance, the pump needs to be removed and cleaned for maintenance activities.
- Pump is out of sight, signs that issues may be developing can be missed
- Mechanical seal failure can lead to moisture in the motor housing
- Motor cooling system failure can lead to overheating
- Limited to small and medium sized pumps

Screw Centrifugal. Screw centrifugal pumps were developed for wastewater applications where rags and accumulations of strings and solids have been found to be troublesome. The pump has a single blade impeller (reminiscent of an Archimedes screw pump or an auger) that operates in a specially cast inlet piece. Close clearance between the impeller vane and the inlet piece are required to maintain operational efficiency. The pumps can be provided as wet pit submersible, dry pit immersible, or horizontal or vertical dry pit separately mounted, close coupled, or built together.

Advantages include the following:

- Large free passage that allows stringy objects and solids pass without clogging
- Pump curves are typically relatively steep where flowrate is less sensitive to TDH changes
- Wet pit and dry pit immersible arrangement do not require seal water

Disadvantages include the following:

- Close clearances can be problematic for gritty slurry applications
- Vibration can be a problem because of the single vane since the disturbing frequencies often are in the range of harmonic response frequencies for piping systems
- Impeller is larger and heavier than non-clog pumps requiring more robust bearings and shaft
- Fewer selections because the impeller cannot be trimmed
- Limited to small and medium sized pumps

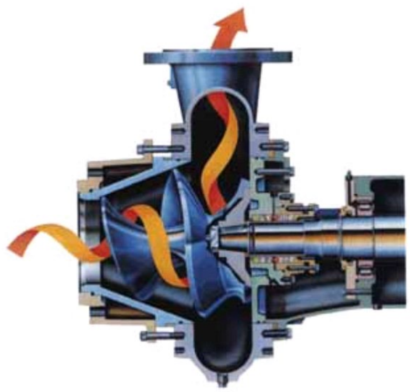


Figure 4-8. Screw Centrifugal Pump Courtesy of Hidrostal

Extended Shaft Pump. Extended shaft pumps are variations of a dry pit pump with the pump and drive located at different levels and connected with an extended shaft. The arrangement allows for the pump to be located in an area that can flood while locating the motor above the flood elevation minimizing impacts to flooding the dry well.

Advantages include the following:

- Motor can be located at grade in a more easily accessible location
- Wide selection from a number of manufacturers. Large capacities available

Disadvantages include the following:

- Requires a seal water system
- Shaft alignment and balancing needs close attention to avoid bearing wear
- Requires intermediate bearings and access platforms for maintenance complicating the pump station structure
- Exposed rotating shaft is a health and safety risk to operating staff

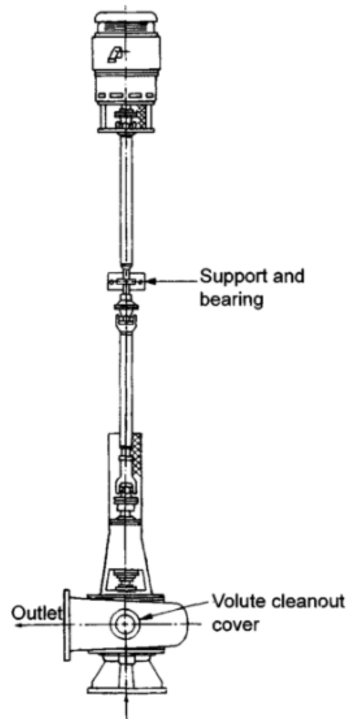


Figure 4-9. Extended Shaft Pump

4.1.2.1 Recommendation

The extended shaft pump option was eliminated from further consideration because the advantages of the non-clog design and reduced maintenance of the dry and wet pit submersibles and screw centrifugal options outweigh the advantages of the extended shaft design. HRSD has moved away from the use of extended shaft pumps in recent years. Extended shaft pumps would have an advantage if the capacities were higher or if the design points could not be met with the more limited selections of the other options.

Preliminary selections were made with the dry pit, wet pit, and screw centrifugal options. The efficiency of the dry pit and wet pit selections were consistently a couple of percentage points higher than the screw centrifugal selections and the capital cost of the pumps were approximately 45% lower with a dry pit or wet pit selection. Although NPSHr values for the preliminary screw centrifugal selections were lower than the preliminary wet pit and dry pit submersible selections (NPSHr values for the preliminary screw centrifugal selections ranged from 8 to 19-ft; compared with 9 to 23-ft for the preliminary wet pit and dry pit submersible selections) the difference was not significant and NPSHa values in all cases met minimum HI margins. Also, during the Hydraulics and Facility Configuration Workshop with HRSD staff on April 20, 2022, it was noted that screw centrifugal pumps and Xylem N-impeller dry pit submersible pumps performed essentially the same in preventing clogging during operation. For these reasons screw centrifugal pumps are not recommended.

Based on this evaluation, the PRS pumps are recommended to be dry pit submersible pumps and the drain pumps are recommended to either be dry pit or wet pit pumps depending on the layout and configuration of the PRS and OLSF.

4.1.3 Pump Life Cycle Costs

A life cycle cost analysis was performed to compare the costs associated with burying the tank to allow for filling using upstream line pressure with the costs to purchase, operate, and maintain larger PRS pumps.

A very rough estimate of the number of events requiring operation of the PRS and OLSF was developed using system pressures at Suffolk PS MMPS-174, just upstream of the proposed Wilroy PRS site. A data set from 3/31/18 through 4/7/22 was used in the analysis. It should be noted that the HGL at the proposed site is anticipated to differ slightly from that seen at MMPS-174 and future weather patterns may increase the frequency that the PRS and OLSF are called into use, but it is believed that the dataset provides a reasonable estimate for use in comparing the two alternatives.

The PRS would operate any time the HGL was above 70 ft. The OLSF would be online any time the HGL was above 100 ft. The data set showed the PRS would operate on average 196 hours per year and the OLSF would be in service an average of 7 days per year.

The operating cost for the two options was calculated using preliminary pump selections for the PRS and drain pumps from the hydraulic model. For the PRS operating cost, the anticipated annual operating hours was used at the max flow. For the drain pump operating cost, it was assumed the pumps would operate for 24 hrs to drain the OLSF after each event.

Figure 4-10 shows the HGL (1-hr increments) over the data set period. The orange line represents any time the PRS will be in operation and the blue line represents any time the OLSF will be in operation.

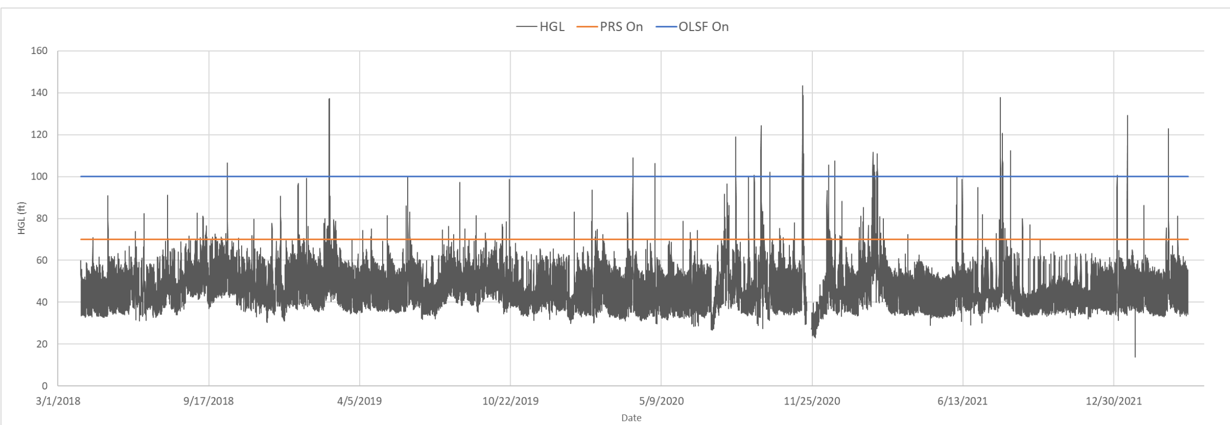


Figure 4-10. HGL of Suffolk PS MMPS-174

Table 4-3 shows the net present worth (NPW) of the pump options for the two scenarios for filling the OLSF.

Table 4-3. Life Cycle Analysis of Pump Options										
Scenario	Description	PRS Pumps				Drain Pumps				Total NPW
		Electricity Cost	O&M Cost	Capital Cost	NPW	Electricity Cost	O&M Cost	Capital Cost	NPW	
1	Fill using upstream line pressure	$3,000	$9,000	$420,000	$690,000	$600	$4,000	$170,000	$270,000	$1,000,000
2	Fill using PRS pumps	$3,000	$11,000	$540,000	$870,000	$300	$4,000	$170,000	$260,000	$1,200,000

1. *The life cycle analysis was evaluated over a 40-year time period*
2. *The inflation rate used in the analysis was 2.4%, this is the long-term US inflation forecast from USDA*
3. *O&M costs were assumed to be 2% of capital cost*
4. *Capital costs are for pumps only, cost are from May 2022 from Xylem*
5. *Capital costs for the drain pumps are shown as a dry pit configuration, a wet pit design will be approximately $5,000 more*
6. *The capital costs presented do not include all project costs and is intended to compare the various pump options only and not a true representation of construction cost.*

As expected, the NPW of Scenario 1 is the lowest cost option for filling the OLSF since it relies on upstream line pressure to fill the OLSF instead of pumping. But the limited time the PRS and OLSF will be in operation per year makes the total difference relatively minor. The costs for the pumps for the two scenarios will be combined with the costs for constructing the PRS and OLSF to identify the preferred option.

4.1.4 PRS Layout Options

BC conducted analysis of multiple configurations of the PRS and OLSF focusing on ease of maintenance and life cycle cost. BC evaluated three main alternative layouts for the PRS which relied on the earlier discussion of OLSF elevation (based on how the tanks would be filled). The following alternatives were analyzed:

- Alternative 1: Filling Using Line Pressure
- Alternative 2: Filling Using PRS or Drain Pumps (all pumps inside the PRS)
- Alternative 3: Drain Pumps Located in the OLSF

4.1.4.1 Alternative 1 - Filling Using Line Pressure

For this scenario we configured the station so that the OLSF would be filled utilizing the line pressure as discussed in Section 4.1.1.1 of this report. This required the PRS and OLSF to have a depth below grade of more than 28 feet. See Figure 4-11 and 4-12 for a sketch of the plan view and section view of the station configuration. The large amount of excavation (approximately 1950 cubic yards) and the dewatering required to construct the PRS and OLSF at the required depth makes this alternative the most expensive layout when compared the other configurations.

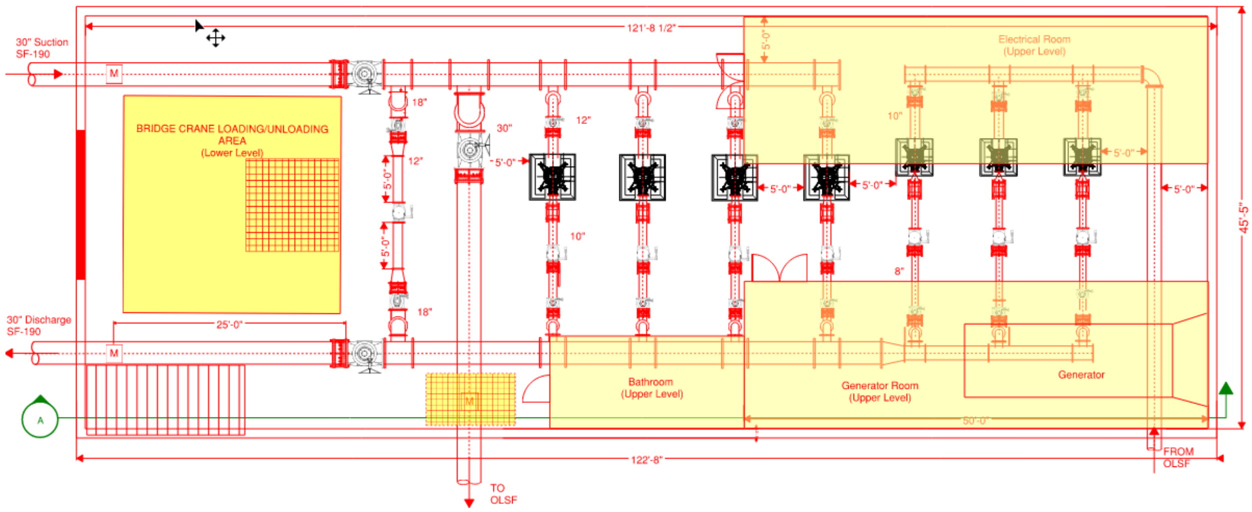


Figure 4-11. Alternative 1 Plan View

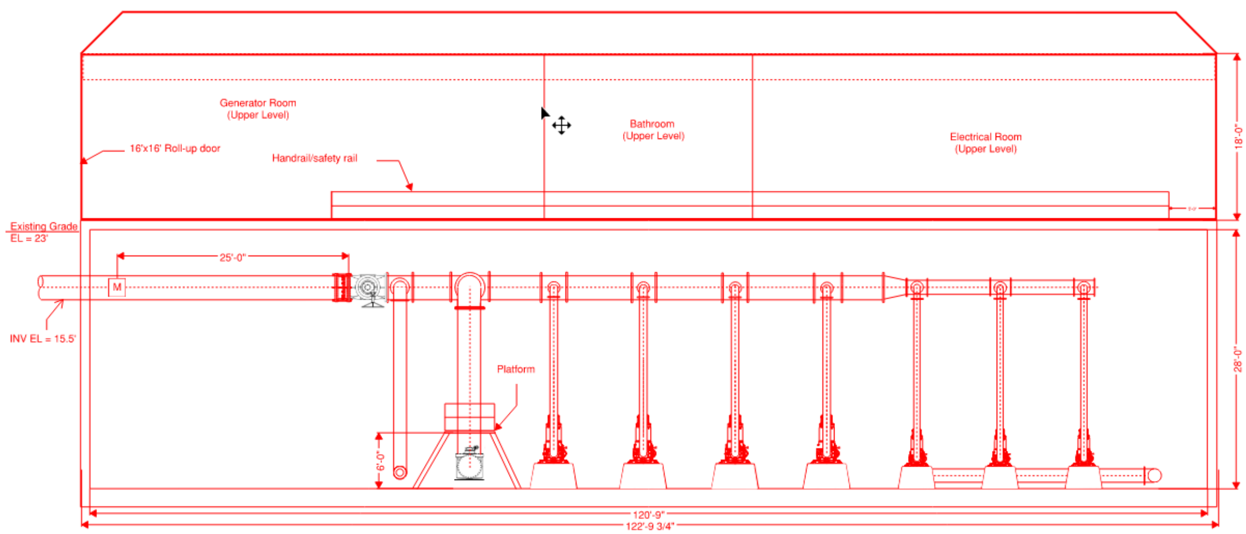


Figure 4-12. Alternative 1 Section View

The station is comprised of two floors. Each floor contains the following:

Pump room (approximately 28 feet below grade):

- Pumps for both PRS and tank draining
- Valves
- Pipes
- Bridge Crane

First floor (at grade):

- Generator room
- Electrical and control room
- Bathroom

All equipment can be accessed and maintained by utilizing elevated platforms that are located around the pumps and valves. These platforms are designed to allow Operations staff to easily walk beneath to facilitate O&M activities. The suction and discharge header are located approximately 20 feet above the lower pump room and would require additional platforms or lifts to access and maintain valves and flow meters. The first floor has a large opening to the pipe gallery which allows access to hoist and remove any pump, valve or piping below using a single bridge crane. Building code dictates the minimum required number of egress locations based floor level and travel distance between exits. Due to the depth and length of the station multiple egress points would be need in the pump room to meet code requirements. Building size and depth are shown in Table 4-4.

Table 4-4. Alternative 1 Building Footprint Sizing

Floor	Area (sq-ft)	FF Elevation
Pump Room	6,250	23’
First Floor	6,250	-5’
Total Footprint	6,250	

4.1.4.2 Alternative 2 - Filling Using PRS or Drain Pumps (All pumps inside the PRS)

Alternative 2 configures the station so that the OLSF are filled utilizing the PRS or OLSF drain pumps as discussed in Section 4.1.1.2. This alternative has all the pumps within the PRS building. See Figure 4-13 and 4-14 for a sketch of the plan view and section view of the station configuration.

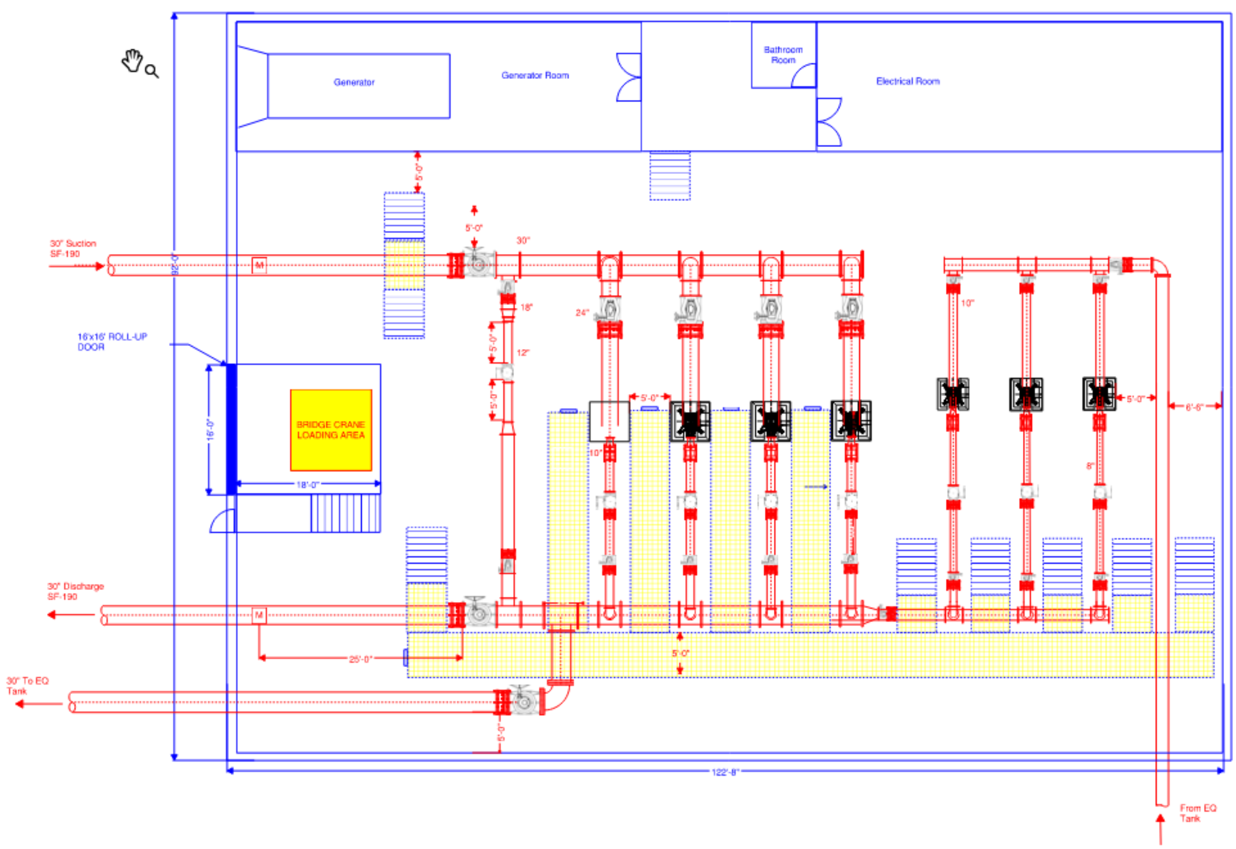


Figure 4-13. Alternative 2 Plan View

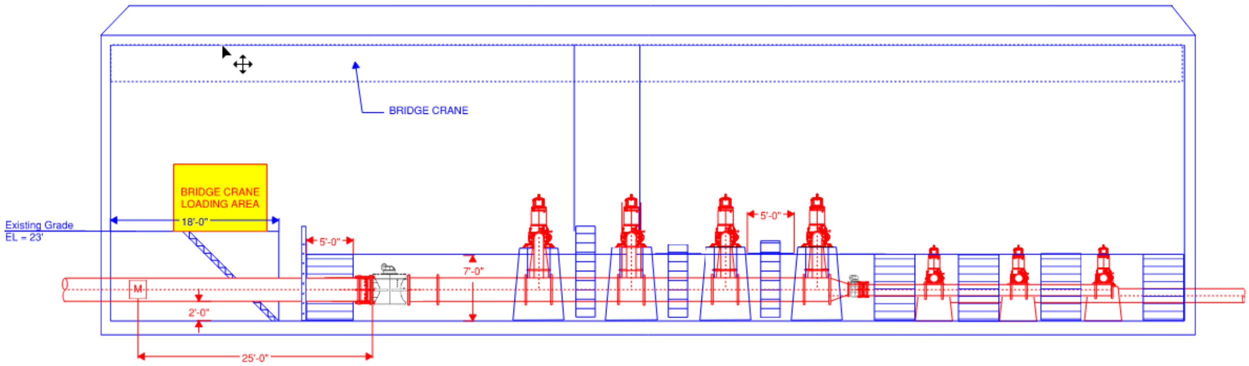


Figure 4-14. Alternative 2 Section View

The station is comprised of two floors. Each floor contains the following:

Pump room (approximately 10 feet below grade):

- Pumps for both PRS and tank draining
- Valves
- Pipes
- Bridge Crane

First floor (at grade):

- Generator room
- Electrical and control room
- Bathroom

The pump room is accessible by multiple stairways to allow for easy access to multiple areas of the station that would be blocked by piping. The suction and discharge header are approximately 2 feet above the lower pump room finished floor elevation. Like the other alternatives, all equipment can be accessed and maintained by utilizing elevated platforms. These platforms are designed to allow the operation staff to easily walk beneath to facilitate O&M activities. The platforms are also used to navigate around and over the large suction and discharge piping. A singular bridge crane will be able to move all piping, valves, and pumps throughout the facility. A loading/landing area has been proposed near a rollup door to provide easy movement of the equipment and materials in and out of the station. Locating all the pumps inside the PRS increases the building footprint by 1,600 square feet compared to Alternative 3. This alternative allows the operators the ability to easily access the pumps and valving all within the same building. Building size and depth are shown in Table 4-5.

Table 4-5. Alternative 2 Building Footprint Sizing

Floor	Area (sq-ft)	FF Elevation
Pump Room	9,375	13’
First Floor	2,000	23’
Total	11,375	

4.1.4.3 Alternative 3 - Drain pumps located in the OLSF

Alternative 3 locates the OLSF drain pumps within tank itself which reduces the building total footprint as well as reducing the amount of excavation need for the pump room floor. See Table 4-5 for building footprint sizing. The tank drain pumps would then be submersible style pumps that slide up and down on guide rails that are installed in the OLSF. A larger sump would be required in the OLSF to accommodate the pumps. Additionally, the operators would need to climb to the top of the tank to maintain and replace the drain pumps. See Figure 4-15 for an example of a tank with additional chamber for pumps. This would also require the tank top to outfitted with a jib crane to hoist the pumps on and off the tank top. This layout is provided in Figure 4-16.

Figure 4-15. Tank with additional chamber for drain pumps

The PRS station is comprised of two floors. Each floor contains the following:

Pump room (approximately 10 feet below grade):

- PRS pumps only
- Valves
- Pipes
- Bridge Crane

First floor (at grade):

- Generator room
- Electrical and controls room
- Bathroom

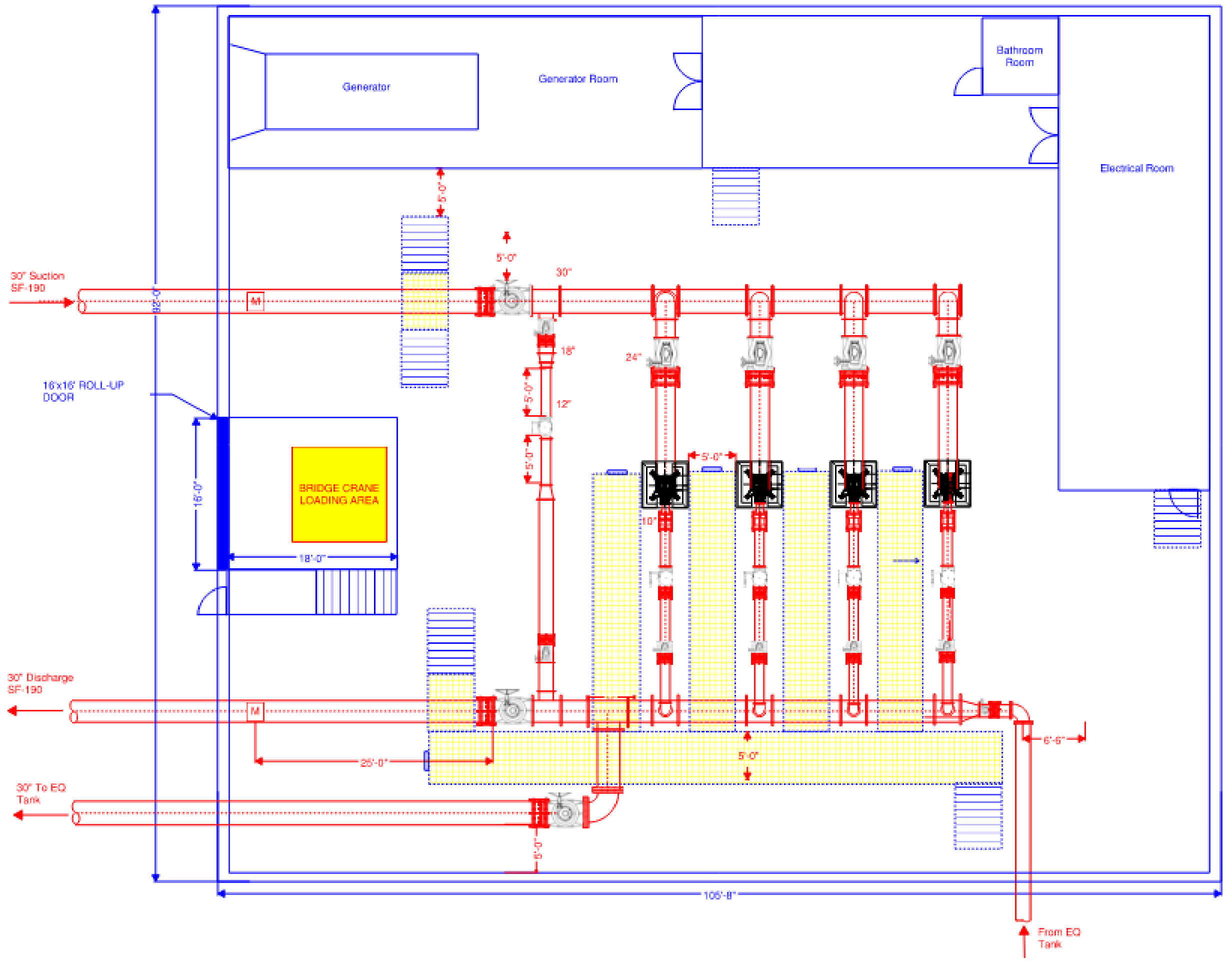


Figure 4-16. Alternative 3 Plan View

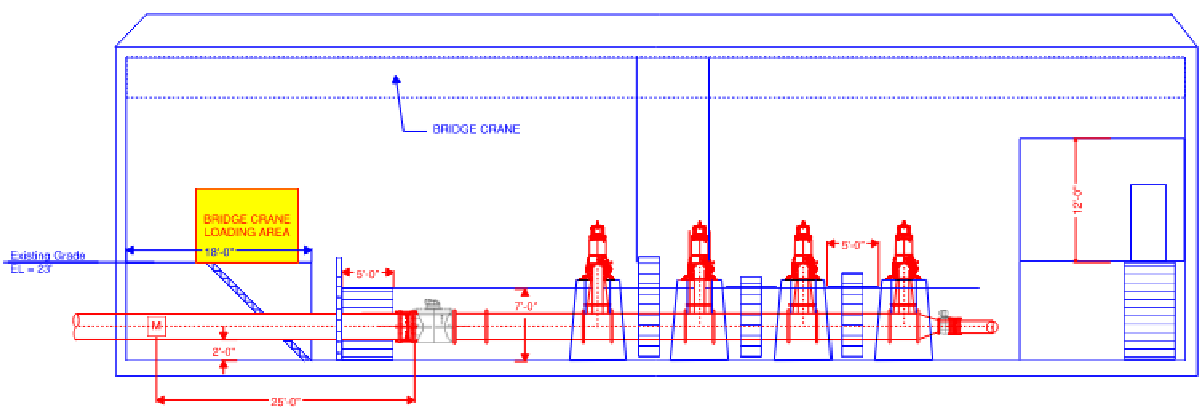


Figure 4-17. Alternative 3 Section View

Table 4-6. Alternative 3 Building Footprint Sizing		
Floor	Area (sq-ft)	FF Elevation
Pump Room	7,390	13’
First Floor	2,340	23’
Total	9,730	

4.1.4.4 PRS Pump Station Alternatives Cost

Table 4-7 presents the relative construction cost for the three PRS alternatives. The costs are relative costs for differences between the alternatives and include excavation, dewatering, shoring, cast-in-place concrete construction of below grade portions of the station and the superstructure above grade.

Table 4-7. Relative Construction Cost of PRS Alternatives	
Alternative	Construction Cost
1	$8,100,000
2	$5,000,000
3	$4,600,000

Note: The construction costs presented do not include all project costs and are intended to compare the various PRS options only and not a true representation of construction cost.

The cost for Alternative 3 also includes the cost for providing a sump in the OLSF large enough to house the submersible drain pumps. This cost was added to the cost of the PRS to account for the total cost for housing all PRS and drain pumps into a single number to properly compare the three alternatives.

The costs for the PRS construction will be combined with the costs for the pumps and constructing the OLSF to identify the preferred option.

4.2 OLSF Tank Alternatives

4.2.1 Construction

The following section provides the evaluation of different construction alternatives for the OLSF tank. These alternatives include the following:

- Prestressed concrete
- Cast-in-Place concrete
- Post-tension concrete

HRSD currently has both cast-in-place and post-tension tanks in service in their system. A pre-stressed tank is also being designed currently for the Tabb PRS and OLSF project. While HRSD Operations staff has stated they are satisfied with the tank’s final construction, it was noted that the Coliseum tank that was constructed had significant issues during construction with passing a leak test. Eventually the contractor was able to adequately seal the leaks to pass the leakage test.

4.2.1.1 Prestressed Concrete

Prestressed concrete tanks (manufactured by CROM Corp and others) are constructed in accordance with ACI 350, ACI Report 372 and AWWA D110 – Wire- and Strand-Wound Circular Pre-Stressed Concrete Water Tanks. Prestressed concrete tanks have exceptional watertightness that is made possible by the Type II Composite Wall and a continuous galvanized steel shell diaphragm. By leveraging the strength of shotcrete in compression, less material is required versus conventional reinforced concrete construction reducing the capital cost of the tank. Shotcrete is a durable, highly impermeable, high-strength building material with a long life which requires minimal maintenance. Pre-stressed concrete tanks are limited to circular, oval, or horseshoe-shaped configurations due to the construction of the steel ring. The design and construction of the tank allows for an expedited construction schedule compared to other tanks designs. A prestressed concrete tank construction by CROM Corp is shown on Figure 4-18.

Figure 4-18. Prestressed Concrete Tank Construction

4.2.1.2 Cast-in-Place (CIP)

Cast-in-place concrete tanks are designed in accordance with ACI 350 and are the most common design type in wastewater applications. This is because of the unlimited design configuration available for shapes and sizes of the tank. Due to the complexities of formwork and labor, typically the cost is higher, and the duration of construction is the longest out of the other tank types.

4.2.1.3 Post-tensioned Concrete

Precast, post-tensioned concrete tanks (as manufactured by Dutchland Inc. and others) are constructed in accordance with ACI 318, ACI 350, and Post-tensioning Institute Standards. Circular tanks are designed in accordance with AWWA D115. Post-tensioned concrete utilizes conventional rebar along with tendons that are embedded and elongated resulting in improved resistance to forces. Tank designs us precast concrete panels that are made in a plant applying stringent quality-control measures which allows for consistency. To ensure that the tank is watertight, grout and sealant is applied to all joints. Coatings are not required for waterproofing. Precast designs limited the maximum height of tank to approximately 40 feet for a rectangular tank and approximately 55 feet for a circular tank. A wide variety of aesthetic options are available for precast panels. Concrete may be stained at the precast plant or in the field. Textures can also be created with form liners to mimic a wide variety of other masonry alternatives, including brick and stone. Precast concrete provides many options for duplicating existing architectural styles with surrounding buildings. A precast, post-tensioned concrete tank construction by Dutchland Inc. is shown on Figures 4-19.

Figure 4-19. Precast Post-tensioned Concrete Tank Construction

4.2.1.4 Recommendation

Based on cost, available footprint, strength, and expedited construction duration BC recommends proceeding with a pre-stressed concrete tank. Table 4-8 shows the advantages and disadvantages between the construction types. See Section 4.2.6 for cost comparison of different construction types and Section 4.3 for the selected alternative recommendation.

Table 4-8. Tank Configuration Analysis

Tank Type	Advantages	Disadvantages
Cast-in-Place (CIP) Concrete	• Flexible configuration	• Expensive • Extended construction duration
Pre-stressed Concrete	• Cost effective design • Expedited construction duration	• Circular, oval, or horseshoe-shaped configurations only
Precast, Post-tensioned Concrete	• Flexible configuration • Expedited construction duration	• Moderately expensive • Multiple construction joints

4.2.2 Geometry

The following section provides an evaluation of the different tank geometry alternatives available. There are two basics geometric classifications, round/oval or rectangular/unique. There are multiple factors that play a role in what geometry will fit best for a project. These factors include the actual geometry and size of the site, tank cleaning/flushing methods, cost, and construction type.

4.2.2.1 Round/Oval

Round/oval tanks are the strongest geometrical structures when compared to rectangular/unique shaped tanks. Cylindrical tanks can withstand exterior forces such as strong wind with less material to obtain a similar loading capacity than square or rectangle tanks. In other words, for an identical volume, cylindrical tanks have less side wall and base thickness requirements than other shaped tanks. A cylindrical tank has the smallest possible ratio of circumference to area, meaning that it has less surface area than other shaped tank of similar volumes.

Although a round tanks may take up less surface area, it can leave more unusable space on a site as it does not always fit perfectly or neatly into a space. Cylindrical tanks, due to their strong geometrical shape and small ratio of circumference to area, tend to be more economical than other shape tanks.

4.2.2.2 Rectangular/Unique

Rectangular/unique shape geometry tanks can be fit into more site-specific areas. Typically, if a tank is buried, excavation can be less as well as the disturbed area with rectangular tanks compared to cylindrical tanks of similar volume. As described in Section 4.2.2.1, rectangular/unique shaped tanks require more concrete per square foot of surface area as compared to a round/cylindrical tank.

4.2.3 Cover

The following section reviews the different tank cover alternatives available. Tank coves consist of dome, flat top, and open-air alternatives. Tank covers for wet weather tanks have two main uses: to keep out rainwater and debris and help contain odors within the system.

4.2.3.1 Dome

Dome roofs provide a cost-effective design by reducing the material needed during construction. The disadvantages of a dome roof are that mobility around the top becomes more difficult due to the unlevel surface. Dome covers are typically only used on circular/oval tanks.

4.2.3.2 Flat

Flat top roofs provided an even surface for operations staff to maneuver around the tank and also provide flat surface for ancillary activities if desired on top of the tank. These ancillary activities could be a parking lot or a park (similar to HRSD's Woodstock OLSF). Flat top roofs tend to be easier to construct either using the cast-in-place method or precast concrete sections. The design for a flat top roof becomes more robust which requires a larger material cost.

4.2.3.3 Open-air

Open top tanks are common in the design of storage tanks used for wet weather events. This is because the tank is not meant to store the wastewater for long durations and typically the flow is more dilute during wet weather events. A tank that is open to air is less expensive due to reduced material need for the top as well as no need for additional support for the top. A few disadvantages to an open-air tank are potential odors from the liquids stored and additional flow into the system from rainwater in the tank.

4.2.3.4 Recommendation

Based on the proximity to other business and residential homes in the area, there are concerns of odor issues when the tank is in use. We recommend proceeding with a dome cover (as coupled to a circular tank) due to its cost-effective design and the ability to limit odors.

4.2.4 Corrosion Protection

The following section provides an evaluation of the different corrosion protection alternatives that are available for concrete tanks. Wastewater facilities are prone to corrosion due to the sulfuric acid attack associated with bacterially mediated process known as biogenic sulfide corrosion. This corrosion leads to degradation of the concrete and steel reinforcement. The next sections will provide the pros and cons of different corrosion protection alternatives:

- Calcium Aluminate Cement (CAC) mortar
- Epoxy coating
- High-Density Polyethylene (HDPE) liner

4.2.4.1 Calcium Aluminate Cement (CAC) Mortar

Calcium aluminate cement (CAC) mortar is a sacrificial coating that provides moderate corrosion resistance over standard concrete. The rate of corrosion is expected to increase overtime as CAC decreases strength compared to the strength at early ages. CAC mortar is the cheapest of the lining options typically used on sewage storage tanks.

4.2.4.2 Epoxy Coating

Epoxy coating is a lining system that has high corrosion resistance with a smooth finish. The low friction allows for easy removal of debris off the tank walls during emptying and cleaning operations. Epoxy coatings need to be properly applied and environmental controls closely monitored to ensure proper adhesion. Failure of coating systems are typically due to improper adhesion during installation.

4.2.4.3 High-Density Polyethylene (HDPE) Liner

HDPE lining provides a high corrosion resistance with a smooth finish similar to epoxy. HDPE liner are comprised of HDPE sheets that utilize anchors which must be cast into the concrete walls during the construction of the tanks. This changes the wall to a Type III design that requires the walls to be precast panels that are then vertical arranged. The joints between panels must be sealed properly to meet leakage requirements. HDPE liners are the most expensive of the options.

4.2.4.4 Corrosion Protection Recommendation

Based on information contained within the HART Report, the OLSF tank will only be used for wet weather event storage. The majority of time the tank will be empty and should be cleaned following a storage event. The post event cleaning and ventilation rate associated with the odor control system will limit biological growth on the surface of the concrete and significantly reduce the potential for concrete corrosion to occur. Due to this operational approach, additional corrosion protection is not recommended at this time.

If the system flows in the future justify utilizing the tank for diurnal peak flow shaving, BC recommends using an epoxy coating system to help protect the concrete from biological induced corrosion.

To design the odor control system and verify that concrete protection recommendations do not need to be adjusted, BC will conduct H2S monitoring at upstream pump stations and air release valves. These readings will be used to calculate an estimate for anticipated peak hydrogen sulfide concentrations within the tank. If the estimated peak hydrogen sulfide concentration is elevated, additives or epoxy coatings may be recommended at that time to improve concrete protection regardless of the anticipated future tank usage.

4.2.5 Tank Cleaning and Mixing

Cleaning and mixing systems are important to limit sediment deposits from tank use and promote easier operation of the facility. Additionally, deposition of solids can cause septicity in the waste, increasing the H2S concentrations within the tank and observable odors around the site.

4.2.5.1 Water Cannons & Hose Stations

Water Cannons and hose stations used for washdown of tanks are very simple in design and have the lowest operational maintenance out of the other cleaning systems. Water cannons are fixed at specific locations while hose stations provide more flexibility in coverage area. These systems require the operators to manual spray down the walls (and possibly floor) of the tank. One downside of the hose stations is that tank entry is generally required, which lead to confined space entry procedures and full personal protective equipment. Water cannons and hose stations must have water supply service connections or by an alternative source, like a pumped rainwater cistern.

It is common to have hose stations as a secondary cleaning method if an automated system is not functioning or if there is additional cleaning required beyond the initial flush. Figures 4-20 and 4-21 are examples of water cannons and hose stations.

Figure 4-20. Water Cannon Example

Figure 4-21. Hose Station Example

4.2.5.2 Deluge Systems

Deluge systems are an automated or manual cleaning system that utilizes a supply header with multiple spray nozzles mounted around the top of the tank to provide a cleaning flush to washdown the tank floor and walls. Deluge systems are commonly used on fire suppression systems. These systems need to be specifically designed to have a flowrate to provide a minimum velocity across the surface to ensure proper cleaning. Due to the orifice size on the spray nozzles, there is a chance for the spray nozzle to become clogged. To repair the clogged nozzle operators will need to enter the tanks and use a ladder or other lifting equipment if a ladder does not reach to replace the individual clogged nozzle. Depending on the tank size/geometry there could be hundreds of these nozzles around the tank. Water for the washdown will need to be supplied by ether a dedicated water supply connection or a pumped rainwater cistern. Even using a rainwater cistern, an alternative water supply backup water connection would be recommended. This would ensure that water is available in case the cistern was out of service. Figure 4-22 shows an example of a deluge nozzle.

Figure 4-22. Deluge Nozzle Example

4.2.5.3 Tipping Buckets

Tipping buckets are an automated flushing system designed to remove debris by releasing a large volume of water in a short period of time to flush the floor utilizing gravity flow. The system can either utilize potable water, rainwater, or even wastewater to fill the buckets. Advantages of tipping buckets are that they are suspended over the tank and would not encounter debris reducing the maintenance required compared to alternatives like flood gates that are submerged. The system is virtually maintenance free with permanently lubricated waterproof bearings. The tanks can be supported on the tank back wall, side walls or roof. Tipping buckets are primarily only used in a rectangular shaped tank. Other geometric shaped tanks tend to become more costly due to number of buckets and have challenges ensuring proper cleaning. For rectangular shapes tanks, tipping buckets are limited to 200 feet flushing lengths and bucket widths of 25 feet.

Figure 4-23. Tipping Buckets

4.2.5.4 Vacuum Flushing System

Vacuum flushing systems designed/manufactured by Grande and Biogest utilize vacuum pumps to hold tank sewage in a column to be later used to flush the floor (think of holding your finger on the end of a plastic straw filled with water). Vacuum flushing systems are fully automated cleaning systems. Advantages to the vacuum system are that there are no submerged moving parts, minimal maintenance, and low energy consumption. The vacuum flush system has an audible whistle sound that comes from the vacuum relief valve release. The sound is cause by the large draw of air when the vacuum is released. The noise level ranges from 70 to 75 dB(A) at 1 meter away (actual decibels depend on the volume flushed). Utilizing a cover over the valve can sometimes reduce the noise levels below background suburban noise levels. This system can provide optimal flushing for circular tanks up to 210 feet and up to 490 feet in length for rectangular shape tanks. The vacuum flushing system and sequencing shown on Figures 4-24 and 4-25.

Figure 4-24. Biogest® Vacuum Flush System

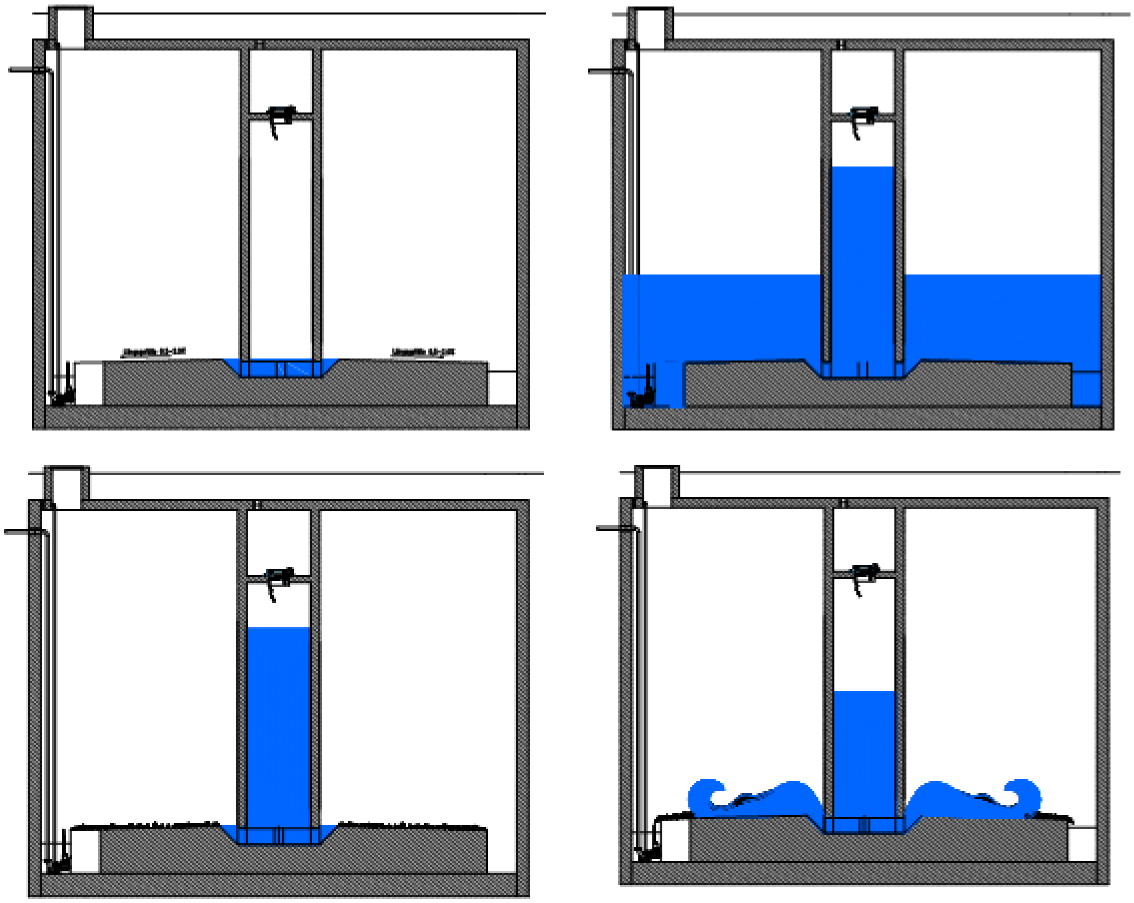


Figure 4-25. Vacuum Flush Operation Sequencing

4.2.5.5 HydroSelf® Circular Flushing System

HydroSelf® is an automatic tank cleaning system that is hydraulically driven and utilizes the incoming sewage to provide flush water. The system is robust being constructed of stainless steel and can provided flushing up to 50 meters or 164 feet. It provides low operational cost and has minimal impact on tank capacity. The system is comprised of a central reservoir that fills during the initial inflow to the tank. Once the tank is emptied a signal from the level transducer can initiate the cleaning. The center reservoir is driven upward by pistons mounted on the central column controlled by a hydraulic pump. The HydroSelf® System and sequencing are shown in Figures 4-26 and 4-27.

Figure 4-26. HydroSelf® Circular Flushing System

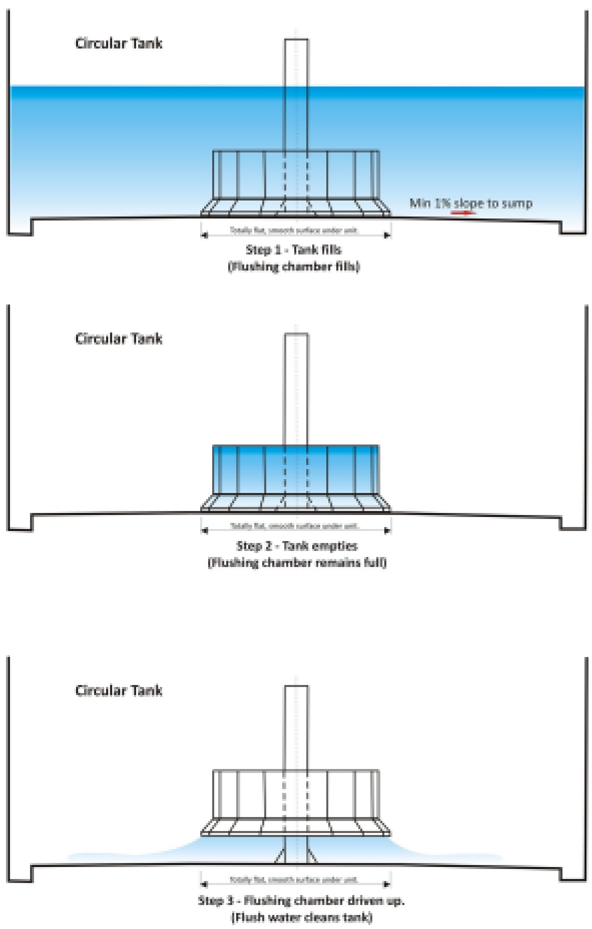


Figure 4-27. HydroSelf® System Operation Sequence

4.2.5.6 Side-Entry Mixers

Side-entry mixers, also known as through-wall mixers, are installed through the side wall of the tank as shown in Figure 4-28 and can be easily removed unless the blades are larger than the opening. If this is the case, the blades must be removed prior to removing the mixer which would require a confined space entry into the tank. Obviously, this style of mixer can only be removed when the tank is empty. These mixers also are not generally used in tanks that are buried or partially buried due to the provisions need on the outside of the tank to access the mixers. Side-entry mixing systems are manufactures by Lyndia, Sulzer, Flygt, and others.

Figure 4-28. Side-entry Mixer

4.2.5.7 Mast-mounted Submersible Mixers

Mast-mounted submersible mixers are mixers that are fitted to a slide rail that allows for remove of the mixer through the top of the tank. A photo of the mixer can be seen on Figure 4-29. This allows for removal with the tank full or empty. The mixing height is manually adjustable if flow requirements change in the future. There are minimum tank levels required to utilize submersible mixers and this may lead to not being able to use during low level events. Mast-mounted mixing systems are manufactured by Flygt, KSB, Lyndia, and others.

Figure 4-29. Mast-mounted submersible mixer

4.2.5.8 Hydraulic Jet Mixers

Jet mixing is an efficient method to distribute mixing energy while minimizing horsepower needed. Flow is typically provided by either a dry-pit or submersible pump inside or outside the tank that draws the fluid within the tank to be used for mixing. Figure 4-30 shows an example of a jet mixing using a dry-pit pump that is easily accessible for maintenance. Like other mixers there is a minimum level that is need for the mixing. Jet mixing systems are manufactures by Flygt, Fluidyne, Lyndia, and others.

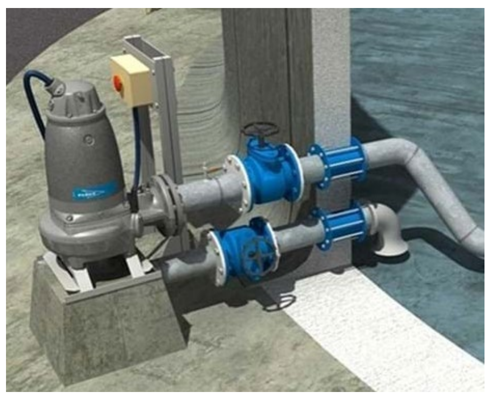


Figure 4-30. Hydraulic Jet mixer by Flygt

4.2.5.9 Cleaning and Mixing Recommendation

Based on the tank planned operation to not be used for diurnal peak shaving, mixers would not be a viable option because of minimum level requirements for the mixers. If in the future the tank does get used for diurnal peak shaving, BC recommends consideration of mast-mounted mixers to be installed to promote mixing to help keep the wastewater form settling and/or turning septic.

For the planned operation scenario, BC recommends installation of the HydroSelf® circular flushing system or the vacuum flushing system due to the cost savings of using the tank liquids for flushing, automation, and ease of maintenance. In addition, it is recommended that there be hose stations installed for secondary cleaning if needed regardless of the cleaning method considered. See Section 4.2.6 for cost comparison and Section 4.3 for selected alternative. Table 4-9 provides a summary of the tank cleaning analysis.

Table 4-9. Tank Cleaning Analysis

Tank Type	Advantages	Disadvantages	Notes
Water Cannons & Hose Stations	• Simple design • Effective	• Requires a lot of water if used alone • Requires tank entry	• Recommended as secondary cleaning for all alternatives
Deluge Systems	• Automated	• Requires potable water or rainwater collection • Nozzles tend to clog easily	• Woodstock Park tank currently uses a deluge system
Tipping buckets	• Automated • Low O&M • Use tank product (sewage) for flushing liquid	• Can require large amounts of potable water or rainwater collection if not using sewage • More suited for rectangular tanks • Expensive	
Vacuum flush system	• Automated • Low maintenance • Use tank product (sewage) for flushing liquid • Suit for both rectangular and round tanks • Can be used in a split tank	• Moderately expensive • Requires a custom tank floor	
HydroSelf Flushing System	• Automated • Use tank product (sewage) for flushing liquid	• Moderately expensive • Requires minimum volume in tank or supplemental water supply needed • Requires a custom tank floor	
Side-entry Mixers	• No additional potable water needed	• Requires minimum liquid level • Does not flush tank floor	• Ideal only for regular tank use • Would still need to be combined with a flushing system or water cannons
Mast-mounted mixers	• No additional potable water needed	• Requires minimum liquid level • Does not flush tank floor	• Ideal only for regular tank use • Would still need to be combined with a flushing system or water cannons
Hydraulic Jet Mixers	• No additional potable water needed	• Requires additional pumps • Does not flush tank floor	• Ideal only for regular tank use • Would still need to be combined with a flushing system or water cannons

4.2.6 OLSF Costs

The cost of the OLSF will be impacted by numerous factors, some of which have already been discussed. The capital costs of the various alternatives were compared to identify the preferred option moving forward. Costs presented are for comparison purposes and do not include all construction costs and markups. These totals do not include costs associated with architecture, HVAC, plumbing, electrical, or I&C. The costs only include differences between the various alternatives and focus on the relative sizes of the PRS and OLSF, amount of excavation, shoring and dewatering required for the different alternatives, and the pump costs of the different alternatives. A full opinion of probable cost of the selected alternative is presented in Section 10.

The alternatives can be differentiated by the following:

- Construction and Geometry
- At-grade or buried
- Number of tanks and tanks layout
- Tank foundation

4.2.6.1 Construction and Geometry

The geometries considered for further evaluation are rectangular or circular. Other options were explored but the more unique shaped geometries suited for constrained sites are not necessary at the proposed sites.

The rectangular design is assumed to be precast post-tension concrete tanks and the circular tanks are assumed to be prestressed concrete tanks constructed in accordance with ACI 350 and AWWA D110. Both tank geometries can also be constructed from cast-in-place concrete, but preliminary cost estimates indicate a cast-in-place design would be more expensive.

4.2.6.2 At-Grade or Buried

Both tank geometries can be constructed either at-grade or buried. The buried option would be required for the OLSF being filled from upstream line pressure; however, it could be used in any alternative. The at-grade options would correspond with the OLSF being filled from either the PRS pumps or drain pumps.

4.2.6.3 Number of tanks and tanks layout

The total storage tank volume required per the HART Report is 3 MG. This can be provided in either a single 3 MG tank or multiple smaller volume tanks.

Multiple smaller tanks would have greater capital costs but would have advantages in operation of the tank. The majority of times the tank is brought online would require a storage volume significantly less than the required 3 MG. Having a smaller tank sized to capture the majority of events would reduce the time required to clean the tank after each event. The first tank could also act as a clarifier to capture the majority of debris reducing the cleaning effort required in the subsequent tanks for the events that require more storage volume.

For a single 3 MG tank, this report used a 30-ft tall x 130-ft diameter tank, which would be an economical selection for a prestressed concrete tank.

For rectangular tank construction, multiple tanks were assumed to be achieved through the use of dividing walls creating multiple bays within a single tank. The number of bays and geometry would be dictated by the flushing alternative selected. This report assumed the tank would have three bays with flushing sized at 25-ft wide by 125-ft long x 19-ft SWD and a larger overflow bay without flushing sized at 100-ft wide x 125-ft long x 19-ft SWD.

For circular tanks, both multiple smaller tanks and a smaller tank constructed within a larger tank was considered. For the purpose of this report, it was assumed two 1.5 MG tanks would be provided. This would provide sufficient storage in each tank to store the simulated volume during a 2-year storm (refer to the HART Report in Appendix B).

4.2.6.4 Tank Foundation

The foundation design will change based on the cleaning option selected.

For circular tanks, the standard foundation design would include a center sump with sloped floor from the tank walls in towards the sump. This style foundation would be used with mixers or if a manual cleaning approach with water cannons and hoses was preferred. The vacuum flushing and HydroSelf flushing options would require a more complex foundation. The foundation would include a trench around the perimeter of the tank with the floor sloped from the center to the wall to facilitate the flushing.

For rectangular tanks, the foundation would be the same regardless of cleaning option, it would include a sump on one end with the floor sloped towards the sump.

Fourteen separate options were developed from the various tank choices. Operation and maintenance of the different tank options are not included in the evaluation because they are not anticipated to be significantly different based on tank geometry and location. The number of tanks will factor into maintenance requirements in the scenarios with multiple bays/tanks since they would reduce the time required for cleaning after small events where only a portion of the tank volume is used. This is factored into the qualitative selection presented in Section 4.3. Below is a comparison of the options and the estimated relative construction cost.

<table>
<tr><th colspan="7">Table 4-10. Summary of Tank Construction Cost</th></tr>
<tr><th>Options</th><th>Tank Geometry</th><th>Tank Location</th><th>Number of Tanks</th><th>Tank Layout</th><th>Tank Foundation Design</th><th>Relative Tank Cost</th></tr>
<tr><td>1</td><td rowspan="2">Rectangular</td><td>Below Grade</td><td>Multiple Bays</td><td rowspan="2">--</td><td rowspan="2">--</td><td>$14,800,000</td></tr>
<tr><td>2</td><td>At Grade</td><td>Multiple Bays</td><td>$7,400,000</td></tr>
<tr><td>3</td><td rowspan="12">Circular</td><td rowspan="6">Below Grade</td><td rowspan="2">1</td><td rowspan="2">--</td><td>Center Sump</td><td>$8,400,000</td></tr>
<tr><td>4</td><td>Flushing Foundation</td><td>$9,000,000</td></tr>
<tr><td>5</td><td rowspan="4">2</td><td rowspan="2">Tank within Tank</td><td>Center Sump</td><td>$8,500,000</td></tr>
<tr><td>6</td><td>Flushing Foundation</td><td>$9,100,000</td></tr>
<tr><td>7</td><td rowspan="2">Separate Tanks</td><td>Center Sump</td><td>$10,100,000</td></tr>
<tr><td>8</td><td>Flushing Foundation</td><td>$10,600,000</td></tr>
<tr><td>9</td><td rowspan="6">At Grade</td><td rowspan="2">1</td><td rowspan="2">--</td><td>Center Sump</td><td>$4,500,000</td></tr>
<tr><td>10</td><td>Flushing Foundation</td><td>$5,100,000</td></tr>
<tr><td>11</td><td rowspan="4">2</td><td rowspan="2">Tank within Tank</td><td>Center Sump</td><td>$5,300,000</td></tr>
<tr><td>12</td><td>Flushing Foundation</td><td>$5,900,000</td></tr>
<tr><td>13</td><td rowspan="2">Separate Tanks</td><td>Center Sump</td><td>$5,500,000</td></tr>
<tr><td>14</td><td>Flushing Foundation</td><td>$6,000,000</td></tr>
</table>

Note: The costs presented include costs associated with concrete, vendor supplied tanks, excavation, sheet piling, and dewatering. It does not include all project costs and is intended to compare the various tank options only and not a true representation of construction cost.

After reviewing the preliminary relative costs for the various tank options, the rectangular tank option was eliminated as those options are significantly higher than the comparable circular option. If the tank is buried, a tank within a tank approach would be the more economical approach while if the tank is at grade a two tank approach is more economical. This reduces the number of options for further consideration to 8 options.

4.2.6.5 Mixing/Flushing Option

Based on the tank configuration options presented above, several of the tank mixing and flushing options were eliminated. The main consideration are highlighted below:

- Tipping buckets and flushing gates are only used on rectangular tanks which were eliminated from consideration and are therefore not included in the evaluation.
- Mixers were not considered because they would only work once the water level reaches a minimum elevation, for events that do not reach that minimum level, mixers would provide no benefit to the facility.
- Mixers keep solids in suspension minimizing the amount of material to be cleaned after an event. For short duration storage, as is the intended use of the Wilroy OLSF, mixers would not provide significant benefits to the facility.
- If extended storage or diurnal use is anticipated in the future, mixers should be reevaluated at that time.
- Deluge systems have a high potential for clogging requiring increased maintenance; especially when used with rainwater harvesting as a water source. For these reasons BC eliminated deluge systems as a cleaning option.
- Manual wash down with hoses/cannons as the only cleaning option was eliminated as well. Although the tank will not be used frequently, it is recommended to provide a means for cleaning the tank after each event without requiring someone to enter the tank.

The two remaining mixing/flushing options considered in the evaluation that can be used with the 8 tank configuration options still in consideration are listed below:

1. Vacuum flushing – this would include a vacuum flushing mechanism to flush the tank floor after each event. Water cannons and hose connections would be provided to clean tank walls as needed.
2. HydroSelf flushing – this would include a center reservoir flushing system to flush the tank floor after each event. Water cannons and hose connections would be provided to clean tank walls as needed.

Table 4-11 compares the relative cost of the different alternatives.

Table 4-11. Capital Costs of Mixing/Flushing Options

Option	Description	Relative Cost
1	Vacuum Flushing[3]	$310,000
2	HydroSelf Flushing	$290,000

1. *Costs for water cannons and hose connections are not included because they are proposed to be include under both options.*
2. *The relative costs presented do not include all project costs and is intended to compare the various flushing options only and not a true representation of construction cost.*
3. *Vacuum flushing capital cost includes the cost for the equipment and the cost for a concrete column to store water used in flushing.*

The cost for both options is similar, with only $20,000 separating them. The vacuum flushing system, while the more expensive selection, has the following benefits:

- The vacuum flushing option only needs enough water in the tank to cover the openings in the center column (approximately 2-ft). The vacuum in the center column allows the column to fill for maximum flushing even at low tank levels. The HydroSelf flushing option requires the water level to overflow into the reservoir. If the water level does not raise above the reservoir height the reservoir needs to be filled from an external source. A check valve lower down the reservoir can be provided to allow water into the reservoir at a lower elevation but unless the reservoir is fully filled the flushing would be suboptimal.
- There are no moving parts on the vacuum flushing option, the only maintenance item would be the small vacuum pumps at the top of the center column. The HydroSelf flushing option has moving parts, a check valve, hydraulic lines, and floats within the tank that would need to be maintained.
- The vacuum flushing option does not have surfaces where rags or other debris could catch. For the HydroSelf flushing option, rags could catch on the top of the reservoir, on the pipe that provides external water source to fill the reservoir, on the floats, or within the check valve.

For this reason, the recommended flushing system is vacuum flushing. For options that include a two tank design only the first stage tank would include a flushing system, the second stage would be manually cleaned.

The tank options that do not include a flushing foundation can be eliminated which reduces the number of tank options to 4.

4.3 Selected Alternative

The selected alternative combines the analysis completed in the previous sections for pump selection, PRS construction, tank geometry, and mixing options to determine the preferred overall design approach.

The two OLSF tank fill options, three PRS alternatives, and four tank options were combined in Table 4-12 below. Not all fill options would work together.

- Fill scenario 1, fill with line pressure would only work with the tank options that are below grade.
- Fill scenario 2 would work with the options that are at grade.
- The deep PRS station is only required for a below grade tank.
- A shallow station with drain pumps in the PRS would only work with a OLSF at grade.

Table 4-12. Alternative Costs							
Alternative	Tank Option	Tank Construction Cost	OLSF Fill Option	NPW Pump Cost	PRS Alternative	PRS Construction Cost	Combined Cost
1	4 - Circular tank, below grade, 1 tank, flushing foundation	$9,000,000	1- Fill off line pressure	$1,000,000	1 - Deep station with PRS and drain pumps in the station	$8,100,000	$18,100,000
2					3 - Shallow station with PRS pumps in station and drain pumps in OLSF	$4,600,000	$14,600,000
3	6 - Circular tank, below grade, tank within a tank, flushing foundation	$9,100,000			1 - Deep station with PRS and drain pumps in the station	$8,100,000	$18,200,000
4					3 - Shallow station with PRS pumps in station and drain pumps in OLSF	$4,600,000	$14,700,000
5	10 - Circular tank, at grade, 1 tank, flushing foundation	$5,100,000	2 - Fill with PRS pumps	$1,200,000	2 - Shallow station with PRS and Drain Pumps in the Station	$5,000,000	$11,300,000
6					3 – Shallow station with PRS pumps in station and drain pumps in OLSF	$4,600,000	$10,900,000
7	14 - Circular tank, at grade, separate tanks, flushing foundation	$6,000,000			2 – Shallow station with PRS and drain pumps in the station	$5,000,000	$12,200,000
8					3 – Shallow station with PRS pumps in station and drain pumps in OLSF	$4,600,000	$11,800,000

From Table 4-12, the least expensive alternatives are Alternatives 5 and 6. The difference between the two is the location of the drain pumps. In Alternative 5 the drain pumps are located in the PRS while in Alternative 6 the drain pumps are located in the OLSF. There are benefits and disadvantages to each with a summary presented in Table 4-13.

Table 4-13. Summary of Low-Cost Alternatives			
Alternative 5		Alternative 6	
Benefits	Disadvantages	Benefits	Disadvantages
Pumps located in the PRS are easier to maintain because they can be worked on without the need to remove the pumps from a wet well to maintain	PRS station needs to be lower than bottom of OLSF to ensure sufficient NPSH is maintained during draining	Drain pumps in the OLSF reduces the size of the PRS and reduce the energy required to heat and ventilate the space.	Removing the pumps from the sump in the OLSF would require a jib crane at the top of the tank
An operator can see the drain pumps when located in the PRS and could potentially identify issues earlier	Long suction pipe	Drain pumps in the OLSF eliminates the suction pipe	Sump for drain pumps complicates tank foundation

While both alternatives are viable, Alternative 5 is recommended due to the operations and maintenance benefits to having the drain pumps located within the PRS. For this reason, Alternative 5 is the recommended alternative. The alternative has the following characteristics.

- Tank Option 10
  - Single circular tank
  - The tank is located at grade
  - The tank includes a flushing foundation for a vacuum flushing system
- OLSF Fill Option 2
  - The tank is filled using the PRS pumps
- PRS Alternative 2
  - The PRS is a shallow station
  - The drain pumps are in the PRS

Section 5

Odor Control Alternatives

Odor control will be provided for the OLSF to prevent fugitive emissions escape and potential community impacts. The odor control system has been sized to maintain a negative pressure on the tank cover and to minimize corrosion potential in the tank headspace.

5.1 Odor Control System Sizing

The following sections describe the basis of design for the new OLSF odor control system, which includes projections for airflow rate and odor loading.

5.1.1 Airflow Rate Calculations

Assumptions for the preliminary sizing and cost assessment included in this report are that the OLSF for which odor control is to be provided is 130-ft diameter and has a depth of 30 ft (when empty). A low-profile dome cover is assumed with a maximum height of 5 ft between the top of the basin to the cover surface.

Fugitive emissions containment and corrosion minimization are the primary drivers for establishing airflow rates for the new OLSF odor control system. These parameters were quantified, and an airflow rate was selected that is projected to be effective but is not overly conservative. Three parameters were used for calculating the design airflow rate:

- **Negative pressure ventilation rate:** BC recommends a range of 0.25 cubic feet per minute per square foot (cfm/ft^2) to 0.5 cfm/ft^2 for dome covers based on pilot testing at similar facilities and findings regarding consistent negative pressure maintenance. Based on the 130-ft diameter tank size, this equates to an airflow in the range of 3,300 cfm to 6,600 cfm. Given the dilute nature of the expected inlet wastewater, it is reasonable to select the lower end of this range and design for 3,300 cfm.
- **Volumetric displacement airflow rate:** the volume of air that is displaced as the liquid is entering the tank must be added to the ventilation rate needed to maintain a negative pressure. Given the projected maximum tank fill rate of 8,462 gallons per minute (gpm), this translates to an additional 1,131 cfm of airflow that must be accounted for when sizing the odor control system.
- **Corrosion minimization airflow rate:** a minimum air change rate will be needed to maintain sufficient air evacuation in the tank headspace so that corrosion potential in minimized. A range of 3 to 4 air changes per hour (ACH) is provided in design guidance found in the Water Environment Federation (WEF) Manual of Practice (MoP) Number 25 Control of Air Emissions and Odors from Wastewater Treatment Plants (2004). Assuming a dilute wastewater during wet weather, the lower portion of this range (3 ACH) is used, and a two-thirds full tank is assumed (10 ft headspace). This equates to an airflow rate of approximately 6,600 cfm.

Because the inside of the tank will not be regularly occupied, National Fire Protection Association (NFPA) 820 code requirements will not apply with respect to air change rate minimums.

The total airflow rate requirements considering the negative pressure and corrosion minimization airflow rate approaches are as follows:

- To maintain a negative pressure while accounting for volumetric air displacement, the total airflow rate would need to be 4,500 cfm.
- An airflow rate of 6,600 cfm is needed to provide an appropriate 3 ACH to a 10-ft headspace. This air change rate is estimated for controlling the amount of moisture in the headspace volume, which would otherwise accelerate corrosion of sensitive materials such as concrete.

Therefore, the more conservative total airflow rate evacuated from the equalization basin headspace is 6,600 cfm. Due to the large diameter of the tank, four draw-off duct locations are assumed, which would be manifolded into a single duct that conveys air to the odor control system. Balancing those 4 draw-off points equally results in individual air pickups of 1,650 cfm. This results in estimated duct size of 16 inches diameter for the four extraction ducts and 28 inches diameter for the single duct conveying foul air into the odor control system.

5.1.2 Odor Loading

The current design assumes that the OLSF will only be used for temporary storage of wet weather flows. When high precipitation events occur and instigate the use of the tank, wastewater tends to be diluted and can be lower temperature, both of which decrease biological activity and reduce odorous emissions. Therefore, the odor control system inlet odor loading is projected to be relatively low for the current OLSF use.

Odor emissions from municipal wastewater collection systems tend to be dominated by hydrogen sulfide (H_2S), which results from liquid-phase sulfide volatilization. Long collection system detention times will produce higher liquid sulfide concentrations, thus resulting in a higher H_2S load at off-gassing locations, such as the entry of the wastewater into the Wilroy OLSF. Areas of high turbulence tend to contain higher localized H_2S concentrations. This could occur in the tank headspace near the wastewater point of entry into the tank, assuming there is a drop, and that the entry point is not submerged.

H_2S data has not yet been collected to support odor loading design criteria. For the purposes of this report, a headspace H_2S concentration of less than 5 ppmv is assumed during wet weather OLSF use and a headspace H_2S concentration of less than 1 ppmv is assumed for the tank headspace when the tank is empty under dry weather conditions. These H_2S loads indicate that a single stage of odor control is sufficient.

5.2 Candidate Odor Control Technologies

The projected lower odor loading associated with the OLSF's use for wet weather only resulted in a recommendation for a single stage of odor treatment. A second stage may be needed in the future if the tank is used for diurnal equalization, as discussed in Section 5.5. Four single-stage odor control technologies were considered in this analysis:

- **Biotrickling filters (BTFs):** This technology includes a reacting vessel containing inert media on which bacteria contained within a flowing liquid remove odorous compounds through oxidation. BTFs use either a constantly recirculating liquid through the media or an intermittent, once-through spray of the media. In either case, the liquid contains nutrients (such as trace organics, nitrogen, phosphorus, and potassium) to enhance the biological growth within the liquid and on the media bed. The BTF technology has the advantage of a capacity to reduce high H_2S concentrations without using chemicals; however, sudden odor (particularly H_2S) load increases are often difficult to remove effectively due to biological adaptation to a consistent feed. Limits of the technology include a lower capacity to remove organic sulfides and volatile organic compounds (VOCs), as compared to biofilters or activated carbon.

- **Biofilters:** Biofilters treat odorous compounds using a combination of sorption, biological degradation, and chemical oxidation. Contaminants in the foul air stream are either adsorbed onto the surface of the biofilter media or absorbed by the thin liquid surrounding the media particles, referred to as the biofilm. Biofilters are larger than BTFs, since contact times are usually at least 45 seconds, compared to 10 to 15 seconds for BTFs. Therefore, they occupy more space, especially when high airflow rates must be treated.
- **Chemical scrubbers:** Chemical scrubbers are best utilized targeting individual compounds or specific groups of compounds. (For example, H_2S and other acidic compounds are treated by alkaline scrubbers using hypochlorite and caustic solutions and acidic scrubbers will target ammonia removal.) Chemical scrubbers typically perform poorly with organic sulfide removal, particularly methyl mercaptan and dimethyl sulfide, which could be problematic as some of these compounds may contribute to the overall odor load. Chemical scrubbers also have significant operation and maintenance (O&M) costs associated with labor and chemical use.
- **Carbon adsorbers:** The dry media technology uses adsorption onto large media pore spaces to remove odorous compounds. The technology is typically the best at removal of a wide variety of compounds, including H_2S, organic sulfides, chlorine, and VOCs. Some manufacturers provide varying carbon and dry media products that target specific compounds, such as H_2S, by creating a higher sorption capacity for that compound in the media production. High-capacity carbon has a greater sorption capacity for H_2S than virgin carbon, though it may be limited in removing some organic sulfides. The dry media adsorption technology is limited in that the media can be quickly depleted of its sorptive capacity with ongoing high pollutant loads, in particular those that contain high H_2S concentrations.

5.3 Selected Odor Control Alternative

Based on the expected foul airflow rate and odor loading for the new OLSF odor control system, an activated carbon adsorber is the best technology choice. This is also the preferred technology based on the operational and efficiency advantages of the carbon unit as compared to the BTF, biofilter, and chemical scrubber technologies. Factors that contributed to the selection of a carbon adsorber odor control unit included:

- The odor control system will only need to be in operation when the OLSF is being used. Due to the intermittent nature of the OLSF usage, a biological-based odor control system is not an appropriate technology as the bacteria require a constant food source to survive and provide acceptable odor reduction. Therefore, the BTF and biofilter alternatives are less desirable.
- A chemical scrubber is a less desirable alternative for this remote collection system PRS as it requires more O&M attention than other alternatives given the number of individual components that must be operating efficiently for design odor removal. This includes sump water quality monitoring probes, chemical injection pumps, and chemical recirculation pumps, all of which are critical and if they fail, the entire scrubber will go offline.
- Carbon adsorbers can be turned on and off intermittently with essentially immediate odor removal being achieved. Chemical scrubbers also provide this. However, biological systems take some time (days up to weeks) to adapt to a high-odor air stream, which is problematic for startup performance.
- Carbon adsorbers have the least amount of instrumentation of the four technologies considered and are generally considered the simplest to operate.
- Carbon adsorbers become problematic as a single stage of treatment if odor loads, particularly H_2S, are high. This is because the carbon media pore spaces fill up quickly when loads are high.

In the case of the Wilroy OLSF odor control system, the dilute nature of the foul air makes carbon adsorption a natural fit.

A single-bed, vertical flow carbon was selected for odor control for the new OLSF odor control system. The design airflow rate will be 6,600 cfm. At that airflow rate and for a single-bed adsorber, the vessel diameter will be approximately 12-ft diameter and the footprint for the odor control unit (including the foul air fan and adsorber vessel) will be approximately 14-ft x 20-ft. The odor control system must contain a high-efficiency mist and grease filter because the foul air is expected to be nearly saturated and grease particulate matter is common in raw wastewater foul air emissions. The mist and grease filter will be installed inline with the inlet foul air duct and just upstream of the fan.

5.4 Capital Cost Estimate

A planning-level conceptual capital cost estimate for the activated carbon odor control system was produced, assuming typical industry equipment costs for the odor control unit, ductwork, dampers, fittings, grease and mist eliminator, interconnecting ducting, and miscellaneous items. The total capital cost was $480,000, which includes an installation estimate.

5.5 Future Expansion

This section provides assumptions and design criteria development processes for maintaining sufficient odor control at the Wilroy PRS site in the future if the designated use of the OLSF changes to diurnal flow equalization.

5.5.1 Projected Odor Control Technology Upgrades

The current design assumes that the OLSF will only be used for temporary storage of wet weather flows. However, there is a potential change in the OLSF use in the future whereby the tank will be used daily for diurnal flow peak shaving. If this were to become the primary use for the tank, wastewater sulfide concentrations would likely increase, causing H_2S emissions to increase as well. Because of this, it is important to identify and reserve space to accommodate a second stage of odor control.

For this system, it would be most appropriate to leave the activated carbon adsorber in place and shift it to being used as a second stage polishing unit, following a biological unit first stage. This may be either a biofilter or a biotrickling filter, depending on the anticipated H_2S loading. This will be best determined following completion of the recommended odor sampling on the existing collection system wastewater that will be conveyed through the new Wilroy PRS. If projected H_2S concentration into the future expanded odor control unit (assuming diurnal equalization) exceeds approximately 10 ppmv, a biotrickling filter would be more appropriate and more cost-effective than a biofilter, which is better for lower H_2S loads.

5.5.2 Odor Sampling Needs

To support future odor loading conditions for the basis of design, odor sampling is recommended in the existing collection system. The sampling will also provide data that would be used in calculating odor loads for the current use designation of the tank (wet weather equalization only). The sampling results would provide a basis for carbon media selection and a better approximation of the carbon life (replacement frequency), which translates to an overall life-cycle cost approximation. The next section provides details on the recommended odor sampling plan.

5.6 Odor Sampling Plan

The following sections outline the recommended odor sampling that will support design development (both current and future conditions), as noted in Section 5.5.2.

5.6.1 Sampling Locations

Figure 5-1 provides a map of the locations proposed for the odor sampling. Upstream pump stations and air release valves (ARVs) will be incorporated into the field events and laboratory analysis, as applicable. Three upstream pump stations have been identified for the sampling program, although two of the three are owned and operated by the City of Suffolk and Isle of Wight County, which will require additional coordination.

The one upstream HRSD pump station collects flow from the dashed gravity line on Figure 5-1. The contribution from this sewer to the future Wilroy PRS will be relatively small – on the order of 0.3 to 0.7 million gallons per day (MGD) average daily flow (ADF). This contribution will be higher during wet weather, when the OLSF will be in use following Wilroy PRS construction.

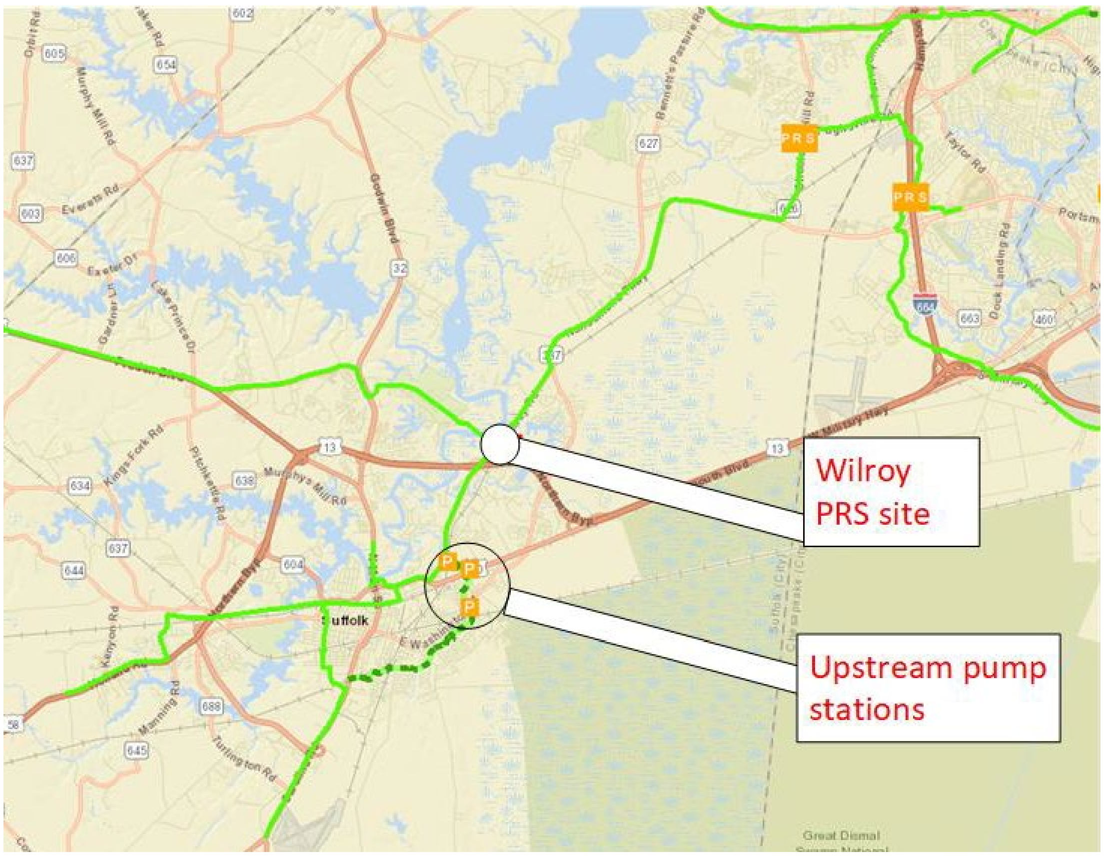


Figure 5-1. Proposed Odor Sampling Locations

Overall, the wastewater flow from south portion of the watershed to the future Wilroy PRS is conveyed through a 30-inch prestressed concrete cylinder pipe (PCCP); the ADF for this portion of the collection system is on the order of 0.7 to 1.8 MGD. Flow from west-northwest is conveyed through a 24-inch ductile iron pipe (DIP); the ADF for this portion of the collection system is on the order of 0.3 to 1.0 MGD. Ideally, odor sampling would be conducted in the sewers from both the south and the west-southwest. However, it may be reasonable and most viable to only collect samples along the dashed line sewer (Figure 5-1) and at the upstream HRSD pump station along that line.

5.6.2 Vapor-Phase H_2S Monitoring

Vapor-phase H_2S monitoring will be conducted in 3 upstream pump station wet wells using Acrulog PPM monitors with an H_2S measurement range of 0 to 200 ppmv. These Acrulogs have a resolution of 1 ppmv (measurements are reported in whole numbers and concentrations below 1 are recorded as 0). BC recommends that the loggers be installed inside upstream wet wells for 2 weeks and collect H_2S measurements in 5-minute intervals. The goal of this monitoring is to identify trends in H_2S concentrations; often H_2S and odor concentrations are highest in the middle of the night when flows are lower and liquid-phase sulfide accumulation is higher.

5.6.3 Liquid Sampling and Field Testing

Liquid-phase field testing will be conducted at all locations where Acrulogs are installed for H_2S monitoring. The following wastewater parameters are to be measured at the pump station wet wells selected for the program:

- Dissolved sulfide concentration
- pH
- Wastewater temperature
- Oxidation-reduction potential (ORP)

All of these parameters are to be measured in the field; no samples are to be sent to offsite laboratories for analysis. The temperature, pH, and ORP measurements may be measured using a single multi-meter instrument and probe, with measurements collected on wastewater samples collected using a bucket.

The sampling locations include the HRSD pump station wet well and the two additional upstream pump stations; if it is determined that the non-HRSD pump stations will not be used in the sampling programs, these locations can be substituted by testing at ARVs along the contributing sewer lines. Liquid sampling from ARVs requires a specific protocol, which will be produced under a separate heading should this become a portion of the sampling plan.

5.6.4 Air Sampling and Laboratory Analysis (OPTIONAL)

Odor sampling may be conducted at upstream locations to characterize potential odor contributions to the new equalization basin. The sampling would include odor panel laboratory analysis and offsite laboratory measurement of reduced sulfur compounds (RSCs). Two sampling events are assumed: one at the beginning of the two-week Acrulog H_2S monitoring period and one at the end of the monitoring period.

If conducted, odor panel analysis will include thresholds analysis, which includes detection threshold quantification, measured as dilutions-to-threshold (D/T) and recognition threshold quantification, measured as recognition-to-threshold (R/T). Laboratory analysis is to be conducted by St. Croix Sensory, who will provide air sampling protocols. Gas chromatograph/mass spectrometry (GC/MS) laboratory analysis is to be conducted by ALS Environmental using ASTM D5504, which measures concentrations of 19 organic sulfides and H_2S in each sample.

Two air samples are proposed to be collected at each upstream pump station location on each day of sampling, for a total of 6 samples collected each day. For each day of sampling, odor panel and RSC samples are proposed to be collected twice – one in the morning (approximately between 7AM and 9AM) and one in the afternoon (approximately between 12PM and 2PM).

Section 6

PRS and OLSF Layout

6.1 Process Mechanical

6.1.1 Selected PRS and OLSF Layout

As discussed in Section 4, BC recommends proceeding with layout Alternative 5. This includes the PRS that is below grade with both the PRS and tank drain pumps within the building itself. It also includes one 3 MG circular prestressed concrete tank with the vacuum flush system for an optimal automated cleaning process. Figures 6-1 and 6-2 show the proposed layouts of the PRS building and OLSF tank. Scaled 11x17 conceptual drawings of the PRS and OLSF can be found in Appendix F.

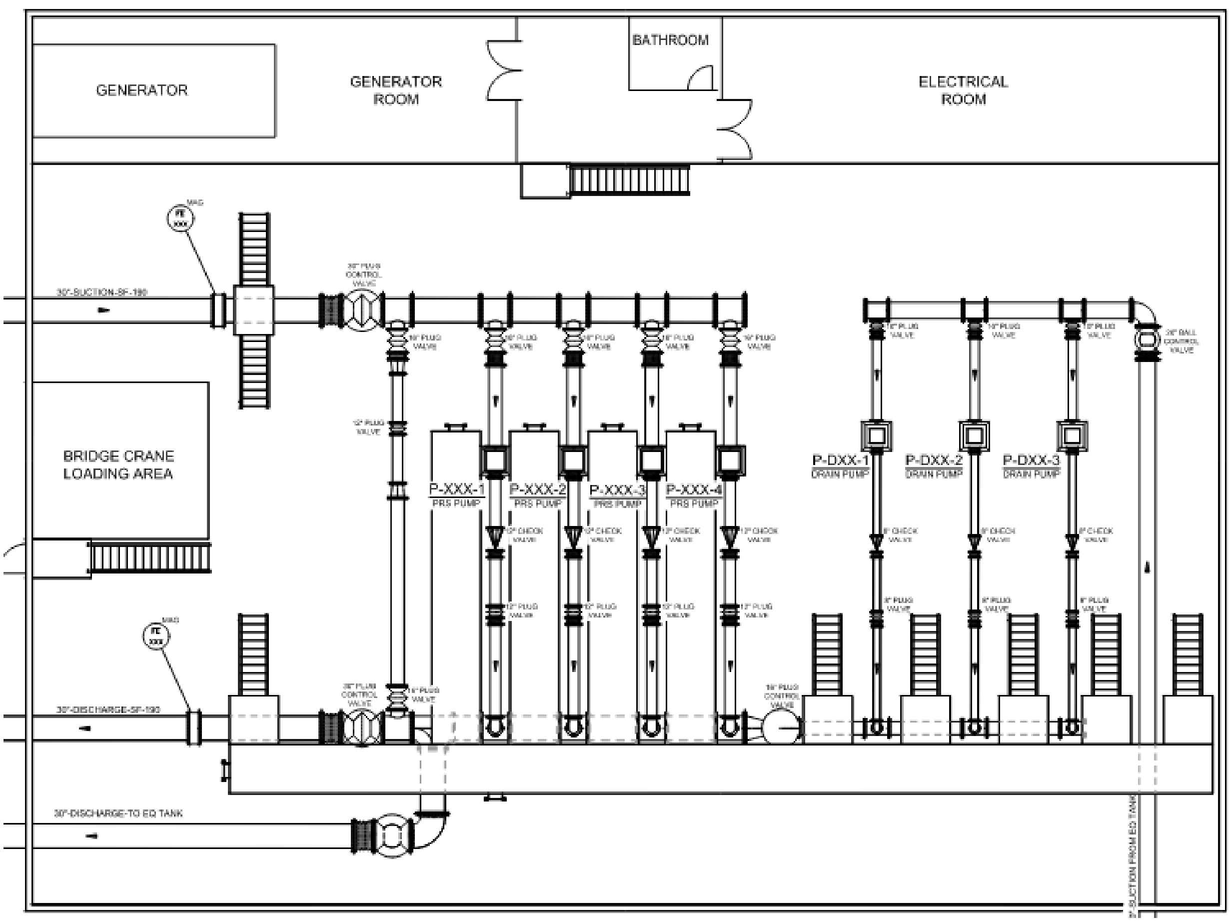


Figure 6-1. PRS Plan View

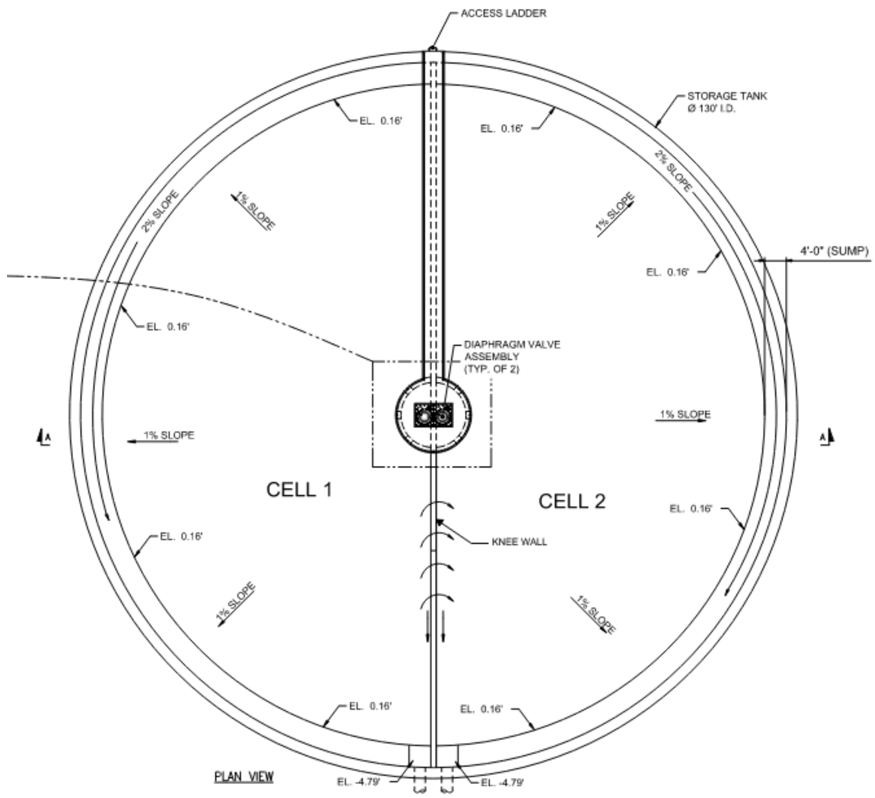


Figure 6-2. OLFS Plan View

6.1.2 Selected Pumps

The proposed PRS and drain pumps documented in Section 4 are dry pit submersible pumps installed in the PRS. The hydraulic performance of the PRS and drain pumps was evaluated using the preliminary model described in Section 4. The model was prepared using the layout drawings presented in Appendix F.

Table 6-1 presents design parameters for the PRS pumps and Figure 6-3 presents the system and pump curves for a preliminary selection.

Table 6-1. PRS Pump Design Parameters

Flow Scenario	Flow (gpm)	Flow per pump (gpm)	Pumps Operating	HGL Discharge (ft)	OLSF Elevation (ft)	TDH (ft)	NPSHr (ft)	NPSHa (ft)	NPSH Margin
2. PRS Operating	4,000	4,000	1	70		43	6	40	6.7
2. PRS Operating	4,000	4,000	1	104		77	6	40	6.7
2. PRS Operating	7,000	3,500	2	70		43	4	40	10
2. PRS Operating	7,000	3,500	2	104		77	5	40	8
3. PRS and OLSF Operating	15,462	5,154	3	104	23	81	10	38	3.8
3. PRS and OLSF Operating	15,462	5,154	3	104	53	81	10	38	3.8

Note: Refer to Table 3-1 for Design Flows and Boundary Conditions

HI 9.6.1 defines the NPSH margin for water and wastewater pumps. For pumps with cast-iron impellers greater than 60 HP operating within the POR, an NPSH margin of 1.2 with a minimum of

3.3-ft is required. All design points displayed in Table 6-1 are within the POR and meet the required NPSH Margin.

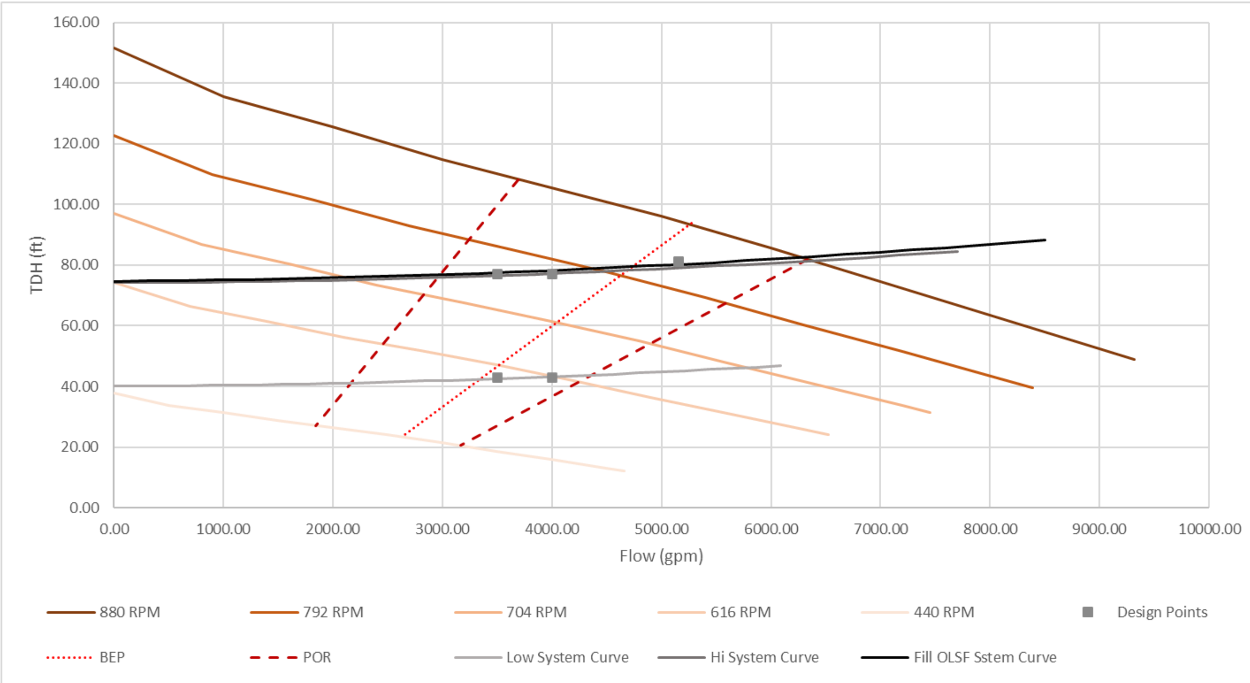


Figure 6-3. Single Pump PRS Pump and System Curves

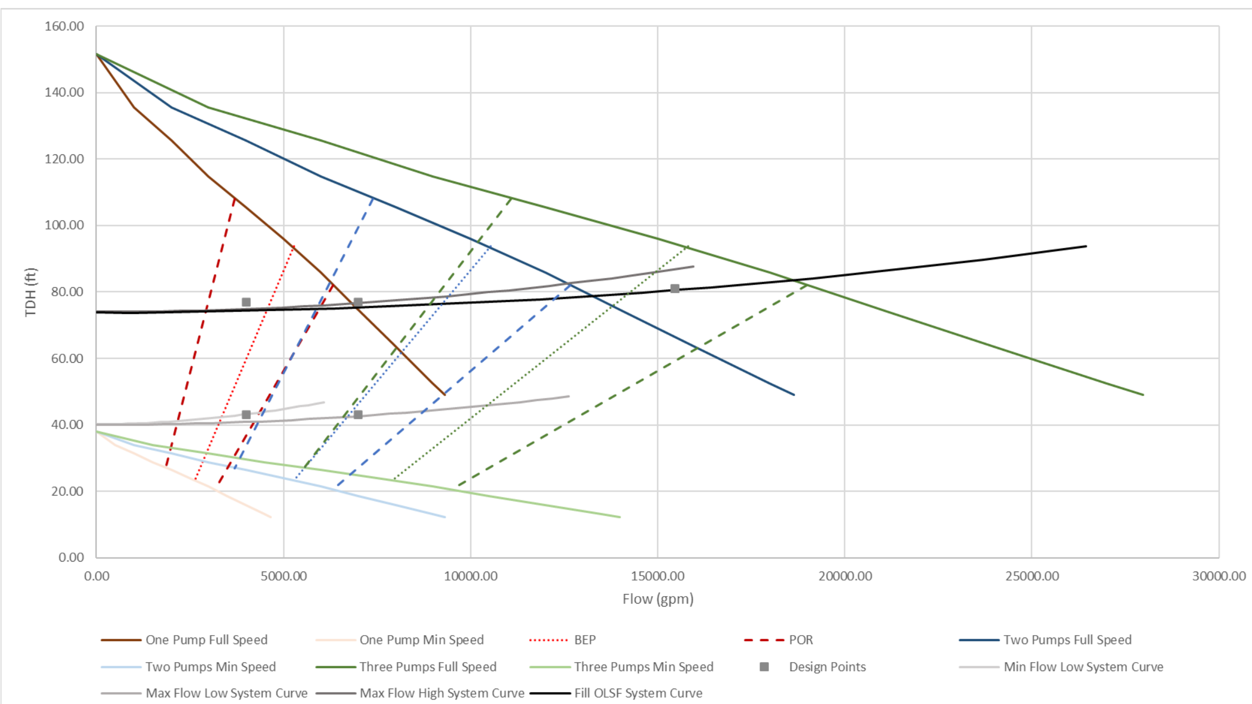


Figure 6-4. Multi-Pump PRS Pump and System Curves

Table 6-2 presents design parameters for the drain pumps and Figure 6-5 presents the system and pump curves for a preliminary selection. A control valve was added to the discharge of the drain pumps in the model to add head to the system as described in Section 4.1.2.2. A pump discharge HGL of 65-ft was used as a set point for the control valve in the model.

Table 6-2. PRS Pump Design Parameters

Flow Scenario	Flow (gpm)	Flow per pump (gpm)	Pumps Operating	HGL Discharge (ft)	OLSF Elevation (ft)	TDH (ft)	NPSHr (ft)	NPSHa (ft)	NPSH Margin
4. Drain	2,083	1,052	2	30	53	17	12	63	5.3
4. Drain	2,083	1,052	2	30	23	47	20	33	1.5
4. Drain	2,083	1,052	2	65	53	17	12	63	5.3
4. Drain	2,083	1,052	2	65	23	48	20	33	1.5

Note: Refer to Table 3-1 for Design Flows and Boundary Conditions

HI 9.6.1 defines the NPSH margin for water and wastewater pumps. For pumps with cast-iron impellers less than 60 HP operating within the POR, an NPSH margin of 1.1 with a minimum of 3.3-ft is required. All design points displayed in Table 6-2 are within the POR and meet the required NPSH Margin.

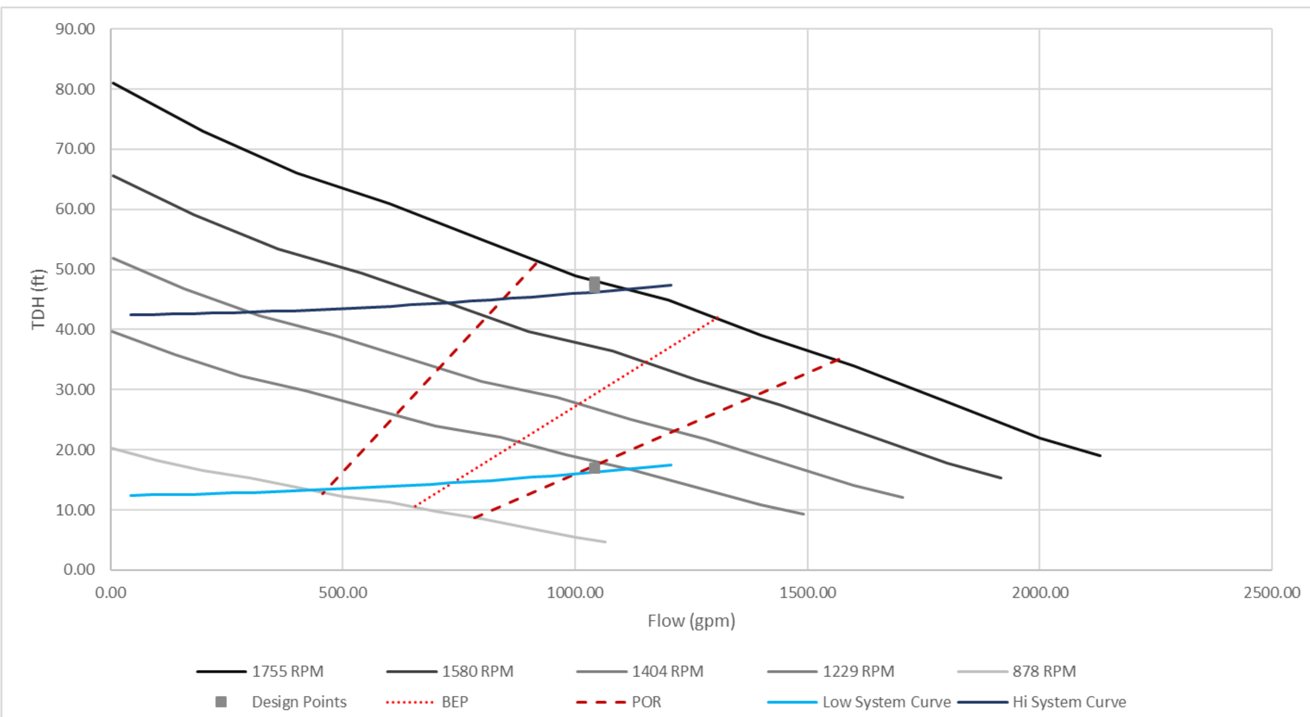


Figure 6-5. Single Pump Drain Pump and System Curves

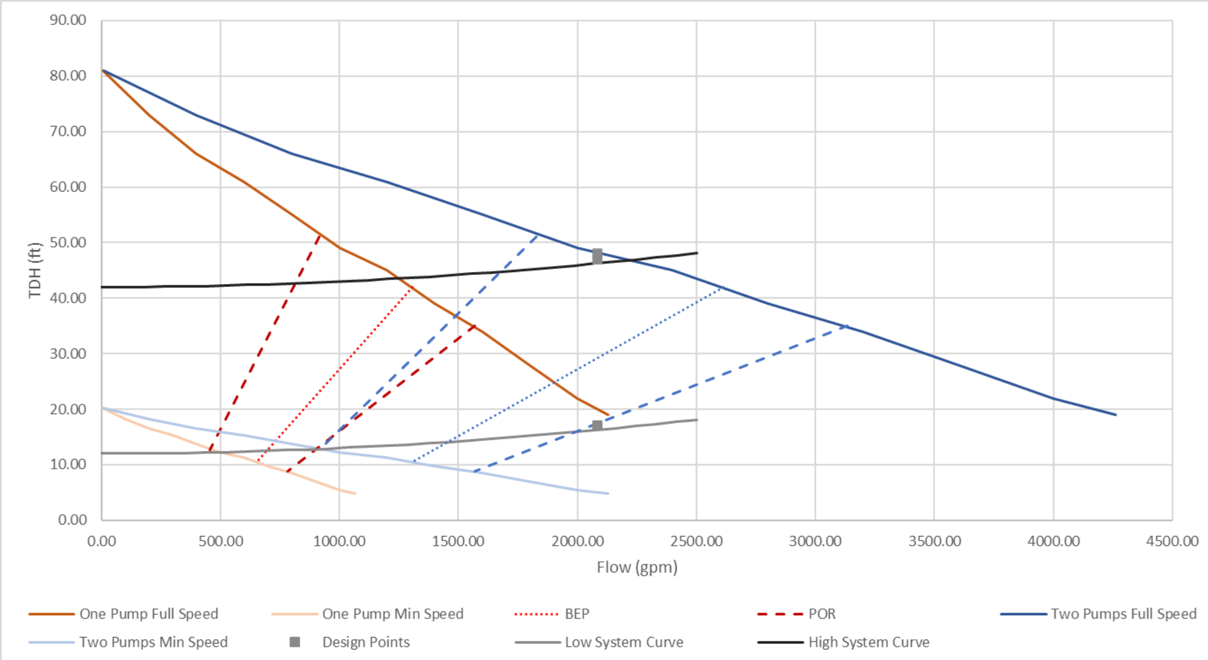


Figure 6-6. Multi-Pump Drain Pump and System Curves

The preliminary pump specifications for the PRS and Drain pumps are presented in Table 6-3.

Table 6-3. Pump Specifications		
Parameter	PRS Pump	Drain Pump
Max Motor HP	185	25
Suction Dia (in)	16	10
Drain Dia (in)	12	6
Max Speed	880	1755
Impeller Dia (mm)	555	224
Preliminary Model	Xylem NT 3315/735 3~ 870	Xylem NT 3171 MT 3~ 437

6.1.3 Pipe and Valves

The following pipe and valve design parameters will be provided:

- All pipe within the PRS will be flanged ductile iron pipe.
- All pipe exterior to the PRS will be restrained push-on ductile iron pipe and mechanical joint fittings.
- An eccentric plug valve will be provided on the suction and discharge of each pump and to isolate the PRS from the FM on the suction and discharge headers.
- An AWWA C508 swing check valve will be provided on the discharge of each pump upstream of the isolation plug valve.
- Eccentric reducers will be provided on the suction and discharge.
- Equipment connection fittings will be provided on the suction and discharge of each pump.
- Exterior wall penetrations will be accomplished with wall sleeves with modular mechanical link seals.

- Manual 2-inch drain ports will be provided on the suction and discharge of each pump and on the suction and discharge headers.
- A cleanout port will be provided on the suction and discharge of each pump.
- Each pump will have a long radius elbow on the suction side.

For the proposed layout the minimum straight run pipe lengths shown in Table 6-4 were used in the development of the plan.

Table 6-4. Straight Length Pipe Requirements

Item	Downstream	Upstream
Pump	10 x Pipe Diameter	-
Check Valve	10 x Pipe Diameter	5 x Pipe Diameter
Ultrasonic Flow Meter	10 x Pipe Diameter	10 x Pipe Diameter
Magnetic Flow Meter	10 x Pipe Diameter	10 x Pipe Diameter

6.1.3.1 HI Requirements

Suction and discharge piping will be designed in accordance with HI 9.6.6, Rotodynamic Pumps for Pump Piping. The following design parameters will be used in piping design:

- Velocity in suction pipe shall be constant or increasing as flow approaches the pump
- Suction pipe shall be at least as large as the pump suction nozzle
- Maximum velocity in suction piping shall be 8 feet per second
- Maximum velocity in discharge piping shall be 15 feet per second
- Minimum required straight pipe length before pump suction inlet defined in Table 9.6.6.3.2 shall be followed

A physical model study is recommended to confirm uniform and symmetric approach flow conditions to the pump inlet. Experience has shown that long radius 90˚ reducing bends leading to the pump inlet with a pipe reduction of at least 1.5 reduce the potential for flow separation and turbulence in the pump inlet. The preliminary PRS selections have an inlet elbow that reduces from 16-inches to 14-inches at the pump inlet, less than the recommended 1.5 reduction. The preliminary drain selection have an inlet elbow that reduces from 10-inches to 8-inches at the pump inlet, less than the recommended 1.5 reduction. Increasing the inlet to meet the recommended 1.5 reduction would cause a deceleration to the pump inlet which is not acceptable. A physical model study is recommended to determine if the preliminary inlet elbow will cause nonuniform or unsymmetric approach flow conditions and identify remedial measures.

6.1.3.2 Air Release Valves

Air release valves will be provided on all local high points to expel gas to prevent air binding. Localized high points are anticipated on the discharge of each pump upstream of the discharge header. The vent lines will be routed to the sump.

6.1.3.3 Bypass

During dry weather flow scenario 1 (refer to Table 3-1), flow will go through the bypass in the Wilroy PRS. A passive bypass will be included in the PRS. The bypass will include isolation plug valves and an AWWA C508 swing check valve. The check valve will allow flow from a higher HGL on the suction side of the PRS and flow to the lower HGL on the suction side. When the PRS is in operation the bypass will close preventing flow reversal.

The bypass check valve was sized based on recommended velocity to keep the disc in the fully open position for the typical range of dry weather flows. Bypass check valve design parameters are presented in Table 6-5.

Table 6-5. Bypass Check Valve Design Parameters

Parameter	Value
Recommended velocity, fps	6 to 10
Full range velocity, fps	4 to 15
Selected check valve size, dia, in	12
Actual velocity range, fps	5.3 to 10.3
Headloss range, ft	1 to 4

1. Recommended and full range velocity based on Valmatic AWWA Swing Check Valve

6.1.3.4 Control Valves

Control valves will be provided to control flow to the OLSF and to add head to the drain pump system.

The design of the control valves will consider the following:

- Control valves will be rotary control ball valves sized to operate between 20% and 80% open throughout the flow range.
- The control valve for the OLSF feed will be installed on the line feeding the OLSF downstream of the PRS pumps. The valve will modulate based on pressure from the suction of the PRS to maintain a constant upstream pressure of 30-ft.
- The control valve for the drain pumps will be installed on the discharge header from the drain pumps. The valve will modulate based on pump discharge pressure to maintain a constant pressure setpoint to keep the pump curve within the POR of the selected pumps.

The preliminary design includes a VFD on the drain pumps to control flow. This may not be necessary and will be investigated during detailed design to determine if the control valve will be sufficient to control both flow and pressure.

6.1.3.5 Connection to Force Main

To provide the maximum relief, both the 24-inch force main from Windsor and the 30-inch force main from downtown Suffolk need to connect into the new station. The connection to the existing force mains will be valved in such a way that the new station can be fully taken offline for maintenance or future upgrades. Line stops and bypass piping will be utilized on both the 24- and 30-inch pipes to cut in new tee fittings and valves.

6.1.4 Equipment Access and Removal

All alternatives reviewed have utilized a bridge crane to lift and move all large equipment, valves and piping necessary for repair/replacement. The bridge crane is designed to able to move the equipment to a central location near the large roll-up door to be transported by truck or trailer. The specific size and type of bridge crane will be selected in final design.

6.1.5 NFPA 820 Evaluation

An NFPA 820 evaluation was completed for the PRS and OLSF spaces that are covered by NFPA 820. Table 6-6 below presents each space, the NFPA 820 designation, the classification, and ventilation, materials of construction and fire protection requirements.

Table 6-6. NFPA 820 Evaluation

Area	NFPA 820 Designation	Function	Fire and Explosion Hazard	Location Classification	Ventilation Reqmnts	Materials of Construction	Fire Protection Reqmnts
PRS Pump Room, Below Grade or Partially Below Grade Wastewater Pumping Station Drywell	Table 4.2.2 Row 15 Line a	Pump room physically separated from wet well, pumping of wastewater from a sanitary or combined sewer system through closed pumps and pipes	Buildup of vapors from flammable or combustible liquids	Unclassified[1]	C	LC, LFS, NC	FE
	Table 4.2.2 Row 15 Line b			Class 1, Group D, Div 2[1]	D		
Below grade metering vault	Table 4.2.2 Row 34 Line a	Physically separated from the wet well and with closed piping system	Buildup of vapors from flammable or combustible liquids	Class 1, Group D, Div 2[2]	Not normally ventilated	NC	NR
	Table 4.2.2 Row 34 Line b			Unclassified[2]	C	LC, LFS, NC	
OLSF	Table 4.2.2 Row 32 Line a	Enclosed Structures temporarily holding untreated or partially treated wastewater	Possible ignition of flammable gases and floating flammable liquids	Class 1, Group D, Div 1[2]	A	NC	NR
	Table 4.2.2 Row 32 Line b			Class 1, Group D, Div 2[2]	B	LC, LFS, NC	
Odor Control and ventilation systems serving classified locations	Table 4.2.2 Row 18 Line d		Leakage and ignition of flammable gasses and vapors	Class 1 Group D, Div 2[3]	Not enclosed, open to the atmosphere	LC, LFS, NC	FE
	Table 4.2.2 Row 18 Line e			Unclassified[4]			

1. Entire room or space
2. Enclosed space
3. Areas within 0.9 m (3ft) of leakage sources such as fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor-control vessels
4. Areas beyond 0.9 m (3 ft)
5. A – No ventilation or ventilated at less than 12 air changes per hour
6. B – Continuously ventilated at 12 air changes per hour
7. C – Continuously ventilated at 6 air changes per hour
8. D – No ventilation or ventilated at less than 6 air changes per hour
9. NR – No requirement
10. FE – Portable fire extinguisher
11. LC – Limited-combustible material
12. LFS – Low flame spread index materials
13. NC – Noncombustible material

PRS Pump Station Pump Room. The pump room in the PRS pump station will be ventilated continuously at 6 air changes per hour to declassify the space.

Meter Vault. The meter vault will not be ventilated, and the space will be rated for Class 1 Div 2.

OLSF. The OLSF will not be ventilated, and the space will be rated for Class 1 Div 1.

Odor Control. The areas within 3-ft of leakages sources will be rated for Class 1 Div 2.

Ventilation systems serving the PRS Pump room. The areas within 3-ft of leakages sources will be rated for Class 1 Div 2.

6.2 Instrumentation and Controls

The Wilroy PRS and OLSF instrumentation and control basis for design is:

- HRSD Design Construction Standards (2022)
- Providence Road PRS and OLSF Control Descriptions
- The May 26, 2022 Electrical, SCADA, & Process Control Workshop
- HRSD ICS Point Naming Convention 10-26-2015
- Additional assumptions as stated in this Report

Instrumentation and control will be as shown on Drawings I-101, 102, 103, and 104 in Appendix F – Process and Instrumentation Diagrams (P&IDs).

6.2.1 Control Systems Equipment

A programmable logic controller (PLC) based remote terminal unit (RTU) provided by the Owner will facilitate control and monitoring of the Wilroy PRS and OLSF.

The RTU will be equipped with a Magellis operator interface terminal (OIT) for local monitoring and control of the system. The OIT will communicate to the PLC over serial Modbus RTU. OIT programming will match the monitoring and control functionality of the SCADA HMI. The RTU network switch shall be Cisco with model as specified by HRSD staff. Communications to the supervisory control and data acquisition (SCADA) server and control signals from other remote site PLCs will be via a cellular modem provided and configured by HRSD.

The RTU will also include an independent Telog monitoring and reporting device. Input signals will be split from the field terminals and wired to both the PLC and Telog system to replicate the signals needed for Telog monitoring. The Telog system will monitor all pump run statuses, influent and effluent flow, and influent and effluent pressure.

PLC, RTU OIT, and supervisory control and data acquisition (SCADA) human machine interface ((HMI) programming will be provided by HRSD. The contractor shall coordinate with HRSD during start-up of the system for control system and programming testing.

6.2.2 Instrumentation Elements

The following instrumentation will be used for monitoring and control of the Wilroy PRS and OLSF system.

Flow Measurement:

> Upstream and downstream flow measurement will be provided by magnetic flow meters mounted in vaults with remote mounted transmitters located outside of the hazardous environment with sensor rated for use in Class 1 Div 1 environment (Endress + Hauser Promag P200, Krohne Optiflux 4000, Badger Meter M4000, or equal).

Level Measurement:

> OLSF tank level measurement will be provided by a radar level transmitter (Rosemount 5408 or equal). High-high and low-low float switches will be provided for backup alarming and OLSF pump interlocking.

Pressure Measurement:

Upstream and downstream pressure measurement will be provided by pressure indicating transducers (Rosemount 3051CG or equal). Pressure transmitters will be mounted with an annular seal (Ashcroft, Red Valve, or equal) to isolate the sensor from the process fluid per HRSD standard design detail drawing 381.

Combustible Gas Analyzer

NFPA 820 does not require a gas analyzer be provided at either location. Gas analyzer will not be provided for this project.

Valve Actuators:

Valve actuators shall be EIM/Bettis or Limitorque with no accepted equal for reasons of standardization for maintenance.

Equipment Tagging:

Equipment and instrument tags are based on the ICS Point Naming Convention (10-26-2015) document and the example project Providence Road PRS tag naming. All equipment and instrumentation tags will be preceded with the same 4-digit site number and 2-digit process number. HRSD shall provide the Wilroy PRS and OLSF 4-digit site number prior to detailed design. The process number is assumed to be “91” as used for the Providence Road PRS. Specific loop tags will consist of 4 characters based on the ISA functional identification (with an “X” character to fill unused character spaces) and a 4-digit loop designation.

6.2.3 PRS Pump Control Strategy

The PRS pumps will be controlled as follows:

1. Description:
    1. The PRS provide pressure relief and increase system capacity during wet weather events. The PRS pump station consists of four (4) variable frequency drive (VFD) driven PRS pumps and bypass piping for non-wet-weather (low pressure) operation. The pumps are designed to operate as Lead/Lag 1/Lag 2/Standby.
    2. There are upstream and downstream pressure transmitters on the sewer main to control the start/stop and speed of the pumps.

2. Control Descriptions:
    1. Local Manual Control:
        1. Each pump has an HOA (HAND-OFF-AUTO) switch on the respective VFD. When the HOA is placed in the HAND mode the pump starts with speed set at a VFD-mounted speed potentiometer. Placing the HOA switch in the OFF position stops the pump.
        2. Each pump is also equipped with a VFD bypass switch, which allows the pump to be run without the VFD using an RVSS.
    2. Local Auto Control: None.
    3. SCADA Manual Control:
        1. When the HOA is in the AUTO position, and MANUAL mode is selected in the SCADA HMI, the pump can be started and stopped and speed adjusted in the SCADA HMI.

4. SCADA Auto Control:
   1. When the HOA switch is in the AUTO position and AUTO mode is selected in the SCADA HMI, the starting and stopping of the pumps and pump speed shall be controlled to maintain an upstream pressure communicated from the upstream pump station below a maximum pressure setpoint. If communication to the upstream pump station is lost, the PRS pumps will be controlled by the on-site influent pressure transmitter.
      1) A PID-type control loop adjusts pump speeds to maintain the upstream pressure setpoint:
      2) If the lead pump is running at 95% speed or greater for an operator-adjustable time delay, the next lag pump in the sequence starts. The speeds of both pumps are then modulated together, as a unit, to maintain the maximum upstream pressure setpoint. Subsequent lag pumps are started similarly.
      3) If the pumps are ever running at minimum speed for an operator adjustable time delay, the last pump in the lag sequence ramps to a stop while the remaining pumps continue to modulate speed to maintain the maximum upstream pressure setpoint.
   2. A software alternation switch P1/P2/P3/P4/ALT is used to select which pump is the Lead. If a pump is not in the Auto mode, it will not be included in the Lead/Lag/Standby sequencing. If the operating pump fails for any reason or is not available, the standby pump in the sequence shall run in its place. When the switch is in the ALT position, the Lead pump shall be rotated automatically after each stop cycle.

3. Interlocks and Permissives:
   1. Refer to the P&IDs.

6.2.4 OLSF Tank Fill Control Strategy

The OLSF tank filling will be controlled as follows:

1. Description:
   1. When wet weather flows exceed the capacity of the PRS pumps to reduce system pressure, the OLSF control valve will open to allow flow to the tank.
   2. There are upstream and downstream pressure transmitters on the sewer main to control the start/stop and speed of the pumps.

2. Control Descriptions:
   1. Local Manual Control:
      1. The control valve has an HOA (HAND-OFF-AUTO) switch on the valve actuator. When the HOA is placed in the HAND mode the valve can be opened and closed at the valve actuator. Placing the HOA switch in the OFF position will keep the valve in the last commanded position.
      2. Local Auto Control: None.

2. SCADA Manual Control:
    1. When the HOA switch is in the AUTO position and MANUAL mode is selected in the SCADA HMI, the valve position can be adjusted by inputting a value in the SCADA HMI.
3. SCADA Auto Control:
    1. When the HOA switch is in the AUTO position and AUTO mode is selected in the SCADA HMI, positioning of the control valve shall be adjusted to maintain an upstream pressure communicated from the upstream pump station. If communication to the upstream pump station is lost, the control valve will be controlled by the on-site influent pressure transmitter. AUTO mode must be selected for the PRS pumps to enable OLSF control valve AUTO mode.
        1) If all active PRS pumps are running at 95% speed or greater for an operator-adjustable time delay, the control valve will open to fill the OLSF tank and adjust percent open to maintain the upstream pressure setpoint.
        2) A PID-type control loop adjusts valve position to maintain the upstream pressure setpoint. The control valve pressure setpoint must be a minimum of 5 psi above the pressure setpoint used for PRS pump control.
        3) While the OLSF control valve is open, Pump speed will be held at a constant maximum speed of 95% and PID-type control disabled to prevent wind-up. If the control valve closes and pressure drops below the PRS pump pressure setpoint, pump speed control will resume per the PRS pump control strategy.
    2. If the OLSF tank level transmitter high level setpoint is reached or if the high-high level backup float is activated, the control valve will automatically close and will not reopen until the level drops below the low level setpoint.

3. Interlocks and Permissives:
    1. Refer to the P&IDs.

6.2.5 OLSF Drain Pumps Control Strategy

The OLSF drain pumps will be controlled as follows:

1. Description:
    1. The Offline Storage Facility (OLSF) collects and stores excess flow during wet weather events and uses drain pumps to return flow to the system once the wet weather peak has subsided. The OLSF drain pump station consists of three (3) variable frequency drive (VFD) driven drain pumps. The pumps are designed to operate as Lead/Lag 1/Standby.
    2. The pumps are controlled based on the discharge flow and the level in the OLSF tank.
2. Control Descriptions:
    1. Local Manual Control:
        1. Each pump has an HOA (HAND-OFF-AUTO) switch on the respective VFD. When the HOA is placed in the HAND mode the pump starts with speed set at a VFD-mounted speed potentiometer. Placing the HOA switch in the OFF position stops the pump.
        2. Local Auto Control: None.
    2. SCADA Manual Control:

1. When the HOA is in the AUTO position, and MANUAL mode is selected in the SCADA HMI, the pump can be started and stopped and speed adjusted in the SCADA HMI.

3. SCADA Auto Control:
    1. When the HOA switch is in the AUTO position and AUTO mode is selected in the SCADA HMI, the starting and stopping of the pumps and pump speed shall be controlled to maintain a discharge flow.
        1. The lead pump will start if the flow falls below the operator adjustable deadband for an operator adjustable time delay while the OLSF tank level is above the low level setpoint. The lead pump will vary speed to maintain the downstream pressure setpoint.
        2. A PID-type control loop adjusts pump speeds to maintain the discharge flow setpoint.
        3. If the lead pump is running at 95% speed or greater for an operator-adjustable time delay, the next lag pump in the sequence starts. The speeds of both pumps are then modulated together, as a unit, to maintain the downstream pressure setpoint.
        4. If the pumps are ever running at minimum speed for an operator adjustable time delay, the lag pump ramps to a stop while the lead pump continues to modulate speed to maintain the upstream pressure setpoint.
    2. A software alternation switch P1/P2/P3/ALT is used to select which pump is the Lead. If a pump is not in the Auto mode, it will not be included in the Lead/Lag/Standby sequencing. If the operating pump fails for any reason or is not available, the standby pump in the sequence shall run in its place. When the switch is in the ALT position, the Lead pump shall be rotated automatically after each stop cycle.
    3. Backpressure for the pumps is maintained by the control valve based on pump speed. When the backpressure control valve HOA switch is in the AUTO position and AUTO mode is selected in the SCADA HMI, the backpressure control valve will open fully before any pumps can be called to run. The backpressure control valve will automatically adjust position to maintain a minimum pump speed (initially 1229 RPM, operator adjustable) only if the calculated head differential (discharge pressure in ft – tank level in ft) drops below the minimum system head differential setpoint (initially 20 ft, operator adjustable). The control valve will fully open when the calculated head differential rises above the minimum system head differential setpoint after an operator adjustable time delay.
    4. The drain pumps will all automatically stop if a pipe-break condition is detected in the downstream piping. HRSD will provide typical logic for detection of pipe-break conditions for the detailed design to be incorporated into this control strategy.

3. Interlocks and Permissives:
    1. Refer to the P&IDs.

6.3 Structural

The following section provides the applicable design codes and requirements for structural design of the project.

6.3.1 Codes and Design Loads

2018 Virginia Uniform Statewide Building Code (USBC)

ACI 318-14, Building Code Requirements for Structural Concrete ACI 350, Code Requirements for Environmental Engineering Concrete Structures

AISC 360-16, Specification for Structural Steel Buildings

ASCE 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AWS D.14D1.4M-2011, Structural Welding Code

SDI RD-2017, Standard for Steel Roof Deck

SJI 100-15, 44th Edition Standard Specification Load Tables and Weight Tables for Steel Joists and Joist Girders K-Series, LH-Series, DHL-Series, Joist Girders

TMS 402-2016, Building Code for Masonry Structures

TMS 602-2016, Specification for Masonry Structures

6.3.2 Design Loads

Dead Loads = Weight of components of building + collateral loads

Pump Room Floor Live load = 300 psf throughout + pump weights

Generator Room Floor = 300 psf + Generator weight

Electrical Room Floor = 125 psf

All other Floors = 100 psf (min)

Roof Live Load = 20 psf

Risk Category = III

Wind Criteria:

Ultimate Wind Speed = 126 mph

Nominal Wind Speed = 97.6 mph

Exposure Category = C

Enclosure Classification = Partially Enclosed; Internal Pressure = ±0.55

Snow Criteria:

Ground Snow Load, Pg = 10.0 PSF

Importance Factor, I = 1.1

Thermal Factor, Ct = 1.10

Exposure Factor, Ce = 1.2

Drift Loads – Will be accounted for at changes in roof slopes and parapets.

Seismic Criteria:

Importance Factor, I = 1.25

Site Class: D (Assumed)

Ss (0.2 sec) = 9.20%g

S1 (1.0 sec) = 4.10%g

Sds = 0.098g

Sd1 = 0.066g

Seismic Design Category = A

Seismic Resisting System – Ordinary Reinforced Masonry Shear Walls

Response Modification Coefficient = 2

Design Base Shear, V = 0.061W

6.3.3 Materials

- Concrete Compressive Strength: 4,500 psi Normal Weight for footings, walls and slab on grade
- Load Bearing Concrete Masonry Units: 2,000 psi (minimum net area compressive strength)
- Reinforcing Steel Yield Strength: ASTM A615, 60,000 psi
- Steel I-Beams & Columns: ASTM A992, Grade 50
- Steel HSS members: ASTM A500, Grade B
- All Other Steel: ASTM A36

6.3.4 Structure Description

The following paragraphs provide BC's recommendation for the structural design elements.

The building structure will be primarily a single-story structure with concrete masonry unit bearing walls and a steel framed roof. The pump room which is the majority of the footprint of the building will have a finished floor elevation approximately 10'-0" below adjacent grade. The areas of the building that house the generator, restroom and electrical rooms will have a finished floor elevation closer to grade elevation. Within the pump room, a concrete platform that is near grade elevation and will provide a staging and loading area for equipment. A 3-ton bridge crane will span the entirety of the pump room allowing access to the platform and allow for lifting of all valves, piping, and pumps within the pump room.

The foundations for the structure are unknown at this time and pending the results of the subsurface investigation by the geotechnical engineer. Either shallow spread foundations or deep foundations are anticipated. Other structures that are part of the project may require piles, thus they may be available if required for the building to resist uplift forces. The below grade wall construction and floor slabs of the structure will be constructed of cast-in-place concrete with waterstops at joints to waterproof the below grade pump room. Equipment and pumps are anticipated to be placed on concrete housekeeping pads.

The roof structure is anticipated to be metal deck spanning to deep long span open web joists that span the pump room and typical open web joists spanning the generator and electrical room. Depending upon roof pitch and layout, the joist top chord can be double pitched or sloped to accommodate roof slope and drainage. The exterior bearing walls will be constructed of concrete masonry unit (CMU) walls above grade bearing on the concrete below grade walls. There is the opportunity to use acoustical CMU for the interior wall surface of the walls and also acoustical metal roof deck to help reduce noise within the pump room and generator rooms.

The 3-ton bridge crane is anticipated to be supported separately from the roof structure. The bridge crane will span the entire pump room on steel rail beams supported on steel columns adjacent to the exterior wall at one side and along the demising wall between the pump room and generator/ electrical room on the other side of the pump room. The steel columns will bear at or near grade level on concrete piers that are built within the below grade building walls.

Openings in bearing walls will require lintels and supports for veneer where required. Reinforced CMU lintels will be utilized at smaller openings while steel lintels will be used at larger openings. All steel lintels will be hot dipped galvanized to prevent corrosion.

The lateral resisting system for the structural will consist of the roof diaphragm transferring loads to the reinforced masonry shear walls and into the foundations.

6.4 Architectural

For development of the architectural approach, GuernseyTingle was subcontracted to BC to provide recommendations that were reviewed by BC's in house architecture staff.

6.4.1 Project Description

The architectural elements of this project include a 13,300-sf wastewater storage tank and a 10,900-sf service building. The service building and tank are partially underground and partially above ground. Two options are presented in the following section for architectural treatments. The height of the service building in Option 1 is 35 ft above grade and the height of the service building in Option 2 is 30 ft above grade. The tank in both options is 23 ft above grade and 32 ft total in height.

The service building is made up of a lower-level open area that houses all the pumps and piping, and an upper level with a single occupant bathroom, a generator room, and an electrical room. The open pump area is roughly 122' x 75' and is open to the roof structure above. The bathroom is 9' x 8' and the ceiling height is 10 ft above floor height. The electrical room and the generator room are each 50' x 16' and have a ceiling height of 12 ft above floor height.

6.4.2 Research Images

The architectural design of the two options below were inspired by the aesthetic of some of the existing buildings in the surrounding area of Wilroy Rd in Suffolk. While doing research on the proposed area, some of the buildings were found to have outdated architectural styles and others to be very plain on the exterior with no openings to allow natural light into the space. Many of the buildings were brick commercial buildings or large metal warehouses. This style was determined to not be a good fit for the pressure reducing station. Therefore, research was focused on just a few of the buildings in the area, so the design would fit in with the architectural language of the area but still be aesthetically appealing.

Inspiration for Option 1:

For Option 1, the design was inspired by some of the contemporary style buildings in the area. The contemporary style is appropriate for the pressure reducing station because the style is classified by being innovative and sustainable. Below are examples of the building that inspired the concept of this option.

The image below is of The Children's Center building. Some of the architectural elements of this building that inspired the first concept of the pressure reducing station are the large asymmetrical windows, the irregular roof shape, and the vertical Hardie panel siding. The large windows and irregular roof shape allow the building to receive abundant natural light and give it a more interesting shape than a typical modular industrial building. The vertical Hardie board allows the gives the building a commercial feel as opposed to a horizontal linear pattern which would make the project look more residential.

Figure 6-7. The Children's Center Building

This next image is of the Seger Electric Company building. The elements of this building that inspired the design of Option 1 include the metal roof on the rear portion of the building and the lower-level roof on the front portion of the building. The metal roof was preferred in our design because it is a noncombustible material as opposed to an asphalt shingle roof with wood structural components which is combustible. The lower-level roof on the front of the building is more inviting because it is closer to the scale of the human, and it directs a person visually to enter in that part of the building. This effect was desired to be mimicked in the design.

Figure 6-8. Seger Electric Company Inc Building

Figure 6-9 shows an example of the recommended look for with the tank in Option 1. This tank has a contemporary feel to it because it has epoxy covered metal panels and a geometric metal roof. The white colored exterior walls are a nod to the white accent color on the trim of the service building.

Figure 6-9. Storage Tank Design

Inspiration for Option 2:

For Option 2, the design was inspired by the rural nature of the surrounding area. This option has a barn-like aesthetic. This style is appropriate for the pressure reducing station because it would allow us to have a large building with a minimal number of openings and still be visually appealing. It also will allow the building to blend in with the surrounding area. Below are examples of the buildings that inspired the concept of this option.

The image below shows a building with typical barn features. Some of the elements of this building that were drawn from for Option 2 were the large barn doors and scarce openings in the exterior walls. The barn doors are more ornate and visually appealing than the roll up steel door of the first design and the structure can be simplified by not having too many openings in the exterior walls.

Figure 6-10. Barn Design (HRSD's Elbow Road PRS)

The building in the image below is the Bridlewood Equestrian Estates. This building as well as the barn design in Figure 6-10 have vertically patterned siding which have been incorporated in design Option 2. Inspiration was also found in the cupolas on the top of this building. Many barn structures include either a decorative or functional cupola on the roof. Since the openings are minimized in the exterior walls of our concept, a skylight structure was added on the roof, similar to the cupolas, to allow the space to receive natural light.

Figure 6-11. Bridlewood Equestrian Estates

Below is an example of the recommended look for with the tank in Option 2. This tank was intended to resemble a silo to continue with the barn-like aesthetic. The elements that aid in achieving this look are the horizontal ribbed metal siding and the metal roof.

Figure 6-12. Storage Tank Design

6.4.3 Applicable Codes

The code analysis below was completed according to the requirements of the Virginia Construction Code, 2018 Edition, and by reference the International Building Code, 2018 Edition and the ICC A117.1 Accessible and Usable Buildings and Facilities, 2017 Edition.

Use group – F-2 (Main Building) and U (Tank)

Construction Type – II B

Fire Suppression System– Not sprinklered

Fire Extinguisher Requirements – (1) 2-A and (2) 1-A Rated Fire extinguishers.

Building Area

Allowable – 23,000 sf
Actual – 11,225 SF

Building Height

Allowable – 55'
Actual – 35'

Number of Stories

Allowable – 3
Actual – 1

Occupancy – 38 Occupants

Fire Resistance Ratings

Structural Frame:	0 Hours
Bearing Exterior Walls:	0 Hours
Bearing Interior Walls:	0 Hours
Non-Bearing Exterior Walls:	0 Hours
Non-Bearing Interior Walls:	0 Hours
Floor Construction:	0 Hours
Roof Construction:	0 Hours
Corridor Walls:	0 Hours

Fire Separation Distance - >10 feet

Life Safety Requirements

Emergency Lighting:	Required
Exit Signs:	Required
Fire Detection System:	Required

Exit Requirements

Common Path of Egress Travel Distance:	75’
Maximum Travel Distance:	300’ Allowed, 160’ Actual
Minimum Number of Exits:	2 Required, 2 Provided
Egress Width:	32” required, 108” Provided

Energy Code Requirements

Insulation Values

Roof	R-30 Continuous Insulation
Above Grade Walls	R-9.5 Continuous Insulation
Below Grade Walls	R-7.5 Continuous Insulation
Floor	R-10 Continuous Insulation

Plumbing Requirements

Water Closets	1 Required, 1 Provided
Lavatories	1 Required, 1 Provided
Water Fountains	1 Required, 1 Provided
Service Sinks	1 Required, 1 Provided

6.4.4 Floor Plan

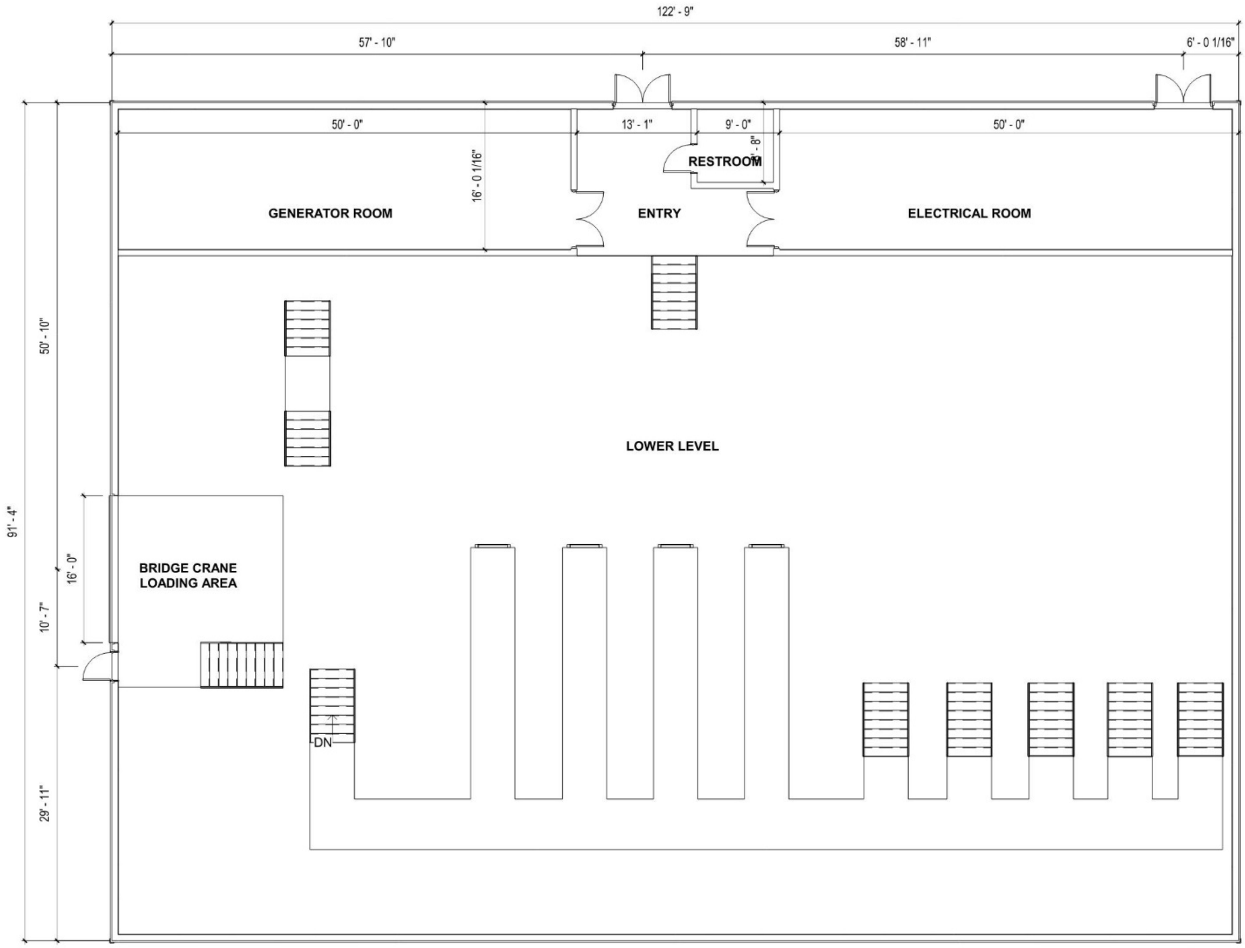


Figure 6-13. Building Floor Plan

6.4.5 Option 1

Figure 6-14. Option 1 Rendering

Option 1 was inspired by the more contemporary style architecture of the area. It has a high-low, asymmetrical roof with high windows to fill the space with natural light.

The color scheme of this option is inspired by the function of the building. The main color is blue to give a hint at the water storage nature of the building while also helping it stand out in the vegetation and in the surrounding area.

The walls of this option are acoustical CMU block with Hardie board vertical board and batten exterior siding above grade. The floors are concrete, and the roof is a standing seam metal roof with a galvanized acoustic metal roof deck on purlins. The roof will have 2' overhangs, and on the low edges, there will be pre-finished metal gutters with 4 downspouts on each side.

The tank for this option will be concrete with epoxy coated steel panels on the exterior and an architectural steel roof covering with a polished, natural finish. The epoxy coated steel panels will be white to bring out the accent color of the service building.

6.4.6 Option 2

Figure 6-15. Option 2 Rendering

Option 2 has more of a barn style aesthetic. This option features a large skylight structure to let in natural night, and large barn doors at the front.

The color scheme of this option is like the first, but the blue is darker in this option than the first. This shade of blue will also allow the building to stand out against the landscape, but the deeper shade of blue is more appropriate for the barn aesthetic.

The walls of this option are also acoustical CMU block with Hardie board vertical board and batten exterior siding above grade. The floors are concrete, and the roof is a standing seam metal with a galvanized acoustic metal roof deck on purlins. The roof will have 2' overhangs and on the low edges, and there will be pre-finished metal gutters with 4 downspouts on each side.

The tank of this option will be similar to a barn silo with a concrete structure and horizontally ribbed metal siding on the exterior and a steel roof. The tank will be polished and have a natural metal finish.

6.4.7 Doors and Hardware

Personnel Doors and frames to be similar to ChemPruf, gel coated, insulated fiberglass with stainless steel hardware.

Overhead roll up door (Option 1) to be epoxy coated insulated steel with electrical motor operation with control stations.

Barn Doors (Option 2) to be insulated steel or aluminum, probably custom made with PVC trim applied and epoxy coated.

6.4.8 Internal Finishes

In the main pump area, the CMU walls should be sealed with epoxy paint. The concrete floors should be sealed with a clear urethane floor sealer. The roof structure should also be sealed with epoxy paint.

For the bathroom, there should be a 4” concrete curb at the base of the wall. The concrete floor and curb should be sealed with a clear urethane floor sealer. The walls should have tile from the concrete curb to the ceiling. The ceiling should be mold and mildew resistant acoustical ceiling tile.

6.5 Electrical

6.5.1 Design Criteria

The electrical systems shall be designed in accordance with the following codes and criteria:

- NFPA 70: National Electrical Code – 2017
- NFPA 780: Standard for the Installation of Lightning Protection Systems
- NFPA 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities – 2020
- HRSD Design and Construction Standards – January 2022
- 2017 Blue Book – Dominion Energy Virginia
- HRSD input provided at May 26, 2022, Electrical, SCADA, & Process Control Workshop
- IES: Illuminating Engineering Society

6.5.2 Utility Power

Utility power shall be brought to the project site by Dominion Energy (DE). Primary service is anticipated to be installed underground from the existing overhead primary installed along Wilroy Road to the proposed location for the utility pad-mounted transformer. DE has confirmed 3-phase primary is installed along Wilroy Road and can serve any property so long as all necessary approvals (permits, easements, etc.) are acquired. The existing circuit fronting the station has sufficient capacity to serve the proposed facility without significant upgrades from DE. Underground primary cable and conduit shall be installed by DE. The utility pad-mounted transformer shall be installed to limit secondary conductors to 50 feet in length so they may be provided and installed by DE. The contractor shall install secondary conduits from the utility transformer to the CT section of the main switchboard within the building.

6.5.3 Standby Power

A diesel-engine generator shall be installed to provide standby power for the entire facility. To provide full-building backup power, (1) 1.5MW, 480/277V, 3-phase, 4-wire generator is anticipated. Generator size excludes (1) redundant PRS pump and (1) redundant drain pump. Size assumes all pumps are started separately with an adjustable time delay between each. The unit shall be installed in a dedicated room within the building on a concrete pad with vibration isolation. Exhaust piping and critical grade silencer shall be fully insulated and supported with vibration isolators. A double-wall underground fuel storage tank coupled with an interior day tank is anticipated to provide 48-hours of run time at full rated load.

The generator shall be connected to a three-way manual transfer switch (MTS) that allows for the facility to be powered by a portable generator in the rare event the permanent standby generator is offline. The MTS shall also allow for a portable load bank to be connected to the standby genset using Leviton 18R24 series connectors in accordance with HRSD standards.

The automatic transfer switch (ATS) integrated into the main switchboard shall be capable of sensing loss of normal power, automatically starting the engine-generator, and shall transfer the station loads to the available source.

6.5.4 Building Power

The electrical characteristics for this building are 480/277V, 3-Phase, 4-Wire. In addition, 120/208V, 3-Phase, 4-Wire power shall be provided by use of step-down dry type transformer(s). The main electrical service equipment rated 2,500-amps shall utilize switchboard construction. The main switchboard shall be furnished with DE metering section, main circuit breaker, ATS, surge suppression, and distribution sections as required. A remote open/close operator and arc flash reduction maintenance switch for the main breaker shall be installed outside of the arc flash boundary.

Yaskawa or Allen Bradley VFDs with integral electronic solid-state soft bypass starters shall be provided for all pressure reducing and drain pump motors. VFDs shall be furnished with integral line reactors and utilize IGBTs to mitigate harmonics.

All wiring shall be run in conduit. Conduit shall be galvanized rigid steel; minimum size shall be 3/4". Polyvinyl chloride (PVC) conduit shall be allowed where properly protected within or beneath concrete floor slabs. Liquid-tight flexible metal conduit shall be limited in application to the connection of interior lighting fixtures, motors, and miscellaneous equipment and in lengths not to exceed six feet. Any exterior branch circuits installed underground shall utilize schedule 40 PVC conduits, minimum 1” in diameter.

Conductors shall be copper and thermoplastic insulated with type THWN, THW or XHHW insulations.

Specific pertinent design standards shall be as follows:

- Service and feeder conductors shall be sized for a maximum voltage drop of 2% at the circuit’s rated capacity. Branch circuits shall have a maximum voltage drop of 3%.
- Receptacles shall be 20-amp, 120V grounding type, specification-grade.
- Ground fault interrupter (GFI) type receptacles shall be provided within 6 feet of a water source.
- Special type receptacles shall be used for user equipment as required.
- Weatherproof GFI receptacles with lockable, metallic, weatherproof while-in-use, “extra-duty” covers shall be strategically located around the exterior of the building and installed in the area of exterior mechanical and electrical equipment.

All electrical power distribution components shall have a short circuit withstand rating that exceeds the available fault current at that point in the system. Components shall be fully rated. Series rated devices shall not be allowed.

6.5.5 Lightning Protection and Grounding

A complete lightning protection system shall be provided in accordance with NFPA 780. The lightning protection system shall meet all the requirements of UL and LPI 175 Standard for the Design – Installation – Inspection of Lightning Protection Systems, complete with air terminals on the roof, bonding of all mechanical equipment and stacks, bonding of structure and railings, bonding of all metallic parts, ground conductors, ground rods, connectors, straps, etc.

A complete equipment grounding system shall be provided such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames and all other conductive items operate continuously at ground potential and provide a low impedance path to ground for possible fault currents. Ground system resistance shall be 5 ohms or less.

The reference ground for the equipment grounding system shall be established from the following grounding electrodes, all bonded together to provide a single point grounding system: Counterpoise loop encircling the building, copper clad driven ground rods, bonding to the building steel and/or rebar (where applicable), and cold-water bond.

Grounding connections shall be made with compression fittings or exothermic welds. A separate insulated equipment-grounding conductor shall be provided for each single and 3-phase feeder and branch circuit. The grounding conductor shall be run with the related phase and neutral conductors. Panel feeders installed in more than one raceway shall have individual, full sized, green grounding conductor in each raceway. The equipment grounding system shall not rely on the metallic raceways for grounding continuity.

6.5.6 Lighting

Lighting intensities shall be as specified in the current edition of the Illuminating Engineers Society handbook, with a minimum average of 30fc. Lighting controls shall be in accordance with HRSD Lighting Guidelines.

Exit lights shall be LED type with red letters, located in all paths of egress. Emergency egress lighting shall typically be provided by emergency battery units (EBUs) in lieu of integral battery backup fixtures. Building mounted exterior lighting for all egress points shall be provided.

All exterior fixtures shall be sharp cut-off type. Building lighting shall be architectural style wall packs strategically positioned and coordinated to complement the building exterior. Any pole mounted fixtures shall be aluminum and no more than 12 feet above grade. All site lighting shall be controlled by photocell.

LED shall have a Color Rendering Index (CRI) of 80 or greater. Color temperature shall be 4000K for interior and exterior lights.

6.6 Building Mechanical

6.6.1 HVAC Design Criteria

The heating, ventilating, and air conditioning (HVAC) systems shall be designed in accordance with the following:

- Virginia Mechanical Code – 2018
- Virginia Energy Conservation Code – 2018
- NFPA 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities – 2020
- HRSD Design and Construction Standards – January 2022

Weather design criteria shall be per ASHRAE design conditions for Suffolk, Virginia:

- 99% heating and 1.0% cooling conditions:
    - Outside winter design temperature: 24.7°F DB
    - Outside summer design temperature: 92.5°F DB / 77.8°F WB

- Extreme Annual Temperatures:
  - Max: 99.3°F DB / 83.9°F WB
  - Min: 13.0°F DB / 12.1°F WB
- 10-year Extreme Temperatures:
  - Max: 103.3°F DB / 87.4°F WB
  - Min: 4.9°F DB / 4.9°F WB

Electrical Room:

Heating and air conditioning shall be provided to maintain temperatures above 50.0°F and below 85°F using a split system heat pump system. Controls shall be by standard thermostat.

Generator Room:

The generator room shall be heated and ventilated to maintain temperatures above 50.0°F and below 105°F, except on peak days where the normal ambient design condition is exceeded. Heating shall be accomplished by electric unit heaters and ventilation will be accomplished by a wall mounted propeller fan. Wall mounted louvers shall be provided for intake air to serve the exhaust fan and generator cooling/combustion air. Louvers shall be furnished with gravity type backdraft dampers and insect/bird screen as applicable.

Pump Room:

The pump room shall be continuously ventilated to comply with NFPA 820. Supply and exhaust air shall operate continuously at 6 air changes per hour (ACH). Fans shall be monitored for failure and shall alarm both the pump room and at the entrance doors to the space if failure is detected. Heating shall be accomplished by electric heating and ventilating units to maintain approximately 50.0°F, except on peak days where the normal ambient design condition is exceeded.

Restroom:

The restroom shall be exhausted per code and heated by use of a cabinet wall heater to maintain 68.0°F. Exhaust fan shall be controlled by a local wall switch and the heater shall be controlled by a thermostat.

6.6.2 Plumbing

Domestic water shall be routed within the building to the restroom, hose bibbs, and other plumbing fixtures as required. On-demand type electric water heaters are anticipated to serve the restroom sink and to provide tempered water to an eye wash station located in the generator room.

Waste piping shall discharge to the gravity sewer system.

6.6.3 Fire Suppression

A fire protection system is not anticipated for the proposed facility.

Section 7

Site Design

7.1 Site Plan

Civil work includes the following and references Proposed Site Plan C-100:

- Installation of erosion and sediment controls during construction
- Installation of underground primary electric service and facility grounding system will be required. See Section 6.7 Electrical for more detail
- Installation of perimeter security fence and any gates. Gate operator type, driveway width, and details will be determined during detailed design
- Installation of yard piping for proposed OLSF and pump station including possible retrofits, odor control ducting, and drainage
- Installation of yard piping for potable water/hose bibbs and sewer connections
- Installation of stormwater controls
- Site grading and paving
- Site restoration, including surface treatments, pavement, curbing, concrete sidewalks, and perimeter security fence

While the physical site location is to be determined, criteria for selecting a site should take the following into consideration:

- Installation of 3 MG OLSF and 21 MGD pump station
- Utility truck turning radius for deliveries and/or maintenance
- Access drive and turnaround
- Working clearance space around tanks
- Crane accessibility
- Adequate ground compaction to support use of cranes
- Vehicular access to refuel underground bulk fuel tank. Fuel station will adhere to City of Suffolk and State of Virginia requirements
- Proposed buildings and tanks will be located outside of floodplain
- Allowance for buffer zone and possible site setbacks along street and possible future expansion/tank addition

7.1.1 Utility Access, Parking, and Driveway

Truck access and a parking area will be required for operation and maintenance personnel and visitors. Truck access should take turning radius, crane access, and possible fire truck access into consideration. Access around the OLSF will be provided for maintenance and graded accordingly. The site will be prepared for any maintenance of the tank or pump station requiring crane access.

Parking and accessibility will adhere to City of Suffolk and State of Virginia requirements. Driveway encroachments must be approved through Virginia Department of Transportation (VDOT).

7.1.2 Fencing

Fencing includes installation of perimeter security fence and any gates. Per HRSD standards, a picket fence should be used where visual screening is less important, but perimeter security is still required. A solid fence may be used where visual screening is of primary concern. Standard signage to be used to designate property and combined safety sign to be displayed at personnel entrances.

7.2 Stormwater Management

A Stormwater Pollution Prevention Plan (SWPPP) that identifies potential sources of pollutants that may reasonably be expected to affect the quality of stormwater discharges from the construction site should be prepared. The standards contained within the Virginia Stormwater Management Program (VSMP) law and regulations, the handbook, and the Virginia Stormwater BMP Clearinghouse website are to be used in the preparation of the stormwater management plan. The plan shall identify and require the implementation of control measures, and shall include, but not be limited to the inclusion of; or the incorporation by reference of, an approved erosion and sediment control plan, an approved stormwater management plan, a pollution prevention plan, and a plan to address, if applicable, specific waste load allocations when discharging waters with an approved TMDL. Unless otherwise specified, the prescribed design storms are the one-year, two-year, and 10- year 24-hour storms using the site-specific rainfall precipitation frequency data recommended by the U.S. National Oceanic and Atmospheric Administration Atlas 14 Partial duration time series shall be used for the precipitation data. The stormwater management plan shall consider all sources of surface runoff and all sources of subsurface and groundwater flows converted to surface runoff. Stormwater quality and quantity will adhere to City of Suffolk and State of Virginia requirements.

Storm sewer systems, drainage inlets, ditches, channels, culverts, and waterway crossings shall be hydraulically designed in accordance with Chapters 3 through 9 and 12 of the VDOT Drainage Manual (VDOT DM), except as amended in these Design Standards. VDOT DM forms are required with all design submittals. Positive drainage, above and below ground, shall be provided for all projects.

The site will be graded to facilitate stormwater runoff. Grading completed on site will be done to minimize ponding and promote drainage away from structures. Positive surface drainage shall be provided. The maximum and minimum grades for drainage as identified in Table 7-1 will be applied to new construction.

Table 7-1. Design Grading

Description	Grading Design Criteria
Roadways, longitudinal	Minimum 0.3%
Roadways, transverse	Minimum 2.0%
Granite pavers in parking areas, sheet flow	Minimum 1.5% Maximum 5.0%
Curb and gutter valley	Minimum 0.3%
Walks, transverse	1.5% for drainage as required
Walks, longitudinal	Minimum 0.3% Maximum 5.0%
Concrete landings	Maximum 2.0%

7.3 Erosion and Sediment Control

Erosion and sediment controls shall be installed during construction. An erosion and sediment control plan consistent with the requirements of the current Virginia Erosion and Sediment Control Law and regulations must be approved prior to the issuance of a land disturbance permit. Erosion and Sediment Control Plans shall be signed and sealed by a Virginia Licensed Professional Engineer. All land disturbing activities in excess of 2,500 square feet within the Chesapeake Bay Preservation Area (CBPA) or 10,000 square feet outside of the CBPA must provide a plan containing adequate measures in accordance with the City Erosion and Sedimentation Control Ordinance and the Virginia Erosion and Sediment Control Regulations.

All erosion and sediment control measures must conform to the Virginia Erosion and Sediment Control Handbook and Regulations, the minimum standards of the Virginia Department of Environmental Quality (DEQ), and the Code of The City of Suffolk. Work should be avoided in the tree drip line area and comply with the Virginia Erosion and Sediment Control Handbook and ANSI A3.

7.4 Permitting Plan

The following permits and approvals will be required for this project:

- Driveway encroachments must be approved through VDOT/City of Suffolk
- SWPPP must be approved by VSMP
- Stormwater Construction General Permit must be approved through Virginia Department of Environmental Quality (VDEQ)
- Erosion and Sediment Control Plan conforming to Virginia Erosion and Sediment Control Program through VDEQ
- Building Permit through City of Suffolk
- Conditional Use Permit through City of Suffolk

The following codes will be used for the final design for this project:

State of Virginia:

- Virginia Erosion and Sediment Control Handbook (VESCH)
- Virginia Stormwater Management Handbook
- Virginia Administrative Code, 9VAC25-870-62 through 9VAC25-870-92
- Virginia Administrative Code, 9VAC25-840

City:

- City of Suffolk, Department of Public Utilities, Public Facilities Manual Volume II, 2014 Release 1
- City of Suffolk, Department of Public Utilities, Public Facilities Manual, Volume I, Second Edition

HRSD:

- Design and Construction Standards, January 2022

Section 8

Environmental Evaluation

With site selection not fully completed, a detailed environmental evaluation is still pending at the time of this report. BC has started to conduct a desktop review and is currently working with the candidate property owners to visit the sites to conduct a preliminary environment assessment of the properties.

8.1 Wetland Delineation

BC conducted a brief desktop review using online resources, such as property documents and online USGS maps. During this assessment BC found that there is possibility of wetlands on the backside of all three sites and a drainage path on the edge of the JTF Properties parcels. Figure 8-1 shows the possible wetlands and drainage path along the properties. Current proposed site layout does not plan on encroach upon these areas. A comprehensive wetlands delineation will be completed upon selection of a site.

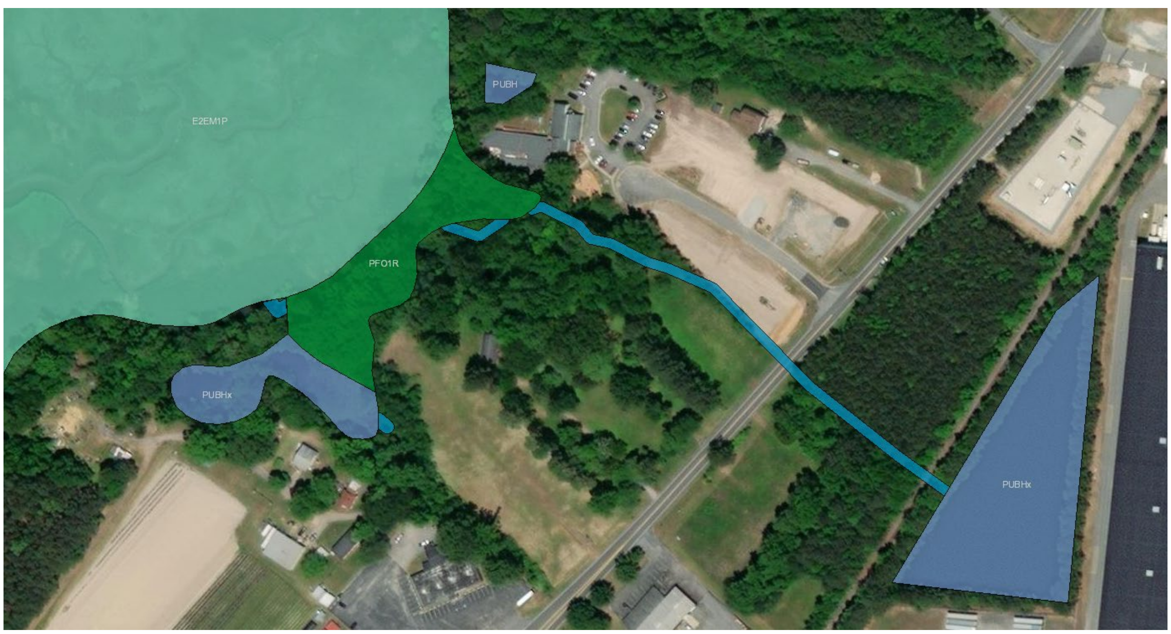


Figure 8-1. Potential Wetland Delineation Map

8.2 Protected Species

8.2.1 Federally Protected Species

BC conducted a desktop reviewed the USFWS's Information for Planning and Consultation (IPaC) tool in June 2022 to identify federally protected species that are known or expected to occur within the vicinity of the project.

USFWS identified the northern long-eared bat (Myotis septentrionalis) (Threatened), the eastern black rail (Laterallus jamaicensis ssp. jamaicensis) (Threatened), the red-cockaded woodpecker (Picoides borealis) (Endangered), and Monarch butterfly (Danaus plexippus) (Candidate). Potential roosting and nesting sites may be found in the area and with tree-cutting potential being needed USFWS may require application for the tree removal. Figures 8-2 and 8-3 provide photographs of the species, courtesy of USFWS.

Figure 8-2. Northern Long-eared Bat

Figure 8-3. Eastern Black Rail (left) and Red-cockaded Woodpecker (right)

Figure 8-3. Monarch Butterfly

8.2.2 State Protected Species

Virginia Endangered Plant and Insect Species Act in the Code of Virginia mandated that the Virginia Department of Agriculture and Consumer Services conserve, protect and manage endangered and threatened plant and insect species. When the act was passed, it listed ginseng as threatened and Virginia round-leaf birch as endangered. Additionally, a list of endangered and threatened plant and insect species since then can be found in VAC5-320-10 which comprises of 25 declared endangered species and 17 declared threatened species. These plants and insects will be investigated further in the detailed field evaluation.

8.3 Invasive Species

Invasive species are organisms that are not indigenous or native to an area that become overpopulated and adversely affect or harms the habitats or ecosystems they are introduced into. This includes nonindigenous or non-native flora, fauna, insects, and aquatic life. The Virginia Department of Conservation and Recreation's (DCR) Division of Natural Heritage currently identifies 90 invasive plant species that threaten or potentially threaten natural areas, parks, and other protected lands in Virginia.

An invasive species assessment will be conducted in the next phase of the project.

8.4 Historical and Cultural Resources

BC performed a desktop review of the project sites and vicinity utilizing the Virginia Cultural Resource Information System (V-CRIS). The proposed project site is not located in the vicinity of any historically significant properties identified via V-CRIS. Once the project site selection is finalized a full review of both the historical and cultural resources of the area will be review.

8.5 Environmental Permits

Permits for the proposed disturbed area may be required by federal, state, and local regulations and restrictions. Since a full environmental study has not been done on a select site, still to be acquired, the full extent of the permits required is not yet determined. Permitting requirements will depend on the final design and the requirements of each permitting or compliance program. Permitting will be readdressed at each design phase.

8.6 Envision

8.6.1 Overview

Envision is a framework that "encourages systemic changes in the planning, design, and delivery of sustainable, resilient, and equitable civil infrastructure." Envision was developed and is managed by the Institute for Sustainable Infrastructure (ISI) and the framework includes 64 sustainability and resilience indicators, also known as "credits," organized around five categories:

- Quality of Life
- Leadership
- Resource Allocation
- Natural World
- Climate and Resilience

Envision is designed as a holistic sustainability rating system for all types and sizes of both public and private infrastructure. Envision was designed to help infrastructure stakeholders implement more sustainable projects. The framework provides a structure in which users can more easily measure progress and identify potential trade-offs amid this complex mix of objective, subjective, quantifiable, and qualitative criteria. The rating scale presented for each sustainability indicator helps users identify and align priorities against a common scale. The benefits of using envision can be long-tern viability, lower cost through management and stakeholder collaboration, reduce negative impacts on the community and the environment, potential to save owners money over time through efficiencies, and an increase in public confidence and involvement in decision making. Table 8-1 shows the verification award levels.

Table 8-1. Verification Award Levels

Award Level	Percent of total applicable points
Verified	20%
Silver	30%
Gold	40%
Platinum	50%

8.6.2 Scoring Results

The HRSD and BC project team performed an Envision (version 3) workshop for this project on May 23, 2022. The purpose of the workshop was to work through ISI's "Envision Checklist (v3)", which was available for download from their website. Prior to the workshop, the BC project team went through and completed the checklist with the goal of identifying how the project currently aligns with the Envision criteria. During the workshop BC worked with HRSD staff to explore how the criteria can improve the project to obtain an even higher level of achievement.

As the design progress through the next phase BC will revisit the assessment and see if there are potential sustainable enhancements to the project that can be achieved. In addition, BC will look to see if any design changes have affected any of the credits already accounted for.

Table 8-2 summarizes the Envision score resulting from the completion of the checklist. As shown the total percentage achieved indicates that during this initial assessment the project would qualify for a Gold Award. Detailed scoring can be found in Appendix E. Figure 8-4 indicates the current points verse the remaining points applicable to the project.

Table 8-2. Envision Credit Analysis

Credit Category	Applicable Credits	Achievable Credits	Percentage
Quality of Life (QL)	156	79	51%
Leadership (LD)	146	88	59%
Resource Allocation (RA)	144	30	21%
Natural World (NW)	210	64	30%
Climate and Resilience (CR)	190	108	57%
Total Points / %	**848**	**369**	**44%**

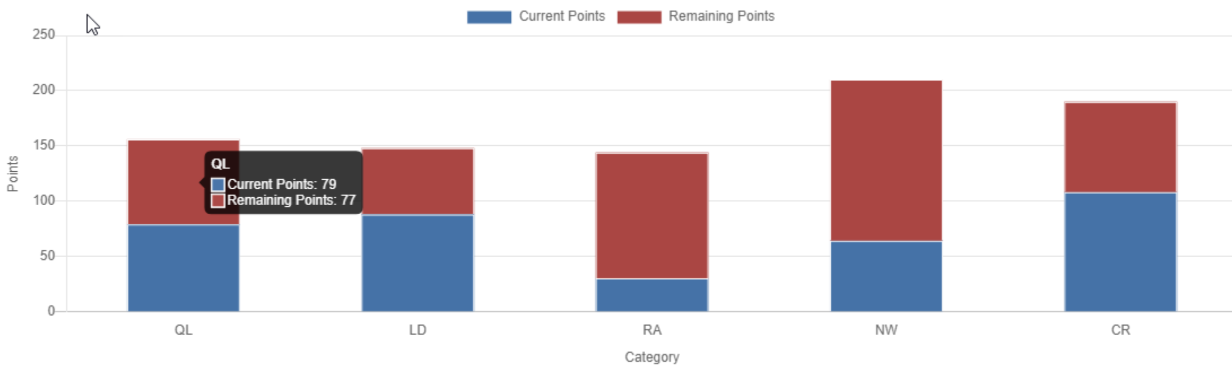


Figure 8-4. Envision Current Score vs Possible Points

8.6.3 Next Steps

The completion of the Envision checklist yielded several additional investigations and action items. The following list summarizes the actions that should be considered in future project phases:

QL 1.4: Minimize Noise and Vibration – These parameters will be discussed with stakeholders, considered in the design, and discussed as part of the pre-construction assessment

QL 1.5: Minimize Light Pollution – Lighting considerations will be discussed with stakeholders and meet City of Suffolk requirements.

QL 3.3: Enhance Views and Local Character – Tank and pressure reducing station aesthetics and buffer to be considered. Meet with Stakeholders and HRSD architectural review committee (ARC).

LD 1.3: Provide for Stakeholder Input – Meet with stakeholders to allow for input and implement into design.

RA 1.1: Support Sustainable Procurement Policies – Review HRSD’s consideration of sustainable procurement policies

RA 2.3: Use Renewable Energy – Review HRSD’s purchase of “Green Power” program covers energy purchase reduction goals utility-wide

NW 2.3: Reduce Pesticide and Fertilizer Impacts – Confirm HRSD’s pesticide and fertilizer purchase and application policies

CR 1.2: Reduce Greenhouse Gas Emissions – Review HRSD’s purchase of “Green Power” program covers greenhouse gas reduction goals utility-wide

CR 2.3: Evaluate Risk and Resilience – Conduct a threat/hazard/risk assessment and review with stakeholders

Section 9

Contractor Procurement

During scoping of this project, it was unclear which approach HRSD would be pursuing to construct the Wilroy PRS and OLSF. Since that time, HRSD has chosen to move forward with Construction Management At Risk (CMAR). This approach is a construction management delivery process where a construction manager is committed to a schedule and price, either a fixed lump sum or a guaranteed maximum price (GMP) based on design milestones. The CMAR initially serves as an advisor to the owner providing preconstruction services such as design and constructability reviews as well as budget schedule and cost monitoring. There are multiple benefits that CMAR can provide to this project which include:

- Method can be utilized to better control project schedule, an important feature because adjacent capital projects have been designed to assume that the tank and PRS are in service
- Allows for the contractor input during the design, which will be beneficial for the complex and impactful construction on a potentially small site, restricted by wetlands and utilities
- Facilitate a single responsible construction entity to carefully manage the diverse and numerous subcontractors required to perform the work, to remain adaptable to changes in construction activities by external entities, both on-site and off-site, and to coordinate design changes resulting from neighboring projects
- Allows for the early and best value selection of subcontractors and equipment and to identify risks early related to limited resources
- Allow the contractor to consider the cost saving alternatives during the design and to provide a guaranteed maximum price during the final design stage.

HRSD staff have received approval from the HRSD Commission to proceed with CMAR and will select a construction manager prior to the next design phase of the project.

Section 10

Project Cost

A Class 4 cost opinion was developed in accordance with American Association for the Advancement of Cost Estimating (AACE). A Class 4 estimate is defined as a Planning Level or Design Technical Feasibility Estimate. Typically, engineering is from 1 to 15 percent complete. Class 4 estimates are used to prepare planning level cost scopes or to evaluate alternatives in design conditions and form the base work for the Class 3 Project Budget or Funding Estimate.

Expected accuracy for Class 4 estimates typically range from -30 to +50 percent, depending on the technological complexity of the project, appropriate reference information and the inclusion of an appropriate contingency determination. In unusual circumstances, ranges could exceed those shown.

This estimate was prepared using quantity take-offs, vendor quotes and equipment pricing furnished either by the project team or by the estimator. The estimate includes direct labor costs and anticipated productivity adjustments to labor and equipment. Where possible, estimates for work anticipated to be performed by specialty subcontractors have been identified.

Construction labor crew and equipment hours were calculated from production rates contained in documents and electronic databases published by R.S. Means, Mechanical Contractors Association (MCA), National Electrical Contractors Association (NECA), and Rental Rate Blue Book for Construction Equipment (Blue Book).

This estimate was prepared using BC's estimating system, which consists of Sage Construction and Real Estate 300 estimating software engine (formerly Timberline) using RS Means database, historical project data, the latest vendor and material cost information, and other costs specific to the project location.

Electrical estimates are performed using ConEst Intellibid electrical estimating software with database provided by Trade Services. The final number from the electrical estimate will be included in the Sage estimate, usually as an "electrical subcontract" number. HRSD will be provided the detailed electrical estimate along with the Sage estimate in their deliverable.

10.1 Estimated Project Costs

Based on the typical accuracy of a Class 4 estimate, the expected range of costs that includes all construction costs, CMAR fee, contingency, mid-project escalation, and BC's construction services fee is:

Table 10-1. Opinion of Probable Costs

Upper Range	Estimated Cost	Lower Range
+50%		-30%
$72,598,551	$48,399,034	$33,879,324

These costs will be refined through final design and in consultation with the selected CMAR. A full detail Detailed Estimate can be found in Append H.

Contractor markup is based on conventionally accepted values which have been adjusted for project-area economic factors. Estimate markups are shown in Table 10-2.

Table 10-2. Estimate Markups

Item	Rate (%)
Net Cost Markups	%
Labor markup	15
Materials and process equipment	10
Equipment (construction-related)	10
2022 Diesel Fuel Adjustment	6
Subcontractor	10
Other – Process Equipment	8
Material Shipping and Handling	2
Gross Cost Markups	
Contractor General Conditions	15
Start-up, Training and O&M	2
Unknown Construction Contingency	20
Unknown Market Conditions	10
Builders Risk, Liability and Auto Insurance	2
Performance and Payment Bonds	1.5
CMAR Fee	10
Escalation to Midpoint of Construction	15.66
BC CA/CI Fee	10

Section 11

Project Management

11.1 Project Schedule

Critical items from the preliminary project schedule are as follows:

- The design scope and fee will be prepared and reviewed by HRSD to be presented at HRSD November 2022 Commission Meeting
- Selection of the CMAR by December 2022 to coincide with 50% design initiation
- Full design services shall be performed with a targeted design completion by September 2023
- Property acquisition represents a critical path item in order to get zoning class rezoned. Rezoning and conditional use permit process can take 6-12 months
- The process of submitting applications for site plan review and any environmental permitting agencies shall begin immediately following the 90% design review workshop

The design is anticipated to be completed by September 2023. The schedule includes 560 days to construct the project and provides flexibility on sequencing of the various project elements. Table 11-1 provides a summary of the project schedule and the full detailed schedule is provided in Appendix D.

Table 11-1. Project Schedule

Task	Completion date
Final PER	Sept 2022
CMAR Selection	Dec 2022
Final Design	Sept 2023
Construction Start	Dec 2023
Substantial Completion	Sept 2025
Project Completion	Dec 2025

11.2 Risk Register

A risk register was developed for this project to identify key areas of potential risk for the overall project. A detailed project risk register is included in Appendix E. As the project progress through design the risk register will be updated to include new risk identified as well as new mitigation measures that have been developed.

11.3 Funding

HRSD has indicated that it plans to fund the Wilroy PRS and OLSF project with the Virginia Clean Water Revolving Loan Fund (VCWRLF). Virginia DEQ, on behalf of the State Water Control Board (SWCB), manages the VCWRLF, administers the policy aspects of the program, receives applications, develops funding recommendations, and provides assistance and oversight for funded projects. The Virginia Resources Authority (VRA) serves as the financial manager of the VCWRLF. This fund is a self-perpetuating fund that provides low interest financing to Virginia local governments and wastewater authorities to assist with improvements to wastewater treatment plants and/or collection systems.

With HRSD's desire to potentially use VCWRLF to fund this project, BC conducted a review the requirements put into place by the VCWRLF to receive funds. DEQ has released procedural guidelines for VCWRLF that provides an overview of the activities involved in the planning, design, and construction of a VCWRLF project including program requirements and recommendations for the successful completion of a project. In addition, the Wastewater Loan Program Design Manual provides a brief summary of the program requirements as they relate to the loan recipients so that they are fully aware of them and can act accordingly. A brief overview of those requirement and recommendations can be found below.

Applicable laws and regulations:

- Virginia Public Procurement Act
- Uniform Financial Report Manual, issued by the Virginia Auditor of Public Accounts pursuant to Section 15.1-66, Code of Virginia (1950) Section 15.1-66, Code of Virginia (1950),
- Office of Management and Budget Circular A-87 and A-102.
- Single Audit Act (SAA)
- Davis Bacon Act
- Minority Business Enterprise/Women's Business Enterprise (MBE/WBE) goals
- American Iron and Steel Act
- The Build America, Buy America Act (BABAA) (for new loans)
- Sewage Collection and Treatment (SCAT) regulations

Financial management/control system:

All recipients receiving funds must maintain a financial management/control system for complete accountability of loan monies. It is BC understanding that HRSD's use of the Unifier program for the project would meet these requirements for a management and control system. An accountability system requires:

- the overall ability to track and control loan activities
- a sound accounting system
- good internal controls
- compliance with all applicable guidelines
- proper procurement procedures

Planning and Design:

Development of a Preliminary Engineering Proposal (PEP) or planning document is required to be completed for the VCWRLF. The PEP is to include an environmental review (similar to National Environmental Policy Act [NEPA] reviews), cost-effectiveness analysis, and water and energy conservation analysis. The Environmental Assessment, including a project description and site location map, must also be forwarded to all necessary review agencies for review and comment. The agencies must be given 30 days for review and comment. The recipient must retain copies of the transmittal letters as well as all review comments received.

Upon completion of design, the plans and specifications must be submitted to the Clean Water Financing and Assistance Program (CWFAP) for review, comment, and final approval. The CWFAP review will focus primarily on the bidding requirements and contract documents, and their conformance with program requirements. Otherwise, processing of the plans and specifications will proceed as outlined in the SCAT regulations.

Plans and Specifications include:

- Compliance with Equal Employment Opportunity
- Certification on Non-Segregational Facilities
- Compliance with Minority and Women's Business Enterprise Goals (MBE/WBE)
- Compliance with the Civil Rights Act of 1964
- Compliance with Age Discrimination Act of 1975, Rehabilitation Act of 1973, and the prohibition against sex discrimination
- Compliance with Section 306 of the Clean Air Act and Section 508 of the Clean Water Act
- Procurement of goods and materials from Small Businesses in Rural Areas of the Commonwealth of Virginia wherever practical and feasible
- Provides that a contractor or subcontractor maintain a drug-free workplace during the performance of contract duties for any wastewater revolving loan-assisted project
- The contractor must demonstrate a "good faith effort" in the solicitation and utilization of Minority and Women's Business Enterprises (MBE/WBE)
- Sewer Use Ordinance - The loan recipient must have an adopted, DEQ-approved, Sewer Use Ordinance in place

Construction

During the construction phase, the CWFAP will maintain off-site construction monitoring and conduct periodic on-site evaluations of construction activities. The purposes of the state oversight program are as follows:

- To provide assistance to loan recipients in all aspects of loan and construction management in order to enhance management effectiveness and efficiency so the project is successfully completed.
- To assess the project's compliance with applicable federal and state requirements and loan conditions.
- To ensure that loan recipients maintain appropriate financial and records management systems.
- To ensure that the project is constructed in substantial accordance with approved plans, specifications, and change orders.
- To verify that payments are being made for work-in-place and to enhance the processing of disbursement requests.

The oversight program includes continuous off-site monitoring, interim project evaluations, a final project evaluation, and a final financial evaluation.

CWFAP will conduct off-site monitoring through the review of evaluation reports, change orders, correspondence and review and approval of disbursement requests. Copies of these documents should be provided to CWFAP, as appropriate, for this purpose.

During construction, the loan recipient must provide for full time project inspection unless otherwise approved by the CWFAP. Inspections will keep loan recipient aware of construction progress, quality, and conformance with plans and specifications. Loan recipient inspections should be documented with construction progress reports that can be reviewed by CWFAP during on-site monitoring. The loan recipient should also provide CWFAP with the MBE/WBE Utilization report on a quarterly basis.

11.3.1.1 Build America, Buy America Act (BABAA)

At this time, BC is working with HRSD and DEQ to determine if the Build America, Buy America Act (BABAA) will apply to the VCWRLF monies that will be distributed for this project.

On November 15, 2021, Bipartisan Infrastructure Law (Infrastructure Investment and Jobs Act) (Pub. L. No. 117-58), which includes BABAA (Pub. L. No. 117-58, §§ 70901-52) was signed into law by President Joe Biden. The Build America, Buy America Act (BABAA) requires that none of the funds made available for federal assistance programs similar to the Water Infrastructure Finance and Innovation Act (WIFIA) funding or State Revolving Fund (SRF) loans, are allocated to projects unless all of the iron, steel, manufactured products, and construction materials used in the infrastructure projects are produced in the United States. Federal assistance means assistance that non-federal entities receive or administer in the form of grants, cooperative agreements, non-cash contributions or donations or property, direct assistance, loans, loan guarantees, and other types of financial assistance. The BABAA requirements went into effect on May 14, 2022.

BABAA strengthens the previous American Iron & Steel (AIS) Act requirements and significantly increases the products and materials required to be produced in the United States. The Act includes the following requirements:

- All iron and steel used in the project are produced in the United States. This means the manufacturing processes, from the initial melting state through the application of coatings, occurred in the United States.
- All manufactured products used in the project are produced in the United States, and the cost of the components of the manufactured product that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components of the manufactured product.
- All construction materials are manufactured in the United States. The Office of Management and Budget ("OMB") has released preliminary guidance on what constitutes "Construction Materials" which includes all manufacturing processes for the construction material occurred in the United States. Currently, all construction material is classified as including an article, material, or supply other than an item of primarily iron or steel, a manufactured product, cement and cementitious materials, aggregates such as stone, sand, or gravel, or aggregate binding agents or additives that are or consist primarily of:
    - Non-ferrous metals
    - Plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables)
    - Glass (including optic glass)
    - Lumber
    - Drywall

The BABAA requirements have the potential to impact the projects in the following ways:

- Certain manufacturers may no longer be a viable option.
- Available manufacturers that can meet BABAA may be lesser quality when compared to BC and HRSD standard manufacturers.
- Available manufacturers may not agree to meet specifications requirements and due to availability; HRSD may be forced to waive requirements that increase end product quality or increase Operations and Maintenance costs/burdens.

- Overall project construction costs may increase and strain budgets.
- Supply chain issues and lead times may increase impacting construction schedules.

EPA has posted a draft waiver specifically for SRF funded projects. Based on the waiver, all projects previously submitted to an applicable state agency prior to May 14, 2022, would be waived from the manufactured products and construction material requirements of BABAA. However, they would still be required to meet BABAA requirements for United States produced Iron and Steel, which is more stringent than the previous AIS Act. The public comment period for this waiver ended on June 29, 2022. Waivers typically take 4 to 6 weeks to post if approved.

BC will continue to coordinate with HRSD and follow the regulations as they are clarified.

11.4 Nearby construction projects

BC has learned about three nearby projects that will be ongoing during the design and construction of the Wilroy PRS and OLSF. These projects consist of a City of Chesapeake raw water main, City of Suffolk Wilroy Road/Nansemond Parkway roadway overpass, and a TC Energy large diameter gas main.

Nansemond Parkway/Wilroy Road overpass project

The purpose of this project is to provide a grade separated crossing of the existing railroad and to address safety, geometrics and capacity issues at the intersection of Nansemond Parkway and Wilroy Road in the City of Suffolk. The proposed improvements include providing a flyover of the existing railroad and to realign Wilroy Road from just north of Bridlewood Lane to approximately 2200 feet south of the existing Wilroy Road/Nansemond Parkway Intersection. Work includes 200-foot bridge structure, a sidewalk, multi-use path, drainage improvements, stormwater management facilities, and signalization.

Current Construction Schedule: October 2022 – October 2024

- Real estate acquisition delays will likely significantly impact this however

Potential concerns:

- Traffic congestion to the north of the project while project is being completed
- Additional concerns/complaints of construction from neighborhoods in vicinity of the project.

Figure 11-1. Nansemond Parkway/Wilroy Rd Overpass Project alignment

Red Top to Lake Gaston Water Treatment Plant 36” Raw Water Transmission Main Section D

The purpose of this project is to provide an additional raw water transmission main for the City of Chesapeake to their Lake Gaston Water Treatment Plant (WTP). This project is located near the intersection of Wilroy Road and QVC Drive. The new transition will run through Candidate Site 23, one of the potential site selections for the PRS and OLSF, west to east where it then crosses Wilroy Road and turns and continues to the south following the railroad tracks.

Current Construction Schedule: Fall 2022- Fall 2023, Design phase complete

- This will likely place the Wilroy PRS project construction directly after the water main project

Potential concerns:

- Additional construction traffic in vicinity of our project.
- Project may need to wait until the water main is in if we were to select that property for construction of the PRS and OLSF

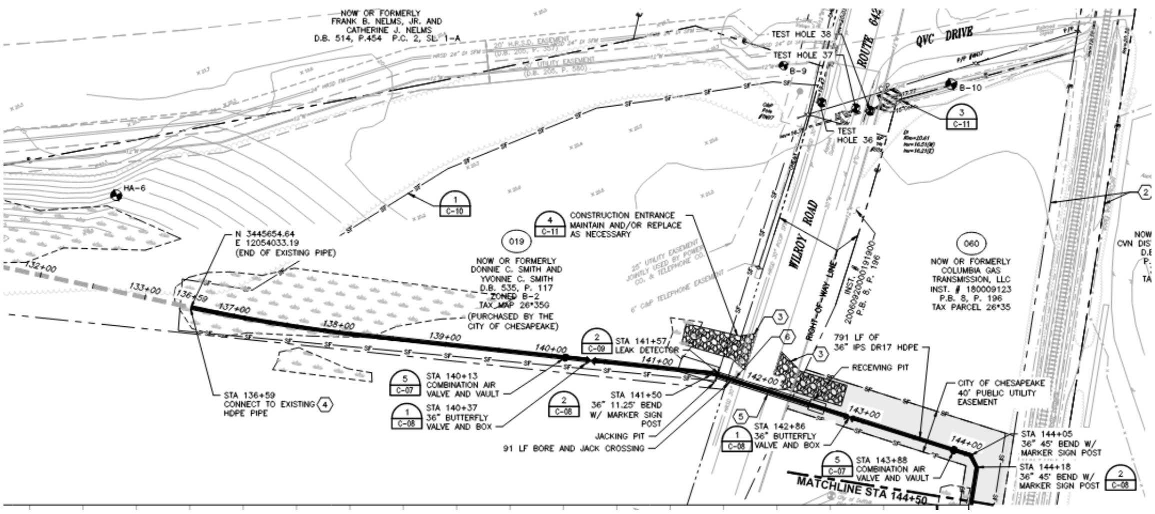


Figure 11-2. City of Chesapeake 36” Raw Water Transmission Main Alignment

TC Energy 24” Natural Gas Pipeline

The purpose of this project is to install a major natural gas transmission main to help serve the Hampton Roads area. The project is located near the intersection of Wilroy Rd and QVC Drive and would also likely cross through Candidate Site 23.

Current Construction Schedule: Fall 2023-Fall 25

Potential concerns:

- Additional construction traffic in vicinity of our project.
- Coordination required for tie-in to the HRSD Windsor Line (SF-214)
- If we were to select the Chesapeake property for construction of the PRS and OLSF additional coordination would be needed.

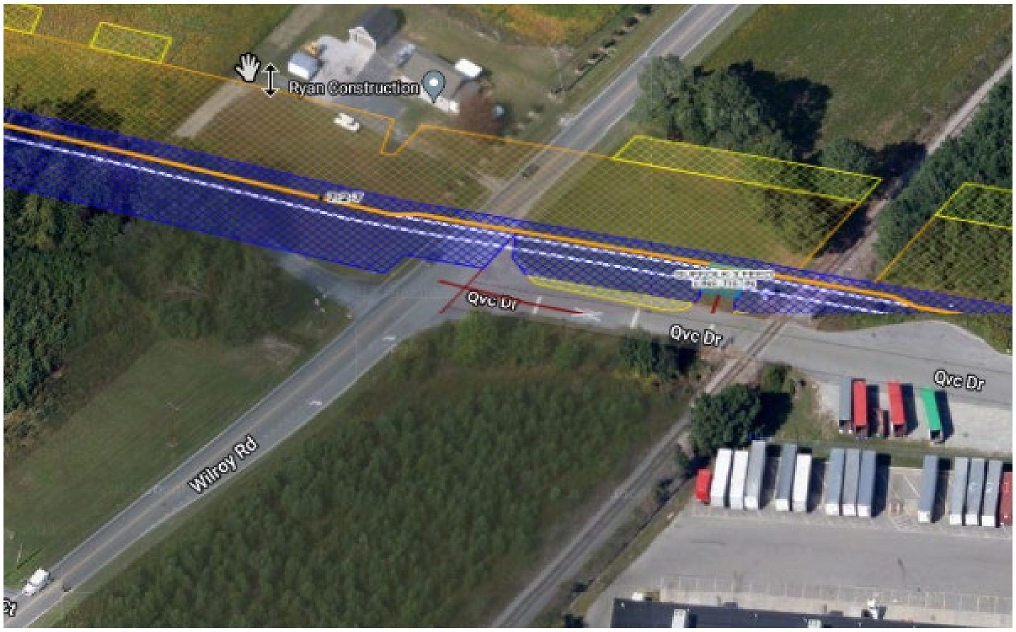


Figure 11-3. TC Energy 24" Natural Gas Transmission Main Alignment

11.5 Community Outreach

Though our initial interactions with the City of Suffolk, BC has been able to identify multiple stakeholders that are likely to be impacted by the project. These include neighborhoods, local businesses and multiple municipalities. Preliminary coordination has occurred with the City of Suffolk in the development of this PER to understand how this community may influence the design of the project. Additional coordination with these stakeholders will be required throughout design and construction.

11.5.1 Neighborhoods and Local Business

11.5.1.1 Neighborhoods

BC has investigated Civic Leagues and neighboring Homeowner Associations in the area that would likely be impacted by the project. To date BC has had limited success identifying any Civil Leagues or Homeowner Associations near the project site. BC has identified the Bridlewood Estates, equestrian neighborhood, which is located roughly two miles north of the project sites. The Estates have expressed their concerns with the Nansemond Parkway/Wilroy Rd Overpass project that is under design by the City of Suffolk. While this project is located a few miles away the community could be a key stakeholder.

11.5.1.2 Local Business

At this time BC has identified a few key stakeholders that are in very close proximity to the three preliminary site selections.

The preliminary sites selections are all in close proximity to The Children's Center, a nonprofit agency that provides children ages birth to five with early childhood education serves. Similarly, Evans Farms, a family owned and run local produce farm open to the public, is also located near all three sites. These businesses would be key stakeholders. After a final site has been selected and we move through the project design, BC will coordinate with HRSD staff to contact these stakeholders and discuss the project.

BC has identified the following business as other potential stakeholders

- Magnolia United Methodist Church
- Seger Electric Company
- QVC Distribution center
- Ryan Construction
- Solenis
- Other business along Progress Road within the business park.

11.5.2 Municipalities Departments

BC has identified several departments with the City of Suffolk (and a few other municipalities) that may be key stakeholders. These municipalities departments are the following:

- City of Suffolk Public Utilities
- City of Suffolk Public Works
- City of Suffolk Economic Development Authority
- City of Suffolk Planning & Community Development
- City of Portsmouth Public Utilities
- City of Chesapeake Public Utilities

Preliminary discussions have been conducted with Suffolk Public Utilities making them aware of the project. Suffolk has existing utilities that run along Wilroy Road and the project will also require a potable water connection.

Preliminary discussions have been conducted with the Public Works making them aware of the project. Suffolk Public Works is stakeholder for this project since the proposed project improvements will impact the roads and stormwater system.

Preliminary discussions with the Economic Development Authority and Planning & Community Development were held in May 2022 during the City's "Friday morning meeting." The conversation focused on comments and concerns with the PRS and OLSF site selection. It was noted during that meeting that the Department of Planning will require a submittal for site plan review. The application submission for review can be completed online and should be planned to be submitted right after the 90% design review workshop.

Preliminary discussions have been conducted with the City of Chesapeake Public Utilities making them aware of the project. Multiple items have already been discussed such as the potential for HRSD to purchase the land that Public Utilities owns (to install their new 36" raw water transmission main). BC also began discussing coordination for the construction phase of both projects.

City of Portsmouth Public Utilities department has be identified a potential stakeholder due to an existing 30" water transmission main that runs along Wilroy Road. Once a survey is complete and the location of the water main is understood, BC will coordinate with the City of Portsmouth on the proposed work.

Section 12

Anticipated Specification Sections

The following section provides a list of specifications anticipated for the final design of the Wilroy PRS and OLSF. These are currently shown in Div 17 format, however may be changed to Div 50 for final design.

DIVISION ONE – GENERAL REQUIREMENTS

01010 Summary of Work
01040 Coordination
01051 Construction Sequence
01060 Special Conditions
01270 Measurement and Payment
01310 Construction Progress Schedules
01323 Record Documents
01340 Submittals
01400 Quality Control
01520 Maintenance of Pipeline and Pumping Operations
01560 Environmental Protection and Special Controls
01570 Traffic Control
01600 Material and Equipment
01650 Facility and Systems Start-up
01730 Operating and Maintenance Information
01750 Spare Parts
01999 Nonbuilding Structures Reference Forms

DIVISION TWO – SITEWORK

02050 Demolition
02082 Manholes and Structures
02100 Site Clearing
02140 Dewatering
02161 Shoring
02200 Earthwork
02270 Erosion and Sedimentation Controls
02324 Trenching, Backfilling and Compaction
02500 Asphalt Paving
02510 Ductile Iron Pipe
02520 Polyvinyl Chloride Pipe
02525 Site Concrete
02531 Line Stops on Sanitary Sewer Force Main Systems
02610 Valves
02611 Mechanical Couplings
02630 Storm Drainage
02700 Sewerage and Drainage

02763 Painted Pavement Markings
02901 Miscellaneous Work and Cleanup
02933 Soil Preparation, Plantings and Site Restoration

DIVISION THREE – CONCRETE

03100 Concrete Formwork
03130 Maintenance of Cast-In-Place Concrete
03200 Concrete Reinforcement
03230 AWWA D110 Type II Prestressed Tank
03250 Concrete Accessories
03300 Cast-In-Place Concrete
03481 Precast Concrete Vaults
03600 Grouting

DIVISION FOUR – MASONRY

04200 Unit Masonry

DIVISION FIVE – METALS

05100 Structural Metals
05121 Architecturally Exposed Structural Steel Framing
05210 Open Web Steel Joists
05311 Steel Roof Decking
05501 Anchor Bolts
05505 Miscellaneous Metalwork
05510 Metal Stairs
05521 Aluminum Railings
05523 Metal Fastenings
05531 Metal Grating and Stair Treads

DIVISION SIX – WOOD AND PLASTICS

06100 Rough Carpentry
06711 Fiberglass Reinforced Products and Fabrications
06741 Fiberglass Reinforced Gratings

DIVISION SEVEN – THERMAL AND MOISTURE PROTECTION

07160 Reactive Waterproofing
07210 Thermal Insulation
07250 Weather Barriers
07260 Vapor Retarders
07411 Formed Metal Roof Panels
07413 Insulated Metal Wall Panels
07542 Thermoplastic-Polyolefin Roofing
07620 Sheet Metal Flashing and Trim
07710 Roof Specialties
07841 Penetration Firestopping Systems
07844 Joint Firestopping

DIVISION EIGHT – DOORS AND WINDOWS

DIVISION NINE – FINISHES

DIVISION TEN – SPECIALTIES

DIVISION ELEVEN – EQUIPMENT

DIVISION TWELVE – FURNISHINGS

DIVISION THIRTEEN -- SPECIAL CONSTRUCTION

DIVISION FOURTEEN – CONVEYING SYSTEMS

DIVISION FIFTEEN – MECHANICAL

15050 Piping Systems
15051 Piping System Schedules
15052 Piping System Schedule, Potable Water
15053 Common Work Results for HVAC
15053 Piping System Schedule, Pressurized Wastewater and Drainage
15055 Piping System Schedule, Building Drainage
15058 Common Motor Requirements for HVAC Equipment
15062 Ductile Iron Pipe
15062 Hangers and Supports for HVAC Piping and Equipment
15064 Thermoplastic Process Pipe
15066 Copper Piping
15074 Vibration and Seismic Controls for HVAC Piping and Equipment
15075 Joint Gaskets
15077 Identification for HVAC Piping and Equipment
15083 HVAC Insulation
15085 Piping Connections
15095 Piping Appurtenances
15096 Pipe Hangers and Supports for Process Piping
15098 Expansion Control for Piping
15110 Eccentric Plug Valve
15118 AWWA C508 Check Valves
15129 Control Ball Valve
15124 Reduced Pressure Principle Backflow Preventers
15151 Air Release and Vacuum Valves for Wastewater
15180 Power Actuated Valve and Gate Schedule for Process Services
15184 Manual Actuators
15185 Powered Actuators
15265 Electrical Heat-Tracing and Insulation Systems
15400 Plumbing
15440 Plumbing Fixtures
15738 Split-System Air-Conditioning Units
15752 Humidifier
15762 Unit Heaters
15815 Metal Ducts
15820 Duct Accessories
15837 Centrifugal Fans
15838 Power Ventilators
15855 Diffusers, Registers, and Grilles
15856 Intake and Relief Ventilators
15900 HVAC Instrumentation and Controls
15950 Testing, Adjusting, and Balancing

DIVISION SIXTEEN – ELECTRICAL

16000 Common Work Results for Electrical
16030 Commissioning of Electrical Systems
16110 Raceways and Boxes for Electrical Systems
16115 Raceway Supports, Hangers, and Restraints
16120 Low-Voltage Electrical Power Conductors and Cables

16125 Medium-Voltage Cables
16140 Wiring Devices
16155 Enclosed Controllers
16175 Electrical Controls and Relays
16231 Diesel Engine Driven Generator Sets
16260 Automatic Transfer Switches
16310 Low-Voltage Switchgear
16321 Liquid Filled Medium-Voltage Substation Transformers
16322 Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
16364 Low-Voltage Switchgear
16410 Power Factor Correction Equipment
16421 Lightning Protection Surge Arresters and Suppressors
16431 Arc Flash Analysis, Short Circuit Study and Protective Device Coordination Report
16446 Lightning Protection for Structures
16450 Grounding and Bonding for Electrical Systems
16460 Low Voltage Transformers
16466 Three Phase Uniterruptable Power Supply
16470 Panelboards
16500 Luminaires
16850 Fire Alarm Systems
16710 Medium Voltage Metal Enclosed Switchgear
16920 Motor Control Centers

DIVISION SEVENTEEN – INSTRUMENTATION

17000 Process Control System General Provisions
17010 Process Control Descriptions
17030 Process Control System Testing
17110 Control System Equipment Panels and Racks
17130 Power Supply and Conditioning Equipment
17200 Schedules for Instrumentation of Process Systems
17211 Flow Measurement
17212 Level Measurement
17310 Programmable Logic Controllers

Section 13

Limitations

This document was prepared solely for HRSD in accordance with professional standards at the time the services were performed and in accordance with the contract between HRSD and Brown and Caldwell dated December 21, 2021. This document is governed by the specific scope of work authorized by HRSD; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by HRSD and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Further, Brown and Caldwell makes no warranties, express or implied, with respect to this document, except for those, if any, contained in the agreement pursuant to which the document was prepared. All data, drawings, documents, or information contained this report have been prepared exclusively for the person or entity to whom it was addressed and may not be relied upon by any other person or entity without the prior written consent of Brown and Caldwell unless otherwise provided by the Agreement pursuant to which these services were provided.

Appendix A: Geotechnical Report

GEOTECHNICAL DATA REPORT

HRSD Wilroy Road Sites Preliminary Exploration
1941-1949 Wilroy Road
Suffolk, Virginia

Schnabel Reference 22330066.000
July 15, 2022

Schnabel ENGINEERING

T 804.649.7035
9800 JEB Stuart Parkway, Suite 100 / Glen Allen, VA 23059
schnabel-eng.com

July 15, 2022

Mr. Christopher Wilson, PE
Brown and Caldwell
301 Bendix Road, Suite 400
Virginia Beach, VA 23452

Subject: **Project 22330066.000, Geotechnical Data Report, HRSD Wilroy Road Sites Preliminary Exploration, 1941-1949 Wilroy Road, Suffolk, Virginia**

Dear Mr. Wilson:

SCHNABEL ENGINEERING, LLC (Schnabel) is pleased to submit our geotechnical data report for this project. This study was performed in accordance with our proposal dated July 7, 2022, as authorized by you. The overall project is to provide preliminary subsurface data at two adjacent sites. One site consists of the lots at 1941 and 1949 Wilroy Road and the other site consists of the lot at 1925 Wilroy Road. This report specially addresses the site at 1941 and 1949 Wilroy Road.

SITE AND PROJECT DESCRIPTION

The project site is located at 1941-1949 Wilroy Road in Suffolk, Virginia. This site consists of two adjacent parcels, with a total of approximately 5.4 acres of land. The site has several small structures but generally consists woods and some grassy areas. The site is bound by Executive Court to the northeast, Wilroy Road to the southeast, 1925 Wilroy Road to the south, and wetlands to the northwest. Site grades are generally flat at about EL 20.

We understand HRSD may develop the property to construct a Pressure Reducing Station and Tank. Specific details regarding the size and structural loading of the proposed development were not available at this time.

We obtained the project and site information from our site reconnaissance, review of aerial photography, Suffolk County GIS Data, and communication with you.

SUBSURFACE EXPLORATION AND TESTING PROGRAM

We performed a subsurface exploration and field testing program to identify the subsurface stratigraphy underlying the site. This program included one test boring. Exploration methods used are discussed below. The appendices contain the results of our exploration.

Test Borings

Our subcontractor, Fishburne Drilling, Inc., drilled one test boring under our observation on July 12, 2022. The Standard Penetration Test (SPT) was performed at selected depths in the boring. Appendix A includes specific observations, remarks, and log for the boring; classification criteria; drilling methods; and sampling protocols. Figure 2, included at the end of this report, indicates the approximate test boring location. We will retain soil samples up to 45 days beyond the issuance of this report, unless you request other disposition.

The SPT samples were obtained using a hydraulically driven automatic trip hammer (ATH). Most correlations with SPT data are based on N-values collected with a safety hammer. The energy applied to the split-spoon sampler using the ATH is about 33 percent greater than that applied using the safety hammer, resulting in lower N-values. The hammer blows shown on the boring log are uncorrected for the higher energy. However, we correct SPT N values for the higher energy when using N values in our analyses.

Soil Laboratory Testing

Our laboratory performed tests on selected samples collected during the subsurface exploration. The testing aided in the classification of materials encountered in the subsurface exploration and provided data for this report. The results of the laboratory tests are included in Appendix B and are summarized for each stratum in the Site Geology and Subsurface Conditions section of this report. Selected test results are also shown on the boring logs in Appendix A.

SITE GEOLOGY AND SUBSURFACE CONDITIONS

Site Geology

The project site is located within the Coastal Plain Province of Virginia. We reviewed existing geologic data and information in our files, and the *Geologic Map and Generalized Cross Sections of the Coastal Plain and Adjacent Parts of the Piedmont, Virginia* (VA DMME, 1989). Based on this review, the project site is underlain by Pleistocene Age alluvial soils of the Tabb Formation and the Miocene Age marine soils of the Yorktown Formation. The Tabb Formation is composed of fluvial and estuarine sand, clay, organic soil and peat. The underlying Yorktown Formation is composed of marine sand and clay. The soils of the Yorktown Formation are preconsolidated and exhibit relatively high strength.

Generalized Subsurface Stratigraphy

We characterized the following generalized subsurface stratigraphy based on the exploration and laboratory test data included in the appendices.

Topsoil:

The boring encountered 4 inches of topsoil at the ground surface overlying the onsite soils.

Stratum A: Tabb Formation

Below the topsoil, the boring encountered Tabb Formation soils to a depth of 12 ft. The soils generally consist of sandy lean clay, clayey sand, and silty sand (CL, SC, SM) with varying amounts of shell fragments. The fine-grained Tabb Formation soils are designated as Stratum A1 on the boring log. The coarse-grained Tabb Formation soils are designated as Stratum A2 on the boring log. Based on the Standard Penetration Testing (SPT) performed, the fine-grained soils are soft to stiff, with N-values ranging from 4 to 12 blows per foot (bpf). The coarse-grained soils are very loose to medium dense, with N-values ranging from Weight of Hammer (WOH) to 10 bpf.

Index testing performed on a sample of Stratum A indicated a liquid limit of 26 and a plasticity index of 11. The natural moisture contents of samples from this stratum varied from about 17 to 39 percent.

Stratum B: Yorktown Formation

Below the Tabb Formation soils of Stratum A, the boring encountered Yorktown Formation soils to a depth of 40 ft, the maximum depth of exploration. The soils generally consist of lean clay with sand, clayey sand, and silty sand (CL, SC, SM) with varying amounts of shell fragments and mica. The fine-grained Yorktown Formation soils are designated as Stratum B1 on the boring log. The coarse-grained Yorktown Formation soils are designated as Stratum B2 on the boring log. Based on the Standard Penetration Testing (SPT) performed, the fine-grained soils are firm, with N-values ranging from 4 to 5 bpf. The coarse-grained soils are loose, with N-values ranging from 4 to 6 bpf.

Groundwater

We observed groundwater in the boring at a depth of 6 ft, about EL 14. The test boring log in Appendix A include groundwater observations obtained during our subsurface exploration. We did not obtain long-term water level readings since we backfilled the test borings upon completion for safety.

The groundwater levels on the logs indicate our estimate of the hydrostatic water table at the time of our subsurface exploration. The final design should anticipate the fluctuation of the hydrostatic water table depending on variations in precipitation, surface runoff, pumping, tidal action, evaporation, leaking utilities, stream levels, and similar factors.

RECOMMENDATIONS FOR FINAL GEOTECHNICAL STUDY

A final geotechnical engineering study should be performed for this site during the design phase. This study should include test borings within the proposed pavement areas, structure footprints, and stormwater management basins, as applicable. Additionally, soil laboratory testing to evaluate the shrink/swell potential, compaction criteria, strengths, and compressibility of the site soils should be performed.

LIMITATIONS

We based the preliminary observations submitted in this report on the information revealed by our exploration. We attempted to provide for normal contingencies, but the possibility remains that unexpected conditions may be encountered. A final geotechnical study should be performed for this site for the design phase.

This report has been prepared to aid in the evaluation of this site and to assist in the design of the project. It is intended for use concerning this specific project.

We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report, or other instrument of service.

We appreciate the opportunity to be of service for this project. Please call us if you have any questions regarding this report.

Sincerely,

SCHNABEL ENGINEERING, LLC

Jonathan T. Baugh, GIT, EIT
Senior Staff Geologist

Paul T. Johnston, PE
Associate

EPW:JTB:PTJ:rl

Figures
Appendix A: Subsurface Exploration Data
Appendix B: Soil Laboratory Test Data

FIGURES

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Projection: WGS 1984 Web Mercator Auxiliary Sphere

NOT TO SCALE

Schnabel ENGINEERING

HRSD WILROY ROAD SITES PRELIMINARY EXPLORATION

1941-1949 WILROY ROAD

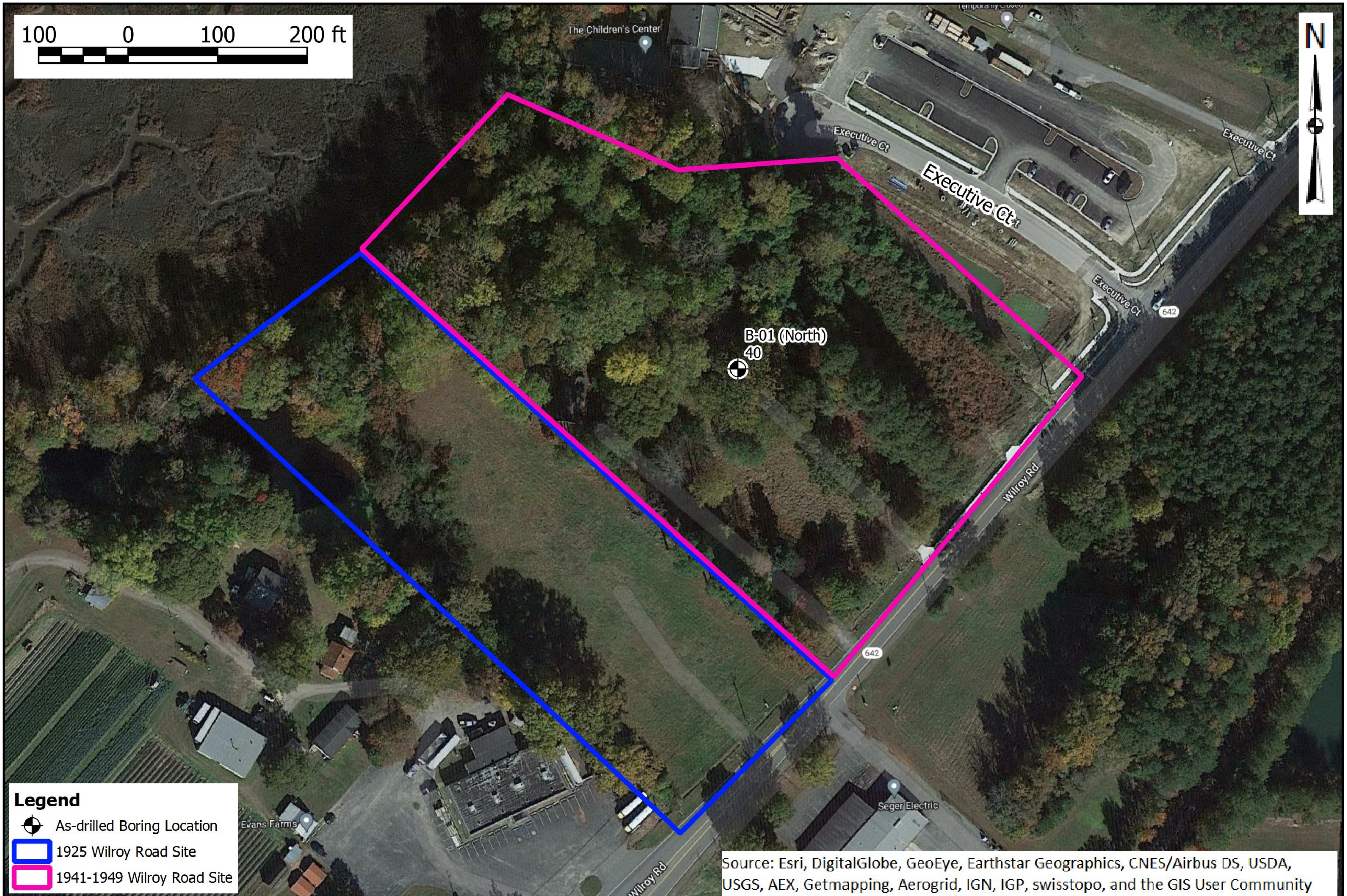
PROJECT NO. 22330066.000

SITE VICINITY MAP

FIGURE 1

7/15/2022 This Map was Created In Schnabel Engineerings Site Vicinity Map Application

arcgis



Schnabel ENGINEERING	HRSD WILROY ROAD SITES PRELIMINARY EXPLORATION 1941-1949 WILROY ROAD SUFFOLK, VIRGINIA	Figure Name: BORING LOCATION PLAN	Done: J. BAUGH	Figure Number: 2
		Project Number: 22330066.000	Reviewed: P. JOHNSTON	Date: JUL 2022

APPENDIX A

SUBSURFACE EXPLORATION DATA

Subsurface Exploration Procedures
General Notes for Subsurface Exploration Logs
Identification of Soil
Boring Log, B-01 (North)

SUBSURFACE EXPLORATION PROCEDURES

Test Borings – Mud Rotary

Drillers advanced the boring using mud rotary drilling techniques. The boring is advanced with a drill string consisting of a 2 15/16-inch diameter tri-cone roller bit attached to A-sized drilled rods. Bentonite drilling fluid is pumped through the drill rods to flush cuttings to the surface. The borehole remains full of drilling fluid to maintain the sides of the borehole. At the designated depth, the drillers removed the drill string and performed the Standard Penetration Test (SPT). Water level data is indicated on the log.

Standard Penetration Test Results

The numbers in the Sampling Data column of the boring log represent Standard Penetration Test (SPT) results. Each number represents the blows needed to drive a 2-inch O.D., 1⅜-inch I.D. split-spoon sampler 6 inches, using a 140-pound hammer falling 30 inches. The sampler is typically driven a total of 18 or 24 inches. The first 6 inches are considered a seating interval. The total of the number of blows for the second and third 6-inch intervals is the SPT "N value." The SPT is performed according to ASTM D1586.

The SPT samples were obtained using a hydraulically driven automatic trip hammer (ATH). Most correlations with SPT data are based on N-values collected with a safety hammer. The energy applied to the split-spoon sampler using the ATH is about 33 percent greater than that applied using the safety hammer, resulting in lower N-values. The hammer blows shown on the boring logs are uncorrected for the higher energy. However, we correct SPT N values for the higher energy when using N values in our analyses.

Soil Classification Criteria

The group symbols on the logs represent the Unified Soil Classification System Group Symbols (ASTM D2487) based on visual observation and limited laboratory testing of the samples. Criteria for visual identification of soil samples are included in this appendix. Some variation can be expected between samples visually classified and samples classified in the laboratory.

Pocket Penetrometer Results

The values following "PP=" in the sampling data column of the log represent pocket penetrometer readings. Pocket penetrometer readings provide an estimate of the unconfined compressive strength of fine-grained soils.

Boring Locations and Elevations

The boring location was located using sub-meter GPS equipment. The approximate boring location is shown on Figure 2. The ground surface elevation at the boring location was obtained from the Suffolk GIS viewer and is indicated on the boring log. Locations and elevations should be considered no more accurate than the methods used to determine them.

GENERAL NOTES FOR SUBSURFACE EXPLORATION LOGS

1. Numbers in sampling data column next to Standard Penetration Test (SPT) symbols indicate blows required to drive a 2-inch O.D., 1⅜-inch I.D. sampling spoon 6 inches using a 140 pound hammer falling 30 inches. The Standard Penetration Test (SPT) N value is the number of blows required to drive the sampler 12 inches, after a 6 inch seating interval. The Standard Penetration Test is performed in general accordance with ASTM D1586.
2. Visual classification of soil is in accordance with terminology set forth in “Identification of Soil.” The ASTM D2487 group symbols (e.g., CL) shown in the classification column are based on visual observations.
3. Estimated water levels indicated on the logs are only estimates from available data and may vary with precipitation, porosity of the soil, site topography, and other factors.
4. Refusal at the surface of rock, boulder, or other obstruction is defined as an SPT resistance of 50 blows for 1 inch or less of penetration.
5. The logs and related information depict subsurface conditions only at the specific locations and at the particular time when drilled or excavated. Soil conditions at other locations may differ from conditions occurring at these locations. Also, the passage of time may result in a change in the subsurface soil and water level conditions at the subsurface exploration location.
6. The stratification lines represent the approximate boundary between soil and rock types as obtained from the subsurface exploration. Some variation may also be expected vertically between samples taken. The soil profile, water level observations and penetration resistances presented on these logs have been made with reasonable care and accuracy and must be considered only an approximate representation of subsurface conditions to be encountered at the particular location.
7. Key to symbols and abbreviations:

S-1, SPT	Sample No., Standard Penetration Test
5+10+10+10	Number of blows in each 6-inch increment

LL	Liquid Limit
MC	Moisture Content (percent)
PL	Plastic Limit
PP	Pocket Penetrometer Reading (tsf)
%Passing#200	Percent by weight passing a No. 200 Sieve

IDENTIFICATION OF SOIL

I. DEFINITION OF SOIL GROUP NAMES (ASTM D2487)

			SYMBOL	GROUP NAME
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels – More than 50% of coarse fraction retained on No. 4 sieve Coarse, ¾” to 3” Fine, No. 4 to ¾”	Clean Gravels Less than 5% fines	GW	WELL GRADED GRAVEL
			GP	POORLY GRADED GRAVEL
		Gravels with fines More than 12% fines	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	Sands – 50% or more of coarse Fraction passes No. 4 sieve Coarse, No. 10 to No. 4 Medium, No. 40 to No. 10 Fine, No. 200 to No. 40	Clean Sands Less than 5% fines	SW	WELL GRADED SAND
			SP	POORLY GRADED SAND
		Sands with fines More than 12% fines	SM	SILTY SAND
			SC	CLAYEY SAND
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays – Liquid Limit less than 50 Low to medium plasticity	Inorganic	CL	LEAN CLAY
			ML	SILT
		Organic	OL	ORGANIC CLAY
				ORGANIC SILT
	Silts and Clays – Liquid Limit 50 or more Medium to high plasticity	Inorganic	CH	FAT CLAY
			MH	ELASTIC SILT
		Organic	OH	ORGANIC CLAY
				ORGANIC SILT
Highly Organic Soils	Primarily organic matter, dark in color and organic odor		PT	PEAT

II. DEFINITION OF SOIL COMPONENT PROPORTIONS (ASTM D2487)

			Examples
Adjective Form	GRAVELLY SANDY	>30% to <50% coarse grained component in a fine-grained soil	GRAVELLY LEAN CLAY
	CLAYEY SILTY	>12% to <50% fine grained component in a coarse-grained soil	SILTY SAND
“With”	WITH GRAVEL WITH SAND	>15% to <30% coarse grained component in a fine-grained soil	FAT CLAY WITH GRAVEL
	WITH GRAVEL WITH SAND	>15% to <50% coarse grained component in a coarse-grained soil	POORLY GRADED GRAVEL WITH SAND
	WITH SILT WITH CLAY	>5% to <12% fine grained component in a coarse-grained soil	POORLY GRADED SAND WITH SILT

III. GLOSSARY OF MISCELLANEOUS TERMS

SYMBOLS .... Unified Soil Classification Symbols are shown above as group symbols. A dual symbol “-“ indicates the soil belongs to two groups. A borderline symbol “/” indicates the soil belongs to two possible groups.

FILL.. Man-made deposit containing soil, rock and often foreign matter.

PROBABLE FILL................... Soils which contain no visually detected foreign matter but which are suspect with regard to origin.

DISINTEGRATED ROCK (DR).. Residual materials with a standard penetration resistance (SPT) between 60 blows per foot and refusal. Refusal is defined as a SPT of 100 blows for 2” or less penetration.

PARTIALLY WEATHERED ROCK (PWR)......................... Residual materials with a standard penetration resistance (SPT) between 100 blows per foot and refusal. Refusal is defined as a SPT of 100 blows for 2” or less penetration.

BOULDERS & COBBLES..... Boulders are considered rounded pieces of rock larger than 12 inches, while cobbles range from 3 to 12 inch size.

LENSES................................. 0 to ½ inch seam within a material in a test pit.

LAYERS................................. ½ to 12 inch seam within a material in a test pit.

POCKET .... Discontinuous body within a material in a test pit.

MOISTURE CONDITIONS..... Wet, moist or dry to indicate visual appearance of specimen.

COLOR .... Overall color, with modifiers such as light to dark or variation in coloration.

Schnabel ENGINEERING TEST BORING LOG	Project: HRSD Wilroy Road Sites 1941 - 1949 Wilroy Road Suffolk, Virginia	Boring Number: **B-01 (North)** Contract Number: 22330066.000 Sheet: 1 of 2

Contractor: Fishburne Drilling, Inc.
Chesapeake, Virginia

Contractor Foreman: R. Hicks

Schnabel Representative: A. Overeem

Equipment: CME-45B (ATV)

Method: 2-15/16" O.D. Tri-cone Roller Bit

Hammer Type: Auto Hammer (140 lb)

Dates Started: 7/12/22 **Finished:** 7/12/22

X: 12053811 ft **Y:** 3445113 ft **By:** Handheld GPS

Coordinate System: VA State Plane (S)

Ground Surface Elevation: 20± (ft) **Total Depth:** 40.0 ft

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	7/12	---	6.0'	---	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
0.3	Topsoil; 4 inches		19.7			S-01, SPT 1+2+2+3 REC=18", 75%	PP = 3.25 tsf	TABB FORMATION
	SANDY LEAN CLAY; moist, brown Change: gray	CL		A1		S-02, SPT 2+4+8+7 REC=21", 88%	LL = 26 PL = 15 MC = 16.6% % Passing #200 = 57.0 PP = 1.50 tsf	
4.0	SILTY SAND, fine to medium grained sand; moist, light brown	SM	16.0		5	S-03, SPT 6+6+4+2 REC=11", 46%		
6.0	CLAYEY SAND, fine to medium grained sand; wet, light orangish brown	SC	14.0			S-04, SPT 1+WOH+1+WOH REC=24", 100%	MC = 38.7%	
8.0	SILTY SAND, fine to medium grained sand; wet, brown, contains shell fragments	SM	12.0	A2	10	S-05, SPT WOH/18"+1 REC=24", 100%		
12.0	SILTY SAND, fine to medium grained sand; wet, greenish gray, contains shell fragments and mica	SM	8.0	B2	15	S-06, SPT 2+2+2+2 REC=23", 96%	LL = 33 PL = 25 MC = 33.1% % Passing #200 = 24.6	YORKTOWN FORMATION
					20	S-07, SPT 3+2+2+3 REC=24", 100%		
						S-08, SPT 2+2+3+2 REC=24", 100%		

(continued)

Schnabel ENGINEERING	TEST BORING LOG	Project: HRSD Wilroy Road Sites 1941 - 1949 Wilroy Road Suffolk, Virginia	Boring Number: **B-01 (North)** Contract Number: 22330066.000 Sheet: 2 of 2

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	SILTY SAND, fine to medium grained sand; wet, greenish gray, contains shell fragments *(continued)*	SM		B2				YORKTOWN FORMATION
27.0	LEAN CLAY WITH SAND; wet, greenish gray, contains shell fragments	CL	-7.0	B1	30	S-09, SPT 3+2+3+2 REC=24", 100%	MC = 39.5% PP = 2.50 tsf	
					35	S-10, SPT 2+2+2+2 REC=24", 100%	PP = 2.50 tsf	
37.0	CLAYEY SAND, fine to medium grained sand; wet, greenish gray, contains shell fragments	SC	-17.0	B2		S-11, SPT 4+3+3+3 REC=24", 100%		
40.0			-20.0		40			

Bottom of Boring at 40.0 ft.
Boring terminated at selected depth.
Boring backfilled with cuttings and borehole plug upon completion.

APPENDIX B

SOIL LABORATORY TEST DATA

Summary of Laboratory Tests
Gradation Curves
Atterberg Limits

Summary Of Laboratory Tests

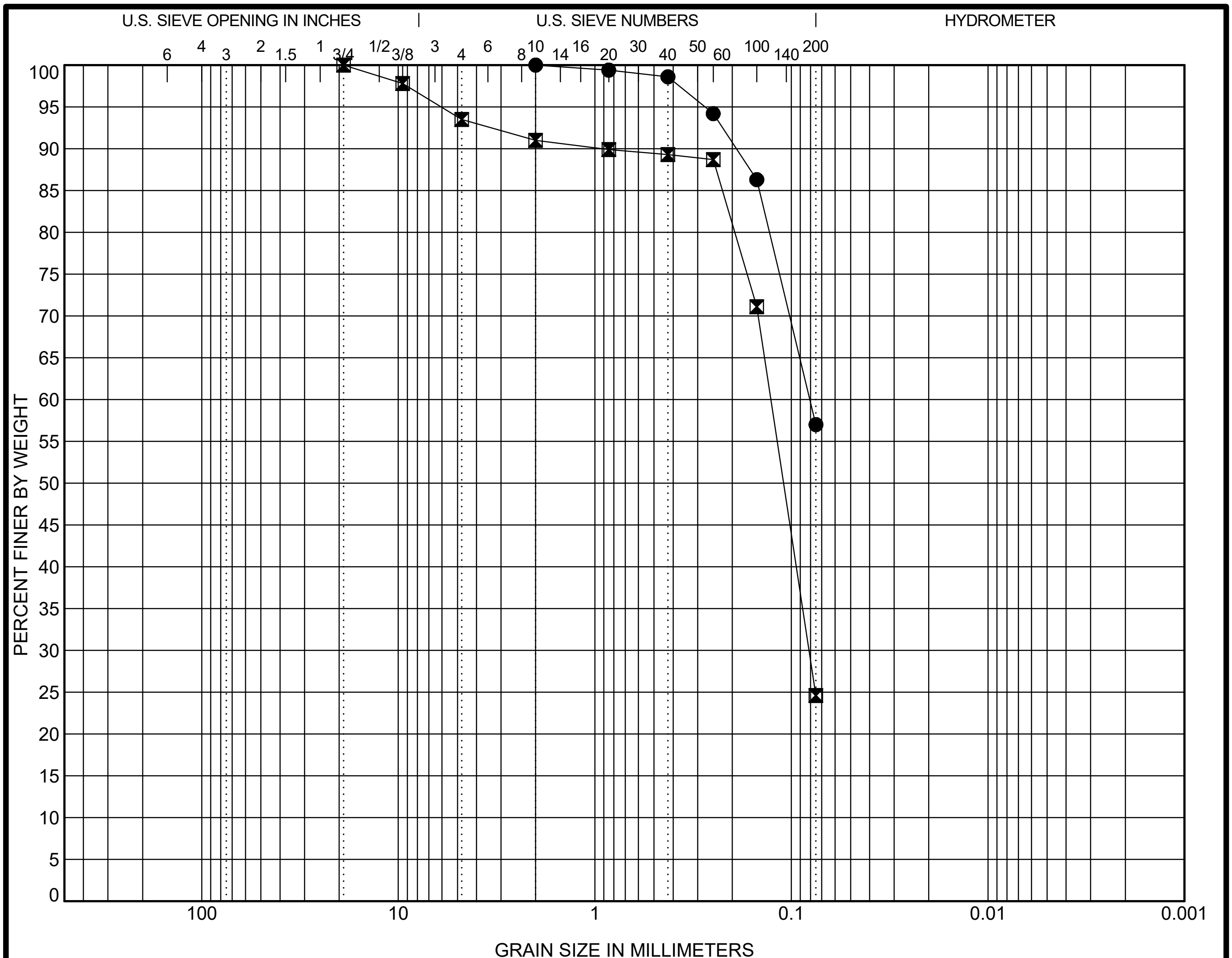
Appendix B
Sheet 1 of 1
Project Number: 22330066.000

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Testing Laboratory	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Passing No. 200 Sieve	% Passing No. 40 Sieve	% Retained No. 4 Sieve
B-01 (North)	2.0 - 4.0 / 18.0 - 16.0	Jar	SANDY LEAN CLAY (CL), gray	NN	A	16.6	26	15	11	57.0	98.6	--
B-01 (North)	13.0 - 15.0 / 7.0 - 5.0	Jar	SILTY SAND (SM) fine to medium grained sand, contains shell fragments and mica, greenish gray	NN	B	33.1	33	25	8	24.6	89.3	6.5

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed

Schnabel ENGINEERING

Project: HRSD Wilroy Road Sites
1941 - 1949 Wilroy Road
Suffolk, VA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI		
●	**B-01 (North)**	**2.0 ft**	**SANDY LEAN CLAY (CL), gray**	**26**	**15**	**11**		
⧗	**B-01 (North)**	**13.0 ft**	**SILTY SAND (SM) fine to medium grained sand, contains shell fragments and mica, greenish gray**	**33**	**25**	**8**		

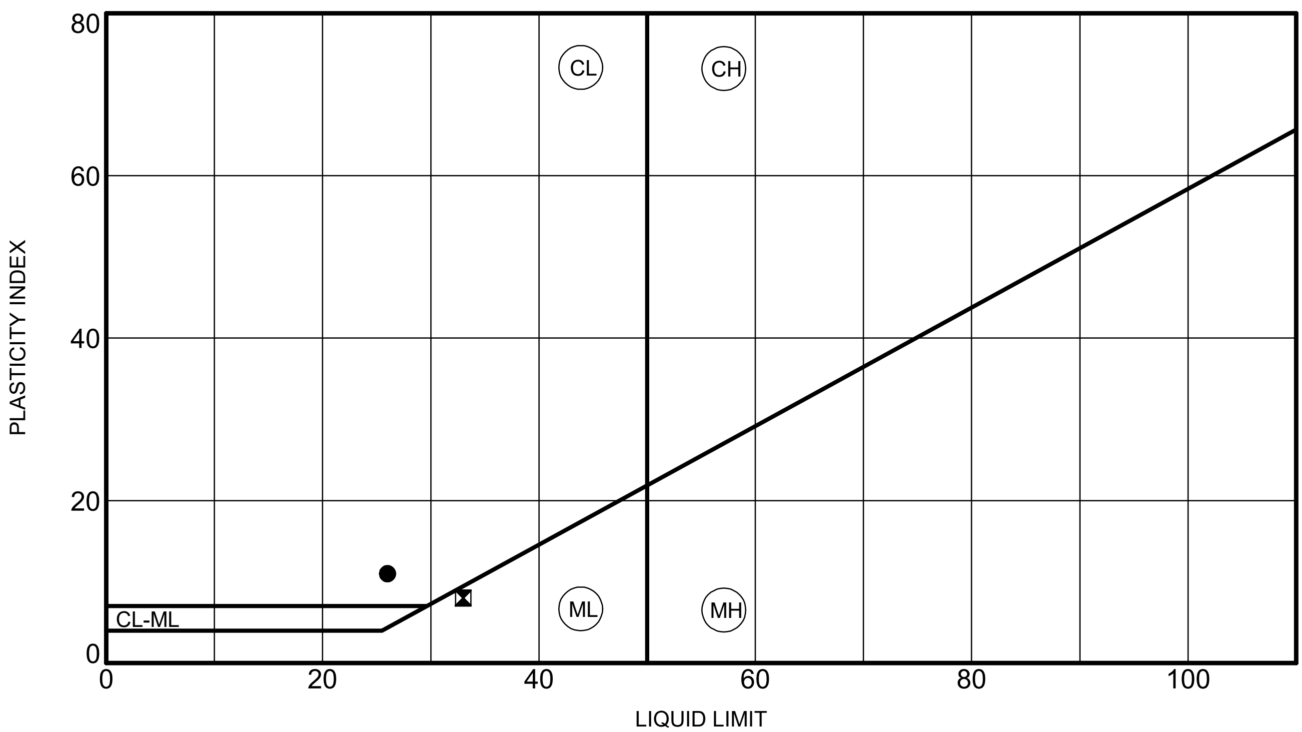
	Specimen		Test Method	Testing Lab	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-01 (North)**	**2.0 ft**	**ASTM D422**	**NN**	**2**	**0.08**	**--**	**--**	**0.0**	**43.0**	**57.0**	
⧗	**B-01 (North)**	**13.0 ft**	**ASTM D422**	**NN**	**19**	**0.13**	**0.08**	**--**	**6.5**	**68.9**	**24.6**	

Schnabel ENGINEERING

GRADATION CURVES

Project: HRSD Wilroy Road Sites
1941 - 1949 Wilroy Road
Suffolk, VA

Contract: 22330066.000



PLOTTED DATA REPRESENTS SOIL PASSING NO. 40 SIEVE

	Specimen		LL	PL	PI	Fines	Testing Lab	Description
●	**B-01 (North)**	**2.0 ft**	**26**	**15**	**11**	**57**	**NN**	**SANDY LEAN CLAY (CL), gray**
⧗	**B-01 (North)**	**13.0 ft**	**33**	**25**	**8**	**25**	**NN**	**SILTY SAND (SM) fine to medium grained sand, contains shell fragments and mica, greenish gray**

ATTERBERG LIMITS

Project: HRSD Wilroy Road Sites
1941 - 1949 Wilroy Road
Suffolk, VA

Contract: 22330066.000

Appendix B: HART Report

TO: Director of Engineering

FROM: HCS

DATE: March 28, 2022

SUBJECT: Hydraulic Analysis for Wilroy PRS and Offline Storage Tank Facilities (CIP NP014000)

EXECUTIVE SUMMARY

This technical memorandum summarizes the hydraulic analysis results for the Wilroy Pressure Reducing Station (PRS) and Offline Storage Facility (OLSF) CIP project NP014000. The objective of this analysis is to re-evaluate the initial design parameters introduced in the RWWMP and subsequently in the HRSD's Integrated Plan High Priority Projects Round I (NP-HPP-1) program and confirm their validity based on the latest and best information available.

The purpose of constructing these facilities is to provide pressure relief and increase system capacity during wet weather events.

Recommendations:

Following the completion of this hydraulic analysis, the following design parameters for Wilroy PRS and OLSF facilities are recommended:

1. Design parameters:

Wilroy PRS:	
Pumps Flow Range (gpm):	4,000 - 7,000
Min. – Max. Pressure Relief (TDH):	40 - 80 ft
Suction Set Point (ft):	30
OLSF Storage Volume (gal):	3 MG

2. Design Considerations:
The design of Wilroy PRS should provide provisions for potential future pump upgrades to meet future development activity trends in the western part of the City of Suffolk.

3. Location of Improvements:
Based on the two locations considered for this analysis, Alternative 1 (Alt. 1) and Alternative 2 (Alt. 2), it is recommended that a property for the improvements should be selected in proximity to Alt. 2 location. Alt. 2 location offers the following potential benefits over Alt. 1:

i. Maximum hydraulic relief in the upstream parts of the interceptor system along Carolina Road and Holland Road corridors thus providing additional system capacity to accommodate future growth. Maximizing system capacity, it will result in minimizing and/or delaying the need for future system improvements.

ii. Potential construction cost savings in:

- OLSF configuration and elevations
- Smaller pumps/motor hp requirements
- Reduced power service/demand

iii. Maximum OLSF utilization

4. <u>Windsor Line:</u>
The site for the proposed improvements must be selected so that the Windsor Line (SF-214) will remain on the suction side of the proposed Wilroy PRS and upstream from the OLSF.

Figure 1. Location of both alternatives, Alt. 1, and Alt. 2

SECTION A: BACKGROUND & PURPOSE

The proposed Wilroy PRS and OLSF infrastructure improvements were first identified in the RWWMP solution set submitted to EPA in 2014 as part of the Regional Consent Decree (CD). In 2017, HRSD submitted to EPA through amendments of the CD, an Integrated Plan (IP) with a list of high priority projects (HPP) including SWIFT. Since then, EPA has encouraged the use of adaptive management approaches featuring iterative decision making to manage and address municipal environmental challenges and public health issues. As such, HRSD developed the Adaptive Regional Plan (ARP) which consists of four (4) phases of projects and initiatives. The facility improvements under consideration were included in Phase 2b of ARP with a target date of completion no later than 2030.

The Wilroy PRS and OLSF as defined in the IP were evaluated using the Regional Hydraulic Model (RHM) with a 5-year peak flow recurrence event as an input flow to the model. Based on that evaluation, the following design parameters were identified and included in the IP ARP:

<u>Wilroy PRS:</u>

Flow: 8,300 gpm

Maximum Relief (TDH) for pumps: 80 ft

<u>OLSF size:</u> 2.9 MG

The main objective for the construction of these facilities is to eliminate SSO events during wet weather conditions. Figure 2 illustrates overflow events as reported by the City of Suffolk and HRSD between 2009 and 2022.

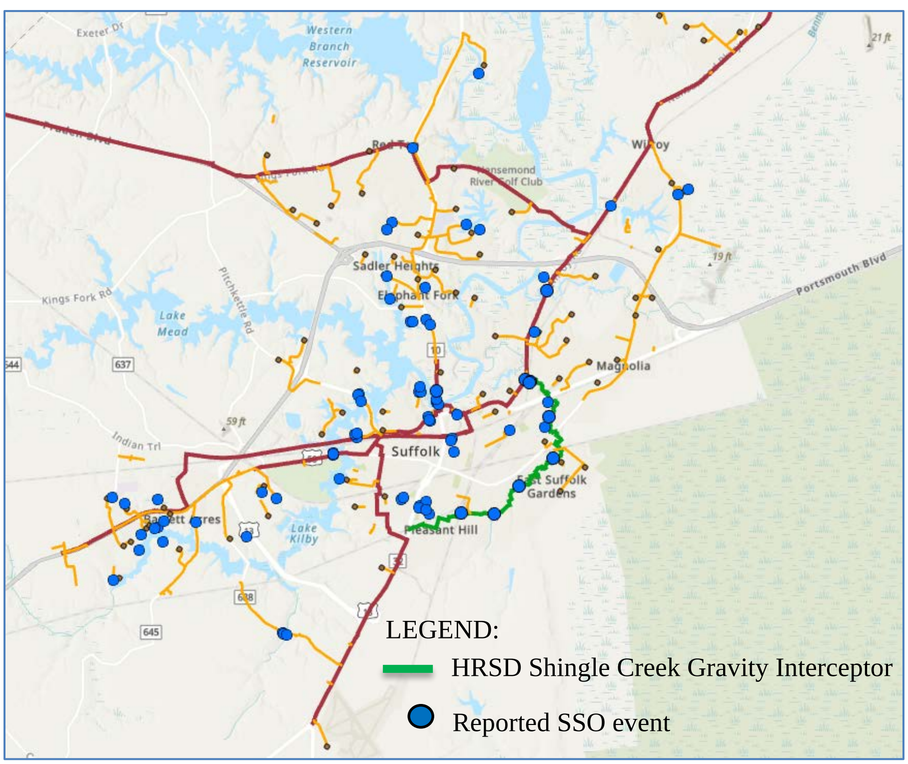


Figure 2: Reported SSOs by the City of Suffolk & HRSD (2009-2022)

Currently, the only PRS operated by HRSD to provide relief for the metro area of the City of Suffolk is Pughsville PRS (PRS #134). This facility is located just south of the Bob White Lane and Shoulders Hill Road intersection. In light of the development trends in recent years and potential for growth, in the western parts of City of Suffolk, this PRS no longer provides pressure relief for the city.

Since 2009, approximately 196 capacity weather related overflows events were reported by the City of Suffolk representing approximately 33 distinct locations within the City's sanitary sewer system. Reported estimated total volume of water spilled during those events was approximately 3.0 MG. Also, HRSD reported approximately 6 SSO events since 2009 with an estimated total volume of 0.6 MG and all of them occurred around the Shingle Creek (SG-191,192,193) gravity interceptor or at the receiving station, HRSD Suffolk PS #135.

It is important to note that the City has an on-going pump station rehabilitation/upgrades CIP program to address the capacity related overflows. Since 2016 the city has completed numerous pump station projects with various degree of improvements. Several pump stations were replaced with new ones, others were retrofitted with new pumps to meet current system pressures, and others were converted from terminal pump stations to lift stations. Hence, the frequency and severity of SSO events today may be less impactful and scarce.

Equally, HRSD is addressing the capacity related overflows associated with PS #135 under CIP NP010620 by replacing the Suffolk PS with two new terminal pump stations with a manifold force main connecting to the existing FM interceptor SF-189 at or near the intersection of Wilroy Road and East Constance Road. In addition to the pump station replacement, approximately 7,000 LF of the Shingle Creek interceptor will be abandoned and/or replaced to divert the flow to the two new stations. The flow contribution from the two new pump stations will be approximately 40% of the total average daily flow conveyed to Wilroy PRS and OLSF.

SECTION B: HYDRAULIC MODELING

1. Model Files

The following Mike Urban (MU) model files were used for this analysis:

SS_RHM_Build_20161031.mdb

SS_RHM_Build_20161031.mup

2. SWMM Output Files

The following SWMM output files were used for this analysis as input flow parameters files to MU model:

2-Year Event (2YR):

Time-varying groundwater and RDII SWMM flow time series input file for the base network scenario was used to generate an output file with a 2-year peak hour recurrence event with a synthetic 4-hour hyetograph. Flow input is based on existing basins using pre-rehab flow parameters with a rainfall intensity corresponding to a Spatial Distribution Factor (SDF) of 0.8. The resulting output file from SWMM was used as an input file to MU for this analysis.

SS_RHM_EXIST_PRE-R_RDII_TVGW_2YR_SDF80_20161023.CRF

5-Year Event (5YR):

One time-varying groundwater and RDII SWMM flow time series input files for the base network with a synthetic 4-hour hyetograph and 5-year peak hour recurrence event flows was used. The event represents existing catchments with pre-rehab flow parameters, and it is loaded with a rainfall intensity corresponding to a Spatial Distribution Factor (SDF) of 0.8.

SS_RHM_EXIST_PRE-R_RDII_TVGW_5YR_SDF80_20161023.CRF

In addition to the above MU input files, an additional parameter was included as an input to the model to account for sediment depth in the interceptor network:

SS_Sediment_UpdatedRHM_20161025.ADP

3. Model Network Setup

The following four model network configurations were used to complete this analysis:

a. Existing Network: This network consists of all existing infrastructure currently servicing the City of Suffolk and its environs. The HRSD Suffolk PS (PS #135) is in service. Three Godwin 12-inch bypass pumps were added to the infrastructure that were not included in the original model files: The first was added at the HRSD-PS-135, and the other two at two city pump stations, PS-004 and PS-048 based on feedback HRSD received from city staff.

Also, the catchments for PS-021 and PS-022 were revised to divert the flow away from the HRSD Shingle Creek gravity interceptor (SG-193). Based on 2018 model submittals by the City of Suffolk, PS-022 is now a terminal pump station with a direct connection to HRSD SF-265 interceptor. PS-021 service area flow is diverted to PS-022 gravity collection system.

Finally, the City of Suffolk infrastructure, i.e., terminal pump stations, pump curves, and force main network included in the MU model reflects the 2016 infrastructure as submitted then by the city to the RHM development team. Hence, subsequent improvements and/or upgrades to the City's system other than the ones described above were not incorporated to this base network nor were they incorporated in the following three model networks described below.

b. Suffolk PS Replacement Network: Under this network, the Suffolk PS (HRSD-PS-135) is removed from the network and replaced with two new pump station facilities, namely, PS-159 and PS-160 in accordance with the latest design submittals under CIP NP010620. Pursuant to the proposed improvements included in the design, sections of the existing Shingle Creek gravity interceptor were removed from the network. In addition, some sections of the HRSD gravity interceptor were replaced with 24" pipe diameter just upstream from PS-160. Both stations are at near 100% design. It is possible some minor design changes may occur prior to final approval of the conformed plans. However, these changes will not impact the overall outcome of this analysis.

Also, it is anticipated that the improvements under NP010620 would be completed ahead of those proposed under NP014000 by approximately two years.

c. Alt. 1 HPP Network: Under this model network setup, the PRS and OLSF facilities were added in the network at Alt. 1 location as shown in Figure 1 above.

d. Alt. 2 HPP Network: Under this model network setup, the PRS and OLSF facilities were added in the network at Alt. 2 location and as shown in Figure 1 above.

4. Wilroy PRS Setup

The PRS facility was set-up to run with 3 pumps during the simulated wet weather event. After some trial and error, the settings for the 3 pumps were set to operate as follows:

Pump START: Discharge HGL > 70 ft

Pump suction set point: 30 ft

The maximum and minimum speed (VFD) pump curves used for the 3 pumps were borrowed from Kempsville PRS; however, they were reduced to match simulated pressures and flow regimes at the proposed site of Wilroy PRS. The pump curves are hypothetical and actual pumps and pump curves will be determined during the design phase. However, the curves used for this analysis were adequate in establishing the hydraulic grade line on the suction side of the PRS while providing a minimum relief (TDH) of 70 feet and maintaining the suction set point at 30 ft. The pump curves used for this analysis can be found in Appendix A.

5. OLSF Setup

For this analysis, the storage tank was configured as a cylinder with a constant cross-sectional area and a height of 30 feet with a total volume of 3.0M gallons. The bottom elevation was set at 0.0 ft with a rim elevation at 30 ft. The connection point elevation for the drainpipe to the tank for Alt. 1 and Alt. 2 is 16.69' and 11.32' respectively with a total length of 60 ft and a pipe diameter of 30 inches for both alternatives. The actual configuration of the tank and critical elevations will be determined during the design phase.

The control valve (CV) regulating the flow diverted to the tank was setup under the following operating conditions:

OPEN CV:	Pump Discharge HGL > 100 ft and 3 pumps are running.
HOLD CV OPEN:	Pump Discharge HGL > 65 ft
CLOSE CV:	Pump Discharge HGL < 65 ft

6. Site Alternatives for Improvements

Under this analysis, two sites were considered for locating the proposed Wilroy PRS and OLSF and are identified in Figure 1 above:

a. Alt. 1: This location is at the vicinity of the Nansemond Parkway and Upton Lane intersection. During the development of the RWWMP (Integrated Plan - IP), this site was used as a potential location of the Improvements. Hence, all hydraulic analyses conducted up to this point had these improvements at this location in the model network.

b. Alt. 2: In addition to Alt. 1, a second location was considered in the analysis to investigate the hydraulic benefits of having the facilities located closer to the historical town center of Suffolk. This location in the model network is immediately downstream from the convergence of the Windsor Line (SF-214) and Wilroy Road Line (SF-190); therefore, it keeps the Windsor Line on the suction side of Wilroy PRS. This site is approximately 11,000 LF upstream of Alt.1 location.

   To do a comparison analysis between the two locations in the model network and to better demonstrate the benefits of one location over the other, identical HPP improvements were configured at each location with the same pump settings and conditions in operating the OLSF.

7. Hydraulic Model Simulations

A total of eight (8) hydraulic simulations were run to complete this analysis. Table 1 below lists all the simulations with their corresponding SWMM input files and model network setup described in Section B of the report. The purpose for each simulation is discussed below.

Sim #	SWMM Input File	Model Network Setup
Sim1	SS_RHM_EXIST_PRE-R_RDII_TVGW_2YR_SDF80_20161023.CRF	Existing Net
Sim1a	SS_RHM_EXIST_PRE-R_RDII_TVGW_5YR_SDF80_20161023.CRF	Existing Net
Sim2	SS_RHM_EXIST_PRE-R_RDII_TVGW_2YR_SDF80_20161023.CRF	Suffolk PS Improvements Net
Sim3	SS_RHM_EXIST_PRE-R_RDII_TVGW_2YR_SDF80_20161023.CRF	Alt. 1: HPP Net
Sim4	SS_RHM_EXIST_PRE-R_RDII_TVGW_5YR_SDF80_20161023.CRF	Alt. 1: HPP Net
Sim5	SS_RHM_EXIST_PRE-R_RDII_TVGW_2YR_SDF80_20161023.CRF	Alt. 2: HPP Net (Revised)
Sim6	SS_RHM_EXIST_PRE-R_RDII_TVGW_2YR_SDF80_20161023.CRF	Alt. 2: HPP Net
Sim7	SS_RHM_EXIST_PRE-R_RDII_TVGW_5YR_SDF80_20161023.CRF	Alt. 2: HPP Net

Table 1: List of Hydraulic Model Simulations

Sim1: The results from this simulation establish existing system performance during the design storm event. Also, they provide a point of reference (base) by which the Wilroy PRS and OLSF overall performance and effectiveness is measured to justify the need for these facilities.

Sim1a: This simulation was conducted to mainly compare model flow rates vs metered flow rates reported in Telog at three monitoring sites during an actual storm event that occurred on July 20, 2012. This event is comparable to the design storm used in the model.

Sim2: The results from this simulation provide an additional reference point that describes system performance during the interim period (approx. 2 years) when the PRS and OLSF facilities are being constructed.

Sim3 and Sim4:
The results from these two simulations will be compared against the results generated from simulations Sim6 and Sim7 to assess the hydraulic benefits derived from Alt.1 over Alt.2 locations pertinent to the Wilroy PRS and OLSF improvements.

Sim5: The results from this simulation are for illustration purpose only and to highlight how it impacts Wilroy PRS performance without the assistance of OLSF. As such, the results from this simulation should not be considered as a design condition during the PRS pump selection process.

Sim6 and Sim7:
The results from these two simulations will be compared against those from Sim3 and Sim4 simulations to assess the hydraulic benefits derived from Alt. 2 over Alt.1 locations pertinent to the Wilroy PRS and OLSF improvements.

8. Hydraulic Model Results

Table 2 below summarize the results generated from the simulations described under Section B.7 of this report.

Provided that the configuration and settings for the operation of Wilroy PRS and OLSF were identical at both locations in the network, a direct comparison of the hydraulic results between the two alternate sites can be made. From the results in Table 1 below, Alt. 2 location offers an optimum hydraulic solution in comparison to Alt. 1 location. The discussion below highlights these advantages as observed in the model.

Storage Volumes:
A comparison between Alt. 1 and Alt. 2 simulations, Sim6 and Sim7 produce approximately 12% - 16% more volume of water in the OLSF than under simulations Sim3 and Sim4.

SSO Volumes:
Results from Sim6 and Sim7 simulations show approximately 50% reduction in overflow volume than under Sim3 and Sim4 simulated overflow volumes.

Wilroy PRS Performance:

With the hypothetical pumps provided in the model, the Wilroy PRS provided almost the same relief across the board with all simulations at both alternative locations when the OLSF is in use. With 3 pumps set to run during the event, the pumps provide 70 ft relief under Sim3 and Sim4 simulations and 74 ft under Sim6 and Sim7 simulations. The PRS was able to maintain the suction set point at 30 ft in all four simulations.
A closer examination in the PRS performance, one notable difference between Alt.1 simulations (Sim3 & Sim4) and Alt. 2 simulations (Sim6 & Sim7) is in the maximum rate passing thru all three pumps. Under Sim6 and Sim7, the total maximum rate is approximately 12 – 15% less than under Sim3 and Sim4 simulations. This is directly related to the rate diverted to OLSF. Indeed, the model results show the maximum diversion rate to the OLSF under Sim6 and Sim7 is 5% and 15% respectively higher under Alt. 2 simulations Sim3 and Sim4.

Finally, under Sim5 simulation, when Wilroy PRS is running without OLSF assistance, the pumps are not able to maintain the suction set point at 30 ft. From Table 1 results, although the pumps provide 58 ft maximum relief, the HGL on the suction side of the pumps is at 120 ft. This outcome is not desirable as the system pressures upstream in the system are approximately 40-ft higher when compared to Sim6 HGL.

Upstream Flow Rates:

One other parameter to compare between the two alternative locations is the maximum rate during the event that is conveyed from upstream to the OLSF and PRS facilities. Under Alt. 2, the maximum flow rate is approximately 8-9% greater than the rate under Alt. 1. What this means as it was stated in the discussion under “Storage Volumes” above, more water is moving through the interceptor system in lieu of being stored in the city’s collection system.

System Hydraulic Grade Lines (HGL):

Another way to compare the results between Alt. 1 and Alt.2 alternatives are the hydraulic grade line time series produced under each simulation.

A comparison of the simulations between the two locations with identical SWMM input file to the hydraulic model are presented in Appendix B side-by-side for easy comparison. A time step during the peak hour of the design event simulations was selected to plot the HGL profiles illustrating the maximum difference in pressure relief between the two alternatives. All HGL profiles were generated representing the interceptor system from the end-of-line at Holland Road to the Nansemond treatment plant.

A. *Sim1 vs Sim2 HGL Comparison*:

The HGL time series plots produced between these two simulations are almost identical with approximately 5-10 ft difference between them at the very upstream end of the interceptor system. This is expected as under Sim2 the existing Suffolk PS is replaced with two new terminal pump stations. The pumps in both stations are proposed as variable frequency drives (VFDs); hence, their operation can be adjusted to ensure they are running as such that they don't lock-out upstream city pump stations during inclement weather conditions and until Wilroy PRS and OLSF are fully operational.

Finally, this graph provides the benchmark by which system performance is compared to the other 2 sets of HGL profiles (Sim3 vs Sim6 and Sim4 vs Sim7) highlighting the value and impact of the proposed Wilroy PRS and OLSF will have in the overall system performance.

B. *Sim3 vs Sim6 HGL Comparison:*

Between the two simulations, Sim6 simulation produces a maximum of 30 feet reduction in system pressures over Sim3 during the peak hour of the event. The additional 30 feet in HGL reduction at the very end of the system should be viewed as additional available capacity in the HRSD interceptor system. Hence, it will allow the system to provide the design level of service and continue to perform within the HRSD HGL Policy for much more years without the need for additional improvements in the near future.

C. *Sim4 vs Sim7 HGL Comparison:*

Similarly to the discussion in section 8.B above, Sim7 simulation produces a maximum of 20 ft reduction in system pressures over Sim4 during the peak hour of the event.

E. *Sim5 vs Sim6 HGL Comparison*:

This graph is for illustration purposes only and not to be considered as a design condition for the Wilroy PRS. It is assumed that the OLSF will always be available to assist the PRS when it is needed. Under Sim5 simulation, the OLSF is not activated during the simulation event; hence, Wilroy PRS performance is downgraded. The pumps are not keeping with the suction set point set at 30 feet. Therefore, the poor performance of the PRs results in two outcomes:

i. The total simulated SSO volume (300,031 gal) under Sim5 is approximately 7.24 times greater when compared to the SSO volume under Sim6 (36,412 gal).

ii. System pressure (HGL) under Sim5 is approximately 43 feet higher during the peak hour event than under sim6 HGL at the upstream parts of the interceptor system.

	Existing Network		Suffolk PS Replacement Network	Alt. 1: HPP Network		Alt. 2: HPP Network (OLSF OFF)	Alt. 2: HPP Network	
Quantified Parameters	**Sim1**	**Sim1a**	**Sim2**	**Sim3**	**Sim4**	**Sim5**	**Sim6**	**Sim7**
OLSF								
Stored Volume (gal):	NA	NA	NA	1,223,236	1,649,801	NA	1,420,225	1,905,100
OLSF Utilization (%):	NA	NA	NA	41	55		47	64
Filling Time (min):	NA	NA	NA	288	344	NA	316	360
Avg. Fill Rate (gpm):	NA	NA	NA	4,082	4,640	NA	4,274	5,321
Max. Rate (gpm):	NA	NA	NA	6,870	8,055	NA	9,173	10,590
Wilroy PRS								
Min. Suction HGL (ft):	NA	NA	NA	30	30	118	30	30
Max. Discharge HGL (ft):	NA	NA	NA	100	100	177	103	104
Max. Relief _TDH (ft):	NA	NA	NA	70	70	59	73	74
Max. Rate thru pumps during storing (gpm):	NA	NA	NA	7,668	7,805	10,081	6,741	6,624
Max. Rate thru pumps post storage (gpm):	NA	NA	NA	7,808	7,807	NA	7,133	7,016
Simulated Overflows (SSO)								
Number of events:	16	20	11	4	8	8	2	6
Total Volume (gal):	430,415	906,602	458,270	71,885	285,998	300,031	36,412	147,584
Aggregate Upstream Flow Rate:								
DW Max (gal):	2,740	2,740	3,143	3,683	3,752	3,143	3,684	3,908
WW Max (gal):	8,018	7,931	8,273	13,370	14,302	10,081	14,639	15,462

Table 2: Hydraulic Model Results Summary

Notes:

1. Aggregate upstream flow rate represents total flow conveyed to Wilroy PRS and OLSF site

SECTION C: Metered vs. Modeled Flow Comparison Analysis

To confirm the validity of the mode results and to have confidence in the design of the facilities with adequate and conservative design parameters, a flow comparison analysis between Sim1a simulation flows and metered flows (Telog) was conducted and it is discussed below. Three monitoring sites were considered for this analysis which were deemed pertinent to this study:

i. <u>MMPS #197 - East Constance:</u> This meter captures all the flow conveyed from three major corridors: Holland Rd, Carolina Rd, and N. Main Street.
ii. <u>MMPS #174 - Suffolk PS:</u> This meter includes all the flow generated from the Shingle Creek gravity interceptor (SG191-193) service area.
iii. <u>MMPS #164 - Pughsville PRS:</u> This meter captures all the flow upstream from this PRS location, which includes the flow registered at the two meters described above.

A map identifying the 3 sites is included in Appendix C. The first two are located upstream from the proposed PRS and OLSF improvements, while the third site is located downstream at the Pughsville PRS facility.

1. <u>Model Design Storms</u>

The model design storms used for this analysis are a 2-YR and 5-YR peak hour recurrence events described in Section B.2 in the report. Both events have a duration of 4 hours producing a rainfall of 2.95" and 3.61" respectively with a special distribution factor (SDF) equal to 1.0. For this analysis, the SDF factor applied throughout the entire Nansemond TP service area is 0.80, which is consistent with how the current HGL Policy was developed. Table 3 summarizes the design storm parameters.

	Rainfall (in)	
SDF	**2-Year**	**5-Year**
SDF 1.0	2.95	3.61
SDF 0.8	2.36	2.89
Duration (hrs)	4	4

Table 3: Model Design Storms

The storm event in all simulations occurs on the forth day in the simulation time preceded by 3 days of dry weather flow conditions.

2. <u>Dry Weather Analysis</u>

Table 4 summarizes the dry weather maximum hourly flows between metered and modeled flows at the three monitoring site locations. The values for the metered flow were obtained by a visual inspection of one year (2021) of data as reported in the Telogers Enterprise Client during dry periods with consistent diurnal flow patterns.

The modeled dry weather flows were obtained from Sim1a simulation at the exact same locations where the monitoring sites are located.

Meter Location	Metered Flow (gpm)	Model Flow (gpm)
	Avg. DW Max	DW Max. Hour Avg.
East Constance Rd	1,500	1,536
Suffolk PS	900	2,142
Pughsville PRS	3,700	3,375

Table 4: Dry Weather Max Flow (Metered vs Model)

Representative dry weather plots reported in Telog at the three monitoring sites are shown in Appendix D.

3. Wet Weather Analysis

For the wet weather flow comparison analysis, the Suffolk PS rain gauge monitoring site was used to identify storm events like the events used in the hydraulic model.

Based on Post Storm Analysis Synopsis reports prepared by the Data Analysis Section from 2009 to 2022, Table 5 lists ten (10) wet weather events recorded at the Suffolk PS rain gauge monitoring facility. These events produced significant amount of rainfall, albeit with different intensities and durations. Only one event which occurred on July 20, 2012, is comparable with the model 5-YR design storm. This event produced 3.26" of rain within a 6-hour period. Hence, Sim1a simulation flows were used for this comparison analysis. Under this simulation, the Wilroy PRS and OLSF are not included in the network and the model is loaded with the 5YR design storm.

The metered peak hour maximum rates and pressures recorded at the three monitoring sites are also included in the table.

				E. Constance MMPS #197		Suffolk PS MMPS #174		Pughsville PRS MMPS # 164	
Event Date	Event RRII	Rainfall (in)	Duration (hrs)	Max. Rate (gpm)	Pressure (ft)	Max. Rate (gpm)	Pressure (ft)	Max. Rate (gpm)	Pressure (ft)
9/7/2009	5 YR	5.8	36	NA	NA	3,200	NA	6,900	41
7/20/2012	5 YR	3.26	6.5	4,100	93	2,800	116	7,500	16
10/9/2013	2-5 YR	4.79	72	3,600	99	4,100	122	6,900	12
7/24/2014	5-10 YR	4.52	21	4,070	115	3,200	138	8,300	16
8/12/2017	2 YR	2.31	12	3,700	99	3,000	125	6,200	9
9/18/2020	5 YR	4.44	12	5,900	116	3,000	133	11,800	10
2/18/2021	NA	1.89	36	5,200	116	2,750	138	8,100	57
8/1/2021	1-2 YR	1.75	28	4,880	127	2,600	145	9,700	21
1/3/2022	1-5 YR	2.13	24	3,500	99	2,600	116	7,600	14
1/16/2022	1 YR	1.76	9	4,422	120	2,500	139	9,000	40

Table 5: Storm events recorded at the Suffolk PS rain gauge site

Table 6 below compares the maximum rates and pressures between the 7/20/2012 storm event and Sim1a simulation results at the three monitoring sites.

Meter Location	Metered Flow and Pressures		Sim1a Flow and Pressures		Model Elevations (ft)
	Peak Hour Max. Rate (gpm)	Max. Hour Pressure (ft)	Peak Hour Max. Rate (gpm)	Peak Hour Pressure (ft)	
East Constance Rd	4,100	93	4,593	133	21.8
Suffolk PS	2,800	116	2,666	144	6.19
Pughsville PRS	7,500	16	9,197	43	15.69

Table 6: 7/20/2012 event vs. Sim1a Simulation data

During the 2012 storm, the City of Suffolk reported two SSO events with an estimated total volume of 36,000 gal, whereas the model predicts 15 SSO events with a total volume of 873,872. Hence, a direct comparison between the 2012 observed flows and model flows cannot be easily made given the disparity in the number of SSOs and volumes reported by both methods. It is reasonable to assume the flows in the hydraulic model are more conservative than may first appear from the table above.

SECTION D: Special Design Considerations:

During the design phase of the improvements and site selection evaluation, the following considerations should be considered:

1. Sea Level Rise and Infrastructure Resiliency

   Currently HRSD is undertaking a study to evaluate the impacts of climate change. With the improvements' proximity to the Nansemond River basin and its tidal influence, sea level rise and the potential for flooding must be considered during design. Until detailed guidance has been incorporated into the HRSD Standards, HRSD Planning and Analysis (P&A) Section can be reached for additional guidance. Additionally, the Mitigation Concepts Summary Report can be made available as a reference to clarify what flood water pathways could be at the selected site of the improvements and how to mitigate them. A copy of the report can be made available.

2. Selected City Terminal Pump Stations Analysis

   As part of this hydraulic analysis, four city terminal pump stations were evaluated further because of their proximity to the proposed HPP improvements. Contingent upon final selection of the site for the improvements, their respective connection points to the HRSD interceptor system may end-up being either upstream (Sim3) or downstream (Sim6) from the Wilroy PRS

   The four city pump stations of concern are shown on a map in Appendix F and are listed below:

   SUFF-PS-031, SUFF-PS-014, SUFF-PS-67, and SUFF-PS-111.

   The results from three simulations were considered: Sim1, Sim3, and Sim6. Sim1 results represent how the existing HRSD interceptor network potentially may perform under the model 2YR design storm. Under Sim3, all four city pump stations will be upstream from the proposed Wilroy PRS, whereas under Sim6, they will be downstream.

The pump curves in all four pump stations in the hydraulic model were provided by the city in 2016. The model results show that under Sim1, all four pump stations are marginal and surcharging at various degrees. The only exception is SUFF-PS-131, which based on the model results is spilling. Under Sim6, all four pump stations performed marginally better with no simulated overflows observed. Under Sim3, pump performance in all four pump stations is improved and the pumps are keeping with incoming flow. Table 7 below lists the maximum HGL at the intersection of Nansemond Pkwy and Wilroy Road.

Sim#	HGL (ft)
Sim1	120
Sim6	95
Sim3	43

Table 7: HGL values at the Nansemond Pkwy and Wilroy PRS intersection

Further investigation to recent submittals by the city and communications with city staff confirmed that at least three of the four pump stations setup in the hydraulic model is not accurate. The discussion below explains why these discrepancies exist.

<u>SUFF-PS-014:</u> This pump station was converted in 2019 from a terminal pump station to a lift station with an outfall to a gravity manhole that is part of SUFF-PS-159 collection system. The pumps in this station have a shut-off head at 170 ft.

<u>SUFF-PS-111</u> received new impellers in 2021 with a new shut-off head point at 124 ft. Of the three city pump stations along Nansemond Pkwy, this station is the furthest downstream and closer to the HRSD connection point.

<u>SUFF-PS-067</u> is being replaced with a new pump station and it is currently under construction. The new pump station is outfitted with high head flygt pumps and with a shut-off head of 135 ft. Similarly, this station

<u>SUFF-PS-031</u>: Based on city's submittals and communications with staff, there has been no upgrades/modifications associated with this pump station; hence, the pumps in the model are assumed to be accurate with a shut-off head at 115 ft.

Based on the findings above, all four pump stations will be running closer to their design point under Alt. 2 condition (Sim6) than under Alt. 1 condition (Sim3).

SECTION E: Conclusions

Based on the hydraulic modeling analysis and results presented in Table 1 above, the following conclusions are summarized below:

A. With the assistance of both Wilroy PRS and OLSF the likelihood of SSO events within the service area is diminished according to the model by at least six fold under Sim3 (Alt.1) and by twelve fold under Sim6 (Alt.2) in comparison to Sim1 simulated overflows.

B. The proposed Wilroy PRS and OLSF when operating in tandem will provide much needed relief pressure in the interceptor system (45ft – 60ft) during inclement weather conditions. This is illustrated in the hydraulic grade line plots provided in Appendix B.

C. Under Sim5 simulation with the OLSF not called to assist, the PRS pumps selected for this analysis could not maintain the suction set point at 30 ft (HGL). As a result, the simulated number of SSO events and total volume increased dramatically. A closer look between Sim1 and Sim5 HGL profiles shows that indeed the profiles look identical as you move away and upstream from the PRS location.

D. Two alternative locations were considered for the proposed improvements, Alt. 1 and Alt. 2. Based on the results and discussion provided above, Alt. 2 provides the most favorable hydraulic solution. By moving the PRS and OLSF upstream and closer to the City of Suffolk town center by approximately 11,000 LF, it provides greater flexibility in the design and operation of the system.

   Alt. 2 location provides the following potential benefits over Alt. 1 location:

   i. Maximum hydraulic relief in the upstream parts of the interceptor system along Carolina Road and Holland Road corridors. This translates to additional system capacity which can be available to accommodate future development activity; thus deferring -if not eliminate- potential future system upgrades even further.

   ii. Potential construction cost savings in:

      - OLSF configuration and elevations
      - Smaller pumps/motor hp requirements
      - Reduced power service/demand

   iii. Maximum OLSF utilization

E. Although none of the simulations considered under this analysis resulted in 100% utilization of the tank, it does not mean it cannot be achieved if required. Indeed, maximum utilization of this storage facility may be needed at times to address some of the wet weather effluent discharge constraints at the Nansemond treatment plant when the Boat Harbor facility goes off-line. A coordination between the two design teams and all stakeholders involved with both projects may be required to ensure the Wilroy PRS and OLSF offer optimum utilization while achieving multiple outcomes.

F. Based on the comparison analysis between metered vs model flows, the hydraulic model flows generated from both design storms (2YR and 5YR) are conservative; thus, allowing adequate design capacity for the PRS and OLSF facilities. As such, special design and planning must be considered during the pump selection process to allow for maximum flexibility and efficiency of the pumps in conjunction with available metered flow data.

G. Based on the findings with the latest upgrades on the city’s four terminal pump stations investigated and described in Section D, it further supports that the location of Wilroy PRS and OLSF being upstream (Alt. 2) from the discharge points of these stations would not have an adverse impact in their operation.

SECTION F: Recommendations

Based on the findings of this analysis and conclusions, the following design parameters, and considerations for the Wilroy PRS and OLSF facilities are recommended:

Design parameters:

Wilroy PRS:	
Pump operating flow range (gpm):	4,000 - 7,000
Min. – Max. Pressure Relief (TDH):	40 ft - 80 ft
Suction HGL Set Point (ft):	30
OLSF Storage Volume (gal):	3 MG

Design Considerations:
The design of Wilroy PRS should provide provisions for potential future pump upgrades to meet future development activity trends in the western part of the City of Suffolk.

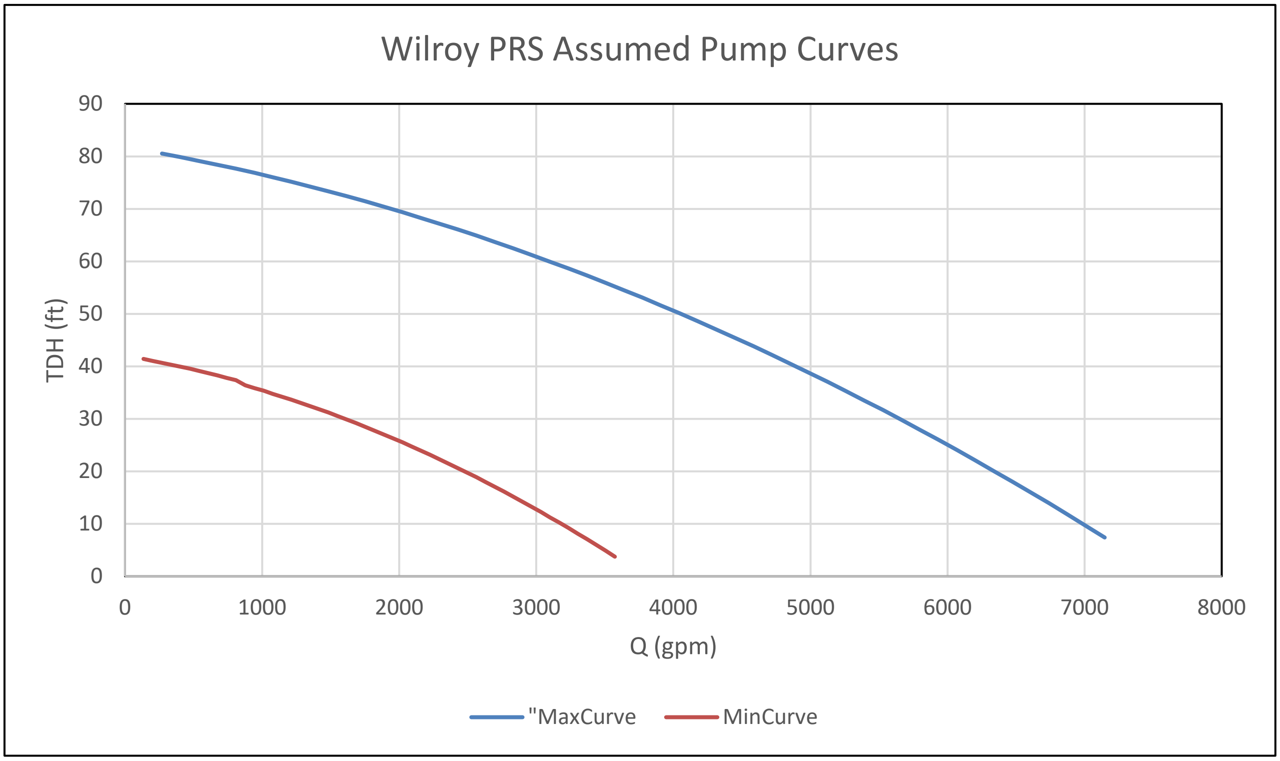
Location of Improvements:
Based on the two locations considered for this analysis, Alt. 2 - or in proximity of this location is recommended. It provides the best hydraulic solution in both pressure relief and maximum storage utilization with greater flexibility in design alternatives for the PRS and OLSF. Furthermore, by locating the improvements closer to the western part of the city's sewer infrastructure, the PRS and OLSF will provide additional available capacity in the system, which if it is measured in pressure head is approximately 30 ft.

Windsor Line (SF-214):
During the property selection evaluation process, consideration must be given so that the Winsor Line (SF-214) remains on the suction side of proposed Wilroy PRS and upstream from the OLSF.

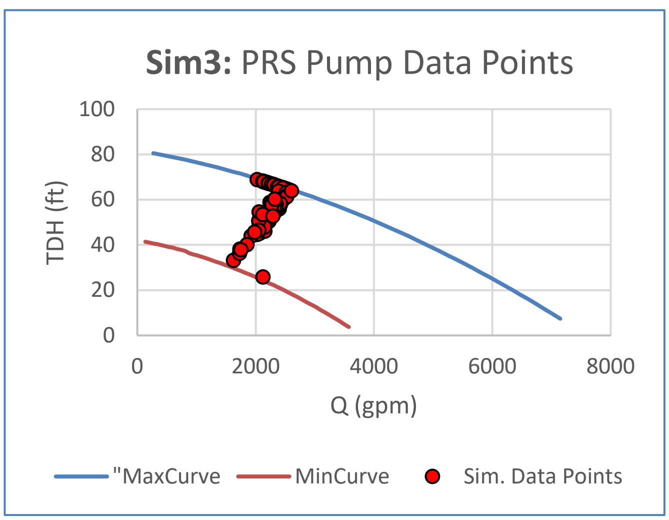
SIGNATURE APPROVAL

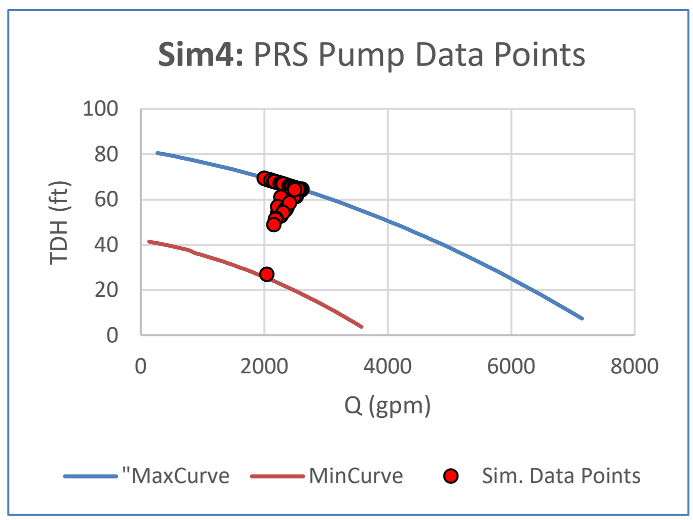
Developed by: Bambos Charalambous, P.E.	Date: 3/25/2022
Operations:	Date: 3/28/2022
Engineering:	Date: 3/29/2022

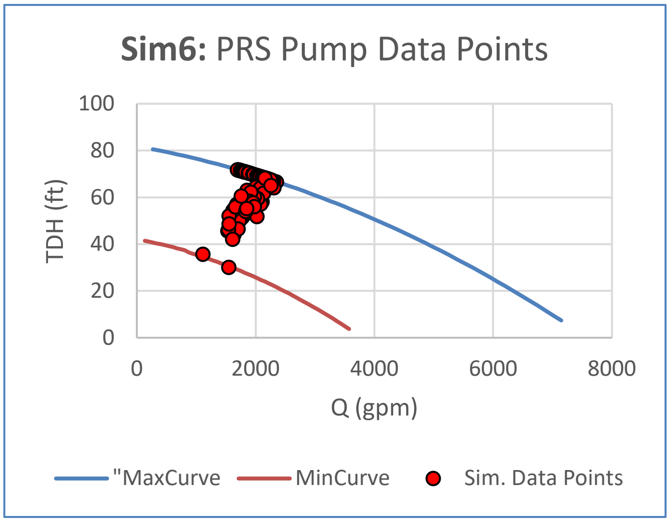
Appendix A: Wilroy PRS Assumed Pump Curves & Simulation Data Points

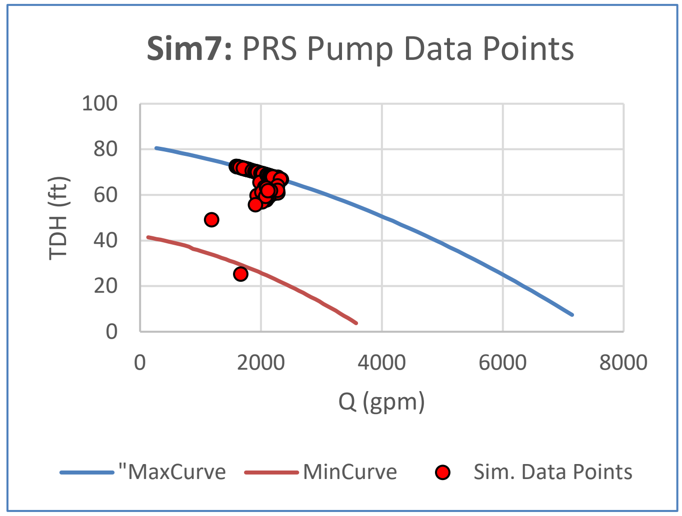


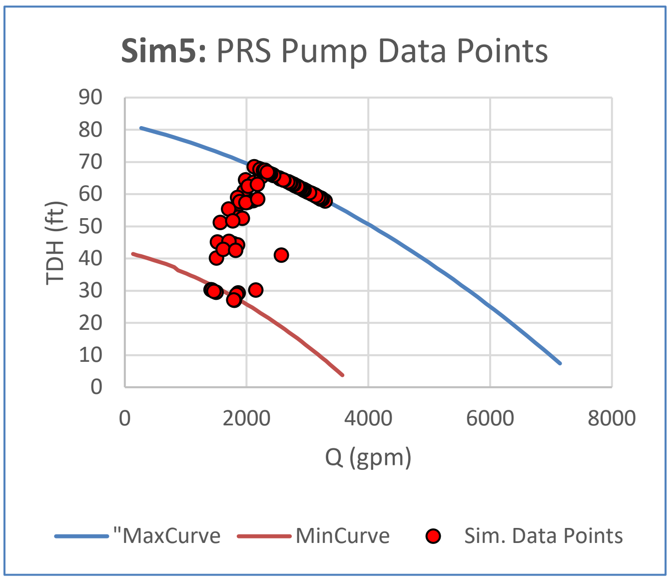
Note: The pump curves illustrated above were assumed to be appropriate for this analysis as they produced hydraulic results comparable to how the system should ultimately operate once the improvements are in service. Actual pumps and pump curves will be further considered during the design phase of the project.





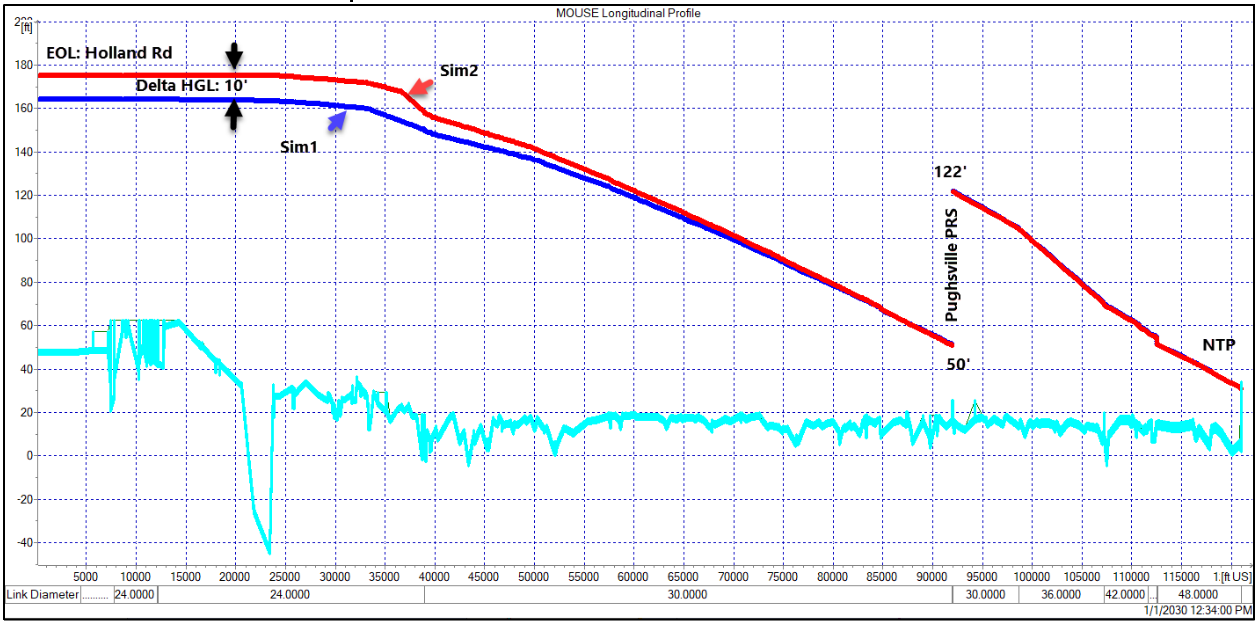

Sim6: PRS Pump Data Points
100
80
60
40
20
0
TDH (ft)
0
2000
4000
6000
8000
Q (gpm)
"MaxCurve
MinCurve
Sim. Data Points


Sim7: PRS Pump Data Points
100
80
60
40
20
0
TDH (ft)
0
2000
4000
6000
8000
Q (gpm)
"MaxCurve
MinCurve
Sim. Data Points

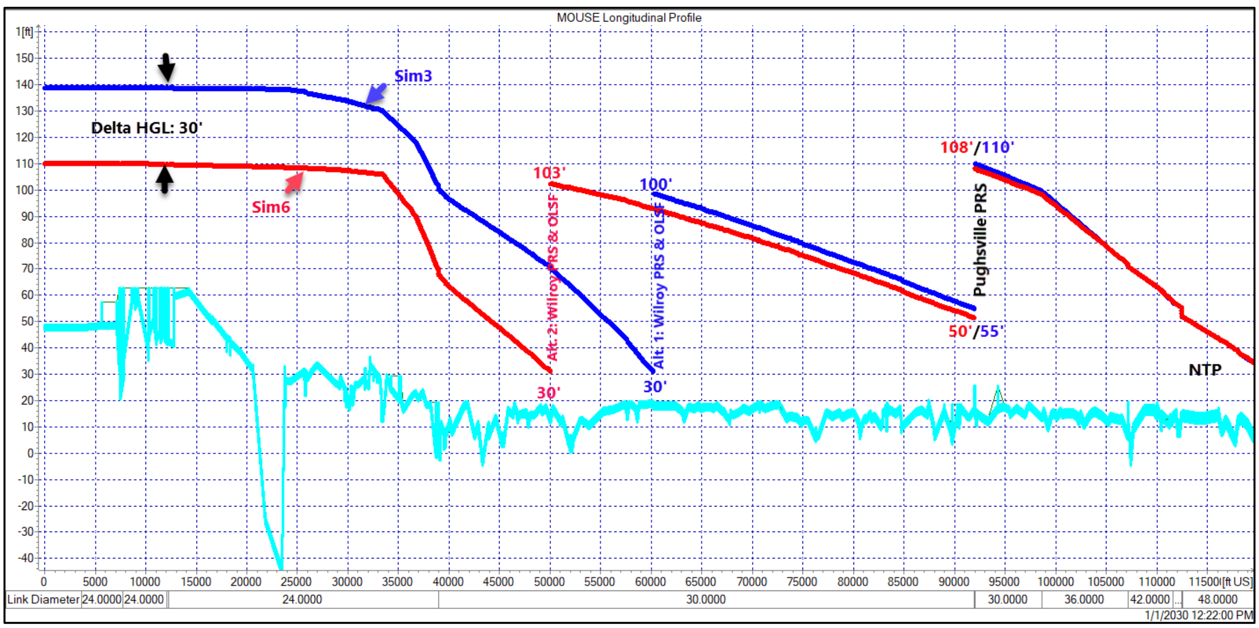

Sim5: PRS Pump Data Points
90
80
70
60
50
40
30
20
10
0
TDH (ft)
0
2000
4000
6000
8000
Q (gpm)
"MaxCurve
MinCurve
Sim. Data Points

Appendix B: Hydraulic Grade Lines

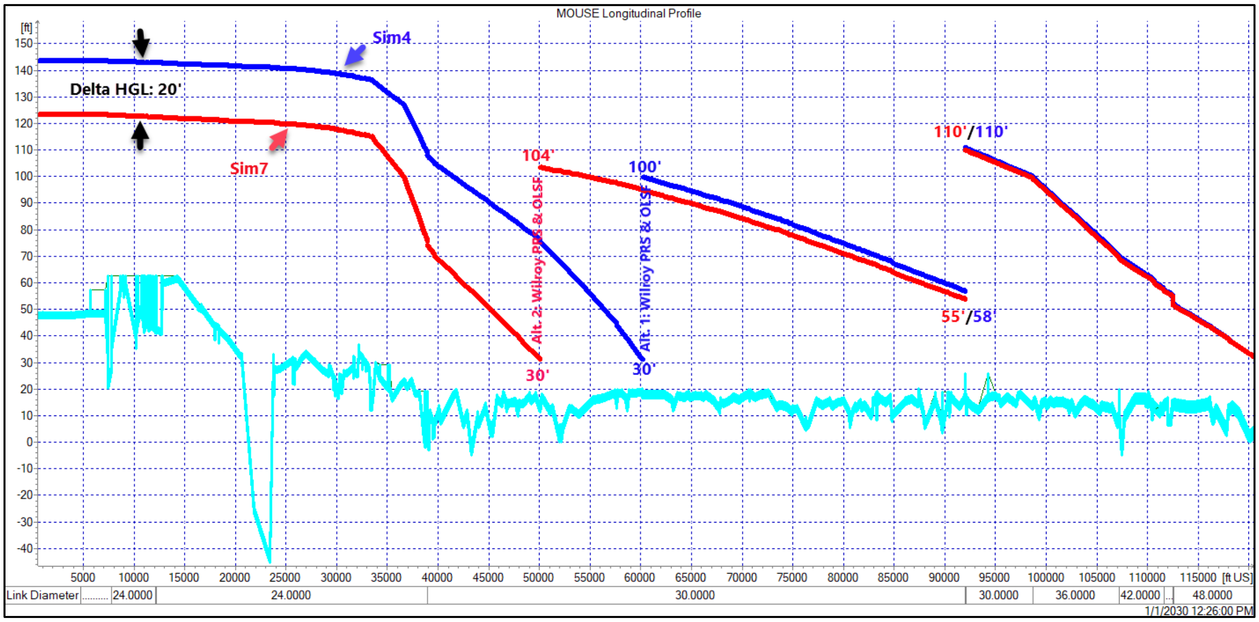
Sim1 vs Sim2 HGL Comparison



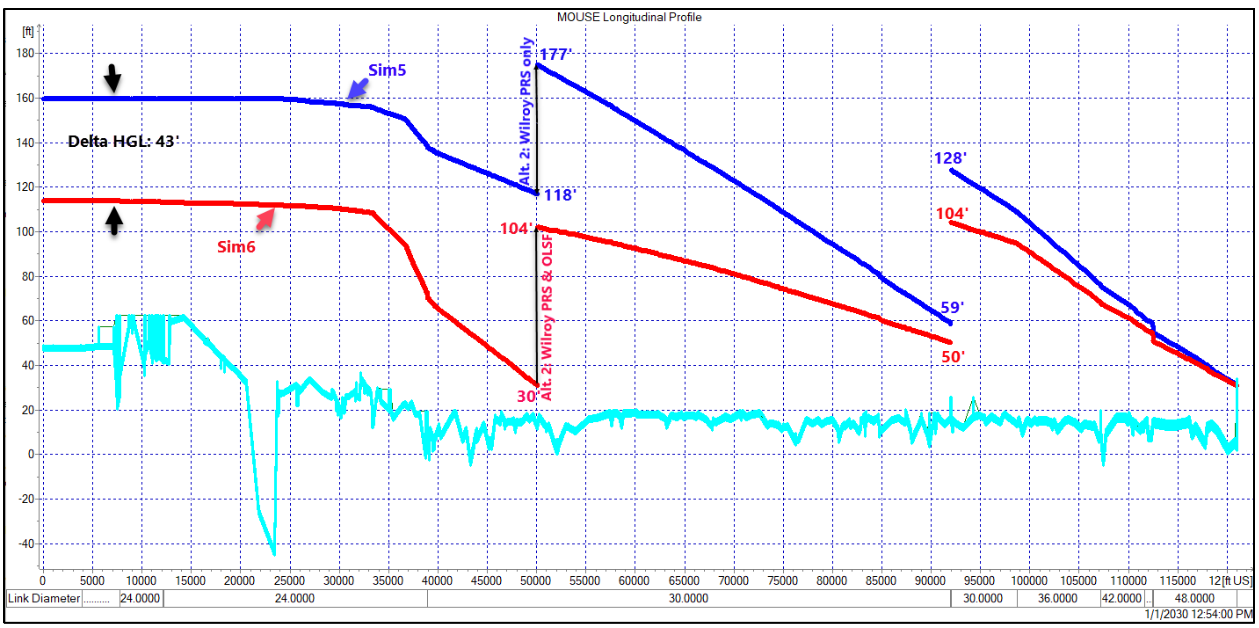
Sim3 vs Sim6 HGL Comparison



Sim4 vs Sim7 HGL Comparison

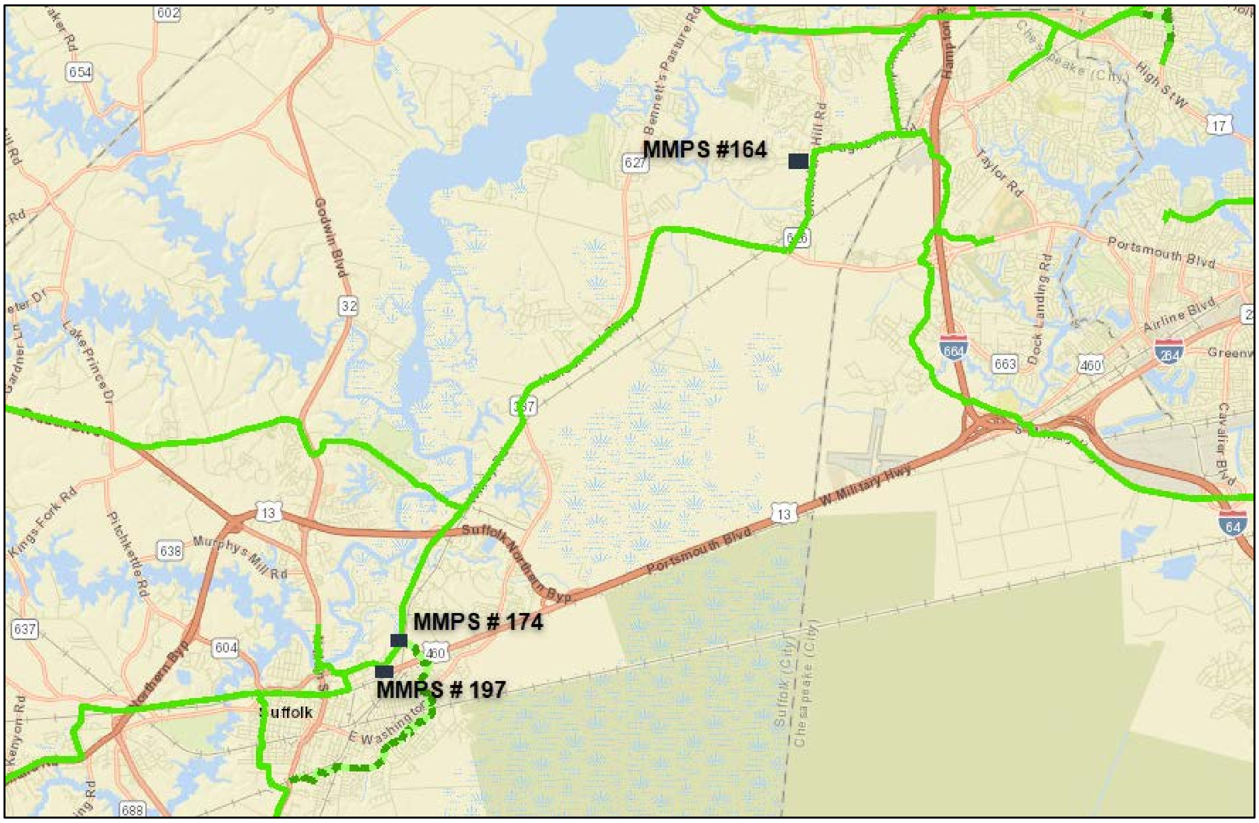


Sim5 vs Sim6 HGL Comparison



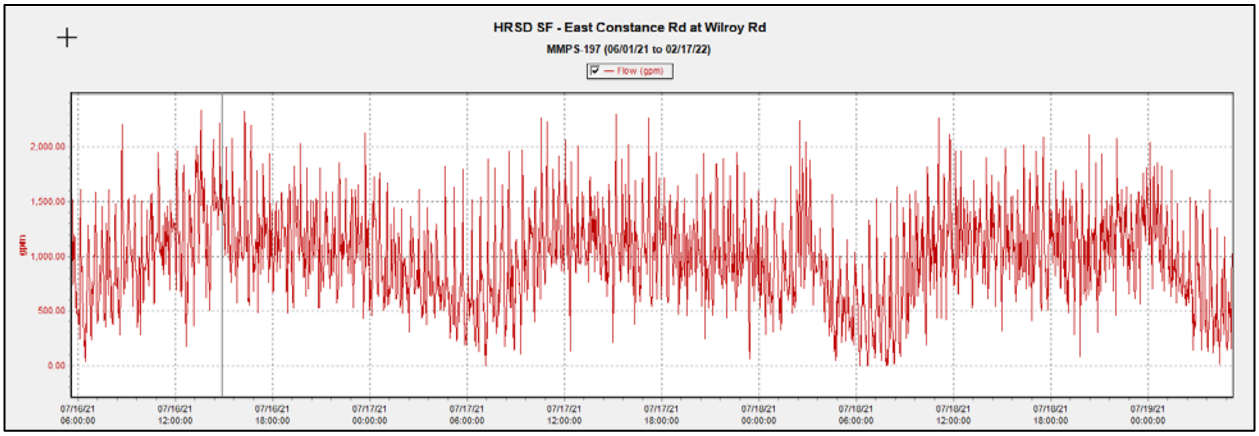
NOTE: Sim5 is compared against Sim6 for illustration purposes only and not to be considered as a design condition for pump selection with Wilroy PRS. This graph highlights the fact that the Wilroy PRS alone without OLSF assistance will not be able to provide necessary relief in the upstream reach of the interceptor system.

Appendix C: Monitoring Sites

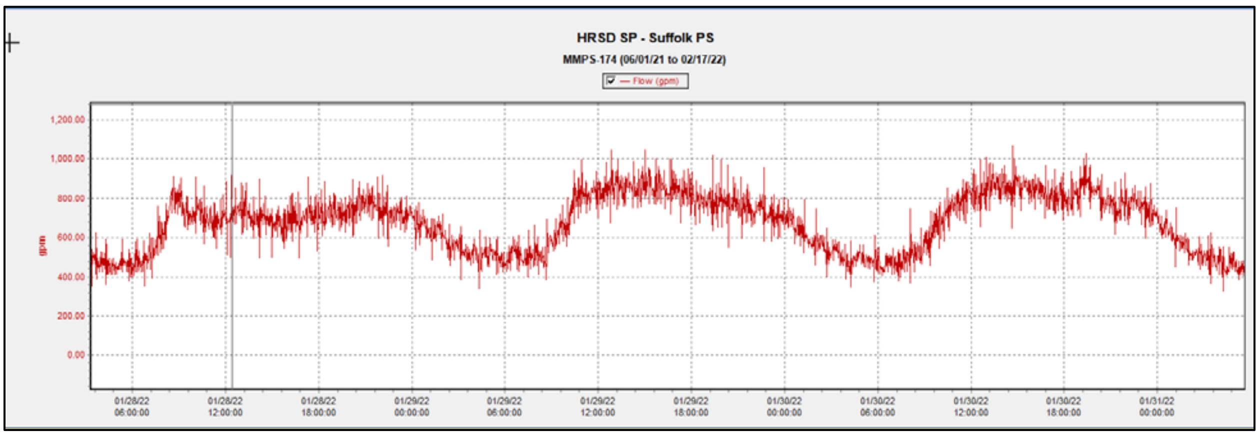


Appendix D: Dry Weather Metered Flow Plots

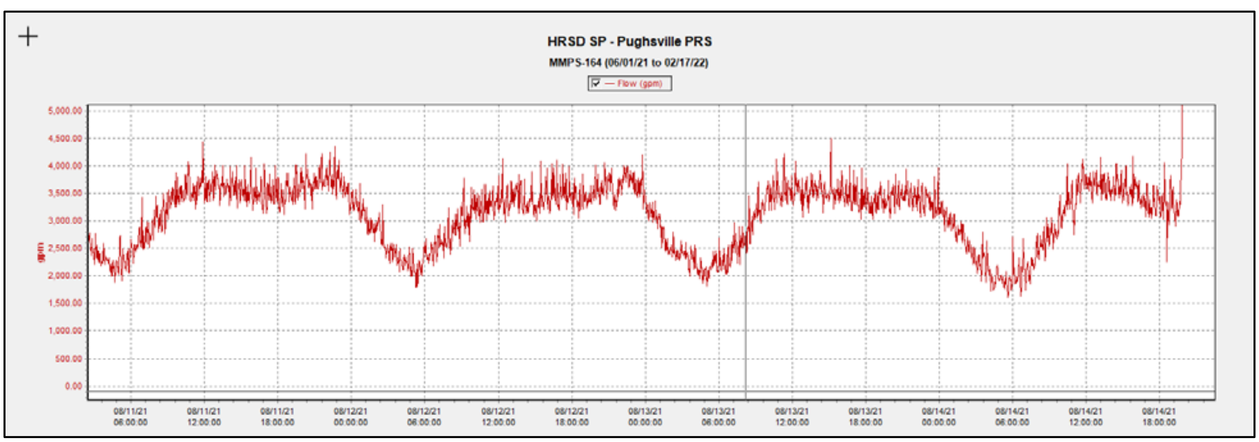
MMPS #197 East Constance Road



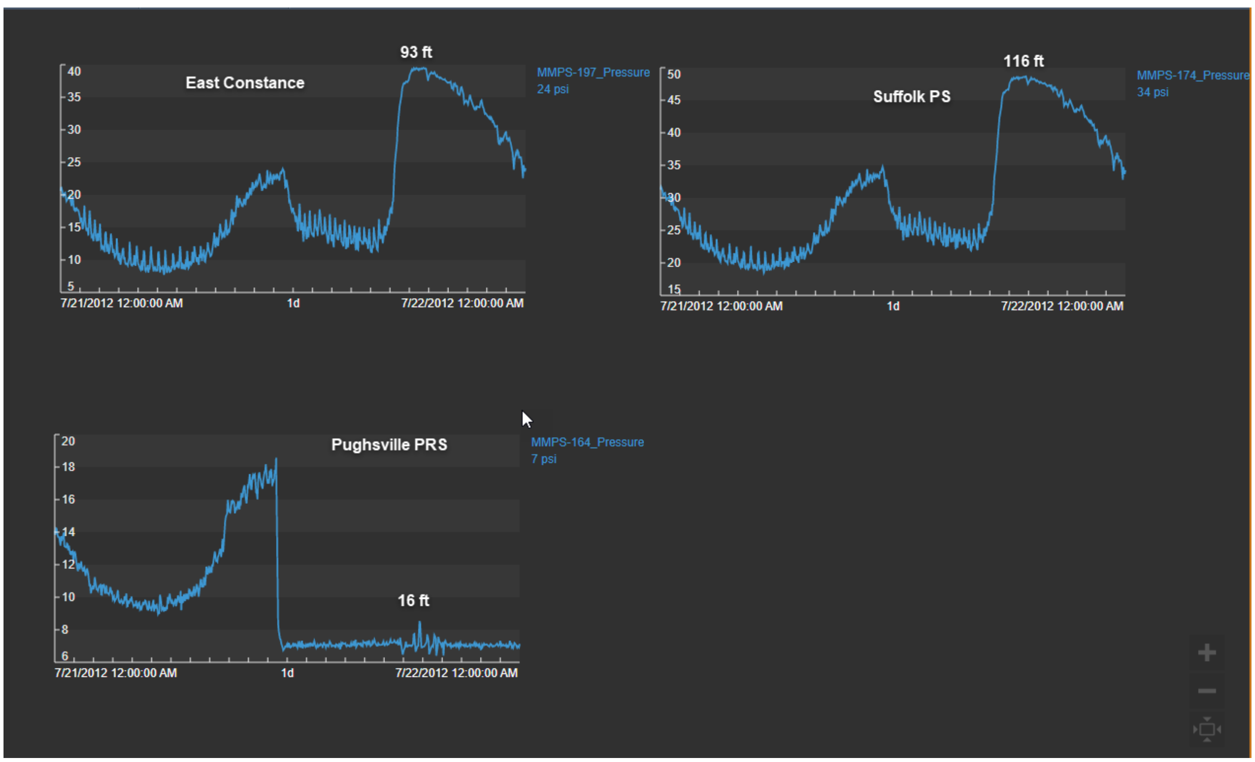
MMPS #174 Suffolk PS



MMPS #164 Pughsville PRS



Appendix E: 7/20/2012 Recorded Event vs Sim1a (5YR event)

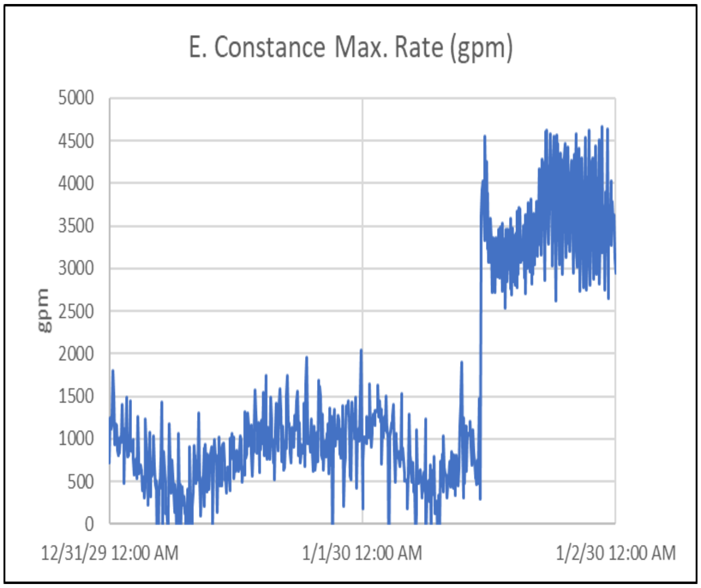


MMPS #197 East Constance Road (7/20/2012 Event) – Max. Hour Rate: 3,950 gpm

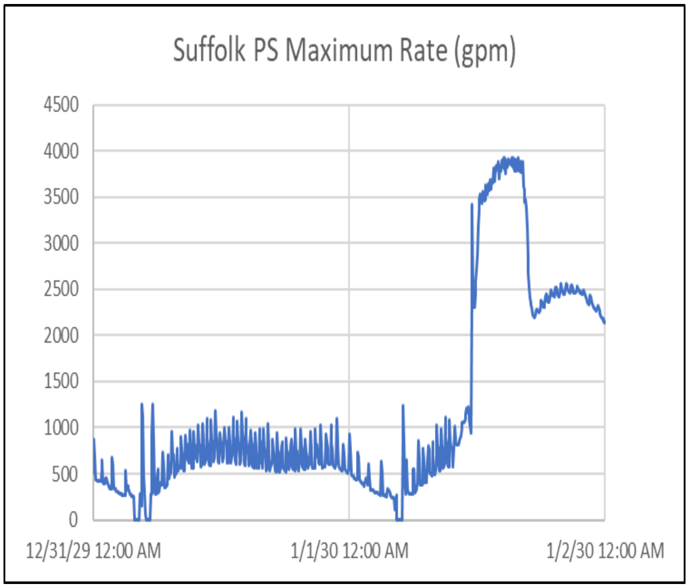
MMPS #174 Suffolk PS (7/20/2012 Event) – Max. Hour Rate: 2,800 gpm

MMPS #164 Pughsville PRS (7/20/2012 Event) – Max. Hour Rate: 7,500 gpm

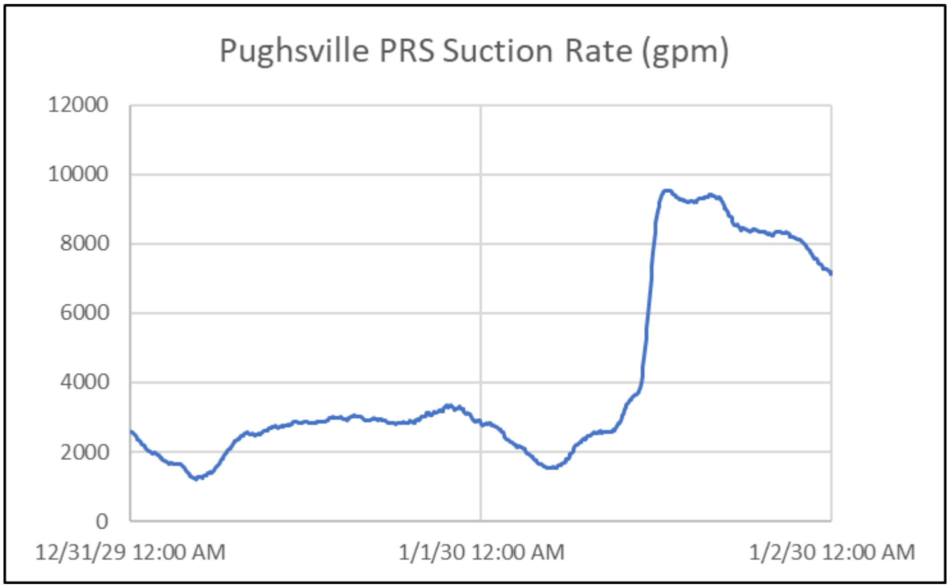
Sim1a Max. Hourly Rate: 4,662 gpm



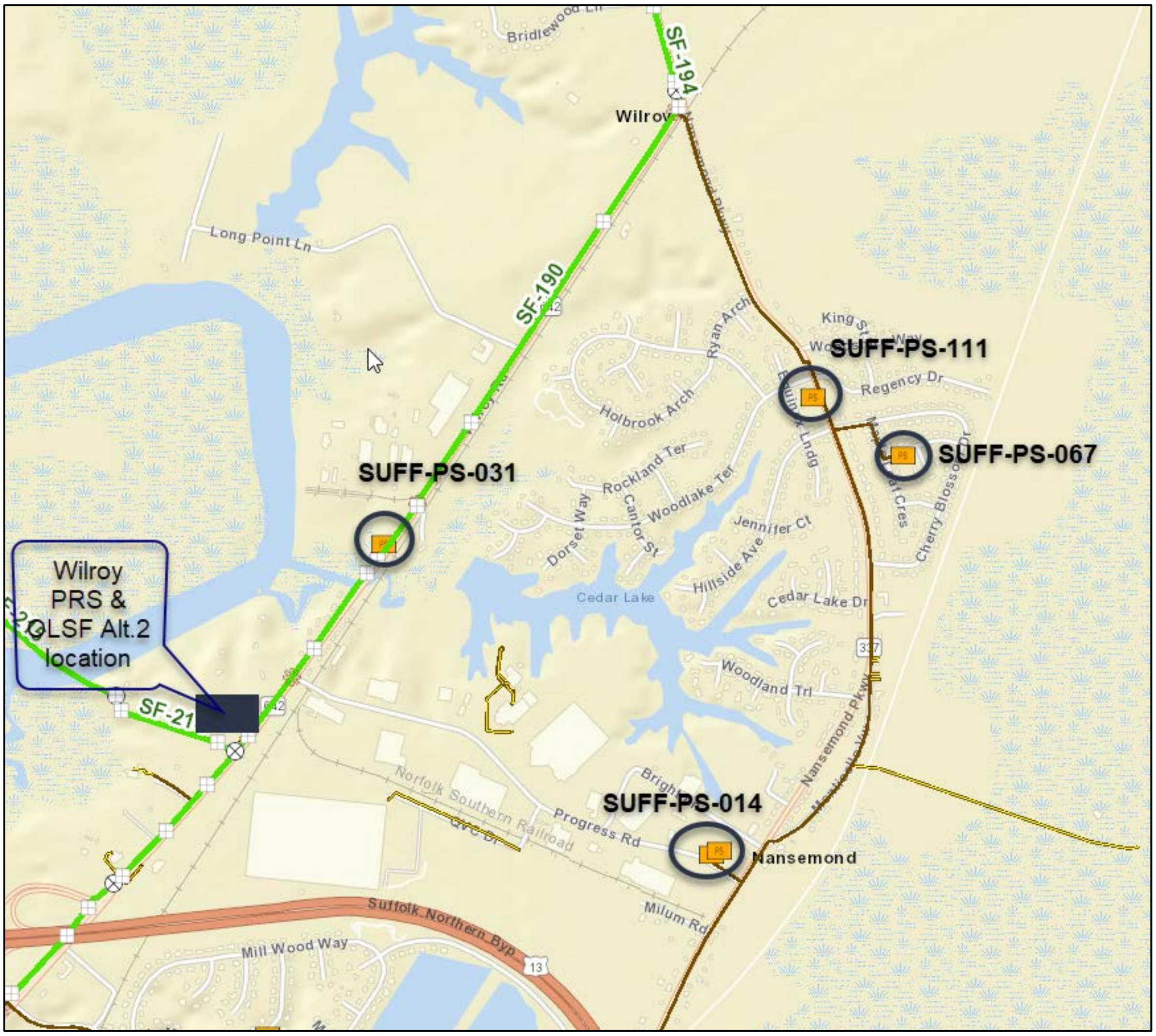
Sim1a Max. Hourly Rate: 3,931 gpm



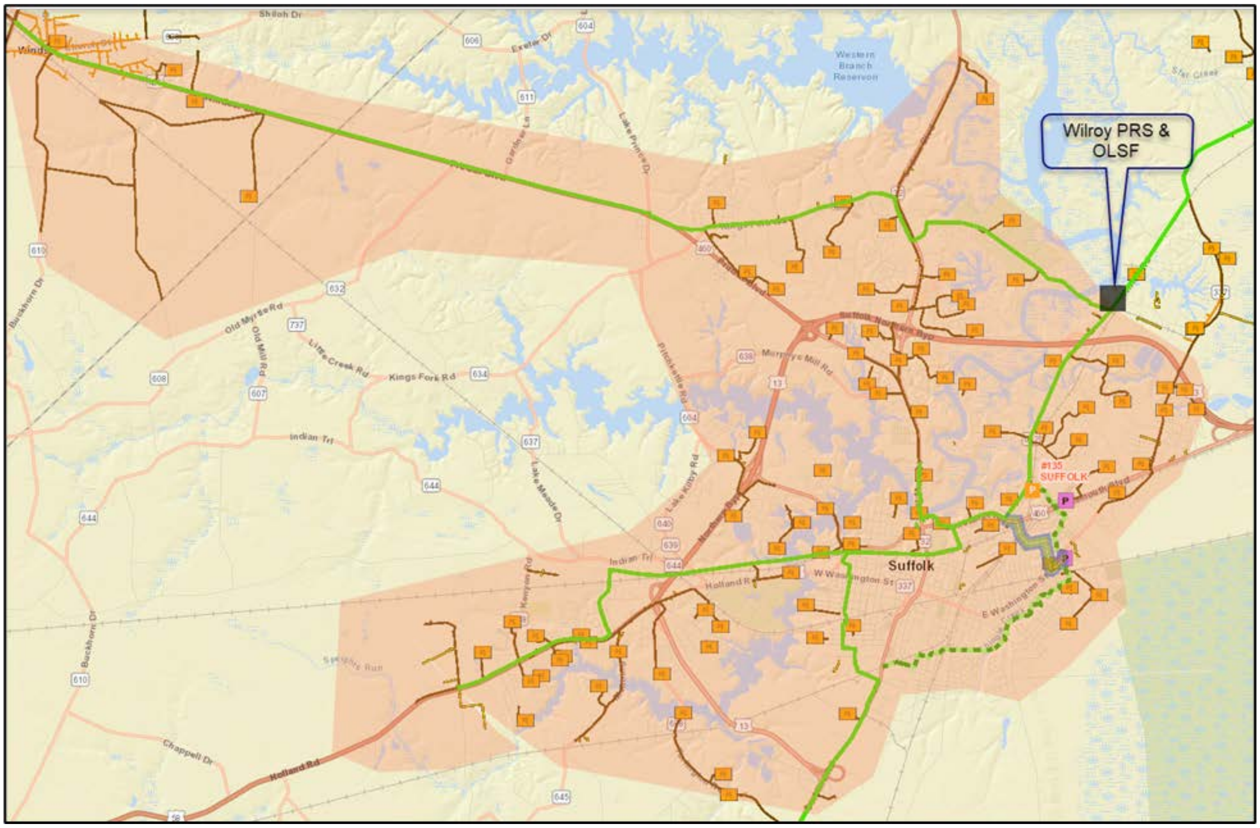
Sim1a Max. Hourly Rate: 9,541 gpm



Appendix F: Nansemond Pkwy City Terminal Pump Stations

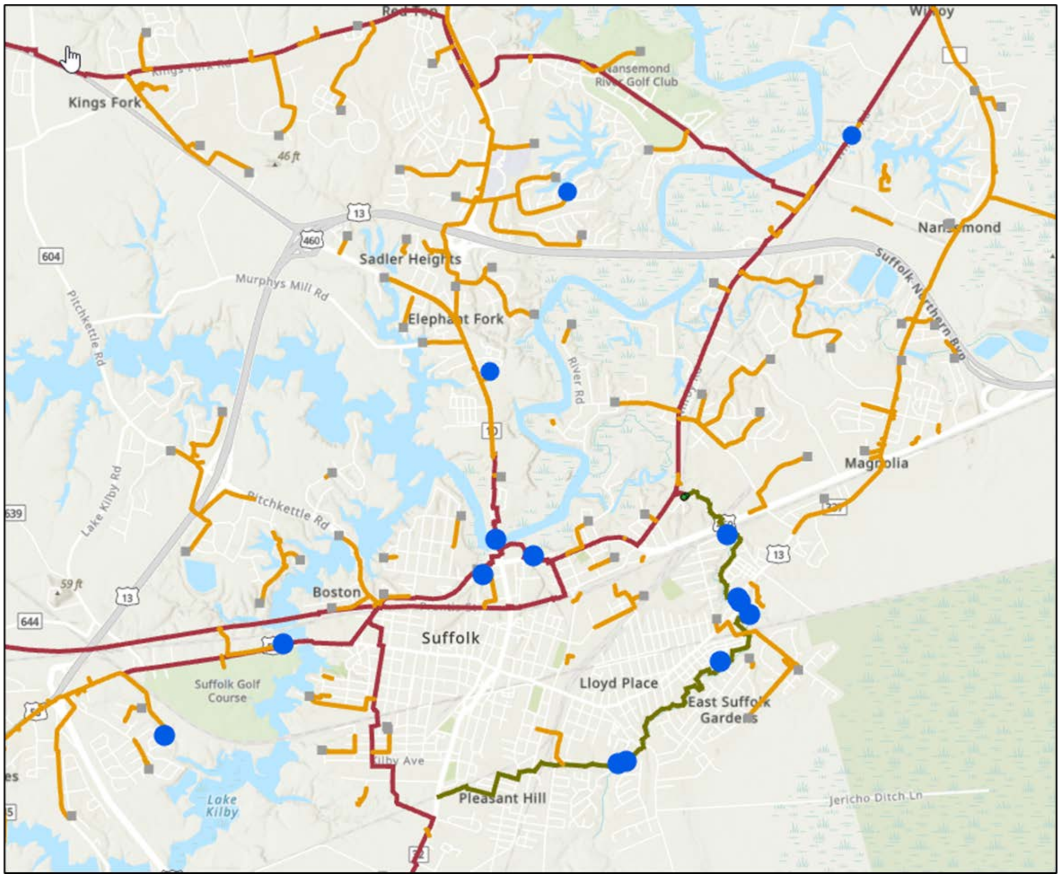


Appendix G: Wilroy PRS and OLSF Service area

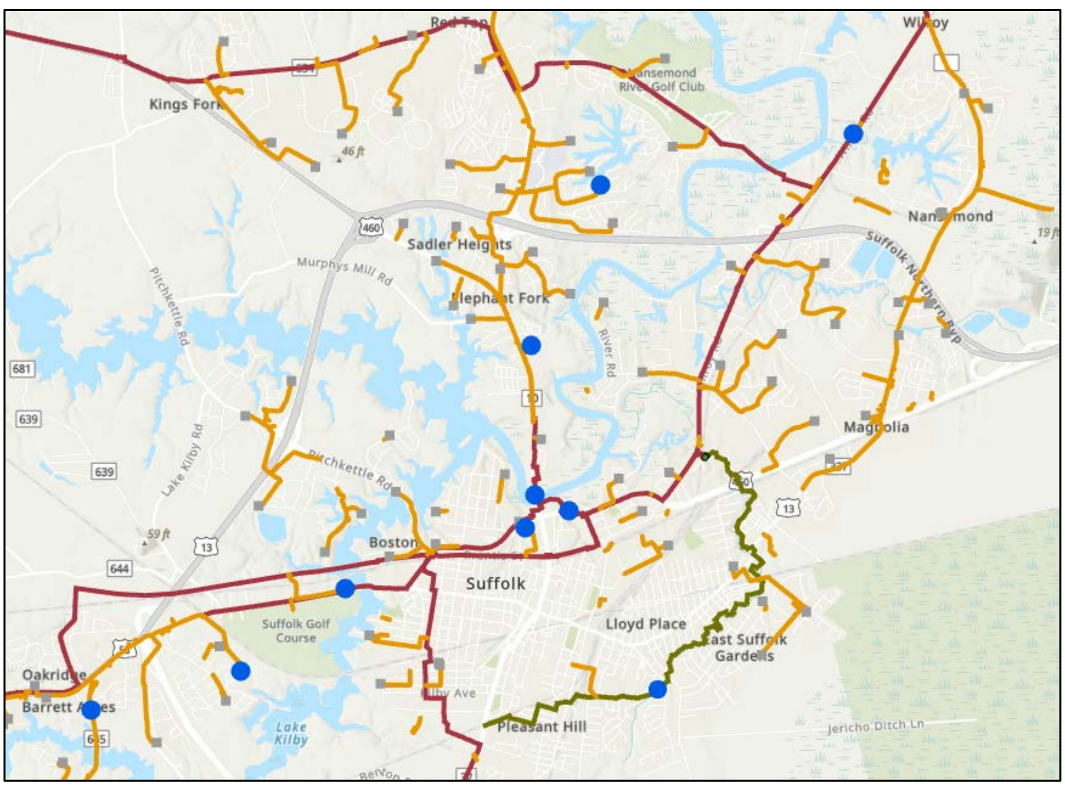


Appendix H:

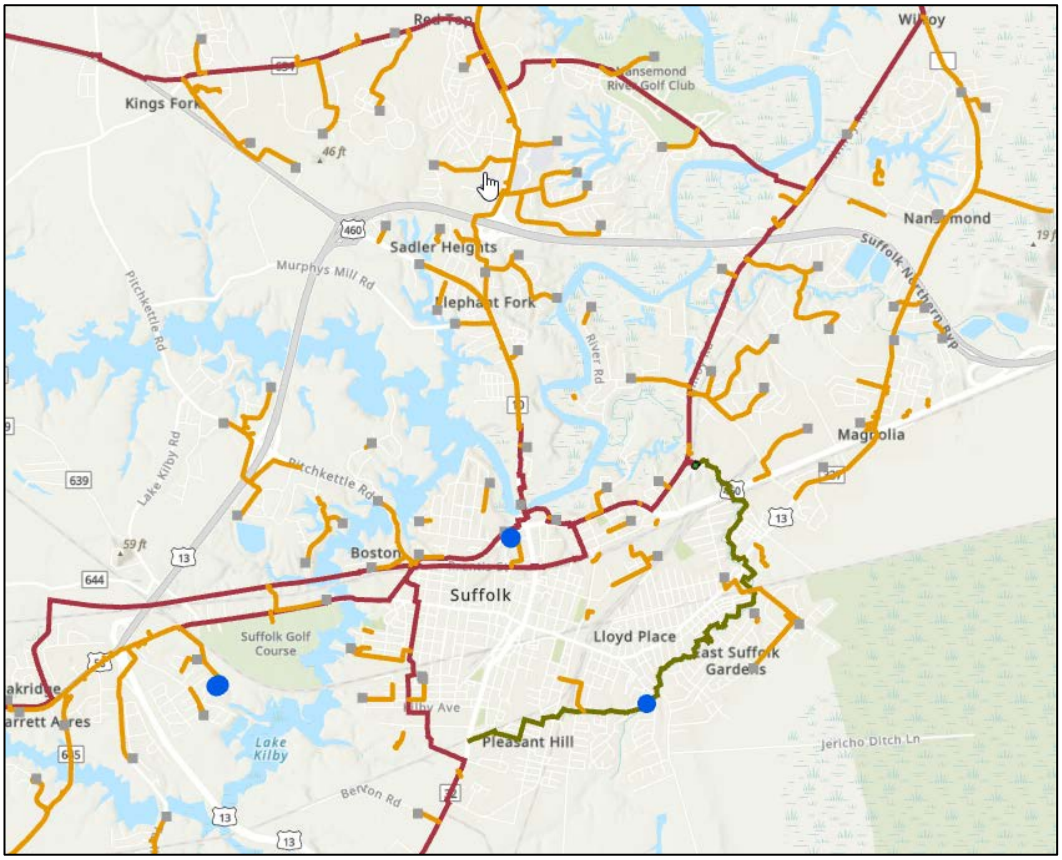
Sim1 Simulated SSO events



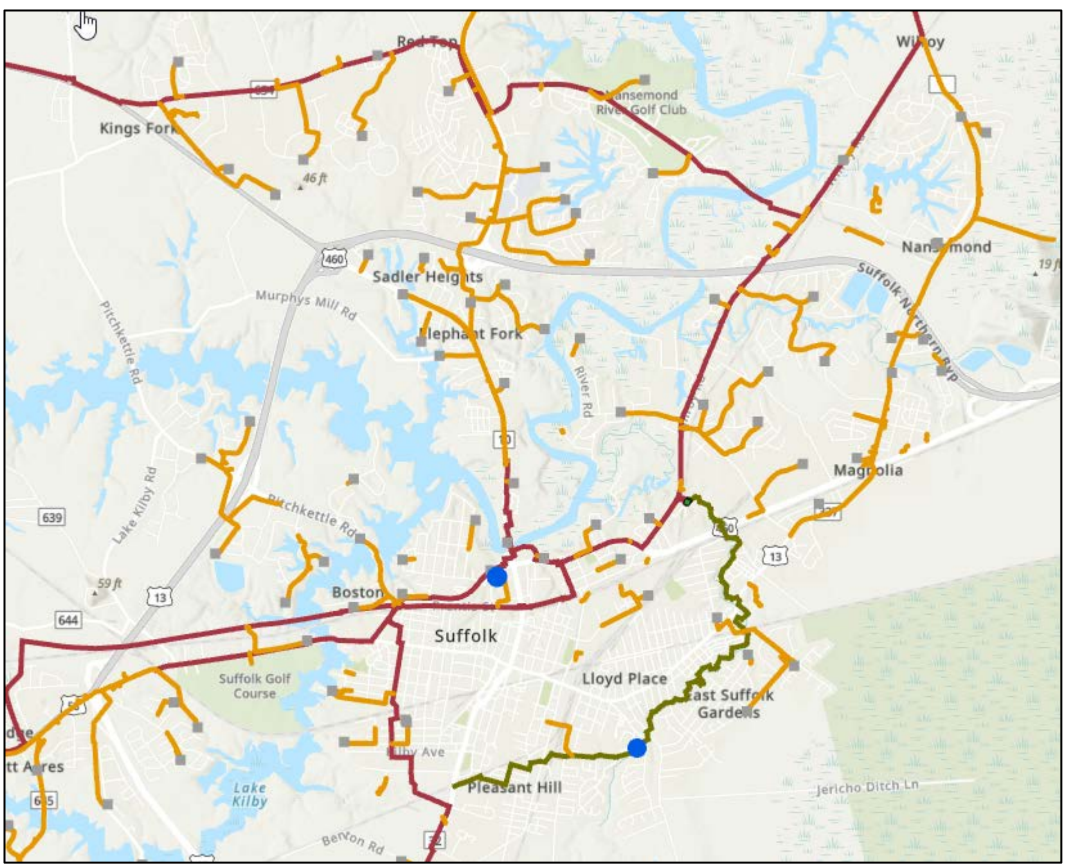
Sim2 Simulated SSOs:



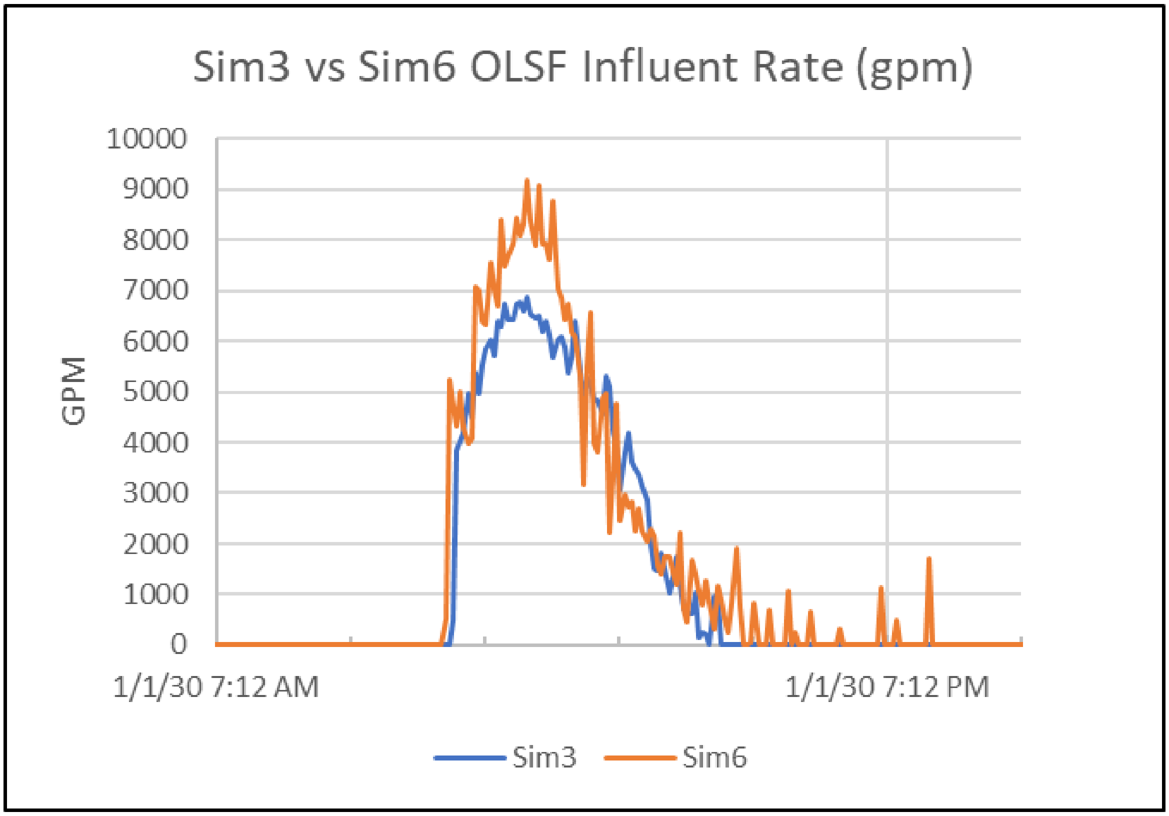
Sim3 Simulated SSOs



Sim6 Simulated SSOs



Appendix I: OLSF Influent Rates between Sim3 (Alt.1) and Sim6 (Alt.2)



Appendix C: Detailed Site Selection Tables

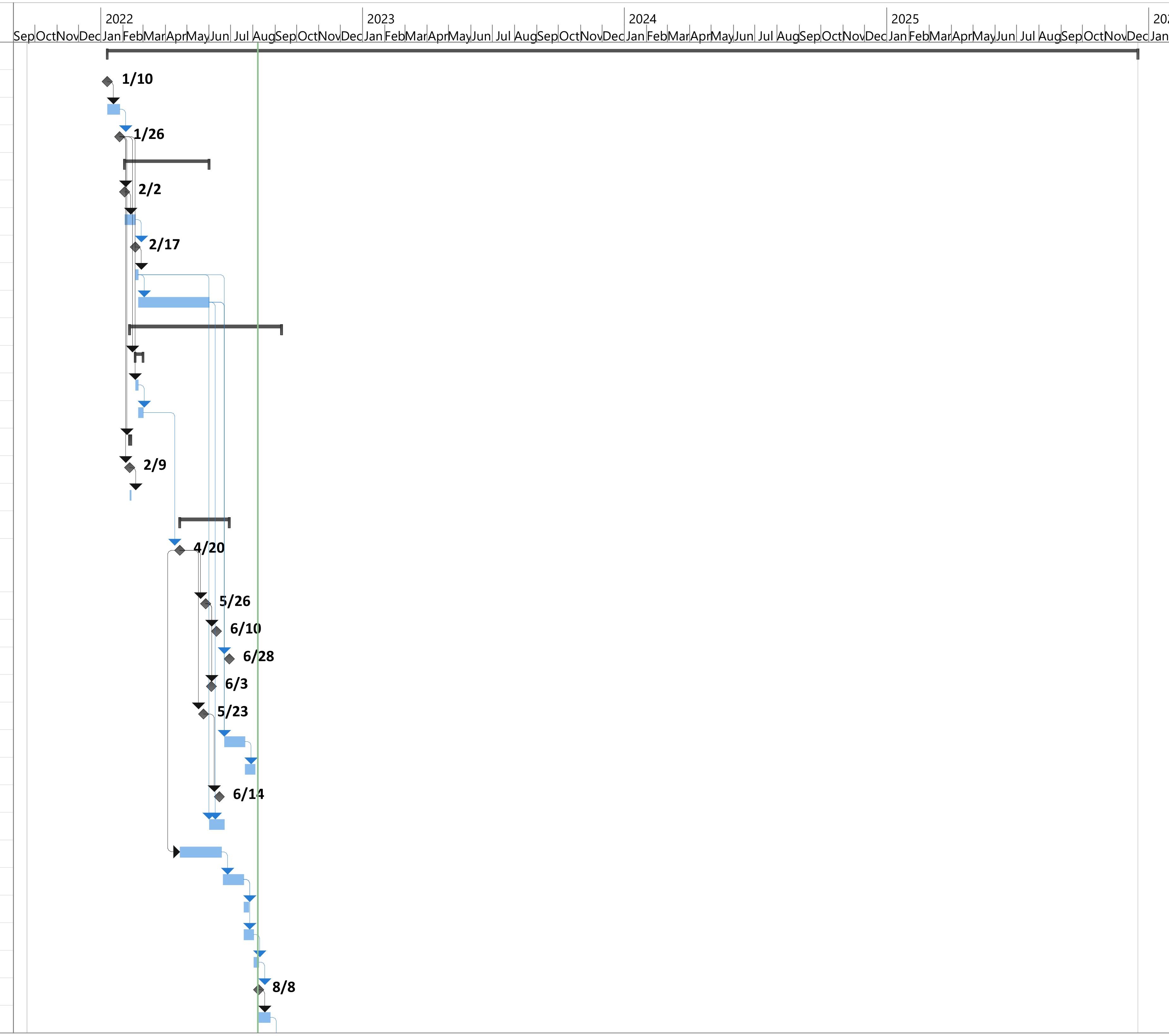
Table 2-1. Site Criteria and Scoring				
Envision Category	Criteria	Scoring		
		+	0	-
Natural World	No/limited wetlands	>500 ft of wetlands	<500 ft of wetlands	Site on wetlands
	Avoid protected species	-	All sites had the same endangered species/migratory birds	-
	Avoid CERCLA/superfund	All sites not near superfund sites	-	-
	Proximity to navigable waters	>1000 ft from navigable waters	500-1000 ft from navigable waters	<500 ft from navigable waters
Climate and Resilience	Elevation of site	>500ft from floodplain	<500ft from floodplain	In floodplain
	Nearby threat/hazard	>1500 ft from chemical plant	500-1500ft from chemical plan	<500 ft from chemical plant
Quality of Life	Likelihood of Owner Selling	Yes	Unknown	No
	Zoning Class	M-2 zoning class	M-1 or A zoning classes	All other zoning classes
	Existing screening trees	Mostly tree cover	Some trees	No tree cover
	Odor	Residential homes >1000ft downwind	Residential homes 500-1000ft downwind	Residential homes <500ft downwind
	City Property	City property	Others	-
	DPW/Roadway Improvement	Others	<1000ft of DPW improvement projects	Adjacent to DPW improvement projects
Resource Allocation	Soil foundation	Loam soil	Fine sandy loam soil	Areas with sink/swell potential
	Proximity to HRSD FM	<200ft of FM	200-1000ft of FM	>1000ft of FM
	Public Roads Access	<100ft to public roads	100-500ft of public roads	>500ft of public roads
	Size of Parcel (3 acres needed minimum)	>5 acres	3-5 acres	<3 acres
	No railroad crossing	No need to cross railroad tracks	Near railroad tracks	Cross railroad tracks
	Hydraulic benefits	Southern section	Middle section	Northern section
	Electrical availability	Powerline runs adjacent to site parcel	Powerline on other side of street	Powerline >500ft of site
	Potable water availability	>200 ft of water pipes	200-1000 ft of water pipes	>1000 ft of water pipes
Leadership	Local community groups	-	All sites	-
	Avoid archeological/historical areas	-	All sites	-

Table 2-2. Site Selection Analysis Results																		
Site #	Parcel ID	Acres	Natural World				Climate and Resilience		Quality of Life						Resource Allocation			
			No/limited wetlands	Avoid protected species	Avoid CERCLA/superfund	Proximity to navigable waters	Elevation of site	Nearby threat/hazard	Likelihood of Owner Selling	Zoning Class	Existing screening trees	Odor	City property	DPW/ roadway improvement	Soil foundation	Proximity to HRSD FM	Public Roads Access	Size of Parcel
1	304154000	50.1	-	0	+	+	+	+	0	-	+	0	0	+	+	+	+	+
2	303737000	70.3	0	0	+	0	0	+	0	-	0	0	0	0	0	-	-	+
3	301897000	4	-	0	+	+	+	+	0	-	+	+	0	0	+	+	+	0
4	305035500	35.9	+	0	+	0	0	+	-	-	-	0	0	0	0	+	+	+
5	300847000	26.8	-	0	+	+	+	+	-	-	+	+	0	-	+	+	+	+
6	305035300	23.3	0	0	+	0	0	+	-	-	0	-	0	-	0	+	+	+
7	301961000	13.3	-	0	+	+	-	+	-	-	+	0	0	-	+	0	+	+
8	304886400	5.5	+	0	+	+	+	+	-	-	-	0	0	-	0	+	+	+
9	300853000	29.7	-	0	+	+	-	+	-	-	+	-	0	-	0	+	0	+
10	300849000	60	+	0	+	+	+	+	-	+	-	+	0	0	0	+	+	+
11	300850000	14.6	+	0	+	+	+	+	-	+	-	+	0	0	0	+	+	+
12	302112000	11.1	-	0	+	0	-	0	-	-	+	+	0	+	-	-	+	+
13	300972300	46.7	0	0	+	0	-	-	-	+	+	0	0	+	0	-	0	+
14	300981000	8.9	0	0	+	+	-	+	-	+	+	+	0	+	0	+	0	+
15	300972200	1.83	+	0	+	+	+	-	-	+	-	-	0	+	0	+	+	-
16	302531000	4.1	0	0	+	0	-	+	-	+	+	0	0	+	-	+	0	0
17	301899100	15.3	0	0	+	-	-	-	-	+	+	-	0	+	-	+	+	+
18	302842000	5.4	-	0	+	0	-	+	0	+	+	0	0	+	-	+	0	+
19	300616500	3.1	-	0	+	-	-	0	0	-	-	+	0	+	-	0	-	-
20	302591500	10.5	0	0	+	-	0	-	0	+	0	+	0	+	0	0	-	+
21	304339500	18.3	0	0	+	+	-	0	0	+	+	0	0	+	0	+	+	+
22	300520000	5.5	+	0	+	+	+	+	0	+	+	0	0	+	0	0	+	+
23	304649300	4.6	+	0	+	+	0	+	+	-	+	-	+	+	0	+	+	0
24	303392500	3.31	+	0	+	+	0	+	+	-	+	-	-	+	0	0	+	0
25	301260000	2.82	+	0	+	+	0	+	+	-	+	-	0	+	0	0	+	0
26	304324200	1.47	+	0	+	+	0	+	+	-	+	-	0	+	0	0	+	0
27	304324300	1.08	+	0	+	+	0	+	+	-	+	-	0	+	0	0	+	0

Site #	Parcel ID	Acres	Resource Allocation				Leadership	
			No railroad crossing	Hydraulic benefits	Electrical availability	Potable water availability	Local community groups	Avoid archeological/ historical areas
1	304154000	50.1	+	-	0	+	0	+
2	303737000	70.3	+	-	-	-	0	+
3	301897000	4	+	-	0	+	0	+
4	305035500	35.9	+	-	0	0	0	+
5	300847000	26.8	+	-	0	+	0	+
6	305035300	23.3	+	-	+	0	0	+
7	301961000	13.3	-	-	0	+	0	+
8	304886400	5.5	-	-	+	+	0	+
9	300853000	29.7	-	0	+	0	0	+
10	300849000	60	+	0	+	+	0	+
11	300850000	14.6	+	0	+	+	0	+
12	302112000	11.1	+	0	+	-	0	+
13	300972300	46.7	+	0	-	-	0	+
14	300981000	8.9	-	0	0	0	0	+
15	300972200	1.83	0	0	+	+	0	+
16	302531000	4.1	-	0	+	0	0	+
17	301899100	15.3	+	+	+	+	0	+
18	302842000	5.4	-	+	+	0	0	+
19	300616500	3.1	+	+	-	-	0	+
20	302591500	10.5	-	+	-	-	0	+
21	304339500	18.3	-	+	0	-	0	+
22	300520000	5.5	-	+	0	-	0	+
23	304649300	4.6	+	+	+	+	0	+
24	303392500	3.31	0	+	+	+	0	+
25	301260000	2.82	-	+	+	+	0	+
26	304324200	1.47	-	+	+	+	0	+
27	304324300	1.08	-	+	+	+	0	+

Appendix D: Project Schedule and Risk Register

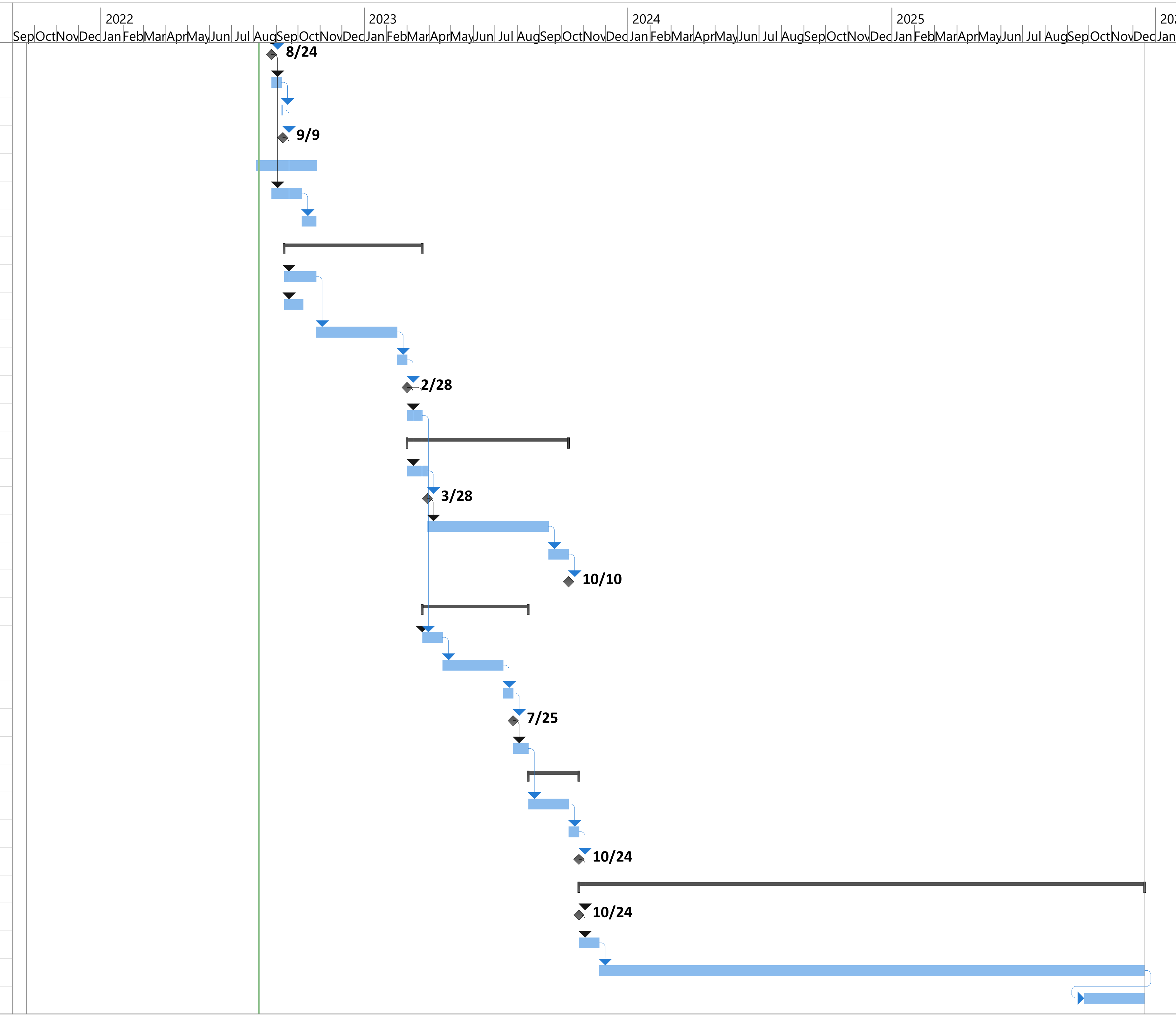
ID	Task Name	Duration	Start	Finish
1	**Wilroy PRS**	**1024 days**	**Mon 1/10/22**	**Tue 12/16/25**
2	NTP	0 days	Mon 1/10/22	Mon 1/10/22
3	Mobilize	13 days	Mon 1/10/22	Wed 1/26/22
4	Kickoff Meeting	0 days	Wed 1/26/22	Wed 1/26/22
5	**Site Selection**	**82 days**	**Wed 2/2/22**	**Tue 5/31/22**
6	Site Selection Criteria Mtg	0 days	Wed 2/2/22	Wed 2/2/22
7	Potential Site Identification	10 days	Thu 2/3/22	Thu 2/17/22
8	Site Selection Mtg	0 days	Thu 2/17/22	Thu 2/17/22
9	Site Selection TM	2 days	Fri 2/18/22	Mon 2/21/22
10	Additional Site Selection Activities	70 days	Tue 2/22/22	Tue 5/31/22
11	**PER**	**149 days**	**Wed 2/9/22**	**Fri 9/9/22**
12	**Existing PRS and OLSF Review**	**7 days**	**Fri 2/18/22**	**Mon 2/28/22**
13	Existing PRS and OLSF Review	2 days	Fri 2/18/22	Mon 2/21/22
14	Existing Facility Review TM	5 days	Tue 2/22/22	Mon 2/28/22
15	**Modeling Data Review**	**2 days**	**Wed 2/9/22**	**Fri 2/11/22**
16	Data Review Meeting	0 days	Wed 2/9/22	Wed 2/9/22
17	Mtg Summary	2 days	Thu 2/10/22	Fri 2/11/22
18	**Workshops**	**48 days**	**Wed 4/20/22**	**Tue 6/28/22**
19	Process Mech/Hydraulics and Facility Config Workshop	0 days	Wed 4/20/22	Wed 4/20/22
20	Process Controls/Electrical Workshop	0 days	Thu 5/26/22	Thu 5/26/22
21	Safety Workshop	0 days	Fri 6/10/22	Fri 6/10/22
22	Architectural Approach Workshop	0 days	Tue 6/28/22	Tue 6/28/22
23	BIM/Asset Mngmnt Workshop	0 days	Fri 6/3/22	Fri 6/3/22
24	Envision Workshop	0 days	Mon 5/23/22	Mon 5/23/22
25	Environmental Evaluation	20 days	Wed 6/22/22	Wed 7/20/22
26	Permitting Plan	10 days	Thu 7/21/22	Wed 8/3/22
27	Contractor Procurement Mtg	0 days	Tue 6/14/22	Tue 6/14/22
28	Stakeholder/Community Evaluation	15 days	Wed 6/1/22	Tue 6/21/22
29	Design Considerations	41 days	Thu 4/21/22	Fri 6/17/22
30	Schematic Drawing Prep	20 days	Mon 6/20/22	Mon 7/18/22
31	Cost Estimate	5 days	Tue 7/19/22	Mon 7/25/22
32	Prepare Draft PER	10 days	Tue 7/19/22	Mon 8/1/22
33	QA/QC	5 days	Tue 8/2/22	Mon 8/8/22
34	Draft PER Submittal to HRSD	0 days	Mon 8/8/22	Mon 8/8/22
35	HRSD Review	12 days	Tue 8/9/22	Wed 8/24/22



Project: Wilroy Schedule 2022-01
Date: Mon 8/8/22

Task	Project Summary	Manual Task	Start-only	Deadline	
Split	Inactive Task	Duration-only	Finish-only	Progress	
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress	
Summary	Inactive Summary	Manual Summary	External Milestone		

ID	Task Name	Duration	Start	Finish
36	PER Review Workshop	0 days	Wed 8/24/22	Wed 8/24/22
37	Revise PER	10 days	Thu 8/25/22	Wed 9/7/22
38	QA/QC	2 days	Thu 9/8/22	Fri 9/9/22
39	Submit Final PER to HRSD	0 days	Fri 9/9/22	Fri 9/9/22
40	CMAR Selection Process	60 days	Thu 8/4/22	Wed 10/26/22
41	Prepare Final Design Scope	30 days	Thu 8/25/22	Wed 10/5/22
42	HRSD Commision Approval Final Design	14 days	Thu 10/6/22	Tue 10/25/22
43	**50% Design**	**137 days**	**Mon 9/12/22**	**Tue 3/21/23**
44	Geotechnical	32 days	Mon 9/12/22	Tue 10/25/22
45	Level B SUE	20 days	Mon 9/12/22	Fri 10/7/22
46	Design	80 days	Wed 10/26/22	Tue 2/14/23
47	QA/QC	10 days	Wed 2/15/23	Tue 2/28/23
48	Submittal	0 days	Tue 2/28/23	Tue 2/28/23
49	Review Workshop with HRSD	15 days	Wed 3/1/23	Tue 3/21/23
50	**Conditional Use Permit**	**160 days**	**Wed 3/1/23**	**Tue 10/10/23**
51	Develop Permit Application	20 days	Wed 3/1/23	Tue 3/28/23
52	Submittal	0 days	Tue 3/28/23	Tue 3/28/23
53	Planning Review	120 days	Wed 3/29/23	Tue 9/12/23
54	City Council	20 days	Wed 9/13/23	Tue 10/10/23
55	Approval	0 days	Tue 10/10/23	Tue 10/10/23
56	**90% Design**	**105 days**	**Wed 3/22/23**	**Tue 8/15/23**
57	Level A SUE	20 days	Wed 3/22/23	Tue 4/18/23
58	Design	60 days	Wed 4/19/23	Tue 7/11/23
59	QA/QC	10 days	Wed 7/12/23	Tue 7/25/23
60	Submittal	0 days	Tue 7/25/23	Tue 7/25/23
61	Review Workshop with HRSD	15 days	Wed 7/26/23	Tue 8/15/23
62	**Construction Documents**	**50 days**	**Wed 8/16/23**	**Tue 10/24/23**
63	Design	40 days	Wed 8/16/23	Tue 10/10/23
64	QA/QC	10 days	Wed 10/11/23	Tue 10/24/23
65	Submittal	0 days	Tue 10/24/23	Tue 10/24/23
66	**Construction**	**560 days**	**Tue 10/24/23**	**Tue 12/16/25**
67	NTP	0 days	Tue 10/24/23	Tue 10/24/23
68	Mobilization	20 days	Wed 10/25/23	Tue 11/21/23
69	Construction	540 days	Wed 11/22/23	Tue 12/16/25
70	Comissioning	60 days	Wed 9/24/25	Tue 12/16/25



Project: Wilroy Schedule 2022-01
Date: Mon 8/8/22

Task	Project Summary	Manual Task	Start-only
Split	Inactive Task	Duration-only	Finish-only
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks
Summary	Inactive Summary	Manual Summary	External Milestone
Deadline	Progress	Manual Progress	

Brown and Caldwell's Internal Risk Register for Projects

Project Name:		HRSD Wilroy PRS and Tank	**Revision D**	7/28/2022
Client Name:		HRSD		
BC's Role:		Engineer of Record		
Risk Identification				
Risk #	**Risk Title**	**Risk Description**	**Risk Score**	**Mitigation Actions (Preventative or Contingency)**
Property Acquisition				
1	Property Acquisition	Limited sites available and single owner of probable location	5	
Budget				
2	Increasing construction cost	Construction costs continue to escalate making project too expensive.	4	Update construction cost through design phase. Notify HRSD when increase cause large increase.
3	Project funding using VCWRLF	VCWRLF funding requirements limit availability of equipment due to new requirements of BABAA.	2	Coordinate early to ensure enough funds are in current HRSD VCWRLF loan. Continual monitor the new BABAA requirements and how they may effect this project in the future.
Project Quality				
4	Odor Control	HRSD changes operation of tank that makes odor control system inappropriate	1	Engage and coordinate with HRSD early.
5	Design Quality Error	Error in design documents	1	BC has a rigorist QC program that shall be implemented. A individual project Quality Management Plan (QMP) to be implement.
6	Construction Quality Error	Error in construction quality control	1	Include all performance testing requirements clearly in specifications (i.e. tank watertight testing, pump performance testing.etc). Ensure thorough and continuous inspection processes by qualified persons
Permitting / Third Party Approvals				
7	Site Plan Approval	Delays caused by site plan approval.	2	Engage agencies early where possible.
8	Environmental Impacts delays	If site is wetlands or complex environmental permitting the overall implementation timeline will be impacted.	2	Engage agencies early where possible.
9	Property Zoning	Property is zoned business requires re-zone and conditional use permitting with outside agencies.	2	Engage agencies early where possible.
Impacts During Construction				
10	Vehicle traffic	Impacts to existing vehicle traffic in the area	1	Appropriate outreach/notification and signage if required.
11	Noise & Vibration	Excessive noise & vibration to neighboring residents & business during construction activities	2	Engage stakeholders early and often. Perform detailed pre-construction assessment containing mitigation techniques
12	Delays with SCADA or other I&C	Delays caused by integration of SCADA and Other I&C	1	Coordination with HRSD early on. Coordination on schedule implementation with Construction.
Community				
13	Claims/Complaints	Backlash from public on facility especially tank.	3	Engage stakeholders and community outreach early.
Design Reviews				
15	Untimely HRSD comments / approvals	Delays due to extend review times by HRSD	1	Establish review schedule early.
16	Untimely City comments / approvals	Delays due to extend review and approvals by the City	1	Establish review schedule early and coordinate reviews and approvals with the City
Utilities				
17	Utilities conflicts	Utility conflicts located during construction that cause re-design and/or a change order. Causing project delays or increased project cost.	2	Perform upfront site review and survey to capture all unknowns possible.
18	Access to utilities	Access to utilities need for site (i.e. electrical and water service)	1	Cordate early with City.
Site Conditions				
19	Geotechnical	Poor soil conditions lead to inflated costs. Additional design complexity and overall construction cost.	4	Preform final geotechnical engineering study include one day of in-situ testing, such as Dilatometers (DMTs), and several supplemental SPT borings to obtain soil samples for laboratory testing and to install at least one temporary groundwater monitoring well.
Coordination				
20	Wilroy Road widening coordination	City widening Wilroy Road could impact location of pipeline and property setbacks.	2	Coordinate early and continually through the project with City of Suffolk. Identify point of contact at City of Suffolk.
21	City of Chesapeake Raw Water line	City of Chesapeake is installing a new 24" raw water transmission line near Wilroy Road and QVC Dr.	2	Coordinate early and continually through the project with City of Chesapeake. Identify point of contact at City of Chesapeake.
22	TC Energy Natural Gas 24" replacement	TC Energy is installing a new 24" natural gas to replace an existing 12" line near Wilroy Road and QVC Dr.	2	Coordinate early and continually through the project with TC Energy. Identify point of contact at TC Energy.
23	VDOT	Electrical service will be required for this project. BC has run into delays due to new service on other projects.	2	Coordinate early and continually through the project with VDOT. Identify point of contact at VDOT.

Appendix E: Envision Checklist

Summary Results

			Credit Assessment Status	Evaluation Questions Assessed		Assessment Status						Assessed Maximum Points Available	Total Maximum Points
				Yes	No	Improved	Enhanced	Superior	Conserving	Restorative	Points		
Quality of Life	Wellbeing	QL1.1 Improve Community Quality of Life	Assessed	6	1	0	0	0	20	0	20	26	26
		QL1.2 Enhance Public Health & Safety	Assessed	4	2	0	0	12	0	0	12	20	20
		QL1.3 Improve Construction Safety	Assessed	4	1	0	0	10	0	--	10	14	14
		QL1.4 Minimize Noise & Vibration	Assessed	4	1	0	0	6	0	0	6	12	12
		QL1.5 Minimize Light Pollution	Assessed	4	2	0	0	6	0	0	6	12	12
		QL1.6 Minimize Construction Impacts	Assessed	6	0	0	0	0	8	--	8	8	8
	Mobility	QL2.1 Improve Community Mobility Access	Not Applicable	0	0	0	0	0	0	0	0	0	14
		QL2.2 Encourage Sustainable Transportation	Not Applicable	0	0	--	0	0	0	0	0	0	16
		QL2.3 Improve Access & Wayfinding	Assessed	1	3	1	0	0	0	--	1	14	14
	Community	QL3.1 Advance Equity & Social Justice	Assessed	3	4	3	0	0	0	0	3	18	18
		QL3.2 Preserve Historic & Cultural Resources	Assessed	2	4	--	2	0	0	0	2	18	18
		QL3.3 Enhance Views & Local Character	Assessed	5	1	0	0	0	11	0	11	14	14
		QL3.4 Enhance Public Space & Amenities	Not Applicable	0	0	0	0	0	0	0	0	0	14

			Credit Assessment Status	Evaluation Questions Assessed		Assessment Status						Assessed Maximum Points Available	Total Maximum Points
				Yes	No	Improved	Enhanced	Superior	Conserving	Restorative	Points		
Leadership	Collaboration	LD1.1 Provide Effective Leadership & Commitment	Assessed	3	1	0	0	12	0	--	12	18	18
		LD1.2 Foster Collaboration & Teamwork	Assessed	4	0	0	0	0	18	--	18	18	18
		LD1.3 Provide for Stakeholder Involvement	Assessed	5	1	0	0	0	14	0	14	18	18
		LD1.4 Pursue Byproduct Synergies	Not Applicable	0	0	0	0	0	0	0	0	0	18
	Planning	LD2.1 Establish a Sustainability Management Plan	Assessed	2	3	4	0	0	0	--	4	18	18
		LD2.2 Plan for Sustainable Communities	Assessed	5	0	0	0	0	0	16	16	16	16
		LD2.3 Plan for Long-Term Monitoring & Maintenance	Assessed	5	0	0	0	0	12	--	12	12	12
		LD2.4 Plan for End-of-Life	Assessed	2	3	2	0	0	0	--	2	14	14
	Economy	LD3.1 Stimulate Economic Prosperity & Development	Assessed	2	3	3	0	0	0	--	3	20	20
		LD3.2 Develop Local Skills & Capabilities	Not Applicable	0	0	0	0	0	0	0	0	0	16
		LD3.3 Conduct a Life-Cycle Economic Evaluation	Assessed	2	3	0	7	0	0	0	7	14	14

			Credit Assessment Status	Evaluation Questions Assessed		Assessment Status						Assessed Maximum Points Available	Total Maximum Points
				Yes	No	Improved	Enhanced	Superior	Conserving	Restorative	Points		
Resource Allocation	Materials	RA1.1 Support Sustainable Procurement Practices	Assessed	0	2	0	0	0	0	--	0	12	12
		RA1.2 Use Recycled Materials	Assessed	0	1	0	0	0	0	--	0	16	16
		RA1.3 Reduce Operational Waste	Not Applicable	0	0	0	0	0	0	--	0	0	14
		RA1.4 Reduce Construction Waste	Assessed	0	2	0	0	0	0	--	0	16	16
		RA1.5 Balance Earthwork On Site	Assessed	0	1	0	0	0	0	--	0	8	8
	Energy	RA2.1 Reduce Operational Energy Consumption	Not Applicable	0	0	0	0	0	0	--	0	0	26
		RA2.2 Reduce Construction Energy Consumption	Assessed	0	2	0	0	0	0	--	0	12	12
		RA2.3 Use Renewable Energy	Assessed	0	1	0	0	0	0	0	0	24	24
		RA2.4 Commission & Monitor Energy Systems	Assessed	0	3	0	0	0	0	--	0	14	14
	Water	RA3.1 Preserve Water Resources	Assessed	6	0	0	0	0	0	12	12	12	12
		RA3.2 Reduce Operational Water Consumption	Assessed	3	1	0	0	0	17	0	17	22	22
		RA3.3 Reduce Construction Water Consumption	Assessed	2	0	1	0	0	0	--	1	8	8
		RA3.4 Monitor Water Systems	Not Applicable	0	0	0	0	0	0	--	0	0	12

			Credit Assessment Status	Evaluation Questions Assessed		Assessment Status						Assessed Maximum Points Available	Total Maximum Points
				Yes	No	Improved	Enhanced	Superior	Conserving	Restorative	Points		
Natural World	Siting	NW1.1 Preserve Sites of High Ecological Value	Assessed	5	1	0	0	0	16	0	16	22	22
		NW1.2 Provide Wetland & Surface Water Buffers	Assessed	3	2	0	5	0	0	0	5	20	20
		NW1.3 Preserve Prime Farmland	Not Applicable	0	0	--	0	0	0	0	0	0	16
		NW1.4 Preserve Undeveloped Land	Assessed	0	2	0	0	0	0	0	0	24	24
	Conservation	NW2.1 Reclaim Brownfields	Not Applicable	0	0	0	0	0	0	0	0	0	22
		NW2.2 Manage Stormwater	Assessed	3	1	2	0	0	0	0	2	24	24
		NW2.3 Reduce Pesticide & Fertilizer Impacts	Assessed	3	1	0	0	0	9	0	9	12	12
		NW2.4 Protect Surface & Groundwater Quality	Assessed	2	4	2	0	0	0	0	2	20	20
	Ecology	NW3.1 Enhance Functional Habitats	Assessed	2	4	2	0	0	0	0	2	18	18
		NW3.2 Enhance Wetland & Surface Water Functions	Assessed	6	1	0	0	12	0	0	12	20	20
		NW3.3 Maintain Floodplain Functions	Assessed	4	1	0	0	0	11	0	11	14	14
		NW3.4 Control Invasive Species	Assessed	2	4	0	2	0	0	0	2	12	12
		NW3.5 Protect Soil Health	Assessed	2	2	--	3	0	0	0	3	8	8

			Credit Assessment Status	Evaluation Questions Assessed		Assessment Status						Assessed Maximum Points Available	Total Maximum Points
				Yes	No	Improved	Enhanced	Superior	Conserving	Restorative	Points		
Climate and Resilience	Emissions	CR1.1 Reduce Net Embodied Carbon	Assessed	0	3	0	0	0	0	--	0	20	20
		CR1.2 Reduce Greenhouse Gas Emissions	Assessed	0	2	0	0	0	0	0	0	26	26
		CR1.3 Reduce Air Pollutant Emissions	Assessed	0	5	0	0	0	0	0	0	18	18
	Resilience	CR2.1 Avoid Unsuitable Development	Assessed	5	1	0	0	0	12	0	12	16	16
		CR2.2 Assess Climate Change Vulnerability	Assessed	3	2	0	14	0	0	--	14	20	20
		CR2.3 Evaluate Risk and Resilience	Assessed	5	1	0	0	24	0	--	24	26	26
		CR2.4 Establish Resilience Goals and Strategies	Assessed	4	0	--	0	0	20	--	20	20	20
		CR2.5 Maximize Resilience	Assessed	4	1	0	0	20	0	--	20	26	26
		CR2.6 Improve Infrastructure Integration	Assessed	5	0	0	0	0	0	18	18	18	18

	Credit Assessment Status	Evaluation Questions Assessed		Assessment Status						Assessed Maximum Points Available	Total Maximum Points
		Yes	No	Improved	Enhanced	Superior	Conserving	Restorative	Points		
Total Points	**All Credits Assessed**	**138**	**84**	**20**	**33**	**102**	**168**	**46**	**369**	**832**	**1000**

Possible Award Level:	**Gold**

Quality of Life

1. WELLBEING

QL 1.1 Improve Community Quality of Life — 20 of 26 Points

Intent: Improve the net quality of life of all communities affected by the project and mitigate negative impacts to communities.

Metric: Measures taken to assess community needs and improve quality of life while minimizing negative impacts.

Applicability: It is likely that all projects have the ability to align project objectives with community needs and goals, identified through active engagement, in order to achieve broad community satisfaction. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team identified and taken into account community needs, goals, and issues?	Yes
B	Does the project meet or support the needs and goals of the host and/or affected communities?	Yes
C	Has the project team assessed the social impacts the project will have on the host and affected communities' quality of life?	Yes
D	Have the affected communities been meaningfully engaged in identifying how the project meets community needs and/or goals?	Yes
E	Has the project team addressed negative social impacts?	Yes
F	Are the affected communities satisfied that the project addresses their needs and goals as well as mitigates negative impacts?	Yes
G	Does the project proactively address long-term social, economic, or environmental changes that impact quality of life?	-
	Yes =	6 of 7

QL 1.2 Enhance Public Health and Safety — 12 of 20 Points

Intent: Protect and enhance community health and safety during operation.

Metric: Measures taken to increase safety and provide health benefits on the project site, surrounding sites, and the broader community in a just and equitable manner.

Applicability: It is likely that all projects, large and small, have the ability to positively impact health and/or safety in some way. Safety actions can be relative to the scale of the project, from repainting a crosswalk to preventing major chemical spills. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Does the project meet all health and safety regulations and laws for operations?	Yes
B	Has the project exceeded minimum legal health and safety requirements as established by regulations and laws?	Yes
C	Does the project include health and safety improvements for the immediate surroundings?	Yes
D	Does the project include health and safety improvements for the broader host or affected communities?	Yes
E	Can the project team demonstrate that health and safety risks and impacts are not disproportionately borne by one community over another?	-
F	Will the project provide critical infrastructure services to communities experiencing, or at risk of experiencing, imminent negative health and/or personal safety impacts?	-
	Yes =	4 of 6

QL 1.3 Improve Construction Safety — 10 of 14 Points

Intent: Enhance public and worker safety during construction.

Metric: Commitments and measures to monitor safety, provide feedback mechanisms, train personnel, establish security plans, and make health programs available.

Applicability: All projects that include construction have the ability to positively impact construction safety. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Have the project owner and contractor (GC/CM) made strong commitments to monitoring and improving health and safety?	Yes
B	Does the project include reliable feedback mechanisms to identify risks, conduct hazard analyses, and communicate hazards to personnel?	Yes
C	Does the project include safety or security training requirements for personnel?	Yes
D	Does the project include a comprehensive security plan to protect workers, the public, and sensitive information?	Yes
E	Does the project include health and/or well-being programs?	No
	Yes =	4 of 5

QL 1.4 Minimize Noise and Vibration — 6 of 12 Points

Intent: Minimize noise and vibrations during operations to maintain and improve community livability.

Metric: The extent that operational noise and vibration is assessed and mitigated, and target levels achieved.

Applicability: Consideration is given to whether the project will have any operational noise. Noises generated by activities induced by the project, such as cars on roads, pedestrians in parks, and trucks accessing facilities, are applicable to this credit. Projects that do not include any operational noise may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		Criteria Met?
A	Has the project team assessed the potential for operational noise impacts on the surrounding community and/or environment?	Yes
B	Has the project mitigated noise generated as a result of the project?	Yes
C	Does the project set or adopt target noise levels?	Yes
D	Has the project team engaged impacted stakeholders on issues of noise and vibration impacts, mitigation strategies, and target levels?	Yes
E	To what extent will the project maintain or reduce existing noise levels? Select one of the following:	No
	None	
	Yes =	4 of 5

QL 1.5 Minimize Light Pollution — 6 of 12 Points

Intent: Reduce backlight, uplight, and glare without jeopardizing safety during operations.

Metric: Lighting meets backlight, uplight, and glare requirements for lighting zones.

Applicability: This credit is not applicable if projects do not include any exterior lighting. Certain types of projects may be required to use lighting that is incompatible with the credit requirements. This is not considered an acceptable reason for designating the credit as not applicable. Projects that are unable to demonstrate achievement in this credit are encouraged to pursue higher performance in other credits.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team conducted an assessment of lighting needs and impacts for the project?	Yes
B	Has the project implemented strategies to reduce light pollution?	Yes
C	Has the project developed a lighting plan establishing lighting zones?	Yes
D	Will luminaires prevent light emission above 90 degrees?	Yes
E	Do all project lights meet backlight, uplight, and glare (BUG) requirements for their respective lighting zones?	No
F	Does the project involve the removal or retrofitting of existing lighting so as to significantly reduce overall existing lighting?	No
	Yes =	4 of 6

QL 1.6 Minimize Construction Impacts — 8 of 8 Points

Intent: Minimize or eliminate the temporary inconveniences associated with construction.

Metric: Extent of issues addressed through construction management plans.

Applicability: Consideration is given to whether the project includes construction activities with the potential to impact the quality of life of individuals. Projects that do not include construction impacts (e.g. an internal refurbishment of a private facility or extremely remote site) may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		**Criteria Met?**
A	Has the project implemented a construction management plan or policies to address construction impacts?	Yes
B	Does the construction management plan mitigate noise and/or vibrations?	Yes
C	Does the construction management plan address safety and wayfinding for pedestrians and vehicles during construction?	Yes
D	Does the construction management plan maintain access to public space and amenities during construction?	Yes
E	Does the construction management plan address distracting or intrusive lighting during construction?	Yes
F	Does the construction management plan or policies include robust feedback mechanisms and performance monitoring and reporting for construction impacts?	Yes
	Yes =	6 of 6

2. MOBILITY

QL 2.1 Improve Community Mobility and Access — 0 of 0 Points

Intent: Plan the project as part of a connected network that supports all transportation modes for the efficient movement of people, goods, and services.

Metric: The extent to which the project broadens mode choices, reduces commute times, reduces vehicle distance traveled,

Applicability: Consideration is given to whether the project has any potential to impact mobility. Non-transportation projects that do not include any mobility impacts (positive or negative), and can demonstrate no potential for positively impacting mobility, may apply to have this credit deemed not applicable with supporting documentation. This credit is inherently applicable to all transportation infrastructure projects.

		Yes/No
	Is this credit applicable?	No

	Assessment Questions:	Criteria Met?
A	Is the project consistent with local transportation plans?	-
B	Has the project team obtained input from the community and key stakeholders regarding issues of mobility and access?	-
C	Does the project include strategies to increase capacity, manage congestion, reduce vehicle distance traveled, or lower accident rates?	-
D	Has the project team worked with the community to expand mobility and access options and/or incorporate complete streets policies?	-
E	Has the project team considered the long-term mobility and access needs of the community?	-
F	Does the project create new or restore previous connections between communities?	-
	Yes =	-

QL 2.2 Encourage Sustainable Transportation — 0 of 0 Points

Intent: Expand accessibility to sustainable transportation choices including active, shared, and/or mass transportation.

Metric: The extent to which active, shared, or mass transportation options are accessible, encouraged, and supported as part of a larger integrated transportation network.

Applicability: Consideration is given to whether the project includes transportation infrastructure, or includes the frequent dependence on transportation for access to the project. This credit is applicable to all transportation infrastructure. Projects that do not include transportation infrastructure and are not accessible, unmanned, or have very small maintenance crews, may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	No

	Assessment Questions:	Criteria Met?
A	Does the project provide convenient access to active, shared, or mass transportation options?	-
B	Is the project configured and designed in such a way to encourage active, shared, and/or mass transportation options?	-
C	Does the project include programs and facilities that support the use of active transportation and transit?	-
D	Does the project contribute to a larger integrated active, shared, or mass transportation strategy for the community or region?	-
	Yes =	-

QL 2.3 Improve Access and Wayfinding — 1 of 14 Points

Intent: Design the project to provide safe and appropriate access in and/or around the project in a way that integrates the project with the surrounding community.

Metric: Incorporating and providing clear access, safety, and wayfinding measures to accommodate emergency services and regular vehicular or pedestrian traffic.

Applicability: Consideration is given to the potential for impacting community access on or around the project site. Infrastructure that is inherently inaccessible (e.g., underground) or extremely remote (e.g., inaccessible by public roads) may apply to have this credit deemed not applicable with supporting documentation. Default restrictions on public access are not considered acceptable justification for marking the credit not applicable. This credit is automatically applicable to any project in proximity to populated areas or other development, adjacent to sensitive sites, or involving regular incoming or outgoing traffic.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		**Criteria Met?**
A	Has the project addressed access, safety, and wayfinding for incident management including evacuation and emergency personnel?	Yes
B	Does the project utilize access, safety, and signage to protect or minimize impacts on the surroundings?	No
C	Does the project provide safe public access points for the benefit of the community?	No
D	Does the project have a positive and transformative impact on community neighborhood access, safety, and/or wayfinding?	No
	Yes =	1 of 4

3. COMMUNITY

QL 3.1 Advance Equity and Social Justice — 3 of 18 Points

Intent: Ensure that equity and social justice are fundamental considerations within project processes and decision making.

Metric: Degree to which equity and social justice are included in stakeholder engagement, project team commitments, and decision making.

Applicability: This credit can be designated as not applicable for projects that do not impact the surrounding community. For example, the installation or refurbishment of systems internal to a facility that do not impact the quality or level of service provided by the infrastructure.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		**Criteria Met?**
A	Does the stakeholder engagement process take into account the historic context of equity and social justice within affected communities?	Yes
B	Has the project team assessed the social impacts the project will have on the host and affected communities?	Yes
C	Have key members of the project team made commitments to equity and social justice within their organizations?	Yes
D	Has the project addressed social impacts related to equity and social justice?	No
E	Will the impacts and benefits of the project be distributed equitably throughout affected communities?	No
F	Has the project team empowered communities to engage in the development process?	No
G	Does the project positively address or correct an existing or historic injustice or imbalance?	No
	Yes =	3 of 7

QL 3.2 Preserve Historic and Cultural Resources — 2 of 18 Points

Intent: Preserve or restore significant historical and cultural sites and related resources.

Metric: Steps taken to identify, preserve, or restore cultural resources.

Applicability: Project teams that are unable to identify any historic or cultural resources relevant to the project may apply to have this credit deemed not applicable with supporting documentation. Supporting documentation should demonstrate how stakeholder engagement activities, cultural resource studies, or equivalent, were implemented in an effort to identify possible historic or cultural resources. This credit is applicable to all infrastructure projects that impact a historic or cultural resource identified in state/provincial, national, or international registries, or identified through stakeholder engagement. This credit is also applicable, and no points achieved, for projects that cannot demonstrate a serious effort was made to identify potential historic or cultural resources.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team worked with the community and required regulatory and resource agencies to identify historic and cultural resources?	Yes
B	Has the project team developed strategies to document, protect, or enhance historic and cultural resources to the project?	Yes
C	Does the identification of historic/cultural resources extend beyond registries to identify important parts of the community culture?	No
D	Has the project team worked with stakeholders to develop a sensitive design and approach?	No
E	Does the project avoid all historic/cultural resources or fully preserve/protect their character-defining features?	No
F	Does the project enhance or restore threatened or degraded historic/cultural resources in the community, or add a resource to a protected registry?	No
	Yes =	2 of 6

QL 3.3 Enhance Views and Local Character — 11 of 14 Points

Intent: Preserve or enhance the physical, natural, and/or community character of the project site and its surroundings.

Metric: Steps taken to assess valued community resources, implement preservation measures, and determine overall satisfaction.

Applicability: Projects that have no public visibility or impact on views, such as underground utilities or the refurbishment of equipment within an existing facility, may submit to have this credit deemed not applicable with supporting documentation. Reviewers are unlikely to accept arguments that a publicly visible project has no impact on views or local character.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		Criteria Met?
A	Has the project team made a reasonable determination of community values and concerns regarding protection and enhancement of views and local character?	Yes
B	Has the project team implemented specific strategies to preserve or enhance views and local character?	Yes
C	Has the project team developed or adopted existing guidelines to preserve views and local character?	Yes
D	Does the project include a construction management plan to protect important natural or man-made features?	Yes
E	Does the community support actions taken to preserve or enhance views and local character?	Yes
F	Will the project result in the restoration or enhancement of views or local character?	No
	Yes =	5 of 6

QL 3.4 Enhance Public Space and Amenities — 0 of 0 Points

Intent: Improve amenities and publicly accessible spaces to enhance community livability.

Metric: Plans and commitments to preserve, conserve, enhance, and/or restore the defining elements of the amenity.

Applicability: This credit is applicable to projects that are publicly accessible or that impact, adjoin, or otherwise connect to existing public spaces or amenities. This represents the large majority of infrastructure projects. Designating this credit as not applicable can be difficult. Projects that by their nature preclude the possibility of addressing public space or amenities may submit to have this credit deemed not applicable with supporting documentation (e.g., mechanical system refurbishments, offshore wind farms, etc.). Not addressing the potential for public space or amenities is not sufficient alone to designate this credit not applicable. Infrastructure projects, especially those traditionally viewed as inaccessible, are encouraged to consider how they can benefit their surrounding community through the enhancement or provision of public space and amenities.

		Yes/No
	Is this credit applicable?	No

Assessment Questions:			Criteria Met?
A	Has the project team assessed and mitigated impacts to existing public space and/or amenities?		-
B	Does the stakeholder engagement process specifically address issues of public space and amenities?		-
C	Are public stakeholders satisfied with the project plans involving public space and amenities?		-
D	To what extent does the project involve significantly enhancing, creating, or restoring public space and/or amenities? Select one of the following:	2	No
	None		
		Yes =	-

Leadership

1. COLLABORATION

LD 1.1 Provide Effective Leadership and Commitment — 12 of 18 Points

Intent: Provide effective leadership and commitment to achieve project sustainability goals.

Metric: The degree to which the project owner and project team have made general, and project-specific, sustainability commitments and instituted sustainability management policies.

Applicability: It is likely that all projects can benefit from effective leadership and strong commitments to sustainability. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Have the project owner and project team made written commitments to address the social, environmental, and economic aspects of the project?	Yes
B	Is the project supported by a sustainability management policy commensurate with the scope, scale, and complexity of the project?	Yes
C	Has the project team periodically revisited project sustainability commitments throughout project delivery?	Yes
D	Have key members of the project team made organizational commitments to sustainability?	No
	Yes =	3 of 4

LD 1.2 Foster Collaboration and Teamwork — 18 of 18 Points

Intent: Enhance project sustainability through interdisciplinary collaboration and teamwork.

Metric: The breadth and inclusivity of interdisciplinary and collaborative meetings and the resulting sustainability performance enhancements.

Applicability: It is likely that all projects can benefit from better collaboration and teamwork in pursuit of more sustainable projects. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Was an interdisciplinary collaborative kickoff meeting held early in the project to define sustainability goals?	Yes
B	Has project sustainability performance been enhanced as a result of the interdisciplinary collaboration?	Yes
C	Did the project team establish regular interdisciplinary and collaborative meetings to set and achieve sustainability goals?	Yes
D	Does the process include construction, operations, or maintenance stakeholders, for better incorporation of considerations in later project phases?	Yes
	Yes =	4 of 4

LD 1.3 Provide for Stakeholder Involvement — 14 of 18 Points

Intent: Early and sustained stakeholder engagement and involvement in project decision making.

Metric: Establishment of sound and meaningful programs for stakeholder identification, early and sustained engagement, and involvement in project decision making.

Applicability: It is likely that all projects can benefit from stakeholder engagement. Although the types and scope of stakeholders may vary depending on the project, it would be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team undertaken a stakeholder mapping exercise to determine stakeholders? Were primary and secondary stakeholders identified through a stakeholder mapping process, and stakeholder concerns and specific objectives for stakeholder engagement defined?	Yes
B	Has the project team analyzed, planned, and executed the engagement for key project stakeholders? Is there a proactive stakeholder engagement process established with clear objectives where: engagement moves beyond education into active dialogue; stakeholder views are monitored, and a two-way line of communication is established to reply to inquiries; and sufficient opportunities are provided for stakeholders to be involved in decision making?	Yes
C	Was a lead member of the project team directly involved with stakeholder groups to understand their needs?	Yes
D	Has stakeholder engagement feedback been incorporated into project plans, design, and/or decision making? Are specific cases in which public input influenced or validated project outcomes, and potentially conflicting stakeholder views were evaluated and addressed equitably during decision making?	Yes
E	Has the project team sought feedback from stakeholders as to their satisfaction with the engagement process and the resulting decisions that were made based on their input?	Yes
F	Has the project engaged one or more stakeholders as partners?	No
	Yes =	5 of 6

LD 1.4 Pursue Byproduct Synergies — 0 of 0 Points

Intent: Critically reconsider whether traditional waste streams can be beneficially reused.

Metric: The extent to which the project team works with external groups to find beneficial use of waste, excess resources, or capacity.

Applicability: It is likely that all projects that use materials or product waste can benefit from byproduct synergies. It would be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

	Yes/No
Is this credit applicable?	No

	Assessment Questions:		Criteria Met?
A	Has the project team assessed the availability of either internal or external excess resources or capacity?		-
B	Has the project team identified opportunities for byproduct synergies or reuse?		-
C	Has the project team actively pursued a byproduct synergy or reuse?		-
D	Does the project include a byproduct synergy by utilizing unwanted excess resources or finding destinations for the beneficial reuse of unwanted excess resources? Select one of the following:		No
	None	2	
E	Is the project part of a circular economy, whereby the majority of operational byproducts are beneficially repurposed or the majority of operational resources consumed are beneficially repurposed?		-
		Yes =	-

2. PLANNING

LD 2.1 Establish a Sustainability Management Plan — 4 of 18 Points

Intent: Create a project sustainability management plan that can manage the scope, scale, and complexity of a project seeking to improve sustainable performance.

Metric: Extent of organizational policies, authorities, mechanisms, education, and business processes put in place.

Applicability: It is likely that all projects can benefit from a sustainability management plan. It would be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Are roles and responsibilities for addressing sustainability assigned to key members of the project team?	Yes
B	Has a sustainability management plan been developed to assess and prioritize the environmental, economic, and social aspects of the project and set project sustainability goals, objectives, and targets?	Yes
C	Does the project include a sustainability management plan that contains sufficient processes and management controls to address the sustainability goals, objectives, and targets?	No
D	Was the sustainability management plan implemented and periodically revisited?	No
E	Is the project sustainability management plan adaptable, flexible, and resilient enough to manage changes in the environmental, social, or economic conditions of the project over its life?	No
	Yes =	2 of 5

LD2.2 Plan for Sustainable Communities — 16 of 16 Points

Intent: Incorporate sustainability principles into project selection/identification in order to develop the most sustainable project for the community.

Metric: The degree to which project selection/identification includes sustainability performance assessments and is part of a larger sustainable development plan.

Applicability: Consideration is given to the scope and scale of the project and whether it has the potential to more broadly impact community sustainability. For example, small projects that involve the retrofitting or refurbishment of components or systems within an existing facility may contribute to improved sustainability performance but may struggle to demonstrate an impact beyond the project site. Small projects that do not impact the broader community sustainability, and do not have the potential to impact community sustainability, may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		**Criteria Met?**
A	Was sustainability considered during project selection/identification?	Yes
B	Were alternative analyses conducted on sustainability performance during project identification?	Yes
C	Was an assessment conducted of the project's impacts to broader long-term community or regional sustainability?	Yes
D	Is the project part of a comprehensive sustainable development plan?	Yes
E	Does the project address an inherently unsustainable condition within the community or region?	Yes
	Yes =	5 of 5

LD2.3 Plan for Long-Term Monitoring and Maintenance — 12 of 12 Points

Intent: Put in place plans, processes, and personnel sufficient to ensure that long-term sustainable protection, mitigation, and enhancement measures are incorporated into the project.

Metric: Comprehensiveness of long-term monitoring and maintenance plans, implementation goals, and commitment of resources to fund the activities.

Applicability: This credit is applicable to all projects that include ongoing monitoring and maintenance. In rare cases where projects do not include operation or maintenance activities, projects may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		**Criteria Met?**
A	Has the project team considered how to reduce ongoing operational impacts?	Yes
B	Is there a clear and comprehensive plan in place for long-term monitoring and maintenance of the completed project?	Yes
C	Has the monitoring and maintenance plan been communicated with operations and maintenance staff?	Yes
D	Have sufficient resources been allocated for long-term monitoring and maintenance of the completed project and appropriate training been conducted?	Yes
E	Is there a plan in place to re-evaluate and modify the maintenance plan based on monitored data?	Yes
	Yes =	5 of 5

LD2.4 Plan for End-of-Life — 2 of 14 Points

Intent: Ensure that the project team is informed by an understanding of the full impacts and costs of the project's end-of-life.

Metric: The degree to which the project team analyzes, and communicates with stakeholders, the end-of-life impacts, cost, and value.

Applicability: It is likely that all projects can benefit from end-of-life planning. It would be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		Criteria Met?
A	Has the project team developed an end-of-life plan?	Yes
B	Has the project team evaluated opportunities to extend the project's useful life or beneficially repurpose the project after end-of-life?	Yes
C	Has the project team assessed potential social, environmental, and economic end-of-life impacts?	No
D	Has the project team evaluated the costs and salvage value of the project's deconstruction, decommissioning, or replacement?	No
E	Has the project team proactively engaged stakeholders in end-of-life planning?	No
	Yes =	2 of 5

3. ECONOMY

LD3.1 Stimulate Economic Prosperity and Development — 3 of 20 Points

Intent: Support economic prosperity and sustainable development, including job growth, capacity building, productivity, business attractiveness, and livability.

Metric: The extent of job creation, increased operating capacity, access, quality, and/or improved socioeconomic conditions.

Applicability: The scope of this credit is broad, covering commercial, industrial, cultural, and recreational aspects of community development. In determining whether this credit is applicable to a project assessment, it is likely that all projects have the ability to support and stimulate economic prosperity and sustainable development. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		Criteria Met?
A	Does the project create a significant number of new jobs during its design, construction, and operation?	Yes
B	Does the project provide new operating capacity for business, industry, or the public?	Yes
C	Does the project provide additional access, increase the number of choices, and/or increase the quality of infrastructure services for business, industry, or the public?	No
D	Does the project improve community attractiveness for business, industry, or the public by generally improving the socioeconomic conditions of the community?	No
E	Will the project stimulate economic prosperity and further economic development?	No
	Yes =	2 of 5

LD3.2 Develop Local Skills and Capabilities — 0 of 0 Points

Intent: Expand the knowledge, skills, and capacity of the community workforce to improve their ability to grow and develop.

Metric: The inclusion of current and future training programs, informed by skill or capability gaps, and targeted to economically depressed or underemployed communities.

Applicability: For this credit, an alternative compliance path is provided in the Evaluation Criteria and Documentation Guidance for projects that are too small to include independent training and skill development. It is therefore unlikely that a project could demonstrate no opportunity for education at any point during its planning, design, or construction. When organizational-level training programs are referenced, project teams must demonstrate a relevance to the project.

		Yes/No
Is this credit applicable?		No

	Assessment Questions:		Criteria Met?
A	Will the project include training programs for local skill development?		-
B	Has the project team identified skill or capability gaps in the local workforce and targeted training programs to address them? Select one of the following:	2	No
	None		
C	Will training, education, or skill development programs continue after project delivery?		-
D	Will training and skill development programs specifically target economically depressed, underemployed, or disadvantaged communities?		-
		Yes =	-

LD3.3 Conduct a Life-Cycle Economic Evaluation — 7 of 14 Points

Intent: Utilize economic analyses to identify the full economic implications and the broader social and environmental benefits of the project.

Metric: The comprehensiveness of the economic analyses used to determine the net impacts of the project, and their use in assessing alternatives to inform decision making.

Applicability: It would be difficult to demonstrate that this credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
Is this credit applicable?		Yes

	Assessment Questions:	Criteria Met?
A	Has a life-cycle cost analysis been conducted to identify the financial impacts of the whole project?	Yes
B	Have life-cycle cost analyses been used to compare alternatives for at least one major project component?	Yes
C	Has the project team mapped the social, environmental, and financial costs and benefits of the project?	No
D	Has a cost benefit analysis been conducted to identify the financial, social, and environmental impacts of the whole project?	No
E	Have cost benefit analyses, including financial, environmental, and social benefits, been used to compare the alternatives for at least one major project component?	No
	Yes =	2 of 5

Resource Allocation

1. MATERIALS

RA1.1 Support Sustainable Procurement Practices		0 of 12 Points
Intent: Develop sustainable procurement policies and programs to source materials and equipment from manufacturers and suppliers that implement sustainable practices.		
Metric: The extent of sustainable procurement programs, and the percentage of materials sourced from manufacturers and/or suppliers that implement sustainable practices.		
Applicability: This credit is applicable to all projects that include the use or consumption of physical materials in construction or operation.		
		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team implemented a sustainable procurement policy or program?	No
B	To what extent do materials, supplies, equipment, manufacturers, and suppliers meet sustainable procurement policy/program requirements? Select one of the following:	No
	None	
	Yes =	0 of 2

RA1.2 Use Recycled Materials		0 of 16 Points
Intent: Reduce the use of virgin natural resources and avoid sending useful materials to landfills by specifying reused materials, including structures, and material with recycled content.		
Metric: Percentage of project materials that are reused or recycled. Plants, soil, rock, and water are not included in this credit.		
Applicability: This credit is applicable to all projects that include the use or consumption of physical materials in construction or operation.		
		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	To what extent has the project team used recycled materials, including materials with recycled content and/or reused existing structures or materials? Select one of the following:	No
	None	
	Yes =	0 of 1

`

RA1.3 Reduce Operational Waste — 0 of 0 Points

Intent: Reduce operational waste and divert waste streams from disposal to recycling and reuse.

Metric: Percentage of total operational waste or byproducts diverted from disposal.

Applicability: This credit is applicable to all projects that produce operational waste or byproducts. Projects that do not include any operational waste may apply to have this credit deemed not applicable with supporting documentation.

			Yes/No
	Is this credit applicable?		No
Assessment Questions:			**Criteria Met?**
A	Has the project team developed a waste management plan to decrease project waste and divert waste from landfills during operation?		-
B	To what extent has the project team reduced waste or diverted waste from landfills? Select one of the following:	2	No
	None		
		Yes =	-

RA1.4 Reduce Construction Waste — 0 of 16 Points

Intent: Divert construction and demolition waste streams from disposal to recycling and reuse.

Metric: Percentage of total waste diverted from disposal.

Applicability: This credit is applicable to all projects that produce construction waste. Projects that do not include any construction waste may apply to have this credit deemed not applicable with supporting documentation.

			Yes/No
	Is this credit applicable?		Yes
Assessment Questions:			**Criteria Met?**
A	Has the project team developed a comprehensive waste management plan to decrease project waste and divert waste from landfills during construction?		No
B	To what extent has construction waste been diverted from landfills? Select one of the following:		No
	None		
		Yes =	0 of 2

RA1.5 Balance Earthwork On Site — 0 of 8 Points

Intent: Minimize the movement of soils and other excavated materials off site to reduce transportation and environmental impacts.

Metric: Percentage of excavated material retained on site or nearby.

Applicability: This credit is applicable to all projects that involve the excavation of qualifying earthwork. Projects that do not include any earthwork, or only involve the excavation of excluded material considered contaminated or hazardous, may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the amount of excavated soil is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of excavated material in the context of the project.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	To what extent has the project team designed the project to balance cut and fill to reduce the excavated material taken off site? Select one of the following:	No
	None	
	Yes =	0 of 1

2. ENERGY

RA2.1 Reduce Operational Energy Consumption — 0 of 0 Points

Intent: Conserve energy by reducing overall operational energy consumption throughout the project life.

Metric: Percentage of operational energy reductions achieved.

Applicability: This credit is applicable to all projects that consume energy during their operation. Projects that do not include operational energy may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the amount of operational energy use is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of operational energy use in the context of the project.

		Yes/No
	Is this credit applicable?	No
Assessment Questions:		**Criteria Met?**
A	Has the project team determined the estimated annual energy consumption of the project during operations?	No
B	To what extent has the project reduced operational energy consumption? Select one of the following: 2	No
	None	
	Yes =	-

RA2.2 Reduce Construction Energy Consumption — 0 of 12 Points

Intent: Conserve resources and reduce greenhouse gases and air pollutant emissions by reducing energy consumption during construction.

Metric: The number of strategies implemented on the project during construction that reduce energy consumption and emissions.

Applicability: This credit is applicable to all projects that consume energy during construction. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award. In rare cases, where the amount of energy used during construction is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of construction energy use in the context of the project.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team conducted planning reviews to reduce energy consumption during construction?	No
B	To what extent have energy conservation strategies been implemented during construction? (strategies are listed in the Envision Guidance Manual) Select one of the following:	No
	None	
	Yes =	0 of 2

RA2.3 Use Renewable Energy — 0 of 24 Points

Intent: Meet operational energy needs through renewable energy sources.

Metric: Extent to which renewable energy sources are incorporated.

Applicability: This credit is applicable to all projects that consume energy (fuel or electricity) during their operation. Projects that do not include operational energy may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the amount of operational energy use is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of operational energy use in the context of the project.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	To what extent does the project meet electricity or fuel needs from renewable sources? Select one of the following:	No
	None	
	Yes =	0 of 1

RA2.4 Commission and Monitor Energy Systems — 0 of 14 Points

Intent: Ensure efficient functioning and extend useful life by specifying commissioning and monitoring of energy systems.

Metric: The inclusion of monitoring equipment and software, the extent of commissioning, and the commissioning agent's independence from the project.

Applicability: This credit is applicable to all projects that consume energy during their operation. Projects that do not include operational energy may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the amount of operational energy use is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of operational energy use in the context of the project.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		**Criteria Met?**
A	Does the design incorporate advanced integrated monitoring systems in order to enable more efficient operations? Select one of the following:	No
	None	
B	To what extent has a commissioning been conducted? Select one of the following:	No
	None	
C	Is there a plan for ongoing commissioning of the energy systems throughout the project's life?	No
	Yes =	0 of 3

RA3.1 Preserve Water Resources — 12 of 12 Points

Intent: Assess and reduce the negative net impact on fresh water availability, quantity, and quality at a watershed scale to positively impact the region's water resources.

Metric: The extent to which the project considers and contributes to positively addressing broader watershed issues.

Applicability: This credit is applicable to all projects that consume water or impact receiving waters. Projects that do not include any impacts to water quantity or quality may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the impact to water quantity or quality is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant impact to water quantity or quality use in the context of the project.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		**Criteria Met?**
A	Has the project team conducted a watershed assessment?	Yes
B	Has the project team estimated the water usage and wastewater generation over the life of the project?	Yes
C	Does the project include features to minimize the negative impacts of water usage, and/or watershed-scale issues?	Yes
D	Does the project have a net-zero impact on the quantity and availability of fresh surface water and groundwater supplies without compromising water quality?	Yes
E	Is the project part of a watershed-level or regional plan?	Yes
F	Does the project make a direct net-positive improvement to the watershed?	Yes
	Yes =	6 of 6

RA3.2 Reduce Operational Water Consumption — 17 of 22 Points

Intent: Reduce overall water consumption while encouraging the use of greywater, recycled water, and stormwater to meet water needs.

Metric: Percentage reduction in potable water use and overall water use.

Applicability: This credit is applicable to all projects that consume water during operations. Projects that do not include any operational water consumption may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the amount of water consumption is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of operational water use in the context of the project.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team conducted planning and design reviews to identify potable water reduction strategies during operation of the project?	Yes
B	To what extent has the project reduced potable water use? Select one of the following:	Yes
	The project reduces potable water use by at least 95%.	
C	To what extent has the project reduced overall water use (including potable and nonpotable water)? Select one of the following:	Yes
	Overall water use (potable and nonpotable) is reduced by at least 40%.	
D	Does the project have a net positive impact on water use?	No
	Yes =	3 of 4

RA3.3 Reduce Construction Water Consumption — 1 of 8 Points

Intent: Reduce potable water consumption during construction.

Metric: The number of strategies implemented during construction that reduce potable water consumption.

Applicability: This credit is applicable to all projects that consume water during construction. Projects that do not include any operational water consumption may apply to have this credit deemed not applicable with supporting documentation. In cases where the amount of water consumption during operations is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of operational energy use in the context of the project.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team conducted planning reviews to reduce water consumption during construction?	Yes
B	To what extent have water conservation strategies been implemented during construction? Select one of the following:	Yes
	At least one (1) potable water conservation strategy is implemented.	
	Yes =	2 of 2

RA3.4 Monitor Water Systems — 0 of 0 Points

Intent: Improve operational performance by including monitoring capabilities.

Metric: Extent and capability of water monitoring equipment and inclusion of response plans.

Applicability: This credit is applicable to all projects that consume water during their operation or include the conveyance of large quantities of water. Projects that do not include operational water use or water conveyance may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the amount of operational water use, or conveyance, is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of water use in the context of the project.

	Yes/No
Is this credit applicable?	No

Assessment Questions:			Criteria Met?
A	Does the design incorporate advanced integrated monitoring systems in order to improve performance? Select one of the following:	2	No
	None		
B	Does the project include real-time water monitoring?		-
		Yes =	-

Natural World

1. SITING

NW1.1 Preserve Sites of High Ecological Value		16 of 22 Points
Intent: Avoid placing the project and temporary works on a site that has been identified as being of high ecological value.		
Metric: Avoidance of high ecological value sites and establishment of protective buffer zones.		
Applicability: Projects that do not contain areas of high ecological value, and cannot demonstrate they actively avoided areas of high ecological value, may apply to have this credit deemed not applicable with supporting documentation.		
		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team identified whether the site contains areas of high ecological value?	Yes
B	Has the project mitigated any areas of high ecological value that are disturbed? <u>Select one of the following:</u>	Yes
	Mitigation is on site or an adjacent contiguous parcel of equal or higher ecological value. Temporary impacts from construction activities do not decrease the capacity of preserved land.	
C	Does the project avoid developing or disturbing areas of high ecological value on site?	Yes
D	Does the project preserve an effective protective buffer zone around areas of high ecological value?	Yes
E	Was the project intentionally sited to avoid areas of high ecological value?	Yes
F	Does the project significantly increase the area of high ecological value?	-
	Yes =	5 of 6

NW1.2 Provide Wetland and Surface Water Buffers — 5 of 20 Points

Intent: Protect, buffer, enhance, and restore wetlands, shorelines, and waterbodies by providing natural buffer zones, vegetation, and soil-protection zones.

Metric: Type and quality of natural buffer zone established around all wetlands, shorelines, and waterbodies.

Applicability: Projects that do not contain wetlands or surface waters, and for which no siting options containing wetlands or surface waters were possible or seriously considered, may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team identified wetlands and surface waters on or near the site?	Yes
B	Has the project team determined the type and width of buffer zones necessary to protect wetlands and surface waters?	Yes
C	To what extent has the project implemented protective buffer zones around wetlands and surface waters? Select one of the following:	Yes
	The project provides a buffer of managed vegetated zones around all wetlands and surface waters. Managed zones may include grass. The buffer is of sufficient width to slow surface runoff, and trap sediments, pesticides, and other pollutants. Minimum width is 100 ft/30 m unless otherwise justified under criterion B.	
D	Was the project intentionally sited to avoid wetlands and surface waters?	No
E	Will the project involve returning previously developed or disturbed sites within the buffer zone to a natural state?	No
	Yes =	3 of 5

NW1.3 Preserve Prime Farmland — 0 of 0 Points

Intent: Identify and protect soils designated as prime farmland, unique farmland, or farmland of importance.

Metric: Percentage of farmland avoided or preserved during development.

Applicability: Projects that do not contain prime farmland, and for which no siting options containing prime farmland were possible or seriously considered, may apply to have this credit deemed not applicable with supporting documentation.

			Yes/No
	Is this credit applicable?		No
Assessment Questions:			**Criteria Met?**
A	Has the project team assessed the project site for soils identified as prime farmland, unique farmland, or farmland of importance?		-
B	To what extent will the project protect or preserve prime farmland, unique farmland, or farmland or importance? Select one of the following:	2	No
	None		
C	Has the project team mitigated any damage or disturbance to prime farmland, unique farmland, or farmland of importance?		-
D	Was the project intentionally sited to avoid prime farmland?		-
E	Does the project preserve existing farmland for posterity or restore previously disturbed farmland?		-
	Yes =		-

NW1.4 Preserve Undeveloped Land — 0 of 24 Points

Intent: Conserve undeveloped land by locating projects on previously developed land.

Metric: Percentage of project development that is located on previously developed land.

Applicability: Assessment of this credit is determined by the extent to which the project is located on previously developed land or previously undeveloped land. As all land falls within these two classifications, it would be difficult to demonstrate that the credit is not applicable. Inability to locate the project on developed land is not sufficient justification to remove this credit from consideration.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		**Criteria Met?**
A	To what extent is the project located on previously developed land? Select one of the following:	No
	None	
B	Has the project returned developed areas to a condition that supports natural open space, habitat, or natural hydrology?	-
	Yes =	0 of 2

2. CONSERVATION

NW2.1 Reclaim Brownfields — 0 of 0 Points

Intent: Locate projects on sites classified as brownfields.

Metric: The extent of remediation of the brownfield site.

Applicability: Project teams that were unable to identify a suitable site may apply to have this credit deemed not applicable with supporting documentation that efforts were made. If no evidence is provided that any consideration was given to locating the project on a brownfield, the credit is considered applicable and no points achieved.

			Yes/No
	Is this credit applicable?		No

Assessment Questions:			Criteria Met?
A	Is the project located on a site currently identified as a closed brownfield?		-
B	Is the project located on a site currently identified as an active brownfield?		-
C	To what extent has the project mitigated or remediated the site? Select one of the following:	2	No
	None		
D	Has the brownfield site been closed or deregulated?		-
		Yes =	-

NW2.2 Manage Stormwater — 2 of 24 Points

Intent: Minimize the impact of development on stormwater runoff quantity, rate, and quality.

Metric: Degree to which the project infiltrates, evapotranspirates, reuses, and/or treats stormwater while not exceeding rate or quantity runoff targets.

Applicability: This credit is applicable to all projects that impact stormwater runoff. In rare cases, where the impact on stormwater runoff is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant impact on stormwater runoff in the context of the project.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	To what extent does the project infiltrate, evapotranspirate, reuse, and/or treat stormwater on site? Select one of the following:	Yes
	Detain and treat 100% of the 85th percentile local 24-hour event. Ensure compliance with local requirements if stricter.	
B	To what extent does the completed project limit rate or quantity of runoff compared to existing conditions? Select one of the following:	Yes
	Do not exceed rate or quantity of runoff for the 2-year 24-hour rainfall event relative to the existing condition (greenfield, greyfield, or brownfield).	
C	Does the project include an erosion, sedimentation, and pollution control plan for all construction activities?	Yes
D	Does the project treat stormwater from other sites or does it function as part of a larger stormwater management plan?	No
	Yes =	3 of 4

NW2.3 Reduce Pesticide and Fertilizer Impacts — 9 of 12 Points

Intent: Reduce non-point-source pollution by reducing the quantity, toxicity, bioavailability, and persistence of pesticides and fertilizers.

Metric: Reductions in quantity, toxicity, bioavailability, and persistence of pesticides and fertilizers used on site, selection of plant species, and use of integrated pest management techniques.

Applicability: Consideration is given as to whether the scope of the project includes exterior vegetated areas. Projects that do not include exterior vegetated areas may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Have operational policies and programs been put in place to control the application of fertilizers and pesticides?	Yes
B	Have runoff controls been put in place to minimize contamination of groundwater and surface water?	Yes
C	To what extent has the project team designed landscaping to require fewer pesticides and fertilizers? Select one of the following:	Yes
	Landscaping is designed with plant species that do not require pesticides or fertilizers.	
D	Has the project team selected pesticides and fertilizers that have lower toxicity, persistence, and bioavailability?	No
	Yes =	3 of 4

NW2.4 Protect Surface and Groundwater Quality — 2 of 20 Points

Intent: Preserve water resources by preventing pollutants from contaminating surface water and groundwater and monitoring impacts during construction and operations.

Metric: Designs, plans, and programs instituted to prevent and monitor surface water and groundwater contamination during construction and operations.

Applicability: This credit is applicable to all projects that contain or use hazardous and/or potentially polluting substances with the potential to contaminate water sources. In addition to chemical use, project teams should consider how chemical leaching from materials may be a source of contamination.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has project team determined the potential for surface water and/or groundwater contamination during construction and operations?	Yes
B	Does the project include spill and leak prevention and response plans, and avoid creating new pathways for contamination during construction and operations?	Yes
C	Based on the types of impacts identified in criterion A, does the project reduces the risk of quality degradation to surface water and/or groundwater? This should include water temperature.	No
D	Have adequate and responsive surface water and/or groundwater quality monitoring and reporting systems been incorporated into the project?	No
E	Has the project actively eliminated at least one source of hazardous and/or potentially polluting substances, or replaced them with nonhazardous or nonpolluting substances or materials?	No
F	Does the project improve surface water and/or groundwater quality?	No
	Yes =	2 of 6

2. ECOLOGY

NW3.1 Enhance Functional Habitats — 2 of 18 Points

Intent: Preserve and improve the functionality of terrestrial (land) habitats.

Metric: The number of habitat functions addressed in order to preserve or enhance the net area and quality of functional habitat.

Applicability: Consideration is given to whether the project contains or impacts natural habitat. Projects that do not contain or impact natural habitat may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team identified existing terrestrial habitats and sited the project to minimize impact?	Yes
B	Does the project mitigate all disturbances to functional terrestrial (land) habitats? Select one of the following:	Yes
	Mitigation measures ensure that existing habitat functions as defined in criteria C, D, and E are maintained (i.e., not degraded or lost). Mitigation must occur on or adjacent to the site and follow a hierarchy that prioritizes avoidance, minimization, restoration, and compensation.	
C	Does the project increase the quantity of terrestrial habitat?	No
D	Does the project improve the quality of any existing or proposed new terrestrial habitat?	No
E	Does the project facilitate movement between terrestrial habitats, provide new connections, or remove barriers, in order to improve habitat connectivity?	No
F	Does the project return developed land to natural habitat, or set aside existing habitat for permanent conservation and protection?	No
	Yes =	2 of 6

NW3.2 Enhance Wetland and Surface Water Functions — 12 of 20 Points

Intent: Maintain and restore the ecosystem functions of streams, wetlands, waterbodies, and their riparian areas.

Metric: Number of functions maintained and restored.

Applicability: Consideration is given to whether the project contains or impacts wetlands or surface waters. This includes direct, indirect, and/or cumulative impacts. Projects that do not contain or impact natural wetlands or surface waters may apply to have this credit deemed not applicable with supporting documentation

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team identified impacts to wetland and surface water functions?	Yes
B	Does the project minimize and mitigate disturbance to wetland and surface water functions? Select one of the following:	Yes
	Efforts are made to avoid and minimize negative impacts to wetland and surface water functions and to compensate for remaining unavoidable losses. Mitigation measures must maintain net aquatic habitat quality and quantity and follow a hierarchy that prioritizes avoidance, minimization, restoration, and compensation	
C	Does the project protect or restore hydrologic connection?	Yes
D	Does the project protect or restore water quality?	Yes
E	Does the project protect or restore aquatic habitat?	Yes
F(1)	Does the project protect sediment transport and reduce sedimentation?	Yes
F(2)	In addition to protecting all existing wetland and surface water functions, can the project demonstrate it has restored at least one previously degraded wetlands and/or surface water function?	No
	Yes =	6 of 7

NW3.3 Maintain Floodplain Functions — 11 of 14 Points

Intent: Preserve floodplain functions by limiting development and impacts of development in the floodplain.

Metric: Efforts to avoid floodplains or maintain natural-acting floodplain functions.

Applicability: Projects that are not within the floodplain and do not impact floodplain functions, may apply to have this credit deemed not applicable with supporting documentation. Some projects that are not directly within the floodplain may still have an impact on flooding and floodplain functions through their handling of stormwater runoff. These projects may also pursue achievement in this credit if they can demonstrate a direct connection to the floodplain. There are strong links between this credit and NW2.2 Manage Stormwater, and some project components and strategies may apply to both credits.

		Yes/No
	Is this credit applicable?	Yes

	Assessment Questions:	**Criteria Met?**
A	Has the project team identified the 100-year or design frequency floodplain in relation to the project location?	Yes
B	To what extent does the project preserve vegetated zones within the floodplain? <u>Select one of the following:</u>	Yes
	The project site maintains a net quantity of 100% of natural/vegetated area within the floodplain.	
C	Does the project mitigate impacts to floodplain functions?	Yes
D	Was the project intentionally sited to avoid floodplains?	Yes
E	Does the project remove structures from the floodplain or return previously developed areas to a vegetated state?	No
	Yes =	4 of 5

NW3.4 Control Invasive Species — 2 of 12 Points

Intent: Use appropriate noninvasive species, and control or eliminate existing invasive species.

Metric: Degree to which invasive species have been reduced or eliminated.

Applicability: This credit is applicable to all projects with sites that contain invasive species. Project teams that conduct site investigations and do not identify existing invasive species may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes

	Assessment Questions:	**Criteria Met?**
A	Does the project avoid introducing invasive species to the site?	Yes
B	Has the project team conducted a site assessment to determine if invasive species are present?	Yes
C	Does the project implement controls for existing infestations of invasive species before, during and post-construction?	No
D	Does the project guard against future infestations by supporting the establishment of native and/or noninvasive species?	No
E	Does the project provide long-term controls to prevent the reintroduction of invasive species?	No
F	Does the project include the ongoing control, suppression, or containment of major infestations of invasive species after construction?	No
	Yes =	2 of 6

NW3.5 Protect Soil Health — 3 of 8 Points

Intent: Preserve the composition, structure and function of site soils.

Metric: Degree to which the disruption of soil health has been minimized and restored.

Applicability: This credit is applicable to all projects that impact soils during construction. Projects that do not impact soil (e.g. the internal refurbishment of an existing facility) may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		**Criteria Met?**
A	Has the project team limited the area that is disturbed by development activities?	Yes
B	Have vegetated areas disturbed by development activities been restored for appropriate soil type, structure, and function to support healthy plant and tree growth?	Yes
C	Has the project team implemented a soil protection plan or policies? <u>Select one of the following:</u>	No
	None	
D	Has the project restored appropriate soil type, structure, and function to vegetated areas disturbed by previous development?	No
	Yes =	2 of 4

Climate And Resilience

1. Emissions

CR1.1 Reduce Net Embodied Carbon — 0 of 20 Points

Intent: Reduce the impacts of material extraction, refinement/manufacture, and transport over the project life.

Metric: Percentage of reduction in net embodied carbon of materials.

Applicability: This credit is applicable to all projects that include the use or consumption of physical materials in construction or operation.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		Criteria Met?
A	Has the project team determined materials that are the primary contributors to embodied carbon for the project during construction and operation?	No
B	Has the project team calculated the primary contributors to overall embodied carbon?	No
C	To what extent does the project reduce the net embodied carbon of materials used in construction and operation? Select one of the following:	No
	None	
	Yes =	0 of 3

CR1.2 Reduce Greenhouse Gas Emissions — 0 of 26 Points

Intent: Reduce greenhouse gas emissions during the operation of the project, reducing project contribution to climate change.

Metric: Percentage of reduction in operational greenhouse gas emissions.

Applicability: This credit is applicable to all projects that consume energy, fuel, or otherwise produce greenhouse gas emissions during their operation. Projects that do not include greenhouse gas emissions during operations may apply to have this credit deemed not applicable with supporting documentation. However, projects that do not produce greenhouse gas emissions because of intentional planning decisions may apply for the Conserving level with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		Criteria Met?
A	To what extent does the project reduce greenhouse gas emissions during its operational life? Select one of the following:	No
	None	
B	Has the project team calculated and reported the annual greenhouse gas emissions of the project?	No
	Yes =	0 of 2

`

CR1.3 Reduce Air Pollutant Emissions — 0 of 18 Points

Intent: Reduce emissions of air pollutants: particulate matter (including dust), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, lead, and volatile organic compounds.

Metric: Reduction of air pollutants compared to baseline.

Applicability: This credit is applicable to all projects that directly produce any of the criteria pollutants. Projects that do not include air pollutant emissions may apply to have this credit deemed not applicable with supporting documentation. However, projects that do not produce air pollutant emissions because of intentional planning decisions to choose non-polluting alternatives may apply for the Conserving level with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Does the project meet all relevant minimum air quality standards and regulations?	No
B	To what extent does the project reduce air pollutant emissions during operations? Select one of the following:	No
	None	
C	Does the project include the ongoing monitoring and management of direct air pollutant emissions?	No
D	Has the project team assessed the materiality of volatile organic compounds to the health of construction workers and the project operators?	No
E	Does the project remove existing air pollutant sources?	No
	Yes =	0 of 5

2. RESILIENCE

CR2.1 Avoid Unsuitable Development — 12 of 16 Points

Intent: Minimize or avoid development on sites prone to hazards.

Metric: The degree to which the project is designed and/or sited to avoid or mitigate site-related risks.

Applicability: Projects that are not located within regions at risk of site hazards, and therefore cannot demonstrate they actively avoided site hazards, may apply to have this credit deemed not applicable with supporting documentation.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team identified potential siting hazards, the vulnerability of the project to the hazard, and the potential for the project to exacerbate the hazard?	Yes
B	Can the project team demonstrate that siting and project alternatives were seriously considered in order to minimize exposure to risk?	Yes
C	Has the project team implemented strategies to mitigate the impact of site hazards?	Yes
D	Can the project team demonstrate that the chosen project and site resulted in the lowest exposure to site hazards while still meeting project requirements?	Yes
E	Was the site chosen to intentionally avoid known site hazards?	Yes
F	Does the project remove or modify structures subject to frequent damage?	No
	Yes =	5 of 6

CR2.2 Assess Climate Change Vulnerability — 14 of 20 Points

Intent: Develop a comprehensive climate change vulnerability assessment.

Metric: Scope and comprehensiveness of climate change vulnerability assessment.

Applicability: This credit is applicable to all projects potentially impacted by climate change, which is the vast majority of infrastructure.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team determined climate change threats to the project and its surroundings?	Yes
B	Has the project team determined the vulnerability of the project to climate change threats?	Yes
C	Has the project team determined the vulnerability of the infrastructure system to climate change threats?	Yes
D	Has the project team determined the vulnerability of the community to climate change threats?	No
E	Has the project team or owner shared their climate threat findings?	No
	Yes =	3 of 5

CR2.3 Evaluate Risk and Resilience — 24 of 26 Points

Intent: Conduct a comprehensive, multihazard risk and resilience evaluation.

Metric: Scope and comprehensiveness of the multihazard risk and resilience evaluation.

Applicability: It is likely that all projects would benefit from a thorough investigation of potential risks. It would, therefore, be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award. Risks are not always major catastrophic events; small and large projects alike may consider how crime/vandalism or personal injury are also potential risks with associated impacts.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	To what extent does the project team's risk assessment include the project, infrastructure system, and community? Select one of the following:	Yes
	The project team draws the assessment boundary for subsequent criteria (B, C, D, and E) around the interdependencies of the project, its associated/connected infrastructure system/network, and the broader community.	
B	Has the project team identified the critical functions and dependencies of the infrastructure asset and its primary components?	Yes
C	Has the project team identified the threats or hazards to the project and its surroundings?	Yes
D	Has the project team identified the vulnerabilities of the critical functions and dependencies of the infrastructure asset?	Yes
E	Has the project team evaluated risks by determining the probability of a threat or hazard occurring and the associated impacts?	Yes
F	Did the risk evaluation conducted by the project include the participation of the owner and a diverse and integrated team of key stakeholders?	No
	Yes =	5 of 6

CR2.4 Establish Resilience Goals and Strategies — 20 of 20 Points

Intent: To support increased project and community resilience through the establishment of clear objectives and goals.

Metric: The degree to which resilience goals expand from initial commitments to quantifiable project objectives, long-term operating plans, and community-wide development plans.

Applicability: All projects that are exposed to risks would benefit from establishing resilience goals and strategies. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes
Assessment Questions:		**Criteria Met?**
A	Has the project team identified the project performance goals and risk appetite of the owner?	Yes
B	Has the project team developed risk management strategies based on a comprehensive risk evaluation?	Yes
C	Have key stakeholders been engaged in developing resilience goals?	Yes
D	Is the project part of, or does it support, larger community resilience or climate change adaptation goals?	Yes
	Yes =	4 of 4

CR2.5 Maximize Resilience — 20 of 26 Points

Intent: Increase resilience, life-cycle system performance, and the ability to withstand hazards by maximizing durability.

Metric: The degree to which the project incorporates elements that increase durability, the ability to withstand hazards, and extend useful life.

Applicability: All projects that are exposed to risks would benefit from increased resilience. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		Criteria Met?
A	Has the project team developed resilience goals and strategies based on a comprehensive risk evaluation?	Yes
B	Has the project team implemented resilience strategies sufficient to address major project risks and improve project resilience?	Yes
C	Has the project team periodically monitored the implementation of project resilience strategies and reviewed their continued effectiveness throughout project delivery?	Yes
D	Will resilience goals and strategies be incorporated into the ongoing operations and maintenance of the project?	Yes
E	Does the project include methods for measuring or quantifying resilience performance targets?	No
	Yes =	4 of 5

CR2.6 Improve Infrastructure Integration — 18 of 18 Points

Intent: Enhance the operational relationships and strengthen the functional integration of the project into connected, efficient, and diverse infrastructure systems.

Metric: The degree to which the project is integrated into other connected systems, where beneficial and appropriate, in order to increase resilience and systems performance.

Applicability: It is likely that all infrastructure would, and should, benefit from the application of an integrated systems approach. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award.

		Yes/No
	Is this credit applicable?	Yes

Assessment Questions:		Criteria Met?
A	Does the project increase internal systems integration?	Yes
B	Will the infrastructure integration reduce the risk of systemic or cascading failures?	Yes
C	Does the project increase external systems integration?	Yes
D	Does the project integrate infrastructure networks?	Yes
E	Does the project integrate data or monitoring systems in order to improve performance?	Yes
	Yes =	5 of 5

Appendix F: Conceptual Drawings

N

0 20' 40'
HORIZONTAL SCALE

Brown AND Caldwell

CONCEPTUAL DRAWINGS

NOT FOR CONSTRUCTION

HRSD
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HRSD WILROY PRS AND TANK

REVISIONS		
REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: -
DRAWN: SITE
CHECKED: -
CHECKED: -
APPROVED: -

FILENAME
157943-XC-SV-002.DWG
BC PROJECT NUMBER
157943
CLIENT PROJECT NUMBER
####

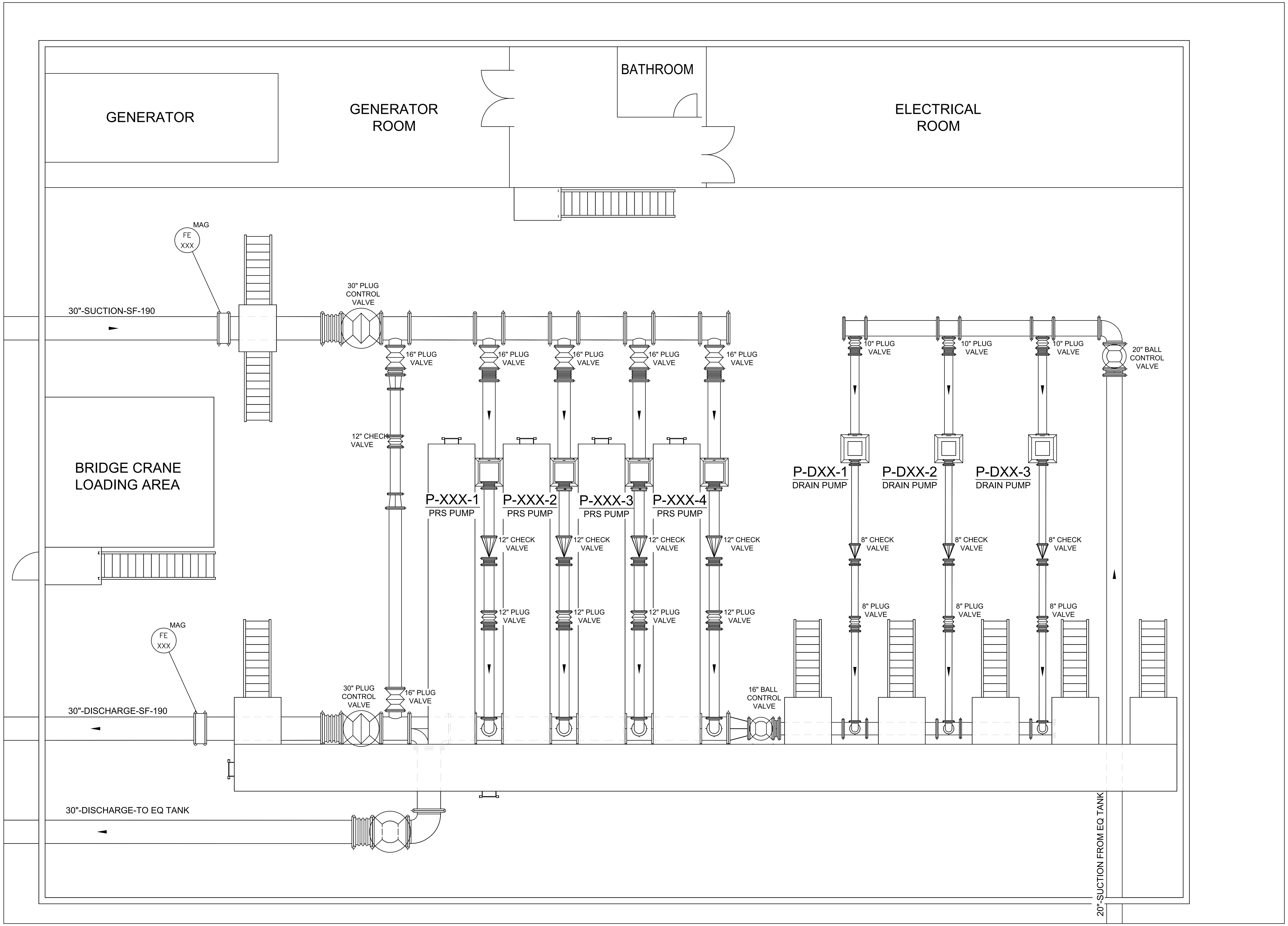
CIVIL

PROPOSED SITE LAYOUT

DRAWING NUMBER
C-100

SHEET NUMBER
OF

Path: C:\BCPW\D2417917 FILENAME: 157943-XC-SV-002.DWG PLOT DATE: 8/5/2022 1:09 PM CAD USER: CHRISTINA DANG



PLAN
SCALE 3/16" = 1'-0"

Path: C:\BCPW\D2417925 FILENAME: 157943-D-100.DWG PLOT DATE: 7/12/2022 3:01 PM CAD USER: KEVIN STUBBLEFIELD

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REVISIONS

REV	DATE	DESCRIPTION
A	7/15/22	ISSUED FOR REVIEW AND COMMENT

LINE IS 2 INCHES AT FULL SIZE

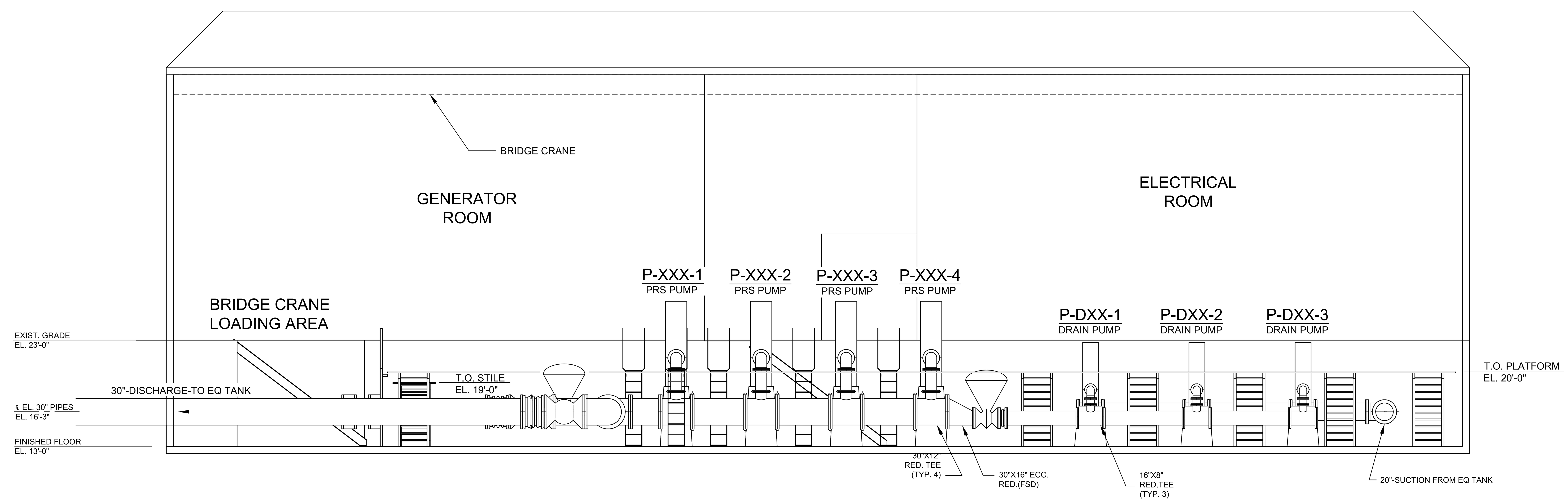
DESIGNED: -
DRAWN: KS
CHECKED: -
CHECKED: -
APPROVED: -

FILENAME
157943-D-100.DWG
BC PROJECT NUMBER
157943
CLIENT PROJECT NUMBER
####

PROCESS

SITE LAYOUT PLAN

DRAWING NUMBER
D-100
SHEET NUMBER
OF



ELEVATION
(LOOKING NORTH)
SCALE 3/16" = 1'-0"

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CONCEPTUAL DRAWINGS

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REVISIONS		
REV	DATE	DESCRIPTION
A	7/15/22	ISSUED FOR REVIEW AND COMMENT

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: -
DRAWN: KS
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APPROVED: -

FILENAME
157943-D-100,101.DWG
BC PROJECT NUMBER
157943
CLIENT PROJECT NUMBER
####

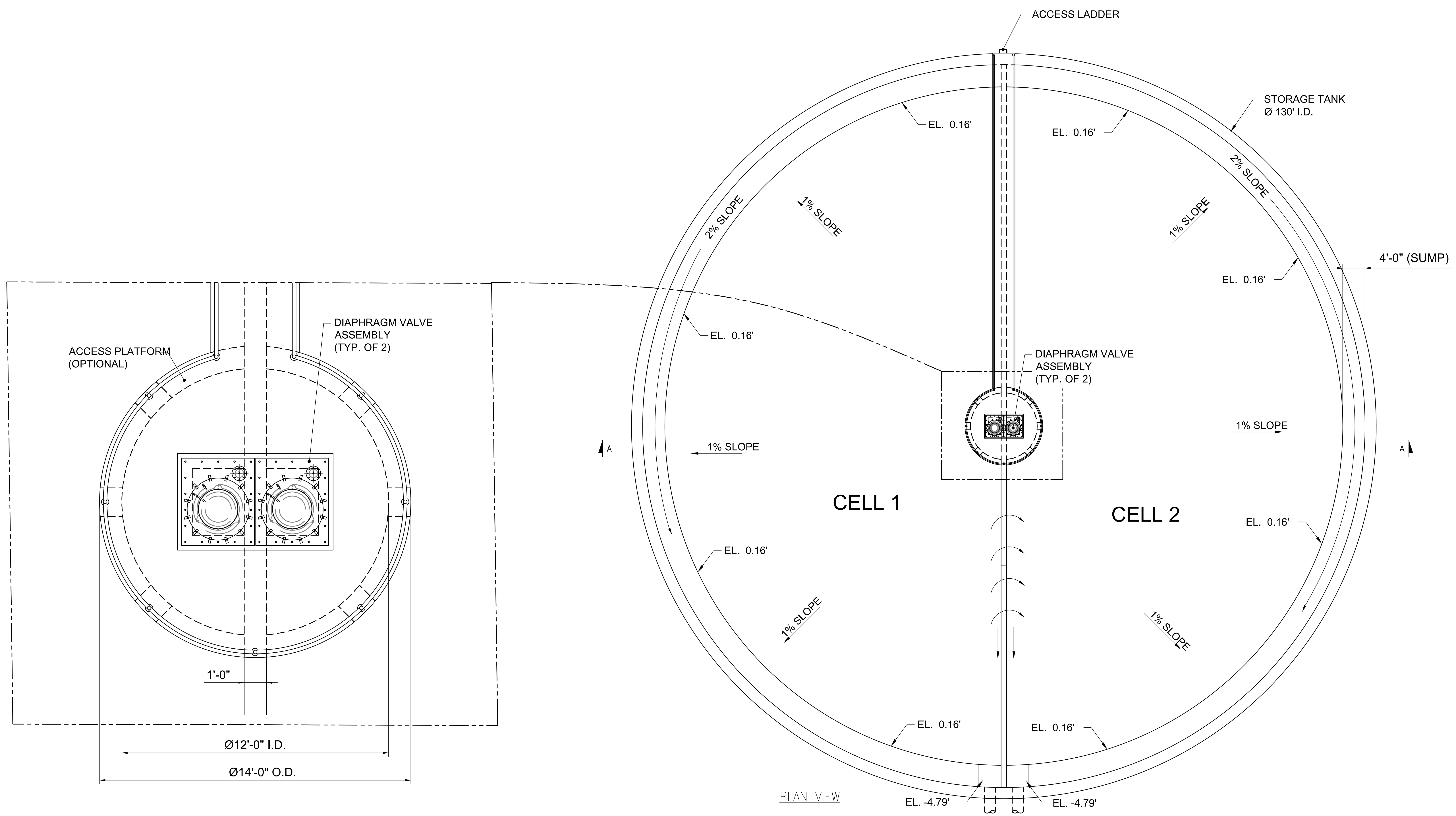
PROCESS

SITE LAYOUT ELEVATION

DRAWING NUMBER
D-101
SHEET NUMBER
OF

Path: C:\BCPW\D2417925 FILENAME: 157943-D-100,101.DWG PLOT DATE: 7/13/2022 1:54 PM CAD USER: KEVIN STUBBLEFIELD

NOTES:
1- GRANDE WATER MANAGEMENT SYSTEMS (GWMS) WILL SUPPLY THE VACUUM FLUSHING SYSTEM WITH TWO (2) DIAPHRAGM VALVES, AS SPECIFIED.
3- THE SUMP SHOULD ACCOMMODATE A MINIMUM FLUSHING VOLUME OF 2004 Ft^3 PER FLUSH (909 Ft^3 OF FLUSH WATER + 1095 Ft^3 OF DEBRIS ASSUMING 2" DEPOSITION).
4- REFER TO DRAWING D-201 FOR SECTION A-A.
5- CONCRETE STRUCTURAL DIMENSIONS MUST BE RESPECTED TO A TOLERANCE OF $\pm\frac{1}{4}$", ALL DIMENSIONS ARE IN IMPERIAL UNITS.



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CONCEPTUAL DRAWINGS

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BC PROJECT NUMBER
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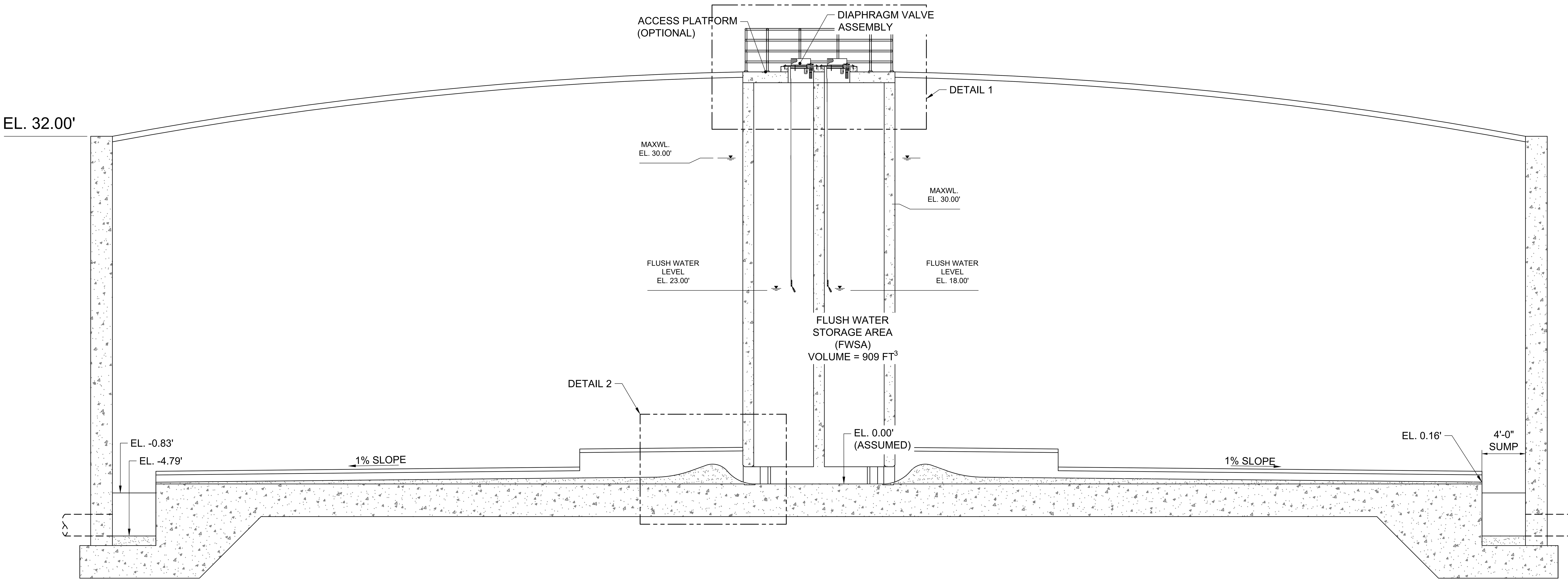
PROCESS

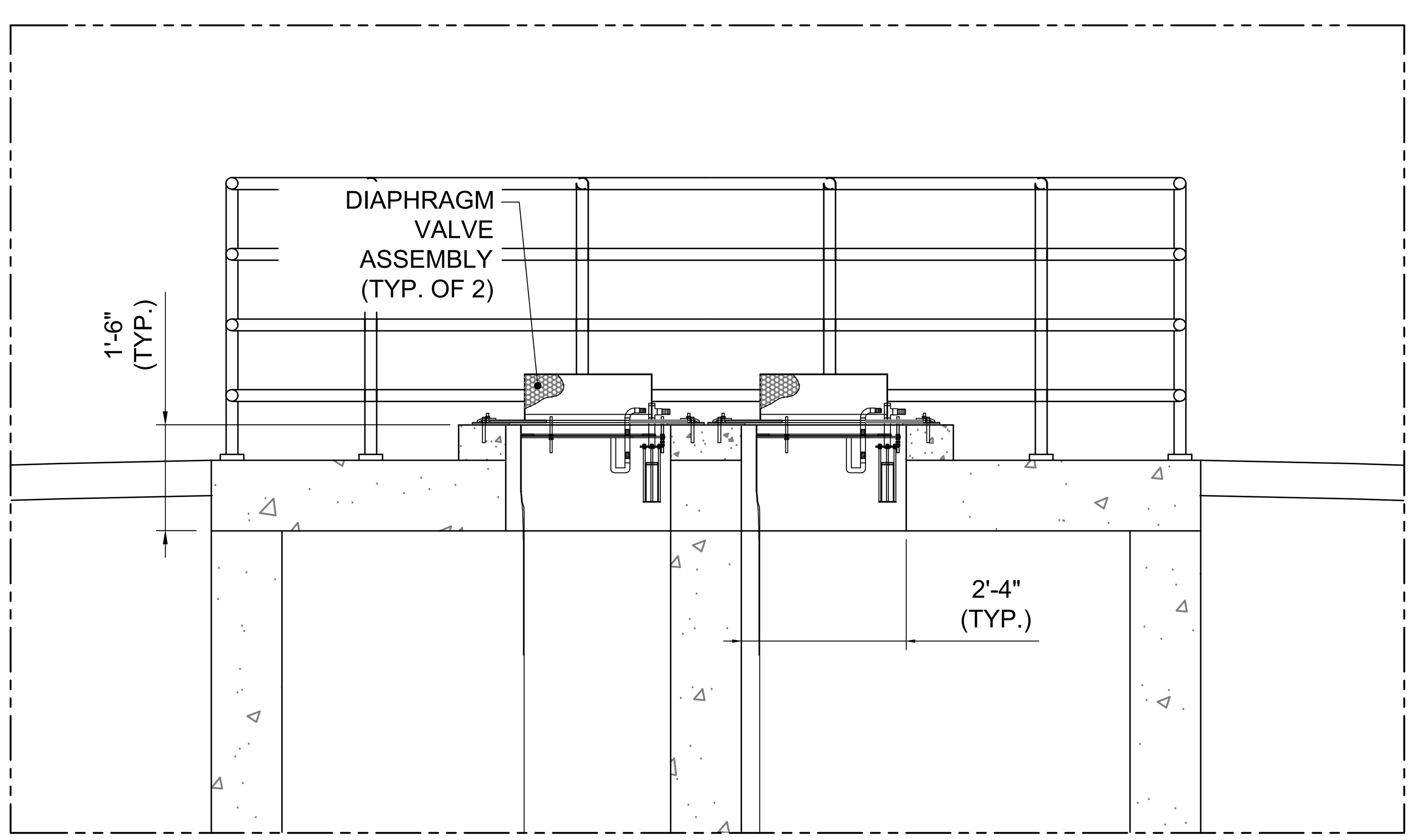
OLSF TANK PLAN

Grande Water management systems
www.grandeinc.com TOLL FREE: 1-855-315-1115

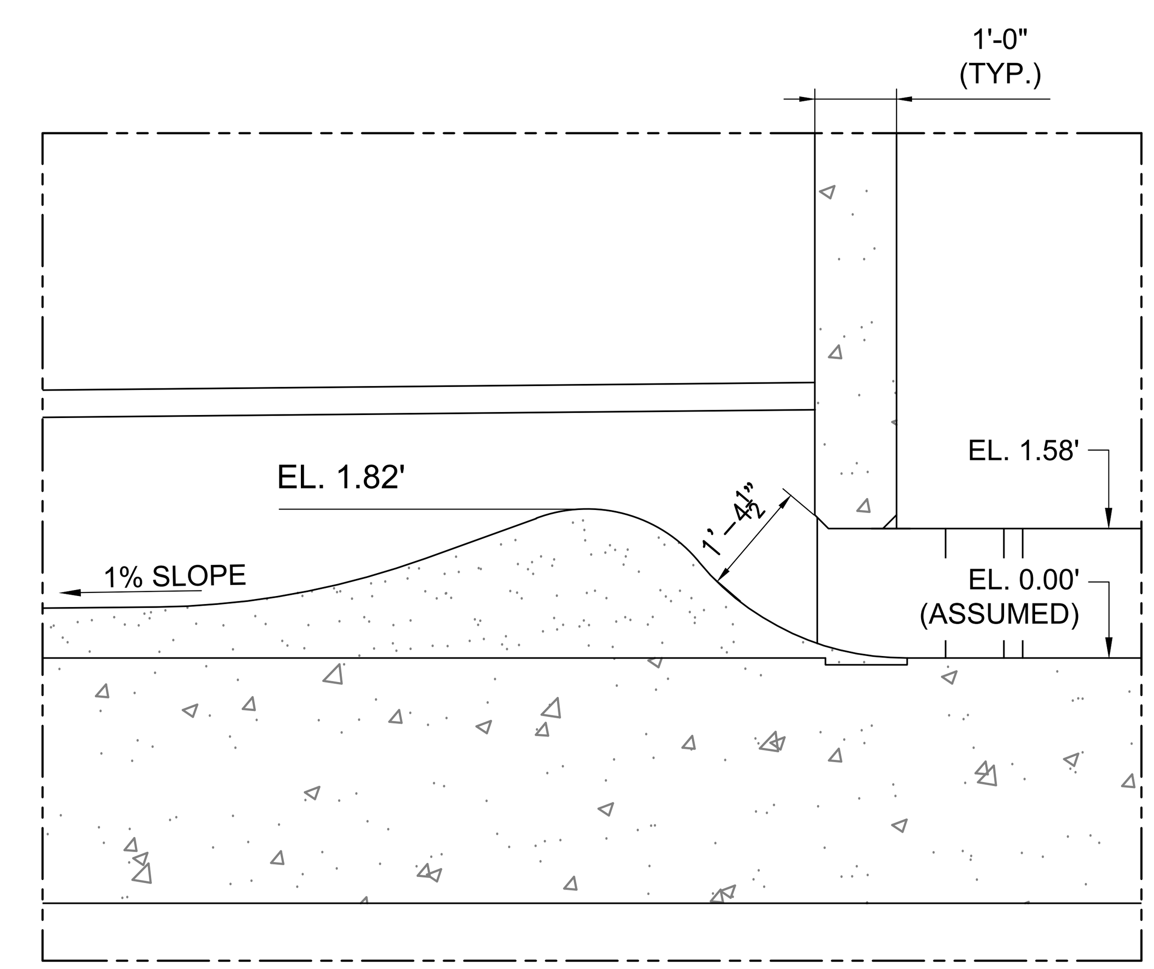
DRAWING NUMBER
D-200
SHEET NUMBER
OF

Path: C:\USERS\RFOSHAY\ONEDRIVE - BROWN AND CALDWELL\DESKTOP FILENAME: 157943-D-200.DWG PLOT DATE: 8/5/2022 2:04 PM CAD USER: RYAN FOSHAY





DETAIL 1



DETAIL 2

Brown AND Caldwell

CONCEPTUAL DRAWINGS

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CHECKED: -
APPROVED: -

FILENAME
157943-D-200.DWG
BC PROJECT NUMBER
157943
CLIENT PROJECT NUMBER
####

PROCESS

OLSF TANK ELEVATION

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D-201
SHEET NUMBER
OF

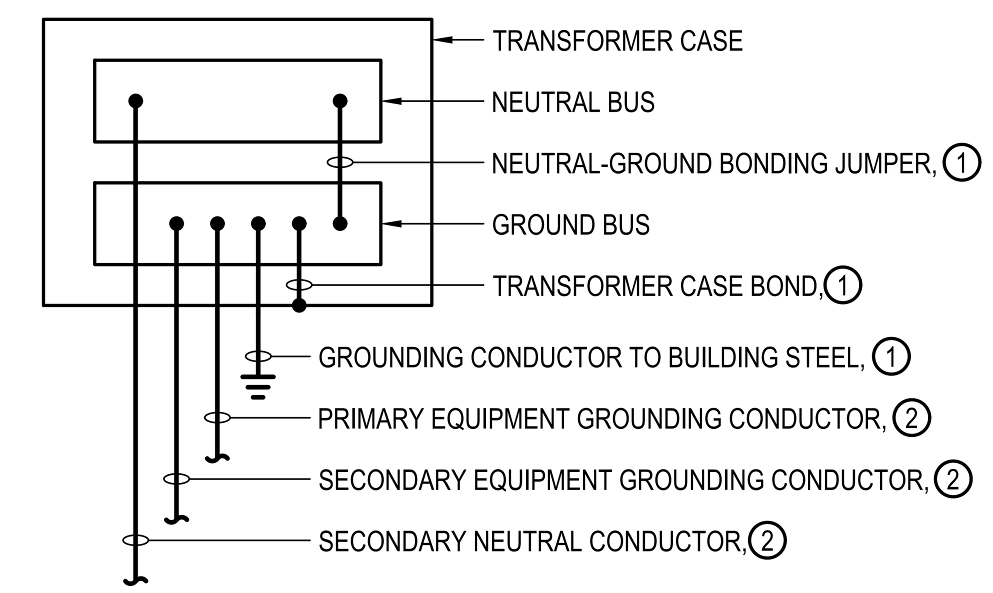
Path: C:\USERS\RFOSHAY\ONEDRIVE - BROWN AND CALDWELL\DESKTOP FILENAME: 157943-D-200.DWG PLOT DATE: 8/5/2022 1:46 PM CAD USER: RYAN FOSHAY

TRANSFORMER SCHEDULE

KVA	INPUT	OUTPUT	PRIMARY BREAKER	SECONDARY BREAKER	PRIMARY FEEDER	SECONDARY FEEDER
45 (1)	480V, 3Ø, 3W	120/208V, 3Ø, 4W	70A-3P	150A-3P	3 #4 , 1 #8 GND - 1-1/4"C	4 #1/0, 1 #6 GND - 2"C

TRANSFORMER SCHEDULE NOTES:

(1) MOUNT TRANSFORMER ON FLOOR, ON CONCRETE HOUSEKEEPING PAD - UNLESS OTHERWISE NOTED.



TYPICAL XFMR GROUNDING DETAIL NOTES:

(1) GROUNDING ELECTRODE CONDUCTOR SIZES:
45KVA: #6 CU GND - 1/2"C

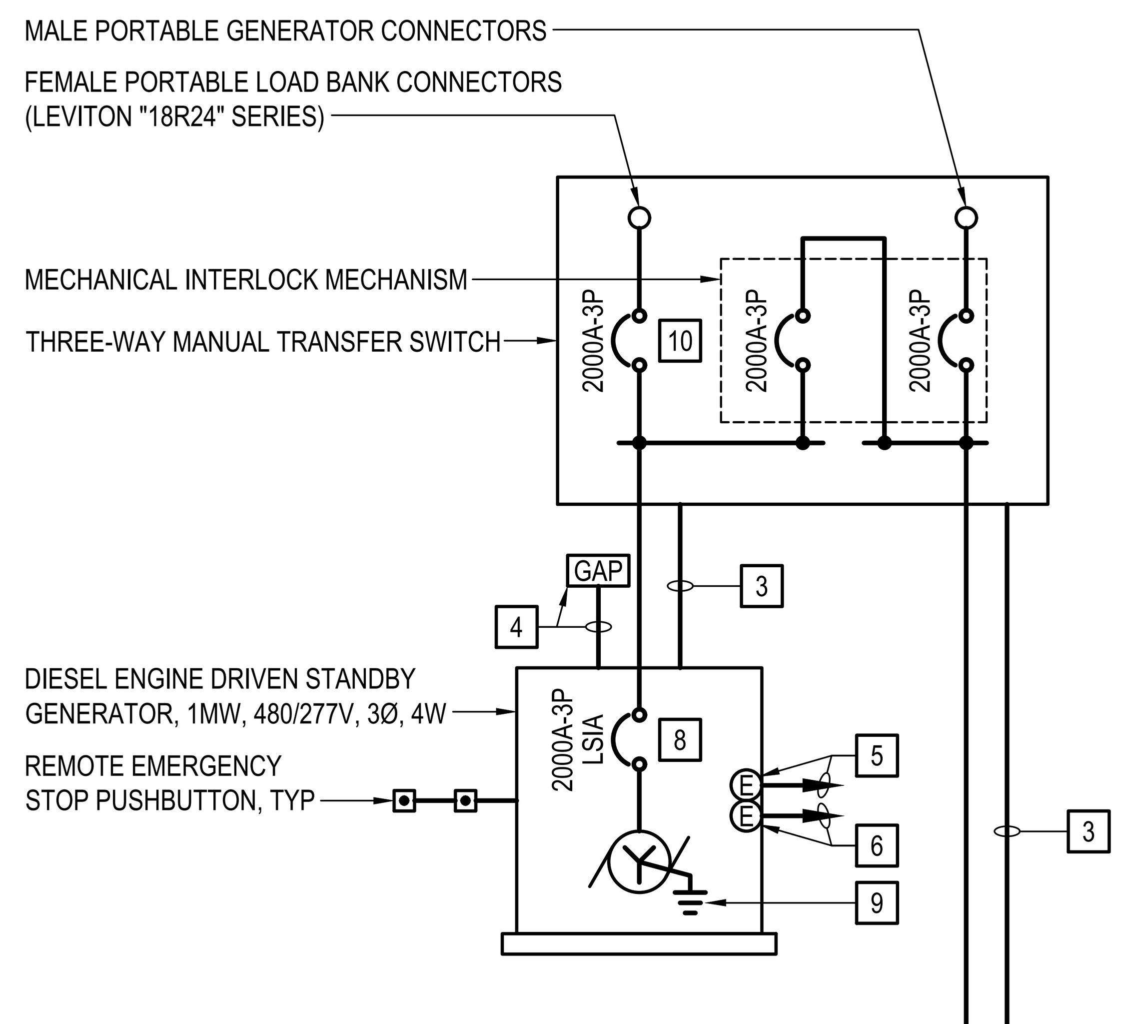
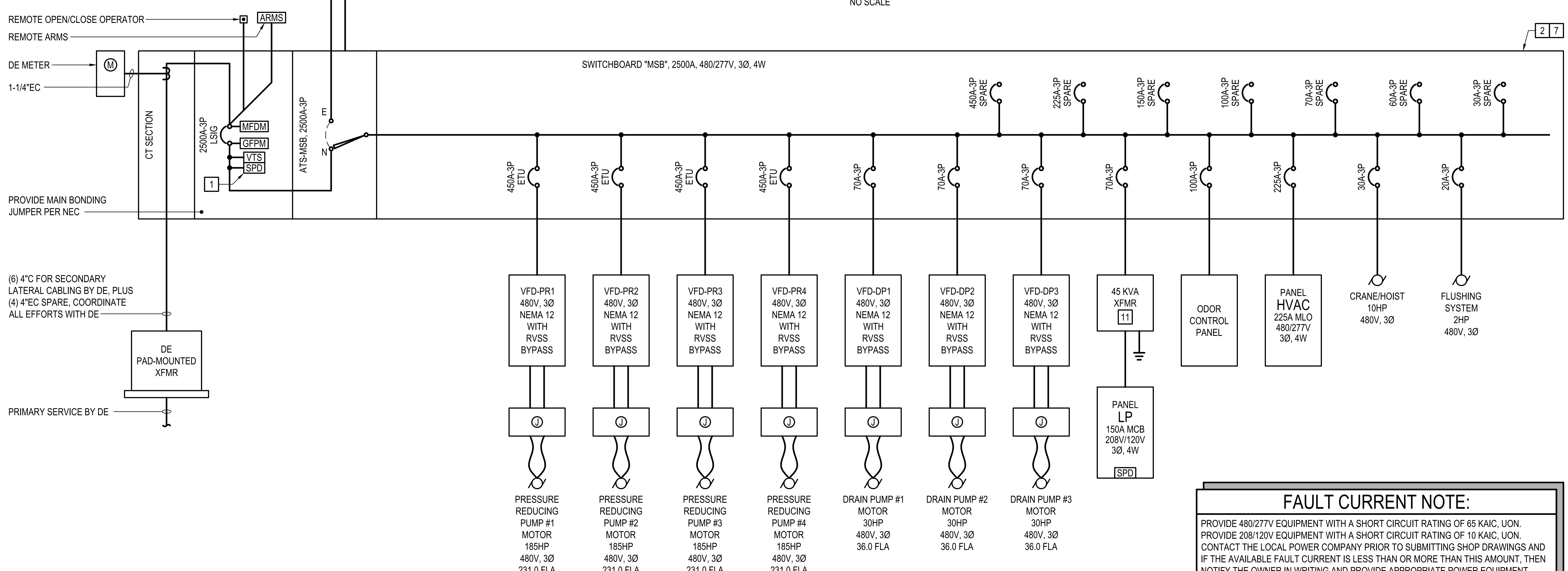
(2) REFER TO TRANSFORMER SCHEDULE FOR CONDUCTOR SIZES.

TYPICAL XFMR GROUNDING DETAIL

NO SCALE

ONE-LINE DIAGRAM NOTES

1. PROVIDE WITH INTEGRAL DISCONNECT. COORDINATE EXACT CIRCUIT BREAKER RATING WITH SPD MANUFACTURER.
2. MOUNT EQUIPMENT ON 4" CONCRETE HOUSEKEEPING PAD. PROVIDE PAD 4" LARGER THAN EQUIPMENT ALL AROUND AND 3/4" CHAMFER ON ALL SIDES.
3. (1) 1"C WITH CONTROL WIRING PER MANUFACTURER'S RECOMMENDATIONS FOR PERMANENT/PORTABLE GENERATOR START SIGNAL.
4. GENERATOR REMOTE ANNUNCIATOR PANEL TO COMPLY WITH NFPA 110 LEVEL-1 SYSTEMS, REFER TO FLOOR PLANS FOR LOCATION. PROVIDE (1) 1"C WITH ANNUNCIATOR WIRING PER MANUFACTURER'S RECOMMENDATIONS.
5. GENERATOR BATTERY CHARGER CONNECTION.
6. GENERATOR JACKET HEATER CONNECTION.
7. PROVIDE PERMANENT MACHINE ENGRAVED SIGN AT SERVICE ENTRANCE EQUIPMENT INDICATING TYPE AND LOCATION OF ON-SITE EMERGENCY POWER SOURCES IN ACCORDANCE WITH NEC ARTICLE 700.7.
8. PROVIDE CIRCUIT BREAKER WITH GROUND FAULT ALARM.
9. GROUND GENERATOR PER NEC.
10. PROVIDE SHUNT TRIP BREAKER. CONNECT TO OPEN LOAD BANK CIRCUIT BREAKER UPON LOSS OF UTILITY POWER.
11. REFER TO TRANSFORMER SCHEDULE SHEET THIS SHEET FOR CONNECTION REQUIREMENTS.

FAULT CURRENT NOTE:

PROVIDE 480/277V EQUIPMENT WITH A SHORT CIRCUIT RATING OF 65 KAIC, UON. PROVIDE 208/120V EQUIPMENT WITH A SHORT CIRCUIT RATING OF 10 KAIC, UON. CONTACT THE LOCAL POWER COMPANY PRIOR TO SUBMITTING SHOP DRAWINGS AND IF THE AVAILABLE FAULT CURRENT IS LESS THAN OR MORE THAN THIS AMOUNT, THEN NOTIFY THE OWNER IN WRITING AND PROVIDE APPROPRIATE POWER EQUIPMENT.

PRELIMINARY PARTIAL ELECTRICAL ONE-LINE DIAGRAM

NO SCALE

Brown AND Caldwell

Pace COLLABORATIVE
MECHANICAL ELECTRICAL ENGINEERS
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LINE IS 2 INCHES
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CHECKED: -
APPROVED: -

FILENAME
22143 PME-1.DWG
BC PROJECT NUMBER
157943
CLIENT PROJECT NUMBER
####

ELECTRICAL

PRELIMINARY
ONE-LINE DIAGRAM

DRAWING NUMBER
PME-1
SHEET NUMBER
OF

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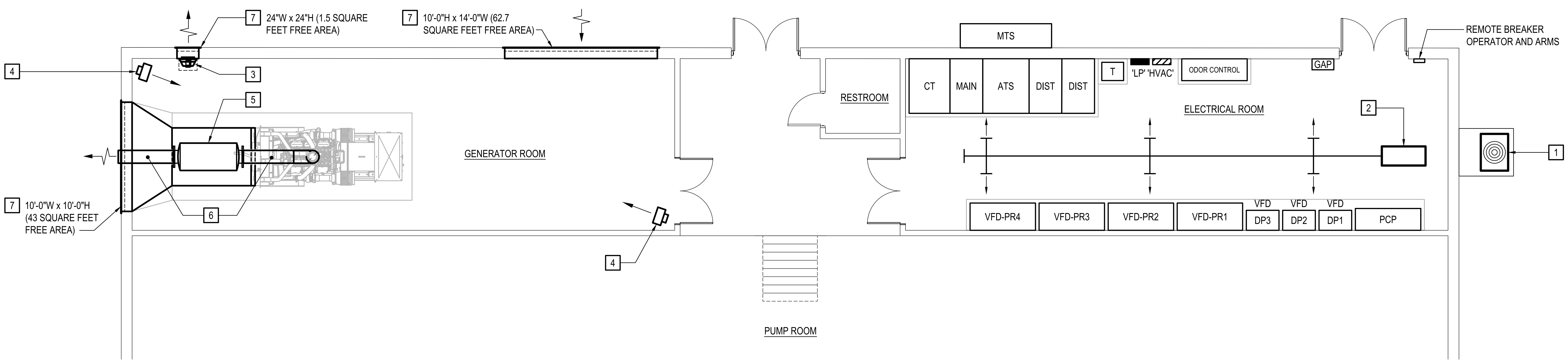

PRELIMINARY PARTIAL FLOOR PLAN

SCALE: 3/16" = 1'-0"

WORK NOTES

1. PROVIDE NOMINAL 7.5 TON AIR-COOLED HEAT PUMP AND SUPPORTS.
2. PROVIDE NOMINAL 7.5 TON AIR HANDLING UNIT, DUCTWORK, SUPPLY REGISTERS, HANGERS AND SUPPORTS.
3. PROVIDE SIDEWALL PROPELLER EXHAUST FAN (APPROXIMATELY 1,500 CFM) AND SUPPORTS COMPLETE.
4. PROVIDE 3.3 KW UNIT HEATER AND SUPPORTS COMPLETE.
5. PROVIDE GENERATOR MANUFACTURER'S INDUSTRIAL GRADE MUFFLER AND CONNECTION FLANGES. SUSPEND FROM OVERHEAD STRUCTURE. PROVIDE FLEXIBLE CONNECTION TO GENERATOR DISCHARGE.
6. PROVIDE INSULATED GENERATOR EXHAUST PIPING, ±14" (SIZE PER MANUFACTURER'S RECOMMENDATIONS) THROUGH WALL (CALCIUM SILICATE INSULATION). PROVIDE INSULATED THIMBLE AT WALL PENETRATION. SEAL PENETRATION WEATHER TIGHT.
7. PROVIDE EXTRUDED ALUMINUM STATIONARY LOUVER, WITH BIRDSCREEN OR INSECT SCREEN. MIN. FREE AREA AND LOUVER SIZE IS AS INDICATED. GREENHECK MODEL EHV-901D OR APPROVED EQUAL. LOUVER SHALL BE LISTED FOR AMCA 550 HIGH VELOCITY WIND-DRIVEN RAIN RESISTANCE WITH HORIZONTAL FRONT BLADE AND VERTICAL REAR BLADE DESIGN, SUITABLE FOR DRY ROOM APPLICATIONS.

0' 5' 10' 20'
3/16" = 1'-0"

Brown AND Caldwell

Pace COLLABORATIVE

PROGRESS PRINT — THIS DRAWING IS **NOT** FOR PRICING OR CONSTRUCTION — NOT FOR CONSTRUCTION

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REVISIONS

REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

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DRAWN: -
CHECKED: -
CHECKED: -
APPROVED: -

FILENAME 22143 PME-2.DWG
BC PROJECT NUMBER 157943
CLIENT PROJECT NUMBER ####

HVAC-ELECTRICAL

PRELIMINARY PARTIAL FLOOR PLAN

DRAWING NUMBER PME-2

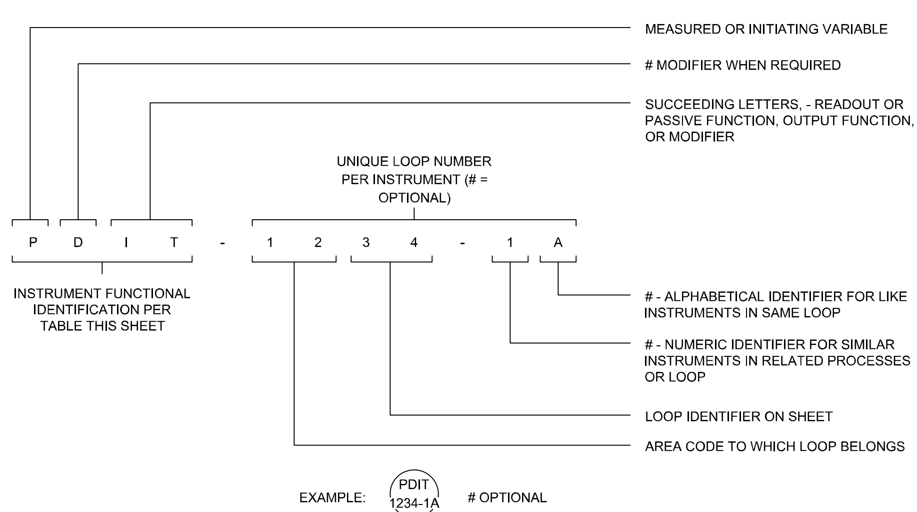
SHEET NUMBER OF

Path: W:\22143\DWGS FILENAME: 22143 PME-2.DWG PLOT DATE: 8/1/2022 9:06 AM CAD USER: ROB WEISE

FUNCTIONAL IDENTIFICATION

VARIABLE	MEASURED OR INITIATING VARIABLE DESCRIPTION	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION				
C	CONDUCTIVITY			CONTROL	CLOSE
D	DENSITY, SPECIFIC GRAVITY	DIFFERENTIAL			DEVIATION
E	VOLTAGE, SOLENOID		PRIMARY ELEMENT		
F	FLOW, FLOW RATE	RATIO			
G	FIRE, SMOKE		GLASS		
H	HAND				HIGH
I	CURRENT		INDICATE		
J	POWER		SCAN		
K	TIME, SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	MOISTURE, HUMIDITY, MOTION	MOMENTARY			MIDDLE, INTERMEDIATE
N	EQUIPMENT STATUS				
O	DISSOLVED OXYGEN		ORIFICE		OPEN
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		RUN
S	SPEED, FREQUENCY	SAFETY		SWITCH	STOP
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE, TORQUE		WELL, PROBE		
X	UNCLASSIFIED	X AXIS			
Y	EVENT, STATE OR PRESENCE	Y AXIS		AUXILIARY DEVICES	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, FINAL CONTROL ELEMENT	

INSTRUMENT TAG AND LOOP IDENTIFICATION



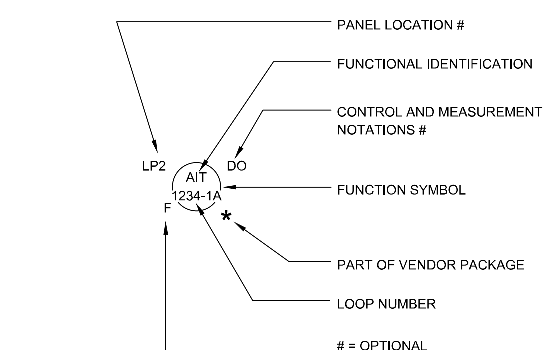
EQUIPMENT IDENTIFICATION SYSTEM

AERATION BLOWER 1 — EQUIPMENT NAME
PXXXX — EQUIPMENT NUMBER
OPTIONAL PER PROJECT:
SPEC: 11486 — SPECIFICATION REFERENCE
TYPE: MULTIPLE STAGE CENTRIFUGAL — EQUIPMENT TYPE
Q: 1500 SCFM — CAPACITY RATING
HEAD: 5.5 PSIG — DISCHARGE PRESSURE RATING
HP: 50 — MOTOR POWER

INSTRUMENT SIGNAL LINES

- INSTRUMENT SUPPLY, PROCESS TAPS
- PNEUMATIC SIGNAL
- ELECTRICAL SIGNAL (ANALOG OR DISCRETE)
- FIELDBUS (DEVICENET OR FOUNDATION)
- CAPILLARY TUBE OR FILLED SYSTEM
- ELECTROMAGNETIC OR SONIC SIGNAL (GUIDED)
- ELECTROMAGNETIC OR SONIC SIGNAL (UNGUIDED)
- SOFTWARE OR DATA LINK
- MECHANICAL LINK
- HYDRAULIC
- ES — ELECTRIC POWER SUPPLY 120 VAC 60 HZ UNLESS OTHERWISE NOTED. (e.g. ES-480 VAC)
- SA — SERVICE AIR SUPPLY
- IA — INSTRUMENT QUALITY AIR SUPPLY
- C2 — WATER SUPPLY C1, C2, C3,ETC.

TYPICAL INSTRUMENT IDENTIFICATION



NETWORK TYPE	
F	FOUNDATION FIELDBUS
D	DEVICENET
E	ETHERNET
P	PROFIBUS
PN	PROFINET
M-RTU	MODBUS RTU
M-TCP	MODBUS TCP
CIP	CONTROL INDUSTRIAL PROTOCOL
E-SNMP	SIMPLE NETWORK MANAGEMENT PROTOCOL

PROCESS LINES

- NEW PRIMARY PROCESS FLOW
- NEW SECONDARY PROCESS FLOW
- NEW UTILITY PROCESS FLOW
- FUTURE
- EXISTING PROCESS FLOW, EQUIPMENT, OR SIGNAL PATH (SCREENED)
- NEW/EXISTING CONNECTIONS
- TEMPORARY PIPING
- PROCESS AREA
- VENDOR PACKAGE BOUNDARY

GENERAL NOTES:

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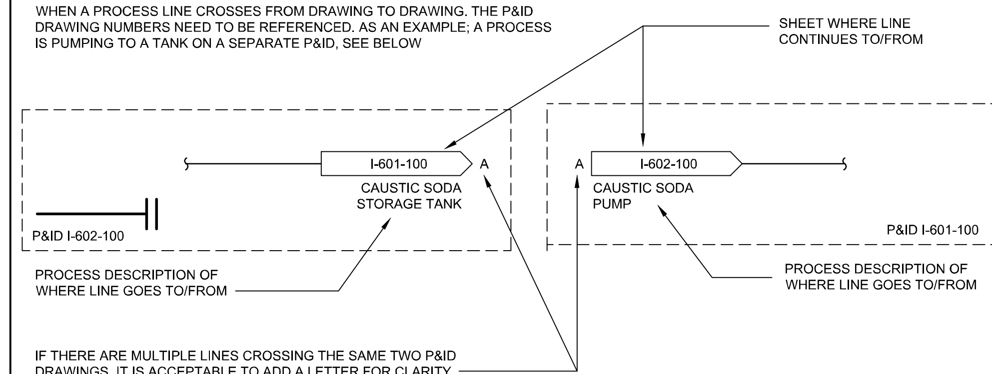
PROCESS AND SIGNAL CROSS REFERENCE SYSTEM

WHEN A PROCESS LINE CROSSES FROM DRAWING TO DRAWING. THE P&ID DRAWING NUMBERS NEED TO BE REFERENCED. AS AN EXAMPLE; A PROCESS IS PUMPING TO A TANK ON A SEPARATE P&ID, SEE BELOW



CONTROL AND MEASUREMENT NOTATIONS

ACK	ACKNOWLEDGE
AM	AUTO/MAN
BYP	BYPASS
CL	CLOSE
CL2	CHLORINE
CMAT	COMPUTER/MANUAL/AUTO/TRACKING
COMB	COMBUSTIBLE GAS
CP	CONTROL POWER
COND	CONDUCTIVITY
DEC	DECREASE
DO	DISSOLVED OXYGEN
ESP	EMERGENCY STOP
FWD	FORWARD
F/R	FORWARD/REVERSE
F/S	FAST/SLOW
HLOA	HIGH/LOW/OFF/AUTO
HOA	HAND/OFF/AUTO
HOAL	HAND/OFF/AUTO/LOCAL
HOR	HAND/OFF/REMOTE
INC	INCREASE
JOA	JOG/OFF/AUTO
LL	LEAD/LAG
LOR	LOCAL/OFF/REMOTE
LOS	LOCKOUT STOP
L/R	LOCAL/REMOTE
M/A LS	MAN/AUTO LOADING STATION
OCA	OPEN/CLOSE/AUTO
OCP	PURGE VALVE OP/CL/PC
OL	OVERLOAD
OP	OPEN
OSC/LP	OPEN/STOP/CLOSE WITH LOCAL/REMOTE SELECT
PA	PAUSE
PAL	LOW PRESSURE
PB	PUSH BUTTON
pH	pH
POT	POTENTIOMETER
RDY	READY
REV	REVERSE
RNG	RUNNING
ROF	REVERSE/OFF/FORWARD
RST	RESET
SO2	SULFUR DIOXIDE
SP	STOP
ST	START
TCP	TEST/CLOSE/PC
T/S	TEST/NORMAL/SILENCE
TBL	TROUBLE

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INSTRUMENTATION

LEGEND AND SYMBOLS 1

DRAWING NUMBER
I-00-001
SHEET NUMBER
OF

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MISCELLANEOUS SYMBOLS

- MCC (MOTOR CONTROL/STARTER)
- PURGE OR FLUSHING DEVICE
- RESET FOR LATCH-TYPE OPERATOR
- SEAL WATER CONTROL UNIT
- INTERLOCKING OR CONTROL FUNCTION
- INTRINSIC SAFETY BARRIER
- DISCRETE INPUT
- DISCRETE OUTPUT
- ANALOG INPUT
- ANALOG OUTPUT
- FOP — FIBER OPTIC PATCH PANEL
- VFD / OIT — VARIABLE FREQUENCY DRIVE WITH OPERATOR INTERFACE TERMINAL
- OIT — OPERATOR INTERFACE TERMINAL

ACTUATORS/MOTORS/POWER

- ASD — ADJUSTABLE SPEED DRIVE (MECHANICAL)
- ROTARY PISTON ACTUATORS, VALVE OR GATE
- LINEAR PISTON ACTUATORS, VALVE OR GATE
- SOLENOID ACTUATOR, VALVE
- ELECTRIC ACTUATOR, VALVE
- MANUAL OR HAND ACTUATOR, VALVE OR GATE (OR BLANK)
- MOTOR (ACTUATOR, VALVE , GATE OR EQUIPMENT)
- PNEUMATIC (ACTUATOR, VALVE , GATE OR EQUIPMENT)
- ENGINE
- EJECTOR, PNEUMATIC
- GENERATOR

PRIMARY ELEMENT SYMBOLS

- ORIFICE PLATE
- FE — FLOW ELEMENT
- VENTURI OR FLOW TUBE
- NOZZLE FLOW
- PITOT TUBE
- PROPELLER OR TURBINE METER
- FLUME
- WEIR
- VARIABLE AREA FLOW INDICATOR (ROTAMETER) — OR — FI
- DIAPHRAGM SEAL
- IN-LINE ANNULAR SEAL
- M — MAGNETIC FLOWMETER
- SONIC FLOWMETER (DOPPLER OR TRANSIT TIME)
- POSITIVE DISPLACEMENT METER
- ΔT — THERMAL FLOW ELEMENT
- VORTEX FLOW ELEMENT
- CORIOLIS FLOW ELEMENT
- FLOAT LEVEL ELEMENT
- ULTRASONIC LEVEL ELEMENT
- BUBBLER LEVEL TUBE
- SUBMERSIBLE LEVEL TRANSMITTER
- HYDROSTATIC LEVEL PROBE
- RADAR LEVEL ELEMENT
- ANNUBAR, PITOT TUBE
- AVERAGING PITOT TUBE

VALVES

NORMALLY OPEN — NORMALLY CLOSED

- GATE VALVE
- PLUG VALVE
- BALL VALVE
- GLOBE VALVE
- NEEDLE VALVE
- KNIFE GATE VALVE
- DIAPHRAGM VALVE
- BUTTERFLY VALVE
- ANGLE VALVE
- THREE WAY VALVE
- FOUR WAY VALVE
- FLOAT VALVE
- PINCH VALVE
- BALANCING VALVE
- THERMOSTATICALLY CONTROLLED VALVE
- DOUBLE LEAF CHECK VALVE CHECK VALVE
- CHECK VALVE
- BALL CHECK VALVE
- PUMP DISCHARGE VALVE
- GAUGE OR ROOT VALVE
- PRESSURE AND VACUUM RELIEF VALVE
- VACUUM RELIEF VALVE
- PRESSURE RELIEF VALVE
- IN-LINE SPRING LOADED RELIEF VALVE
- PRESSURE REGULATING VALVE (SELF-CONTAINED)
- BACK PRESSURE REGULATING VALVE (SELF-CONTAINED)
- FUSIBLE LINK
- S — SOLENOID VALVE
- DIAPHRAGM OPERATED VALVE
- M — MOTOR OPERATED VALVE
- M — MOTOR OPERATED VALVE, MODULATING
- PISTON OPERATED VALVE

NOTE: USE VALVE BODY SYMBOL TO MATCH TYPE OF VALVE.

- TELESCOPING VALVE
- MUD VALVE
- ANTI SIPHON VALVE
- LIFT CHECK VALVE

FUNCTION SYMBOLS

- SHARED DISPLAY, PROCESS CONTROL SYSTEM
- SHARED DISPLAY, SAFETY INSTRUMENTED SYSTEM
- XXX — SOFTWARE FUNCTIONALITY REFER TO SPECIFICATION SECTION 40 61 96 FOR NETWORK DATA EXCHANGE REQUIREMENTS FOR COMMON EQUIPMENT TYPES IDENTIFIED BY THE "XXX" DESCRIPTION ABOVE SOFTWARE I/O SYMBOLS ON P&IDs
- FIELD OR PANEL DEVICE

LOCATION AND ACCESSIBILITY MODIFIERS FOR FUNCTION SYMBOLS

- STAND ALONE DEVICE, OPERATOR ACCESSIBLE
- LOCATED ON FRONT OF MAIN PANEL OR CONSOLE, OPERATOR ACCESSIBLE
- LOCATED IN REAR OF MAIN PANEL OR CONSOLE, OPERATOR INACCESSIBLE
- LOCATED ON FRONT OF SECONDARY PANEL OR CONSOLE, OPERATOR ACCESSIBLE
- LOCATED IN REAR OF SECONDARY PANEL OR CONSOLE, OPERATOR INACCESSIBLE

INSTRUMENTATION SYMBOLS

- XXX XXXXXXA — INTEGRAL INSTRUMENT — PRIMARY ELEMENT SYMBOL
- XXX XXXXXXA — CLOSE COUPLED INSTRUMENT — PRIMARY ELEMENT SYMBOL
- XXX XXXXXXA — SEPARATE OR REMOTE MOUNTED INSTRUMENT — PRIMARY ELEMENT SYMBOL
- XXX XXXXXXA / XXX XXXXXXA — MULTI VARIABLE INSTRUMENT
- XXX XXXXXXA — SEPARATE OR REMOTE MOUNTED INSTRUMENT — PRIMARY ELEMENT SYMBOL — FLANGE OR ELEMENT TAPS
- XXX XXXXXXA — SEPARATE OR REMOTE MOUNTED INSTRUMENT — PRIMARY ELEMENT SYMBOL — PIPE TAPS
- XXX XXXXXXA — SEPARATE OR REMOTE MOUNTED INSTRUMENT — PRIMARY ELEMENT SYMBOL — COMBINATION TAPS
- XXX XXXXXXA — SINGLE VARIABLE INSTRUMENT

SLIDE AND SLUICE GATES

NORMALLY OPEN — NORMALLY CLOSED

- FLAP GATE
- BUTTERFLY GATE (NO / NC)
- STOP GATE
- SLIDE GATE
- SLUICE GATE

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INSTRUMENTATION

LEGEND AND SYMBOLS 2

DRAWING NUMBER I-00-002

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PUMPS

- PUMP, CENTRIFUGAL
- PUMP, DIAGHRAGM
- PUMP, GEAR
- PUMP, METERING
- PUMP, PERISTALTIC
- PUMP, PROGRESSING CAVITY
- PUMP, ROTARY LOBE
- PUMP, SUBMERSIBLE
- PUMP, JET
- PUMP, VERTICAL

BLOWERS/COMPRESSORS

- BLOWER OR CENTRIFUGAL FAN
- BLOWER OR COMPRESSOR, LIQUID RING
- BLOWER OR COMPRESSOR, ROTARY LOBE
- COMPRESSOR, ROTARY SCREW
- COMPRESSOR, ROTARY SLIDING VANE
- COMPRESSOR, PISTON

PIPE LINE DEVICES

- TRAP
- SEDIMENT TRAP
- GAS DRIP TRAP
- SEPARATOR/ DRYER
- PIPELINE FILTER
- RUPTURE DISK (VACUUM RELIEF)
- RUPTURE DISK (PRESSURE RELIEF)
- CONNECTION BETWEEN NEW AND EXISTING PIPING
- UNION
- QUICK CONNECTOR
- CAP OR PLUG
- BLIND FLANGE
- FLEX CONNECTOR
- FABRIC EXPANSION JOINT
- BRAIDED FLEX CONNECTOR

- VENT TO ROOF
- VENT
- STEAM VENT
- AUTOMATIC VENT
- MANUAL VENT
- STRAINERS
- FOOT VALVE
- AIR SEPARATOR
- DRAIN
- DRAIN VALVE
- CALIBRATION CHAMBER
- PULSATION DAMPENER

- INJECTOR
- FLAME TRAP
- FLAME TRAP WITH THERMO SHUTOFF ASSEMBLY
- FLAME CHECK
- SAMPLING AND FLUSHING CONNECTIONS
- SUCTION DIFFUSER
- TEMPERATURE WELL
- FLOW STRAIGHTENING VANES
- PRA — PRESSURE REDUCING ASSEMBLY
- AMMONIA UNION
- DAMPER
- SIGHT GLASS
- PIG LAUNCHER/ RECEIVER
- REDUCER
- FLEX COUPLING

HVAC RELATED

- FAN, INLINE
- CHILLER
- FILTER OR FILTER-SILENCER INLET AIR
- BOILER
- CHILLER

MIXERS

- MIXER
- DRAFT TUBE MIXER
- MIXER, INLINE STATIC

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INSTRUMENTATION

LEGEND AND SYMBOLS 3

DRAWING NUMBER
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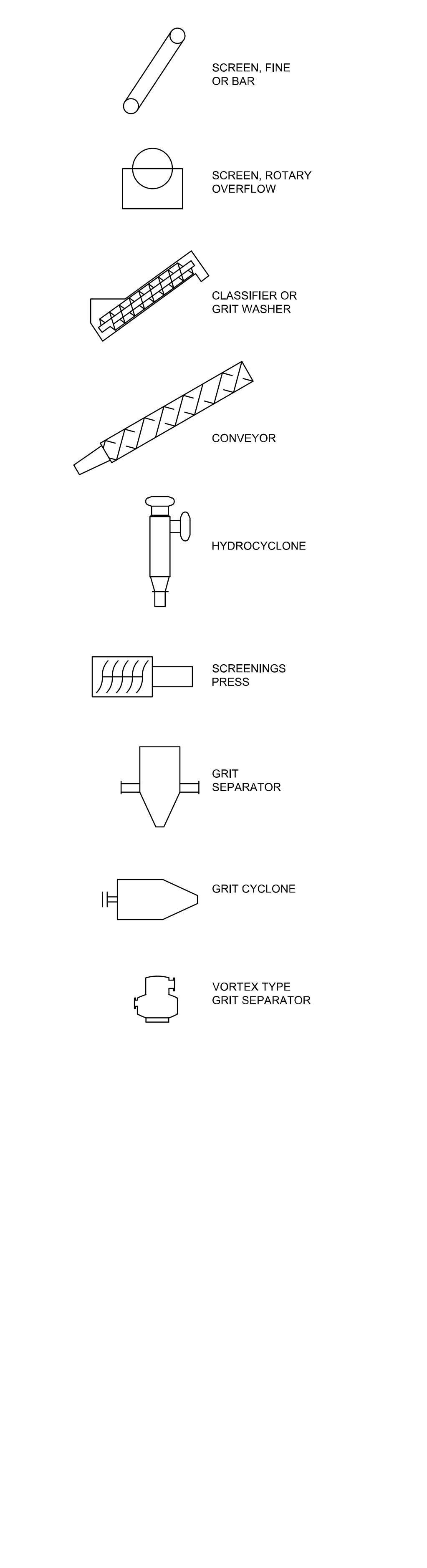
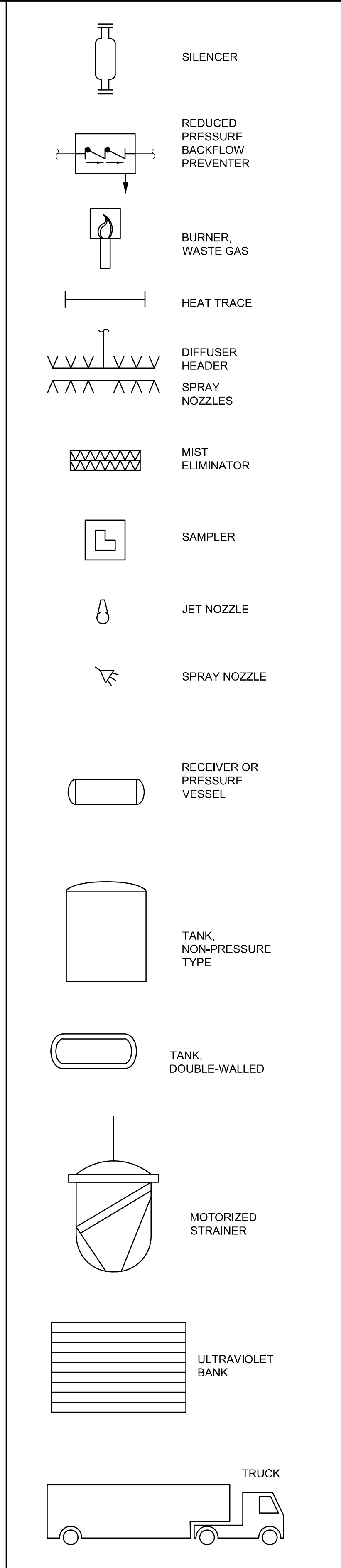
OF

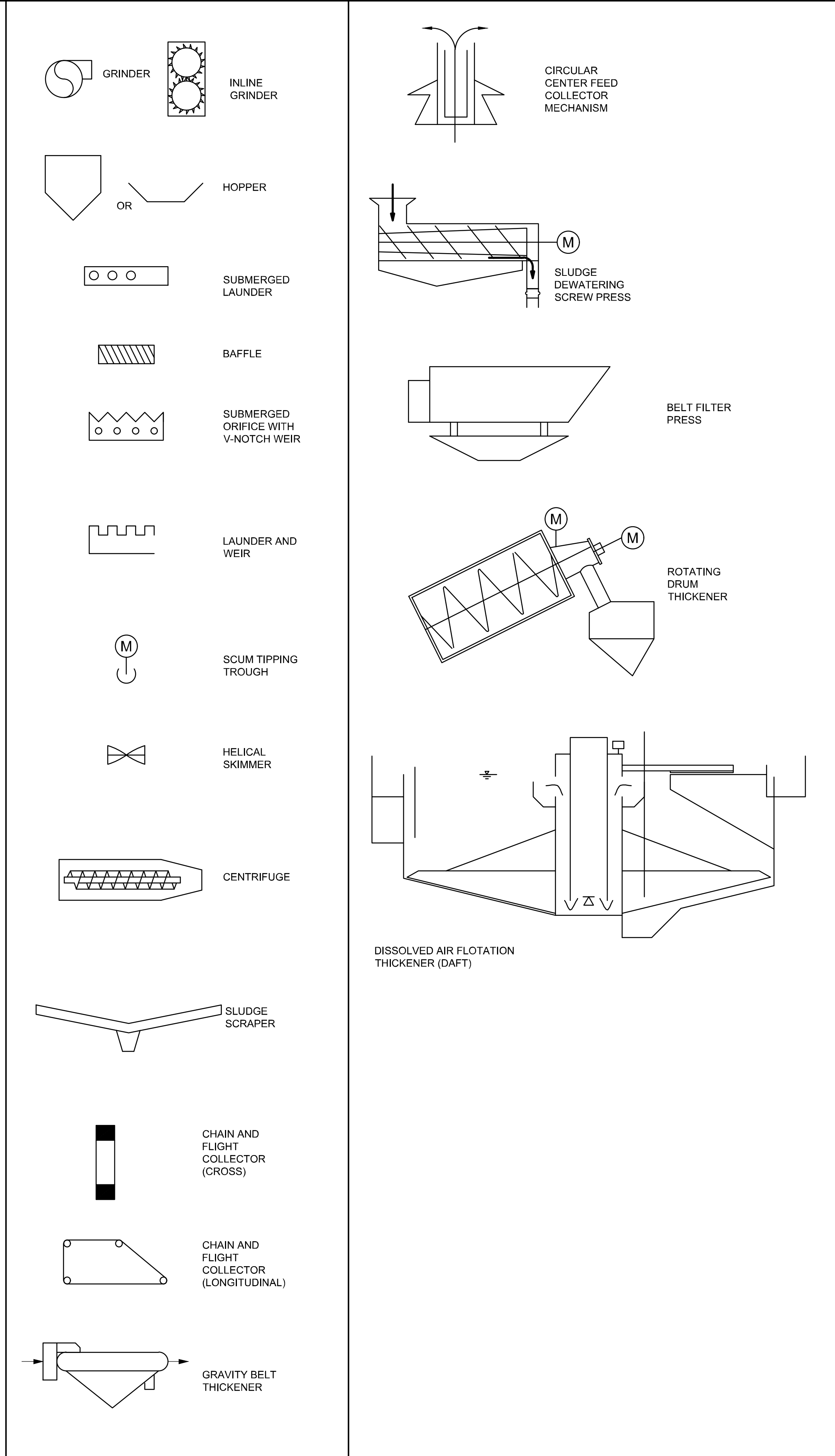
SCREENINGS/CONVEYORS



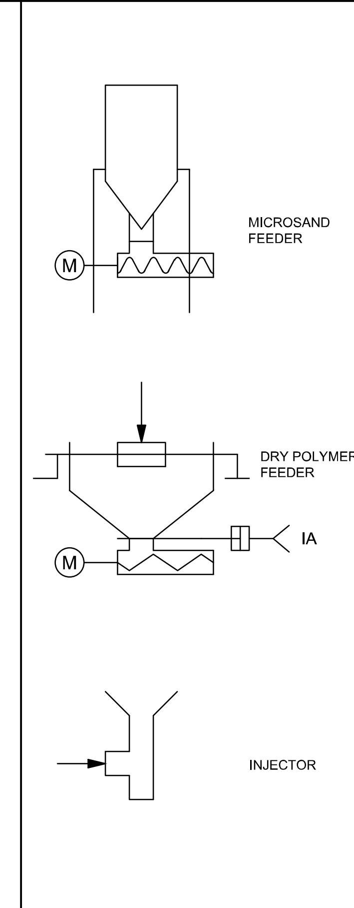
MISC. EQUIPMENT



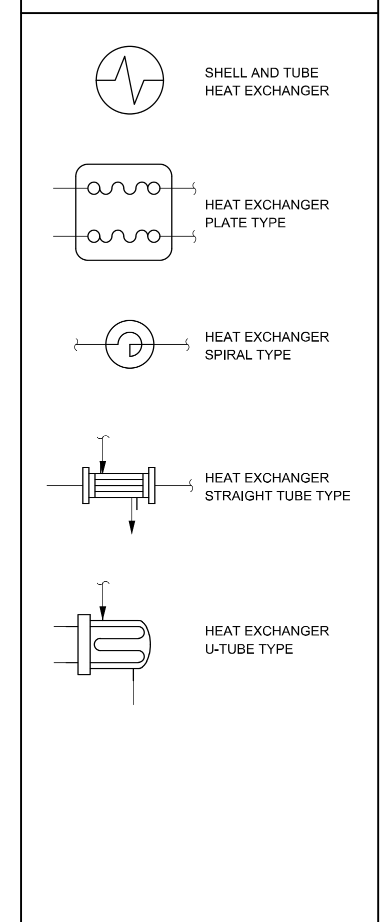
SLUDGE, SCUM AND SOLIDS EQUIPMENT



FEEDERS



HEAT EXCHANGERS



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LEGEND AND SYMBOLS 4

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PIPING SYSTEMS

ABBREVIATION	SERVICE
A	
A	AERATION AIR
AA	AGITATION AIR
AFE	AIR FLOTATION EFFLUENT
AL	ALUM
AW	APPLIED WATER
B	
B	BRINE
BA	BACKWASH AIR
BC	BIOFILTER CIRCULATION
BCTL	BOILER CHEMICAL TREATMENT, LOW PRESSURE
BCTM	BOILER CHEMICAL TREATMENT, MEDIUM PRESSURE
BDL	BOILER BLOWDOWN, LOW PRESSURE
BDM	BOILER BLOWDOWN, MEDIUM PRESSURE
BFE	BIOFILTER EFFLUENT
BFL	BIOFILTER FEEDWATER, LOW PRESSURE
BFM	BIOFILTER FEEDWATER, MEDIUM PRESSURE
BW	BACKWASH WATER
C	
CCW	CONDENSER COOLING WATER
CD	CHEMICAL DRAIN
CEN	CENTRATE
CF	CENTRIFUGE FEED
CL	CONDENSATE, LOW PRESSURE
CLG	CHLORINE GAS
CLL	CHLORINE LIQUID
CLS	CHLORINE SOLUTION
CLV	CHLORINE VACUUM
CM	CONDENSATE, MEDIUM PRESSURE
CS	CIRCULATING SLUDGE
CSO	CAUSTIC SODA
CWR	CHILLED WATER RETURN
CWS	CHILLED WATER SUPPLY
D	
D	DRAIN
DIW	DEIONIZED WATER
DS	DIGESTED SLUDGE
DSF	DIESEL FUEL
DSS	SCREENED DIGESTED SLUDGE
DW	DISTILLED WATER
E	
EE	ENGINE EXHAUST
ES	EQUALIZED SLUDGE
F	
F	FLOAT
FA	FOUL AIR
FC	FERRIC CHLORIDE
FLT	FILTRATE
FS	FLOTATION SLUDGE
FW	FILTERED WATER
G	
GAS	GASOLINE
GAV	GAS VAPOR RETURN
GC	GAS CIRCULATION
GR	GRIT
H	
HOH	HIGH PRESSURE HYDRAULIC OIL
HRR	HEAT RESERVOIR RETURN
HRS	HEAT RESERVOIR SUPPLY
HRW	RECIRCULATING POTABLE HOT WATER
HSG	HIGH PRESSURE SLUDGE GAS
HW	POTABLE HOT WATER
HWR	LOW TEMPERATURE HEATING RETURN
HWS	LOW TEMPERATURE HEATING SUPPLY
I	
IA	INSTRUMENT AIR
J	
JWR	JACKET WATER RETURN
JWS	JACKET WATER SUPPLY
L	
LOR	LUBE OIL RETURN
LOS	LUBE OIL SUPPLY
LOW	LUBE OIL WASTE
LSG	LOW PRESSURE SLUDGE GAS
M	
MG	MIXED GAS
ML	MIXED LIQUOR
MS	MIXED SLUDGE
MSG	MEDIUM PRESSURE SLUDGE GAS
MTWR	MEDIUM TEMPERATURE HEATING RETURN
MTWS	MEDIUM TEMPERATURE HEATING SUPPLY
N	
NG	NATURAL GAS
O	
OF	OVERFLOW
OLP	OXYGEN LOW PRESSURE
P	
PD	PUMPED DRAINAGE
PE	PRIMARY EFFLUENT
POL	POLYMER
PS	PRIMARY SLUDGE
PSC	PRIMARY SCUM
R	
RAS	RETURN ACTIVATED SLUDGE
RS	RAW SEWAGE
RW	RAW WATER
RWP	RAINWATER PIPE
RWR	RECLAIMED WATER
S	
SA	SERVICE AIR
SCR	STEAM CLEAN RINSE
SCR	STEAM CLEAN RINSE
SCS	STEAM CLEAN SUPPLY
SD	SANITARY DRAIN
SDG	SULFUR DIOXIDE GAS
SDL	SULFUR DIOXIDE LIQUID
SDS	SULFUR DIOXIDE SOLUTION
SDV	SULPHUR DIOXIDE VACUUM
SE	SECONDARY EFFLUENT
SEP	SEPTAGE
SN	SUPERNATANT
SS	SECONDARY SLUDGE
SSC	SECONDARY SCUM
STA	STARTING AIR
STD	STORM DRAIN
STML	STEAM, LOW PRESSURE
STMM	STEAM, MEDIUM PRESSURE
T	
TD	TANK DRAIN
TE	THICKENER EFFLUENT
THS	THICKENED SLUDGE
TO	THICKENER OVERFLOW
TS	TRANSFER SLUDGE
TSC	THICKENED SCUM
TWAS	THICKENED WASTE ACTIVATED SLUDGE
V	
V	VENT
VA	VACUUM
VC	CHEMICAL VENT
VP	PETROLEUM VENT
VSL	STEAM VENT, LOW PRESSURE
VSM	STEAM VENT, MEDIUM PRESSURE
W	
WAS	WASTE ACTIVATED SLUDGE
WML	WASTE MIXED LIQUOR
1	
1W	POTABLE WATER (CITY WATER)
1WS	POTABLE SOFT WATER
2	
2W	NONPOTABLE CITY WATER
2WHP	NO. 2 WATER HIGH PRESSURE
2WL	LANDSCAPE IRRIGATION
2WS	SOFTENED NONPOTABLE CITY WATER
3	
3W	NO.3 WATER (SECONDARY EFFLUENT)
3WHP	NO. 3 WATER HIGH PRESSURE
3WLC	NO. 3 WATER LOW PRESSURE CHLORINATED
3WLP	NO. 3 WATER LOW PRESSURE
3WS	NO. 3 SPRAY WATER

EQUIPMENT PREFIXES

A	
A	AERATOR
ACC	AIR CONDITION COIL
ACU	AIR CONDITIONING UNIT
AD	AIR DRYER
AF	AIR FILTER
AHC	AIR HANDLING UNIT W/COIL
AHU	AIR HANDLING UNIT
ASC	ADJUSTABLE SPEED CONTROL
ASD	ADJUSTABLE SPEED DRIVE
ATS	AUTOMATIC TRANSFER SWITCH
B	
B	BLOWER
BFP	BELT FILTER PRESS
BLR	BOILER
BNR	BURNER
BP	BACKFLOW PREVENTER
BSN	BAR SCREEN
C	
C	COIL
CDR	CONDENSOR
CFR	CHEMICAL FEEDER
CHR	CHILLER
COL	COLLECTOR
COM	COMMINUTOR
CON	CONVEYOR
CP	COMPRESSOR
CRN	CRANE
CTF	CENTRIFUGE
CV	CONTROL VALVE
CYL	CYLINDER
D	
DIS	DISTRIBUTOR
DPR	DAMPER
DS	DISCONNECT SWITCH
DU	DRIVE UNIT
E	
E	ENGINE
EB	ENGINE BLOWER MODULE
EG	ENGINE GENERATOR MODULE
EPR	EVAPORATOR
F	
F	FAN
FLC	FLOCCULATOR
FLT	FILTER
FP	FILTER PRESS
FPU	FLUID POWER UNIT
FUR	FURNACE
G	
GEN	GENERATOR
GDR	GRINDER
GT	GATE
H	
H	HOIST
HEX	HEAT EXCHANGER
HO	PHYDRAULIC OPERATOR
HP	HEAT PUMP
HPU	HYDRAULIC POWER UNIT
HTR	HEATER
HTT	HEAT TRACER TAPE
HV	HAND OPERATED VALVE
I	
INJ	INJECTOR
L	
LVR	LOUVER
M	
M	MOTOR
MCC	MOTOR CONTROL CENTER
MEE	MISCELLANEOUS ELECTRICAL EQUIPMENT
MIE	MISCELLANEOUS INSTRUMENTATION EQUIPMENT
MME	MISCELLANEOUS MECHANICAL EQUIPMENT
MOP	MOTOR OPERATOR
MSP	MOTOR STARTER PANEL
MUX	MULTIPLEXER
MX	MIXER
MZ	MULTIZONE UNIT
O	
ORT	ODOR REMOVAL TOWER
P	
P	PUMP
PBD	PANELBOARD, ELECTRICAL LIGHTING AND BRANCH CIRCUIT
PC	PROCESS OR PERSONAL COMPUTER
PEJ	PNEUMATIC EJECTOR
PLC	PROGRAMMABLE LOGIC CONTROLLER
PNL	PANEL
POP	PNEUMATIC OPERATOR
PVL	PRESSURE VESSEL
R	
REC	RECEIVER
S	
SCN	SCREEN (BAR, ETC.)
SCR	SCRUBBER
SEP	SEPARATOR
SLR	SILENCER
SMP	SAMPLER
SS	SAND SEPARATOR
ST	STEAM TRAP
SUB	SUBSTATION
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
T	
T	TANK
TBN	TURBINE
TCV	TEMPERATURE CONTROL VALVE
TFR	TRANSFORMER
TM	TIMER
TRS	TRANSFER SWITCH
U	
UH	UNIT HEATER
US	UTILITY STATION
V	
VEN	VENTILATOR
VP	VACUUM PUMP
W	
WH	WATER HEATER
WHR	WASHER
WSR	WATER SOFT

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CONCEPTUAL DRAWINGS

NOT FOR CONSTRUCTION

HRSD WILROY PRS AND TANK

REVISIONS

REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: Designer
DRAWN: Author
CHECKED: Checker
CHECKED:
APPROVED: Approver

FILENAME

BC PROJECT NUMBER
123456

CLIENT PROJECT NUMBER
XX

INSTRUMENTATION

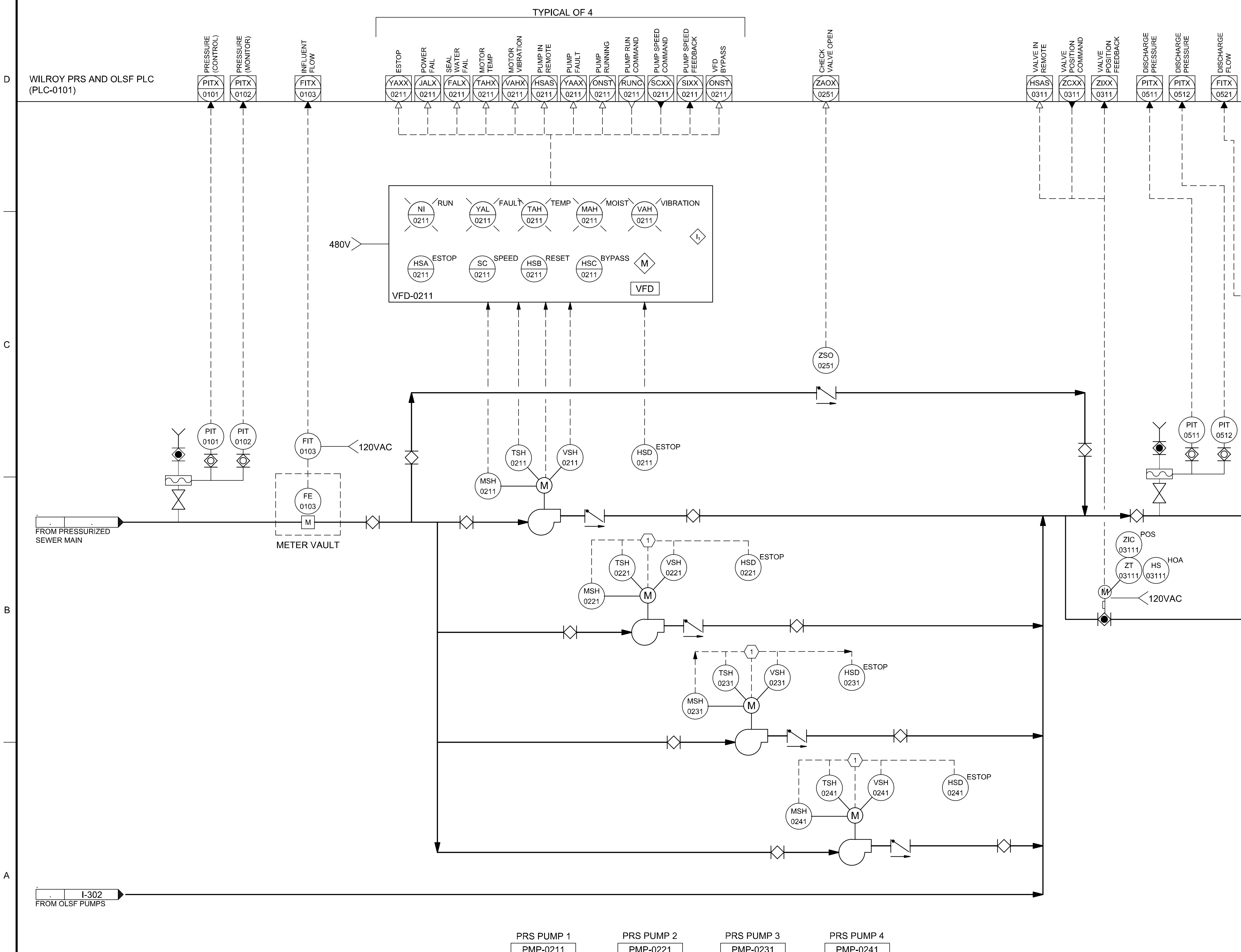
ABBREVIATIONS

DRAWING NUMBER
I-00-0005

SHEET NUMBER
OF

Path: C:\Users\teastman\OneDrive - Brown and Caldwell\CAD Standards\Legends\Legends Check\BC_Training-Dev-Standards-2020-Legends\REVIT\DPS_GENERAL_V19.rvt

Plot Date: 2/28/2022 5:24:09 PM



GENERAL NOTES:

1. ALL EQUIPMENT AND INSTRUMENTATION TAGS SHOWN SHALL BE PRECEDED BY THE SITE AND PROCESS DESIGNATION "0XXX91".

KEY NOTES:

1. PUMP, DRIVE, CONTROL, MONITORING, INTERLOCKS, AND I/O SIGNALS SHALL BE SIMILAR TO PRS PUMP 1 (PMP-0211, VFD-0211).

INTERLOCKS:

1. PUMP SHALL BE HARDWIRED TO STOP ON HIGH TEMPERATURE, MOISTURE DETECTION AND HIGH VIBRATION.

Brown AND Caldwell

CONCEPTUAL DRAWINGS

NOT FOR CONSTRUCTION

HRSD
Cleaning wastewater every day for a better Bay.

HRSD WILROY PRS AND TANK

REVISIONS

REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: -
DRAWN: -
CHECKED: -
CHECKED: -
APPROVED: -

FILENAME
I-101.DWG
BC PROJECT NUMBER
157943
CLIENT PROJECT NUMBER
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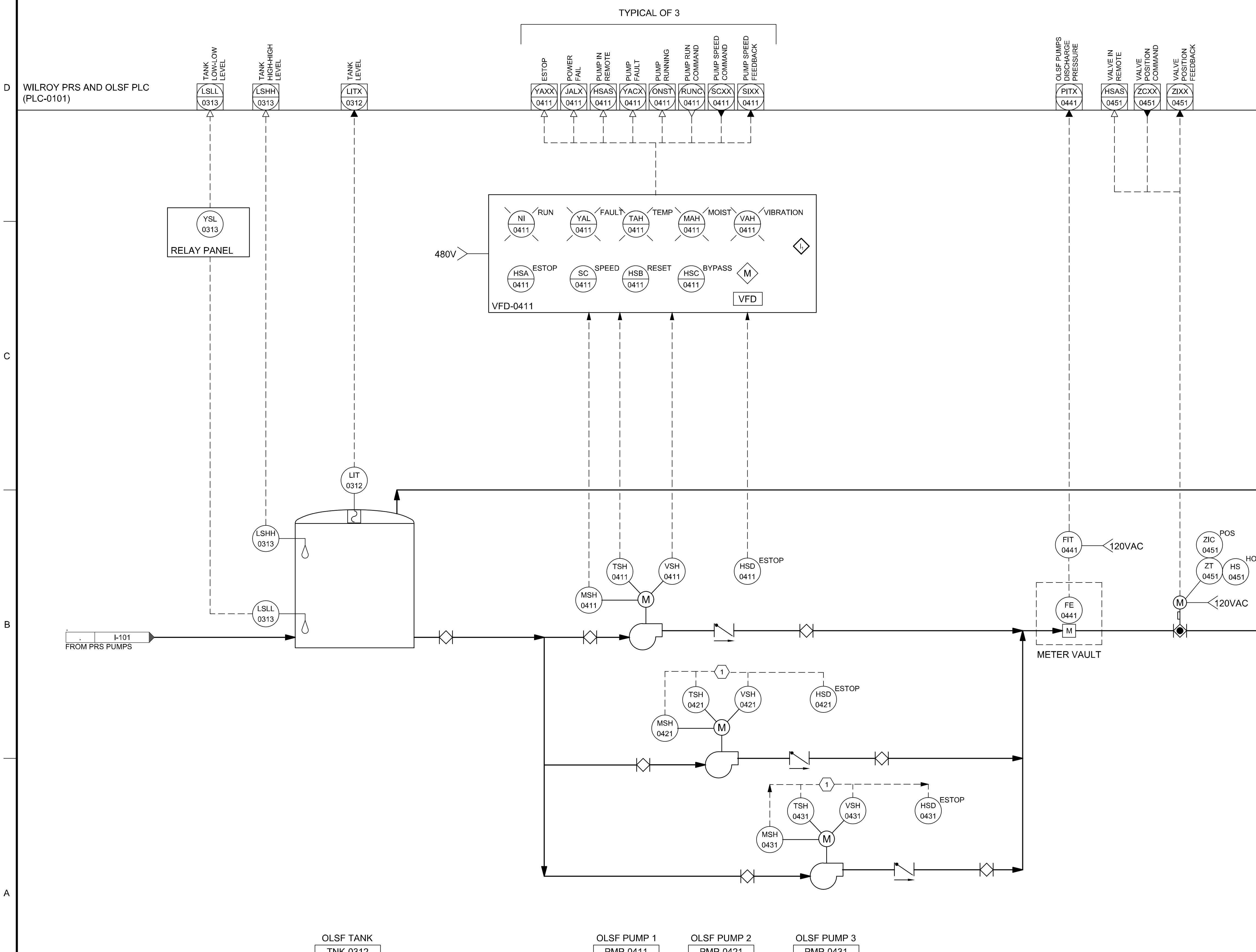
DRAWING NUMBER
####
SHEET NUMBER
OF



GENERAL NOTES:

1. ALL EQUIPMENT AND INSTRUMENTATION TAGS SHOWN SHALL BE PRECEDED BY THE SITE AND PROCESS DESIGNATION "0XXX91".

KEY NOTES:

1. PUMP, DRIVE, CONTROL, MONITORING, INTERLOCKS, AND I/O SIGNALS SHALL BE SIMILAR TO PRS PUMP 1 (PMP-0411, VFD-0411).

INTERLOCKS:

1. PUMP SHALL BE HARDWIRED TO STOP ON HIGH TEMPERATURE, MOISTURE DETECTION, HIGH VIBRATION, AND LOW-LOW LEVEL.

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REVISIONS

REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: -
DRAWN: -
CHECKED: -
CHECKED: -
APPROVED: -

FILENAME
I-102.DWG
BC PROJECT NUMBER
157943
CLIENT PROJECT NUMBER
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DRAWING NUMBER
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SHEET NUMBER
OF

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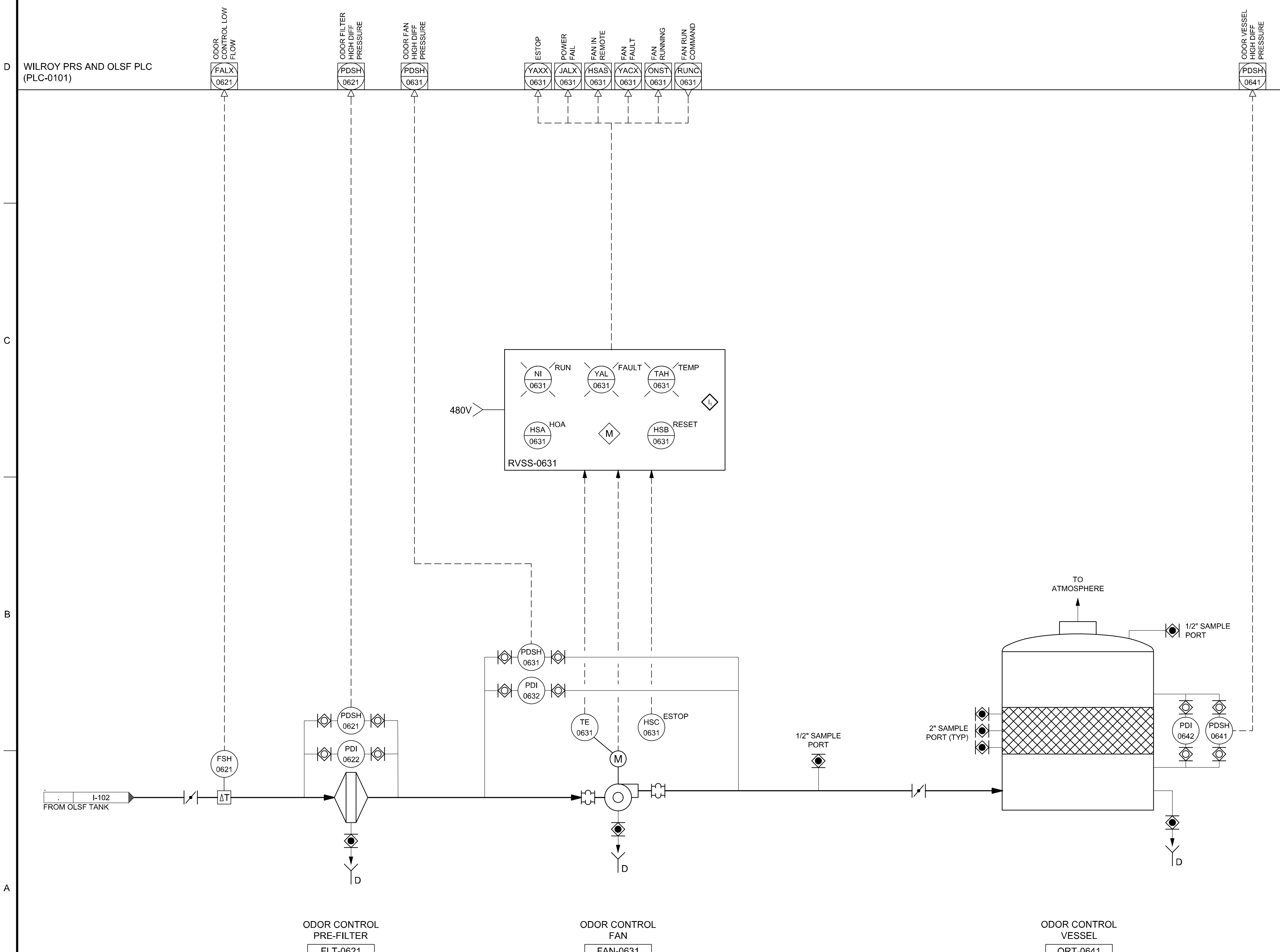

GENERAL NOTES:

1. ALL EQUIPMENT AND INSTRUMENTATION TAGS SHOWN SHALL BE PRECEDED BY THE SITE AND PROCESS DESIGNATION "0XXX91".

KEY NOTES:

1.

INTERLOCKS:

1. FAN SHALL BE HARDWIRED TO STOP ON HIGH TEMPERATURE.

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CONCEPTUAL DRAWINGS

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REVISIONS		
REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: -
DRAWN: -
CHECKED: -
CHECKED: -
APPROVED: -

FILENAME I-103.DWG
BC PROJECT NUMBER 157943
CLIENT PROJECT NUMBER ####

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DRAWING NUMBER
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SHEET NUMBER
OF

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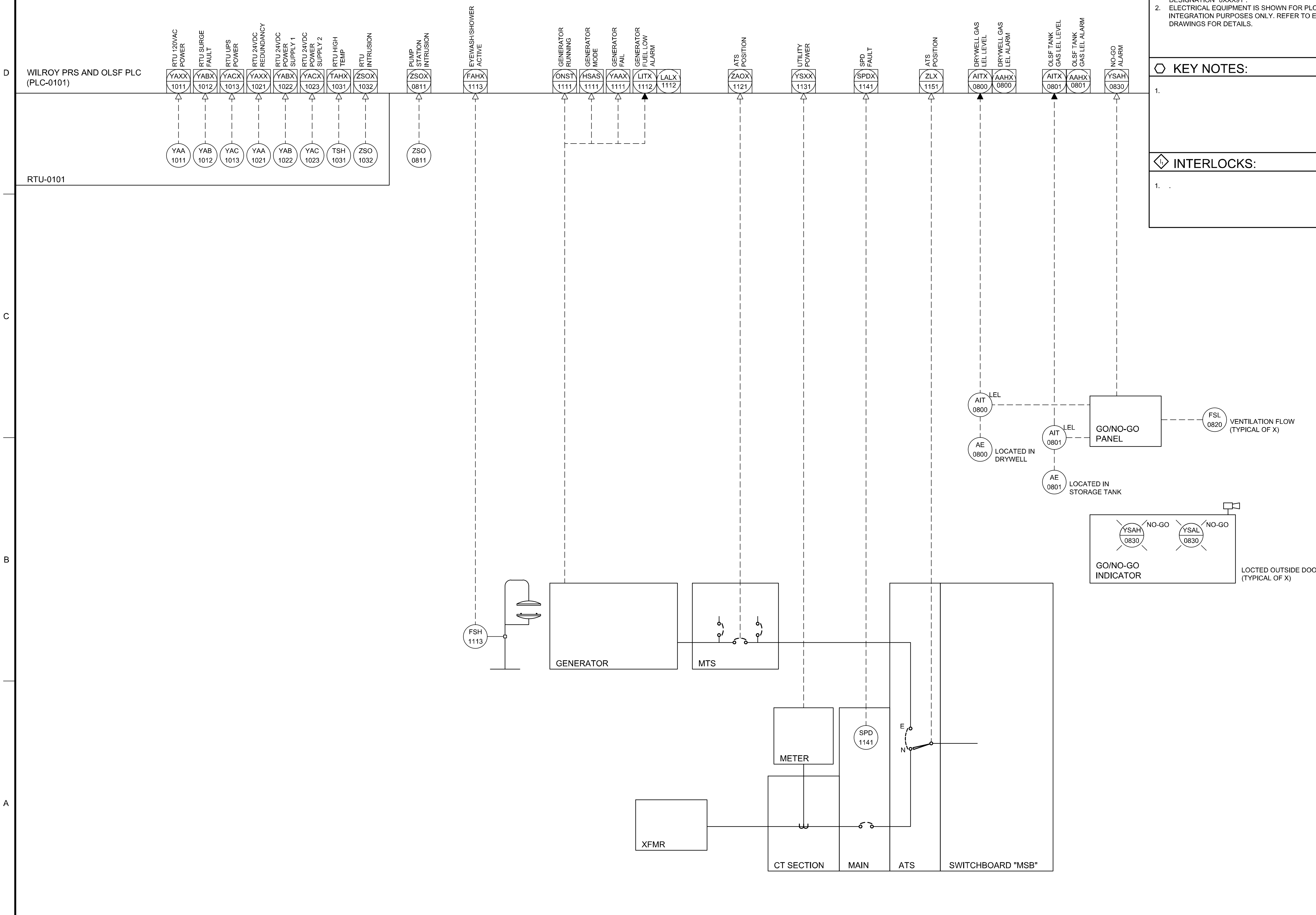

GENERAL NOTES:

1. ALL EQUIPMENT AND INSTRUMENTATION TAGS SHOWN SHALL BE PRECEDED BY THE SITE AND PROCESS DESIGNATION "0XXX91".
2. ELECTRICAL EQUIPMENT IS SHOWN FOR PLC AND NETWORK INTEGRATION PURPOSES ONLY. REFER TO ELECTRICAL DRAWINGS FOR DETAILS.

KEY NOTES:

1.

INTERLOCKS:

1. .

Brown AND Caldwell

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HRSD WILROY PRS AND TANK

REVISIONS		
REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: -
DRAWN: -
CHECKED: -
CHECKED: -
APPROVED: -

FILENAME
I-104.DWG
BC PROJECT NUMBER
157943
CLIENT PROJECT NUMBER
####

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DRAWING NUMBER
####
SHEET NUMBER
OF

Appendix G: Detailed Opinion of Probable Construction Cost

Memorandum

Date: August 8, 2022

To: Chris Wilson, Virginia Beach

From: Breeze Walter, Cincinnati, Yadiel Rodriguez, Atlanta

Reviewed by: William Agster, Denver

Copy to: Ryan Foshay, Virginia Beach

Project No.: 157943-340-****

Subject: Wilroy PRS and Tank
BODR Design Completion
Basis of Estimate of Probable Construction Cost

The Basis of Estimate Report and supporting estimate reports for the subject project are attached. Please call me if you have questions or need additional information.

Enclosures (3):

1. Basis of Estimate Report
2. Summary Estimate
3. Detailed Estimate

Basis of Estimate Report

Wilroy PRS and Tank

Introduction

Brown and Caldwell (BC) is pleased to present this opinion of probable construction cost (estimate) prepared for the Wilroy PRS and Tank, HRSD Suffolk, VA.

Estimated Project Costs

Based on the typical accuracy of a Class 4 estimate, the expected range of costs is:

Upper Range	Estimated Cost	Lower Range
+50%		-30%
$72,598,551	$48,399,034	$33,879,324

Summary

This Basis of Estimate contains the following information:

- Scope of work
- Background of this estimate
- Class of estimate
- Estimating methodology
- Direct cost development
- Indirect cost development
- Bidding assumptions
- Estimating assumptions
- Estimating exclusions
- Allowances for known but undefined work
- Contractor and other estimate markups

Scope of Work

Scope of work for the project includes:

- New (1) Pressure Reducing Station (PRS) (pump station) with 80 ft of assistance and approximately 21 MGD capacity which will include new facilities building which will house the new pumps, motors, valves, piping, sump pumps, electrical room with all new equipment, HVAC, back-up generator, bathroom for operators.
- (1) 3 million gallons (MG) prestressed Offline Storage tank, tank cleaning mechanisms, discharge pumps, valving, and piping.

- The new PRS and storage tank will be constructed on a newly acquired property along Wilroy Road in Suffolk, VA.
- The first 10 feet depth of soil is not usable as foundation base. Over excavation for the pump station and tank foundations will be necessary and include structural backfill prior to foundation placement.
- Option 1 Architectural Design 1 has been included in the estimate.
- This is a CMAR project and the fee for the CMAR is included in the cost estimate.
- The fee for construction administration and constriction inspections is included in the estimate.

Background of this Estimate

The attached estimate of probable construction cost is based on documents dated July 2022, received by the Estimating and Scheduling Group (ESG). These documents are described as 5 percent complete based on the current project progression, additional or updated scope and/or quantities, and ongoing discussions with the project team. Further information can be found in the detailed estimate reports.

Class of Estimate

In accordance with the Association for the Advancement of Cost Engineering International (AACE) criteria, this is a Class 4 estimate. A Class 4 estimate is defined as a Planning Level or Design Technical Feasibility Estimate. Typically, engineering is from 1 to 15 percent complete. Class 4 estimates are used to prepare planning level cost scopes or to evaluate alternatives in design conditions and form the base work for the Class 3 Project Budget or Funding Estimate.

Expected accuracy for Class 4 estimates typically range from -30 to +50 percent, depending on the technological complexity of the project, appropriate reference information and the inclusion of an appropriate contingency determination. In unusual circumstances, ranges could exceed those shown.

Estimating Methodology

This estimate was prepared using quantity take-offs, vendor quotes and equipment pricing furnished either by the project team or by the estimator. The estimate includes direct labor costs and anticipated productivity adjustments to labor and equipment. Where possible, estimates for work anticipated to be performed by specialty subcontractors have been identified.

Construction labor crew and equipment hours were calculated from production rates contained in documents and electronic databases published by R.S. Means, Mechanical Contractors Association (MCA), National Electrical Contractors Association (NECA), and Rental Rate Blue Book for Construction Equipment (Blue Book).

This estimate was prepared using BC's estimating system, which consists of Sage Construction and Real Estate 300 estimating software engine (formerly Timberline) using RS Means database, historical project data, the latest vendor and material cost information, and other costs specific to the project location.

Electrical estimates are performed using ConEst Intellibid electrical estimating software with database provided by Trade Services. The final number from the electrical estimate will be included in the Sage estimate, usually as an "electrical subcontract" number. Clients will be provided the detailed electrical estimate along with the Sage estimate in their deliverable.

Direct Cost Development

Costs associated with the General Provisions and the Special Provisions of the construction documents, which are collectively referred to as Contractor General Conditions (CGC), were based on the estimator's interpretation of the contract documents. The estimates for CGCs are divided into two groups: a time-related group (e.g., field personnel) and non-time-related group (e.g., bonds and insurance). Labor burdens such as health and welfare, vacation, union benefits, payroll taxes, and worker's compensation insurance are included in the labor rates. No trade discounts were considered.

Indirect Cost Development

This project is tax exempt. A percentage allowance for contractor's home office expense has been included in the overall rate markups. The rate is standard for this type of heavy construction and is based on typical percentages outlined in Means Heavy Construction Cost Data.

The contractor's cost for builder's risk, general liability and vehicle insurance has been included in this estimate. Based on historical data, this is typically two to four percent of the overall construction contract amount. These indirect costs have been included in this estimate as a percentage of the gross cost and are added after the net markups have been applied to the appropriate items.

Bidding Assumptions

The following bidding assumptions were considered in the development of this estimate.

1. Bidders must hold a valid, current Contractor's credentials, applicable to the type of project.
2. Bidders will develop estimates with a competitive approach to material pricing and labor productivity, and will not include allowances for changes, extra work, unforeseen conditions or any other unplanned costs.
3. Estimated costs are based on a minimum of four bidders. Actual bid prices may increase for fewer bidders or decrease for a greater number of bidders.
4. Bidders will account for General Provisions and Special Provisions of the contract documents and will perform all work except that which will be performed by traditional specialty subcontractors as identified here:
   - Electrical
   - HVAC systems
   - Precast Tank

Estimating Assumptions

As the design progresses through different completion stages, it is customary for the estimator to make assumptions to account for details that may not be evident from the documents. The following assumptions were used in the development of this estimate.

1. The takeoff for the electrical is based on a BODR.
2. The electrical proposal is made following the National Electrical Code (NEC).
3. The electrical prices are not based on hard quotes.
4. Security system is not included in electrical estimate.
5. Light fixtures are based on OSHA lumens per sq ft.
6. Dominion Energy (DE) is providing the following items:

   a. Main transformer
   b. Primary service feeder
   c. Perform the secondary termination on the main transformer
7. Soils are of adequate nature to support the structures. Over excavation is required with structural backfill. No piles have been included in this estimate.
8. Contractor performs the work during normal daylight hours, nominally 7 a.m. to 5 p.m., Monday through Friday, in an 8-hour shift. No allowance has been made for additional shift work or weekend work.
9. Contractor has complete access for lay-down areas and mobile equipment.
10. Equipment rental rates are based on verifiable pricing from the local project area rental yards, Blue Book rates, and/or rates contained in the estimating database.
11. Contractor markup is based on conventionally accepted values that have been adjusted for project-area economic factors.
12. Major equipment costs are based on vendor supplied price quotes obtained by the project design team and/or estimators and on historical pricing of like equipment.
13. Process equipment vendor training using vendors' standard Operations and Maintenance (O&M) material is included in the purchase price of major equipment items where so stated in that quotation.
14. Bulk material quantities are based on manual quantity take-offs.
15. There is enough electrical power to feed the specified equipment. The local power company will supply power and transformers suitable for this facility.

Estimating Exclusions

The following estimating exclusions were assumed in the development of this estimate.

1. Hazardous materials remediation and/or disposal.
2. O&M costs for the project except for the vendor supplied O&M manuals.
3. Utility agency costs for incoming power modifications.
4. Permits beyond those normally needed for the type of project and project conditions.
5. Impacts from COVID-19 including additional labor and management hours required to meet social distancing, personal protection, and cleaning routines, additional costs of protective equipment, supply chain impacts, and material shortages.

Allowances for Known but Undefined Work

The following allowances were made in the development of this estimate.

1. Arc Flash & Short circuit studies $49,187.
2. PLC & programming $232,272.
3. Instrumentation $75,862.
4. Temporary power $91,043.
5. Plumbing $10,000
6. HVCV $5.00/SF
7. Odor Control Equipment $266,400

Contractor and Other Estimate Markups

Contractor markup is based on conventionally accepted values which have been adjusted for project-area economic factors. Estimate markups are shown in Table 1.

Table 1. Estimate Markups	
Item	Rate (%)
Net Cost Markups	
Labor markup	15
Materials and process equipment	10
Equipment (construction-related)	10
2022 Diesel Fuel Adjustment	6
Subcontractor	10
Other – Process Equipment	8
Sales Tax – Tax Exempt	0
Material Shipping and Handling	2
Gross Cost Markups	
Contractor General Conditions	15
Start-up, Training and O&M	2
Undesign/ Undeveloped Construction Contingency	20
Unknown Market Conditions	10
Builders Risk, Liability and Auto Insurance	2
Performance and Payment Bonds	1.5
CMAR Fee	10
Escalation to Midpoint of Construction	15.66
BC CACI Fee	10

Labor Markup

The labor rates used in the estimate were derived from RS Means latest national average wage rate tables and city cost indexes. These include base rate paid to the laborer plus fringes. A labor burden factor is applied to these such that the final rates include all employer paid taxes. These taxes are FICA (which covers social security plus Medicare), Workers Comp (which varies based on state, employer experience and history) and unemployment insurance. The result is fully loaded labor rates. In addition to the fully loaded labor rate, an overhead and profit markup is applied at the back end of the estimate. This covers payroll and accounting, estimator's wages, home office rent, advertising and owner profit.

Materials and Process Equipment Markup

This markup consists of the additional cost to the contractor beyond the raw dollar amount for material and process equipment. This includes shop drawing preparation, submittal and/or re-submittal cost, purchasing and scheduling materials and equipment, accounting charges including invoicing and payment, inspection of received goods, receiving, storage, overhead and profit.

Equipment (Construction) Markup

This markup consists of the costs associated with operating the construction equipment used in the project. Most GCs will rent rather than own the equipment and then charge each project for its equipment cost. The equipment rental cost does not include fuel, delivery and pick-up charges, additional insurance requirements on rental equipment, accounting costs related to home office receiving invoices and payment. However, the crew rates used in the estimate do account for the equipment rental cost. Occasionally, larger contractors will have some or all the equipment needed for the job, but to recoup their initial purchasing cost they will charge the project an internal rate for equipment use which is like the rental cost of equipment. The GC will apply an overhead and profit percentage to each individual piece of equipment whether rented or owned.

To address the significant increase in fuel pricing from early 2022 to the date of this estimate, a 6% Diesel Fuel Adjustment markup is applied in addition to the standard equipment markup.

Subcontractor Markup

This markup consists of the GC's costs for subcontractors who perform work on the site. This includes costs associated with shop drawings, review of subcontractor's submittals, scheduling of subcontractor work, inspections, processing of payment requests, home office accounting, and overhead and profit on subcontracts.

Sales Tax (Materials, Process Equipment and Construction Equipment)

This project is tax exempt.

Contractor Startup, Training, and O&M Manuals

This cost markup is often confused with either vendor startup or owner startup. It is the cost the GC incurs on the project beyond the vendor startup and owner startup costs. The GC generally will have project personnel assigned to facilitate the installation, testing, startup and O&M manual preparation for equipment that is put into operation by either the vendor or owner. These project personnel often include an electrician, pipe fitter or millwright, and/or I&E technician. These personnel are not included in the basic crew makeup to install the equipment but are there to assist and troubleshoot the startup and proper running of the equipment. The GC also incurs a cost for startup for such things as consumables (oil, fuel, filters, etc.), startup drawings and schedules, startup meetings and coordination with the plant personnel in other areas of the plant operation.

Builders Risk, Liability, and Vehicle Insurance

This percentage comprises all three items. There are many factors which make up this percentage, including the contractor's track record for claims in each of the categories. Another factor affecting insurance rates has been a dramatic price increase across the country over the past several years due to domestic and foreign influences. Consequently, in the construction industry we have observed a range of 0.5 to 1 percent for Builders Risk Insurance, 1 to 1.25 percent for General Liability Insurance, and 0.85 to 1 percent for Vehicle Insurance. Many factors affect each area of insurance, including project complexity and contractor's requirements and history. Instead of using numbers from a select few contractors, we believe it is more prudent to use a combined 2 percent to better reflect the general costs across the country. Consequently, the actual cost could be higher or lower based on the bidder, region, insurance climate, and the contractor's insurability at the time the project is bid.

Material Shipping and Handling

This can range from 2 to 6 percent, and is based on the type of project, material makeup of the project, and the region and location of the project. Material shipping and handling covers delivery costs from vendors, unloading costs (and in some instances loading and shipment back to vendors for rebuilt equipment), site paperwork, and inspection of materials prior to unloading at the project site. BC typically adjusts this percentage by the amount of materials and whether vendors have included shipping costs in the quotes that were used to prepare the estimate. This cost also includes the GC's cost to obtain local supplies, e.g., oil, gaskets and bolts that may be missing from the equipment or materials shipped.

Escalation to Midpoint for Labor, Materials and Subcontractors

In addition to contingency, it is customary for projects that will be built over several years to include an escalation to midpoint of anticipated construction to account for the future escalation of labor, material and equipment costs beyond values at the time the estimate is prepared. For this project, the anticipated rate of escalation is 6 percent per annum.

The estimated construction time for this project is 24 months, exclusive of unusual weather or site conditions delays. Construction is anticipated to start January 2024 and be completed by January 2026. The escalation factors used in this estimate are calculated from the date of this estimate to the anticipated midpoint of construction which is approximately 29.2 months from the date of this estimate.

Undesigned/Undeveloped Contingency

The contingency factor covers unforeseen conditions, area economic factors, and general project complexity. This contingency is used to account for those factors that cannot be addressed in each of the labor and/or material installation costs. Based on industry standards, completeness of the project documents, project complexity, the current design stage and area factors, construction contingency can range from 10 to 50 percent.

Performance and Payment Bonds

Based on historical and industry data, this can range from 0.75 to 3 percent of the project total. There are several contributing factors including such items as size of the project, regional costs, contractor's historical record on similar projects, complexity and current bonding limits. BC uses 1.5 percent for bonds, which we have determined to be reasonable for most heavy construction projects.

HRSD
Wilroy PRS and Tank
BODR

Estimator	Breeze Walter
BC Project Manager	Chris Wilson
BC Office	Virginia Beach
Est Version Number	1
QA/QC Reviewer	William Agster
QA/QC Review Date	7-29-2022
Other Estimators	Yadiel Rodriguez
Factor table	Virginia-Norfolk

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Grand Total Cost/Unit	Gross Total Costs
01 Total										
01.0 Sitework										
	03330	OC Foundation Slab	240.0 cy	3,962	11,516	113			73.27 /cy	17,585
	31240	Dewatering Systems PS	4.0 mo	250,806		372,963			179,637.11 /mo	721,063
	31240	Dewatering Systems Tank	5.0 mo	310,774		430,534			170,747.38 /mo	856,810
	31250	Shoring Systems PS 122' x 76'x 10' depth	32,320.0 sf	343,706	282,444	220,659			29.94 /sf	967,564
	31250	Shoring Systems Tank 140' diameter 10' depth	8,792.0 sf	93,498	76,833	60,026			29.94 /sf	263,206
	31290	_Structure Excavation and Backfill PS	5,600.0 cy	167,124	43,742	171,169		543,669	183.38 /cy	1,026,903
	31290	_Structure Excavation and Backfill Tank	7,593.3 cy	225,664	57,452	231,923		737,190	182.93 /cy	1,389,056
	32740	Asphaltic Paving & Sidewalks	18,416.0 sf	17,883	121,133	7,958			8.98 /sf	165,465
		01.0 Sitework		1,413,418	593,120	1,495,344		1,280,859		5,407,652
02.0 Yard Piping										
	33490	_Trench for Utilities 30" Piping	584.0 lf	50,815	36,378	46,942		127,568	498.99 /lf	291,408
	33490	_Trench for Utilities 24" Line	1,000.0 lf	69,673	54,096	72,281		186,976	426.49 /lf	426,492
	40120	Piping DI Flanged 30" Yard Piping from Road to PS	314.0 lf	46,183	275,237	7,480			1,178.51 /lf	370,053
	40120	Piping DI Flanged 30" from PS to Tank	270.0 lf	41,560	290,128	6,412			1,408.05 /lf	380,175
	40120	Piping DI Flanged 24"	1,000.0 lf	94,491	337,851	57			487.12 /lf	487,124
	40120	Temp By Pass 30"	40.0 lf	15,210	845,221	1,107			24,135.57 /lf	965,423
	40120	Temp By Pass 24"	20.0 lf	7,009	403,872	1,107			23,084.08 /lf	461,682
		02.0 Yard Piping		324,942	2,242,785	135,386		314,544		3,382,357
03.1 Structural PS										
	03330	PS Foundation Lower Level 122' x 76' x 2' Thick	686.8 cy	85,729	238,298	3,931			538.78 /cy	370,042
	03330	PS Foundation Upper Level 122' x 16' x 2' Thick	144.6 cy	18,780	51,835	828			557.51 /cy	80,613
	03345	_Concrete Walls Lower level 10' tall x 2' Thick	296.3 cy	80,164	99,357	3,243			699.40 /cy	207,230
	03345	_Concrete Walls Upper Level 1' thick x 25' Tall to 31' Tall	479.4 cy	217,111	165,587	6,403			923.14 /cy	442,563
	03355	Slab over Metal Decking (Standard Flute Depths) 122' x 92'	155.9 cy	40,554	105,884	2,206			1,076.32 /cy	167,786
	03370	_Equipment Pad Generator	7.7 cy	1,047	2,361	42			505.94 /cy	3,898
	03370	_Equipment Pads Electrical Equipment	4.4 cy	1,320	1,794	28			818.05 /cy	3,560
	04220	Interior Walls Upper Level 28' Tall	4,144.0 sf	54,097	51,515	450			29.06 /sf	120,430
	05121	_Elevated Aluminum Platform, aluminum structure	1,370.0 sf	102,437	402,386	28,771			439.31 /sf	601,848
	05200	Steel Joists, Joist Girders and Trusses	92.7 ton	73,034	554,476	21,456			7,870.63 /ton	729,891
		03.1 Structural PS		674,273	1,673,492	67,358				2,727,860
03.2 Structural Tank										
	03330	Tank Foundation 4' Thck average	1,337.8 cy	149,070	433,292	4,251			494.60 /cy	661,648
	03345	_Concrete Wall - Dividing Wall	6.6 cy	3,154	2,428	129			979.71 /cy	6,495
	46999	Precast Tank 3MG	1.0 LS					2,259,000	2,439,720.00 /LS	2,439,720
		03.2 Structural Tank		152,224	435,719	4,379		2,259,000		3,107,863
04.1 Architecture Design 1										
	09999	Architecture Finishes - Tank	1.0 LS					356,380	384,890.40 /LS	384,890
	09999	Architectural Finishes - PRS	1.0 LS					743,768	803,269.44 /LS	803,269

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Grand Total Cost/Unit	Gross Total Costs
32999 Landscaping and Site Development			1.0 LS					76,116	82,205.28 /LS	82,205
		04.1 Architecture Design 1						1,176,264		1,270,365
05.0 HVAC, Plumbing										
22999 Plumbing Allowance			1.0 LS				10,000		11,000.00 /LS	11,000
23999 HAVC Equipment			1.0 LS	11,190	26,990	803			44,028.51 /LS	44,029
23999 Misc. HVAC Allowance			1.0 LS				46,360		50,996.00 /LS	50,996
		05.0 HVAC, Plumbing		11,190	26,990	803	56,360			106,025
06.0 Process Pipe										
40120 Piping DI Flanged 30" in PS			211.0 lf	36,216	536,692	7,121			3,085.32 /lf	651,003
40120 Piping DI Flanged 16" in PS			63.0 lf	7,663	58,296	2,137			1,215.61 /lf	76,584
40120 Piping DI Flanged 20" in PS			80.0 lf	10,058	61,654	2,829			1,048.75 /lf	83,900
40120 Piping DI Flanged 10" and 8" in PS			120.0 lf	9,011	50,085	3,126			584.04 /lf	70,085
40120 Piping DI Flanged 16" and 12" in PS			170.0 lf	17,401	129,095	5,964			1,008.92 /lf	171,517
		06.0 Process Pipe		80,350	835,823	21,177				1,053,089
07.0 Equipment										
11999 Bridge Crane			1.0 LS	11,495	71,666	782			94,392.71 /LS	94,393
46999 Drain Pumps			1.0 LS	17,597	3,500	65,636		690,000	845,494.61 /LS	845,495
46999 OC Equipment Allowance			1.0 LS	7,032	120,000	6,168			149,641.42 /LS	149,641
46999 Vac-Flush System			1.0 LS					265,680	286,934.40 /LS	286,934
		07.0 Equipment		36,124	195,166	72,586		955,680		1,376,463
08.0 Electrical and I&C										
26002 _Electrical, Instrumentation, and Controls Subcontract			1.0 ls				3,158,362		3,474,197.82 /ls	3,474,198
		08.0 Electrical and I&C					3,158,362			3,474,198
		01 Total		2,692,520	6,003,095	1,797,033	3,214,722	5,986,348		21,905,872

Estimate Totals

Description	Rate	Hours	Amount	Totals
Labor		39,002 hrs	3,096,399	
Material			6,723,466	
Subcontract			3,536,194	
Equipment		115,694 hrs	2,084,558	
Other			6,465,256	
			21,905,873	**21,905,873**
Material Sales Tax - Exempt				
Other - Process Eqp Sales Tax - Exempt				
Net Markups				**21,905,873**
Contractor General Conditions	15.00 %		3,285,881	
			3,285,881	**25,191,754**
Start-Up, Training, O&M	2.00 %		503,835	
			503,835	**25,695,589**
Undesign/Undevelop Contingency	20.00 %		5,139,118	
Unknown Market Condtions	10.00 %		2,569,559	
			7,708,677	**33,404,266**
Bldg Risk, Liability Auto Ins	2.00 %		668,085	
			668,085	**34,072,351**
Payment and Performance Bonds	1.50 %		511,085	
			511,085	**34,583,436**
CMAR Fee	10.00 %		3,458,344	
			3,458,344	**38,041,780**
Escalation to Midpoint (ALL)	15.66 %		5,957,343	
			5,957,343	**43,999,123**
BC CACI Fee	10.00 %		4,399,912	
Gross Markups			**4,399,912**	**48,399,035**
Total				**48,399,035**

HRSD
Wilroy PRS and Tank
BODR

Estimator	Breeze Walter
BC Project Manager	Chris Wilson
BC Office	Virginia Beach
Est Version Number	1
QA/QC Reviewer	William Agster
QA/QC Review Date	7-29-2022
Other Estimators	Yadiel Rodriguez
Factor table	Virginia-Norfolk

Phase	Item	Description	Quantity		Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit		Total Net Amount
01 Total												
01.0 Sitework												
03330 OC Foundation Slab												
31-22-16.10	1100	Fine grading, fine grade for slab on grade, machine	26.7	sy	34	-	21	-	-	2.07	/sy	55
03-05-13.25	1050	Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only	17.8	cy	-	579	-	-	-	32.56	/cy	579
03-21-10.60	0600	Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	3.1	ton	3,385	5,037	-	-	-	2,707.16	/ton	8,422
03-21-10.60	2005	Reinforcing in place, unloading & sorting, add to above - slabs	3.1	ton	130	-	50	-	-	58.07	/ton	181
03-21-10.60	2215	Reinforcing in place, crane cost for handling, add to above, slabs	3.1	ton	142	-	55	-	-	63.12	/ton	196
03-31-05.35	0350	Structural concrete,ready mix,normal weight,4500 psi,includes local aggregate,sand,portland cement and water,excludes all additives and treatments	37.3	cy	-	7,141	-	-	-	191.27	/cy	7,141
03-31-05.70	2900	Structural concrete, placing, foundation mat, direct chute, over 20 C.Y., includes vibrating, excludes material	37.3	cy	338	-	5	-	-	9.20	/cy	344
03-35-29.30	0200	Concrete finishing, floors, monolithic, screed, float and hand trowel finish	240.0	sf	316	-	-	-	-	1.32	/sf	316
03-39-13.50	0300	Curing, sprayed membrane curing compound	2.4	csf	26	46	-	-	-	29.99	/csf	72
03-35-29.30	2350	Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add	240.0	sf	185	95	-	-	-	1.17	/sf	280
		OC Foundation Slab	**240.0**	**cy**	**4,556**	**12,898**	**131**			**73.27**	**/cy**	**17,585**
31240 Dewatering Systems PS												
01-54-33.70	1100	Rent wellpoint 25' long w/fittings & riser pipe 1-1/2" or 2" diameter	973.3	day	-	-	55,548	-	-	57.07	/day	55,548
01-54-33.70	0600	Rent wellpoint header pipe, 8" diameter, 800 gpm, per foot	396.0	day	-	-	13,541	-	-	34.19	/day	13,541
01-54-33.70	0950	Rent wellpoint header pipe, 6" diam, quick couplg, alum & plastic add, per foot	396.0	day	-	-	2,997	-	-	7.57	/day	2,997
01-54-33.70	1500	Rent wellpoint pump, diesel, 75 HP, 10" suction	486.7	day	-	-	204,308	-	-	419.81	/day	204,308
01-54-33.70	0350	Rent 12" diam wellpoint discharge pipe, per foot	4,000.0	day	-	-	156,243	-	-	39.06	/day	156,243
31-23-19.40	0110	Wellpoints, single stage system, 0.75 labor hours per LF, installation and removal	396.0	hdr	22,454	-	-	-	-	56.70	/hdr	22,454
31-23-19.40	0410	Wellpoints, pump operation, 4 @ 6 hour shifts, per 24 hour day	121.7	day	265,972	-	-	-	-	2,186.07	/day	265,972
		Dewatering Systems PS	**4.0**	**mo**	**288,427**		**432,637**			**179,637.11**	**/mo**	**721,063**
31240 Dewatering Systems Tank												
01-54-33.70	1100	Rent wellpoint 25' long w/fittings & riser pipe 1-1/2" or 2" diameter	1,216.7	day	-	-	69,435	-	-	57.07	/day	69,435
01-54-33.70	0600	Rent wellpoint header pipe, 8" diameter, 800 gpm, per foot	439.6	day	-	-	15,031	-	-	34.19	/day	15,031

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
31240 Dewatering Systems Tank										
01-54-33.70	0950	Rent wellpoint header pipe, 6" diam, quick couplg, alum & plastic add, per foot	439.6 day	-	-	3,327	-	-	7.57 /day	3,327
01-54-33.70	1500	Rent wellpoint pump, diesel, 75 HP, 10" suction	608.3 day	-	-	255,384	-	-	419.81 /day	255,384
01-54-33.70	0350	Rent 12" diam wellpoint discharge pipe, per foot	4,000.0 day	-	-	156,243	-	-	39.06 /day	156,243
31-23-19.40	0110	Wellpoints, single stage system, 0.75 labor hours per LF, installation and removal	439.6 hdr	24,927	-	-	-	-	56.70 /hdr	24,927
31-23-19.40	0410	Wellpoints, pump operation, 4 @ 6 hour shifts, per 24 hour day	152.1 day	332,464	-	-	-	-	2,186.07 /day	332,464
		Dewatering Systems Tank	**5.0 mo**	**357,391**		**499,420**			**170,747.38 /mo**	**856,810**
31250 Shoring Systems PS 122' x 76'x 10' depth										
31-41-16.10	1600	Sheet piling, steel, 27 psf, 20' excavation, per S.F., drive, extract and salvage, excludes wales	32,320.0 sf	395,262	316,338	255,964	-	-	29.94 /sf	967,564
		Shoring Systems PS 122' x 76'x 10' depth	**32,320.0 sf**	**395,262**	**316,338**	**255,964**			**29.94 /sf**	**967,564**
31250 Shoring Systems Tank 140' diameter 10' depth										
31-41-16.10	1600	Sheet piling, steel, 27 psf, 20' excavation, per S.F., drive, extract and salvage, excludes wales	8,792.0 sf	107,523	86,053	69,630	-	-	29.94 /sf	263,206
		Shoring Systems Tank 140' diameter 10' depth	**8,792.0 sf**	**107,523**	**86,053**	**69,630**			**29.94 /sf**	**263,206**
31290 _Structure Excavation and Backfill PS										
31-23-16.42	4400	Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum	5,600.0 bcy	47,757	-	45,386	-	-	16.63 /bcy	93,142
31-23-23.23	7000	Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	224.0 ecy	680	-	134	-	-	3.63 /ecy	813
31-23-23.16	0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	1,041.9 lcy	13,249	30,548	2,419	-	-	44.36 /lcy	46,216
31-23-23.23	7000	Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	896.0 ecy	2,718	-	534	-	-	3.63 /ecy	3,253
31-23-23.16	0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	629.0 lcy	7,999	18,443	1,460	-	-	44.36 /lcy	27,902
31-23-23.23	7000	Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	547.0 ecy	1,659	-	326	-	-	3.63 /ecy	1,986
31-23-23.19	BC-0011	Loading trucks, 2.5 C.Y. bucket, front end loader, wheel mounted	5,600.0 bcy	3,667	-	2,422	-	-	1.09 /bcy	6,089
31-23-23.18	0560	Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	7,000.0 lcy	114,464	-	145,876	-	-	37.19 /lcy	260,340
02-22-03.30	BC-0006	Dump Charge, typical urban city, fees only, bldg constr mat'ls	8,435.0 ton	-	-	-	-	587,163	69.61 /ton	587,163

Phase	Item	Description	Quantity		Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit		Total Net Amount
		_Structure Excavation and Backfill PS	**5,600.0**	**cy**	**192,193**	**48,991**	**198,556**		**587,163**	**183.38**	**/cy**	**1,026,903**
31290 _Structure Excavation and Backfill Tank												
31-23-16.42	4400	Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum	7,593.3	bcy	64,756	-	61,541	-	-	16.63	/bcy	126,297
31-23-23.23	7000	Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	303.7	ecy	921	-	181	-	-	3.63	/ecy	1,103
31-23-23.16	0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	1,412.7	lcy	17,965	41,421	3,280	-	-	44.36	/lcy	62,666
31-23-23.23	7000	Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	1,214.9	ecy	3,686	-	725	-	-	3.63	/ecy	4,410
31-23-23.16	0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	781.9	lcy	9,943	22,925	1,815	-	-	44.36	/lcy	34,683
31-23-23.23	7000	Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	679.9	ecy	2,062	-	406	-	-	3.63	/ecy	2,468
31-23-23.19	BC-0011	Loading trucks, 2.5 C.Y. bucket, front end loader, wheel mounted	7,593.3	bcy	4,972	-	3,284	-	-	1.09	/bcy	8,256
31-23-23.18	0560	Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	9,491.7	lcy	155,208	-	197,800	-	-	37.19	/lcy	353,008
02-22-03.30	BC-0006	Dump Charge, typical urban city, fees only, bldg constr mat'ls	11,437.5	ton	-	-	-	-	796,165	69.61	/ton	796,165
		_Structure Excavation and Backfill Tank	**7,593.3**	**cy**	**259,513**	**64,346**	**269,031**		**796,165**	**182.93**	**/cy**	**1,389,056**
32740 Asphaltic Paving & Sidewalks												
31-22-16.10	0100	Fine grading, for roadway, base or leveling course, large area, 6,000 S.Y. or more	2,046.2	sy	1,365	-	835	-	-	1.08	/sy	2,200
32-06-10.10	0400	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3,000 psi, 6" thick, excludes base	710.0	sf	2,782	3,879	-	-	-	9.38	/sf	6,661
32-06-10.10	0520	Sidewalks, driveways, and patios, sidewalks, concrete, excludes base, for 8" thick bank run gravel base, add	710.0	sf	824	1,202	64	-	-	2.94	/sf	2,091
32-11-23.23	0304	Base course drainage layers,aggregate base course for roadways and large paved areas,crushed stone base,compacted,crushed 1-1/2"stone base,12"deep	1,967.3	sy	3,162	43,956	2,708	-	-	25.33	/sy	49,826
32-11-23.23	7000	Base course drainage layers, prepare and roll sub-base, small areas to 2,500 S.Y.	1,967.3	sy	3,056	-	1,989	-	-	2.56	/sy	5,045
32-11-26.19	0700	Bituminous-stabilized base courses, for roadways and large paved areas, liquid application to gravel base, asphalt emulsion	393.5	gal	101	3,250	67	-	-	8.69	/gal	3,418

Phase	Item	Description	Quantity		Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit		Total Net Amount
32740 Asphaltic Paving & Sidewalks												
32-12-16.13	0200	Plant-mix asphalt paving, for highways and large paved areas, binder course, 4" thick, no hauling included	1,967.3	sy	3,798	39,426	1,654	-	-	22.81	/sy	44,877
32-12-16.13	0460	Plant-mix asphalt paving, for highways and large paved areas, wearing course, 3" thick, no hauling included	1,967.3	sy	3,539	32,500	1,560	-	-	19.11	/sy	37,599
32-17-13.26	1300	Pipe bollards, steel, concrete filled/painted, 8' L x 4' D hole, 6" di	18.0	ea	1,939	11,456	354	-	-	763.82	/ea	13,749
		Asphaltic Paving & Sidewalks	**18,416.0**	**sf**	**20,566**	**135,669**	**9,231**			**8.98**	**/sf**	**165,465**
		01.0 Sitework			**1,625,431**	**664,294**	**1,734,599**		**1,383,328**			**5,407,652**
02.0 Yard Piping												
33490 _Trench for Utilities 30" Piping												
31-23-16.13	6210	Excavating, trench or continuous footing, sand and gravel, 1-1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering	1,314.0	bcy	3,018	-	2,316	-	-	4.06	/bcy	5,334
01-54-33.40	7070	Rent trench box 12,000 pounds 10' x 20'	36.0	day	-	-	7,804	-	-	216.77	/day	7,804
31-23-23.19	BC-0016	Trench box, move and reset	60.0	ea	5,117	-	3,926	-	-	150.71	/ea	9,043
31-23-23.16	0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	381.7	lcy	4,854	11,191	886	-	-	44.36	/lcy	16,930
31-23-23.16	0500	Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench	331.9	ecy	2,237	-	440	-	-	8.07	/ecy	2,677
33-05-97.10	0400	Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill	6.0	clf	24	16	-	-	-	6.69	/clf	40
31-23-23.16	0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	1,007.4	lcy	12,811	29,537	2,339	-	-	44.36	/lcy	44,687
31-23-23.23	7000	Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	876.0	ecy	2,657	-	522	-	-	3.63	/ecy	3,180
31-23-23.19	BC-0011	Loading trucks, 2.5 C.Y. bucket, front end loader, wheel mounted	1,314.0	bcy	860	-	568	-	-	1.09	/bcy	1,429
31-23-23.18	0560	Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	1,642.5	lcy	26,858	-	34,229	-	-	37.19	/lcy	61,087
02-22-03.30	BC-0006	Dump Charge, typical urban city, fees only, bldg constr mat'ls	1,979.2	ton	-	-	-	-	137,774	69.61	/ton	137,774
01-54-33.50	5400	Roadway plate, steel, 1" x 8' x 20'	30.0	day	-	-	1,424	-	-	47.47	/day	1,424
		_Trench for Utilities 30" Piping	**584.0**	**lf**	**58,437**	**40,744**	**54,453**		**137,774**	**498.99**	**/lf**	**291,408**

33490 _Trench for Utilities 24" Line

Phase	Item	Description	Quantity		Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit		Total Net Amount
33490 _Trench for Utilities 24" Line												
31-23-16.13	1000	Excavating, trench or continuous footing, common earth, 1-1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering	1,925.9	bcy	4,866	-	3,734	-	-	4.47	/bcy	8,600
01-54-33.40	7070	Rent trench box 12,000 pounds 10' x 20'	60.0	day	-	-	13,006	-	-	216.77	/day	13,006
31-23-23.19	BC-0016	Trench box, move and reset	100.0	ea	8,528	-	6,543	-	-	150.71	/ea	15,071
33-41-23.19	0400	Geotextile subsurface drainage filtration, drainage material, pea stone fill in trench	476.3	cy	2,518	15,603	460	-	-	39.01	/cy	18,581
33-05-97.10	0400	Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill	10.0	clf	40	26	-	-	-	6.69	/clf	67
31-23-23.16	0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	1,533.3	lcy	19,499	44,958	3,560	-	-	44.36	/lcy	68,017
31-23-23.23	7000	Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	1,333.3	ecy	4,045	-	795	-	-	3.63	/ecy	4,840
31-23-23.19	BC-0011	Loading trucks, 2.5 C.Y. bucket, front end loader, wheel mounted	1,925.9	bcy	1,261	-	833	-	-	1.09	/bcy	2,094
31-23-23.18	0560	Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	2,407.4	lcy	39,366	-	50,169	-	-	37.19	/lcy	89,535
02-22-03.30	BC-0006	Dump Charge, typical urban city, fees only, bldg constr mat'ls	2,900.9	ton	-	-	-	-	201,934	69.61	/ton	201,934
01-54-33.50	5400	Roadway plate, steel, 1" x 8' x 20'	100.0	day	-	-	4,747	-	-	47.47	/day	4,747
		_Trench for Utilities 24" Line	**1,000.0**	**lf**	**80,124**	**60,588**	**83,846**		**201,934**	**426.49**	**/lf**	**426,492**
40120 Piping DI Flanged 30" Yard Piping from Road to PS												
40-05-19.20	A301002 200000	Pipe Plain End-Ductile Iron--C-151 30 Inch (750mm)	314.0	lf	-	96,453	-	-	-	307.17	/lf	96,453
40-05-19.20	A302412 000000	Fitting Flanged & Bolted-Ductile Iron-Ell90-Non-Specific 30 Inch (750mm)	2.0	ea	-	20,789	-	-	-	10,394.46	/ea	20,789
40-05-19.20	A302414 000000	Fitting Flanged & Bolted-Ductile Iron-Tee-Non-Specific 30 Inch (750mm)	2.0	ea	-	42,346	-	-	-	21,173.23	/ea	42,346
40-05-19.10	A302426 000000	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Non-Specific 30 Inch (750mm)	4.0	ea	-	8,627	-	-	-	2,156.65	/ea	8,627
40-05-05.00	L303466 010000	Pipe Erection-Handle Fittings-Metal-Std 30 Inch (750mm)	4.0	ea	800	-	-	-	-	200.09	/ea	800
40-05-62.00	A306437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 30 Inch (750mm)	2.0	ea	-	131,236	-	-	-	65,617.82	/ea	131,236
40-05-51.00	L304062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 30 Inch (750mm)	2.0	ea	1,123	-	-	-	-	561.63	/ea	1,123
40-05-19.10	A303002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 30 Inch (750mm)	4.0	ea	-	759	-	-	-	189.87	/ea	759
40-05-19.20	L304002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 30 Inch (750mm)	314.0	lf	36,189	-	-	-	-	115.25	/lf	36,189

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
40120 Piping DI Flanged 30" Yard Piping from Road to PS										
40-05-05.00	A303400 006200	Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 30 Inch (750mm)	5.0 ea	762	5,636	-	-	-	1,279.71 /ea	6,399
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	2,466.2 sqft	1,593	2,420	-	-	-	1.63 /sqft	4,013
40-05-05.00	L309048 000000	Field Testing-Hydrotest-Non-Specific 30 Inch (750mm)	314.0 lf	3,590	-	-	-	-	11.43 /lf	3,590
40-05-05.00	XL60906 4009000	Pipe Erection-Handle Pipe-Construction Equipment	100.0 mh	6,466	-	6,198	-	-	126.64 /mh	12,664
40-05-05.00	XL60906 4010000	Pipe Erection-Handle Fittings and Valves-Contruction Equipment	40.0 mh	2,586	-	2,479	-	-	126.64 /mh	5,065
		Piping DI Flanged 30" Yard Piping from Road to PS	**314.0 lf**	**53,110**	**308,266**	**8,677**			**1,178.51 /lf**	**370,053**
40120 Piping DI Flanged 30" from PS to Tank										
40-05-19.20	A301002 200000	Pipe Plain End-Ductile Iron--C-151 30 Inch (750mm)	270.0 lf	-	82,937	-	-	-	307.17 /lf	82,937
40-05-19.20	A302411 000000	Fitting Flanged & Bolted-Ductile Iron-Ell45-Non-Specific 30 Inch (750mm)	5.0 ea	-	49,020	-	-	-	9,803.97 /ea	49,020
40-05-19.20	A302412 000000	Fitting Flanged & Bolted-Ductile Iron-Ell90-Non-Specific 30 Inch (750mm)	1.0 ea	-	10,394	-	-	-	10,394.46 /ea	10,394
40-05-19.20	A302414 000000	Fitting Flanged & Bolted-Ductile Iron-Tee-Non-Specific 30 Inch (750mm)	1.0 ea	-	21,173	-	-	-	21,173.23 /ea	21,173
40-05-19.10	A302426 000000	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Non-Specific 30 Inch (750mm)	8.0 ea	-	17,253	-	-	-	2,156.65 /ea	17,253
40-05-05.00	L303466 010000	Pipe Erection-Handle Fittings-Metal-Std 30 Inch (750mm)	7.0 ea	1,401	-	-	-	-	200.09 /ea	1,401
40-05-62.00	A306437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 30 Inch (750mm)	2.0 ea	-	131,236	-	-	-	65,617.82 /ea	131,236
40-05-51.00	L304062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 30 Inch (750mm)	2.0 ea	1,123	-	-	-	-	561.63 /ea	1,123
40-05-19.10	A303002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 30 Inch (750mm)	8.0 ea	-	1,519	-	-	-	189.86 /ea	1,519
40-05-19.20	L304002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 30 Inch (750mm)	270.0 lf	31,118	-	-	-	-	115.25 /lf	31,118
40-05-05.00	A303400 006200	Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 30 Inch (750mm)	5.0 ea	762	5,636	-	-	-	1,279.71 /ea	6,399
40-05-07.00	A306044 000000	Pipe Support 30 Inch (750mm)	3.0 ea	412	374	-	-	-	261.80 /ea	785
40-05-07.00	A306045 000000	Hanger Rod 30 Inch (750mm)	3.0 ea	343	2,430	-	-	-	924.17 /ea	2,773
40-05-07.00	A306043 000000	Hilti-Chemical Anchor - Pipe Support Size 30 Inch (750mm)	11.0 ea	419	891	-	-	-	119.10 /ea	1,310
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	2,120.6 sqft	1,370	2,081	-	-	-	1.63 /sqft	3,450
40-05-05.00	L309048 000000	Field Testing-Hydrotest-Non-Specific 30 Inch (750mm)	270.0 lf	3,087	-	-	-	-	11.43 /lf	3,087

Phase	Item	Description	Quantity		Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit		Total Net Amount
40120 Piping DI Flanged 30" from PS to Tank												
40-05-05.00	XL60906 4009000	Pipe Erection-Handle Pipe-Construction Equipment	80.0	mh	5,173	-	4,958	-	-	126.64	/mh	10,131
40-05-05.00	XL60906 4010000	Pipe Erection-Handle Fittings and Valves-Contruction Equipment	40.0	mh	2,586	-	2,479	-	-	126.64	/mh	5,065
		Piping DI Flanged 30" from PS to Tank	**270.0**	**lf**	**47,794**	**324,943**	**7,437**			**1,408.05**	**/lf**	**380,175**
40120 Piping DI Flanged 24"												
40-05-19.20	A241002 200000	Pipe Plain End-Ductile Iron--C-151 24 Inch (600mm)	1,000.0	lf	-	139,625	-	-	-	139.62	/lf	139,625
40-05-19.20	A242416 000000	Fitting Flanged & Bolted-Ductile Iron-Reducer 1 Dia-Non-Specific 24 Inch (600mm)	3.0	ea	-	20,336	-	-	-	6,778.56	/ea	20,336
40-05-19.20	A242414 000000	Fitting Flanged & Bolted-Ductile Iron-Tee-Non-Specific 24 Inch (600mm)	3.0	ea	-	45,202	-	-	-	15,067.46	/ea	45,202
40-05-19.10	A242426 000000	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Non-Specific 24 Inch (600mm)	10.0	ea	-	14,378	-	-	-	1,437.76	/ea	14,378
40-05-05.00	L243466 010000	Pipe Erection-Handle Fittings-Metal-Std 24 Inch (600mm)	5.0	ea	829	-	-	-	-	165.79	/ea	829
40-05-62.00	A246437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 24 Inch (600mm)	3.0	ea	-	106,949	-	-	-	35,649.51	/ea	106,949
40-05-51.00	L244062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 24 Inch (600mm)	3.0	ea	1,091	-	-	-	-	363.59	/ea	1,091
40-05-19.10	A243002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 24 Inch (600mm)	10.0	ea	-	1,364	-	-	-	136.35	/ea	1,364
40-05-19.20	L244002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 24 Inch (600mm)	1,000.0	lf	91,927	-	-	-	-	91.93	/lf	91,927
40-05-05.00	A243400 006200	Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 24 Inch (600mm)	10.0	ea	762	6,702	-	-	-	746.44	/ea	7,464
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	6,283.2	sqft	4,059	6,165	-	-	-	1.63	/sqft	10,223
40-05-05.00	L249048 000000	Field Testing-Hydrotest-Non-Specific 24 Inch (600mm)	1,000.0	lf	9,147	-	-	-	-	9.15	/lf	9,147
33-14-17.15	8420	Water service connection, tapping sleeves with rubber gaskets, 24" x 24", excludes excavation and backfill	3.0	ea	850	37,674	66	-	-	12,863.41	/ea	38,590
		Piping DI Flanged 24"	**1,000.0**	**lf**	**108,665**	**378,393**	**66**			**487.12**	**/lf**	**487,124**
40120 Temp By Pass 30"												
40-05-19.20	A301002 200000	Pipe Plain End-Ductile Iron--C-151 30 Inch (750mm)	40.0	lf	-	12,287	-	-	-	307.17	/lf	12,287
40-05-19.20	A302412 000000	Fitting Flanged & Bolted-Ductile Iron-Ell90-Non-Specific 30 Inch (750mm)	4.0	ea	-	41,578	-	-	-	10,394.46	/ea	41,578
40-05-19.20	A302414 000000	Fitting Flanged & Bolted-Ductile Iron-Tee-Non-Specific 30 Inch (750mm)	4.0	ea	-	84,693	-	-	-	21,173.23	/ea	84,693
40-05-19.10	A302426 000000	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Non-Specific 30 Inch (750mm)	4.0	ea	-	8,627	-	-	-	2,156.65	/ea	8,627
40-05-05.00	L303466 010000	Pipe Erection-Handle Fittings-Metal-Std 30 Inch (750mm)	8.0	ea	1,601	-	-	-	-	200.09	/ea	1,601

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
40120 Temp By Pass 30"										
40-05-62.00	A306437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 30 Inch (750mm)	8.0 ea	-	524,943	-	-	-	65,617.82 /ea	524,943
40-05-51.00	L304062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 30 Inch (750mm)	8.0 ea	4,493	-	-	-	-	561.62 /ea	4,493
40-05-19.10	A303002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 30 Inch (750mm)	4.0 ea	-	759	-	-	-	189.86 /ea	759
40-05-19.20	L304002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 30 Inch (750mm)	40.0 lf	4,610	-	-	-	-	115.25 /lf	4,610
40-05-05.00	A303400 006200	Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 30 Inch (750mm)	20.0 ea	3,049	22,545	-	-	-	1,279.71 /ea	25,594
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	314.2 sqft	203	308	-	-	-	1.63 /sqft	511
40-05-05.00	L309048 000000	Field Testing-Hydrotest-Non-Specific 30 Inch (750mm)	40.0 lf	457	-	-	-	-	11.43 /lf	457
40-05-05.00	XL60906 4009000	Pipe Erection-Handle Pipe-Construction Equipment	10.0 mh	647	-	620	-	-	126.64 /mh	1,266
40-05-05.00	XL60906 4010000	Pipe Erection-Handle Fittings and Valves-Contruction Equipment	10.0 mh	647	-	620	-	-	126.64 /mh	1,266
33-14-17.15	8420	Water service connection, tapping sleeves with rubber gaskets, 30" x 30", excludes excavation and backfill	2.0 ea	567	25,116	44	-	-	12,863.41 /ea	25,727
22-20-00.31	BC-0306	Piping line stop, 30" dia	2.0 ea	1,219	225,792	-	-	-	113,505.29 /ea	227,011
		Temp By Pass 30"	**40.0 lf**	**17,492**	**946,648**	**1,284**			**24,135.57 /lf**	**965,423**
40120 Temp By Pass 24"										
40-05-19.20	A241002 200000	Pipe Plain End-Ductile Iron--C-151 24 Inch (600mm)	20.0 lf	-	2,793	-	-	-	139.63 /lf	2,793
40-05-19.20	A242412 000000	Fitting Flanged & Bolted-Ductile Iron-Ell90-Non-Specific 24 Inch (600mm)	2.0 ea	-	15,930	-	-	-	7,964.98 /ea	15,930
40-05-19.20	A242414 000000	Fitting Flanged & Bolted-Ductile Iron-Tee-Non-Specific 24 Inch (600mm)	2.0 ea	-	30,135	-	-	-	15,067.47 /ea	30,135
40-05-19.10	A242426 000000	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Non-Specific 24 Inch (600mm)	2.0 ea	-	2,876	-	-	-	1,437.77 /ea	2,876
40-05-05.00	L243466 010000	Pipe Erection-Handle Fittings-Metal-Std 24 Inch (600mm)	4.0 ea	663	-	-	-	-	165.79 /ea	663
40-05-62.00	A246437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 24 Inch (600mm)	4.0 ea	-	142,598	-	-	-	35,649.51 /ea	142,598
40-05-51.00	L244062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 24 Inch (600mm)	4.0 ea	1,454	-	-	-	-	363.59 /ea	1,454
40-05-19.10	A243002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 24 Inch (600mm)	2.0 ea	-	273	-	-	-	136.34 /ea	273
40-05-19.20	L244002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 24 Inch (600mm)	20.0 lf	1,839	-	-	-	-	91.93 /lf	1,839
40-05-05.00	A243400 006200	Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 24 Inch (600mm)	10.0 ea	762	6,702	-	-	-	746.44 /ea	7,464

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
40120 Temp By Pass 24"										
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	125.7 sqft	81	123	-	-	-	1.63 /sqft	204
40-05-05.00	L249048 000000	Field Testing-Hydrotest-Non-Specific 24 Inch (600mm)	20.0 lf	183	-	-	-	-	9.15 /lf	183
40-05-05.00	XL60906 4009000	Pipe Erection-Handle Pipe-Construction Equipment	10.0 mh	647	-	620	-	-	126.64 /mh	1,266
40-05-05.00	XL60906 4010000	Pipe Erection-Handle Fittings and Valves-Contruction Equipment	10.0 mh	647	-	620	-	-	126.64 /mh	1,266
33-14-17.15	8420	Water service connection, tapping sleeves with rubber gaskets, 24" x 24", excludes excavation and backfill	2.0 ea	567	25,116	44	-	-	12,863.41 /ea	25,727
22-20-00.31	BC-0306	Piping line stop, 30" dia	2.0 ea	1,219	225,792	-	-	-	113,505.29 /ea	227,011
		Temp By Pass 24"	**20.0 lf**	**8,061**	**452,337**	**1,284**			**23,084.08 /lf**	**461,682**
		02.0 Yard Piping		**373,683**	**2,511,919**	**157,047**		**339,708**		**3,382,357**
03.1 Structural PS										
03330 PS Foundation Lower Level 122' x 76' x 2' Thick										
31-22-16.10	1100	Fine grading, fine grade for slab on grade, machine	1,030.2 sy	1,322	-	808	-	-	2.07 /sy	2,130
03-05-13.25	1050	Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only	686.8 cy	-	22,362	-	-	-	32.56 /cy	22,362
03-15-13.50	1300	Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide	396.0 lf	1,422	2,556	-	-	-	10.05 /lf	3,978
03-15-13.50	5250	Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide	33.0 ea	308	1,282	-	-	-	48.18 /ea	1,590
03-21-10.60	0600	Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	60.1 ton	65,386	97,303	-	-	-	2,707.15 /ton	162,689
03-21-10.60	2005	Reinforcing in place, unloading & sorting, add to above - slabs	60.1 ton	2,519	-	970	-	-	58.07 /ton	3,490
03-21-10.60	2215	Reinforcing in place, crane cost for handling, add to above, slabs	60.1 ton	2,739	-	1,054	-	-	63.12 /ton	3,793
03-31-05.35	0350	Structural concrete,ready mix,normal weight,4500 psi,includes local aggregate,sand,portland cement and water,excludes all additives and treatments	721.2 cy	-	137,934	-	-	-	191.27 /cy	137,934
03-31-05.70	2950	Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material	721.2 cy	7,749	-	1,307	-	-	12.56 /cy	9,056
03-35-29.30	0250	Concrete finishing, floors, monolithic, machine trowel finish	9,272.0 sf	9,010	-	420	-	-	1.02 /sf	9,429
03-39-13.50	0300	Curing, sprayed membrane curing compound	92.7 csf	1,000	1,780	-	-	-	29.99 /csf	2,780
03-35-29.30	2350	Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add	9,272.0 sf	7,133	3,676	-	-	-	1.17 /sf	10,809
		PS Foundation Lower Level 122' x 76' x 2' Thick	**686.8 cy**	**98,589**	**266,894**	**4,560**			**538.78 /cy**	**370,042**

Phase	Item	Description	Quantity		Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit		Total Net Amount
03330 PS Foundation Upper Level 122' x 16' x 2' Thick												
31-22-16.10	1100	Fine grading, fine grade for slab on grade, machine	216.9	sy	278	-	170	-	-	2.07	/sy	449
03-05-13.25	1050	Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only	144.6	cy	-	4,708	-	-	-	32.56	/cy	4,708
03-15-13.50	1300	Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide	276.0	lf	991	1,781	-	-	-	10.05	/lf	2,773
03-15-13.50	5250	Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide	23.0	ea	215	893	-	-	-	48.18	/ea	1,108
03-21-10.60	0600	Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	12.7	ton	13,766	20,485	-	-	-	2,707.15	/ton	34,251
03-21-10.60	2005	Reinforcing in place, unloading & sorting, add to above - slabs	12.7	ton	530	-	204	-	-	58.07	/ton	735
03-21-10.60	2215	Reinforcing in place, crane cost for handling, add to above, slabs	12.7	ton	577	-	222	-	-	63.12	/ton	799
03-31-05.35	0350	Structural concrete,ready mix,normal weight,4500 psi,includes local aggregate,sand,portland cement and water,excludes all additives and treatments	151.8	cy	-	29,039	-	-	-	191.27	/cy	29,039
03-31-05.70	2950	Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material	151.8	cy	1,631	-	275	-	-	12.56	/cy	1,907
03-35-29.30	0250	Concrete finishing, floors, monolithic, machine trowel finish	1,952.0	sf	1,897	-	88	-	-	1.02	/sf	1,985
03-39-13.50	0300	Curing, sprayed membrane curing compound	19.5	csf	211	375	-	-	-	29.99	/csf	585
03-35-29.30	2350	Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add	1,952.0	sf	1,502	774	-	-	-	1.17	/sf	2,276
		PS Foundation Upper Level 122' x 16' x 2' Thick	**144.6**	**cy**	**21,598**	**58,055**	**960**			**557.51**	**/cy**	**80,613**
03345 _Concrete Walls Lower level 10' tall x 2' Thick												
03-11-13.85	9260	Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning	8,000.0	sfca	49,051	6,030	-	-	-	6.89	/sfca	55,081
03-15-05.95	3050	Form oil, up to 800 S.F. per gallon, coverage, includes material only	21.3	gal	-	536	-	-	-	25.13	/gal	536
03-21-10.60	0700	Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	25.9	ton	21,626	41,978	-	-	-	2,453.28	/ton	63,604
03-21-10.60	2010	Reinforcing in place, unloading & sorting, add - walls, cols, beams	25.9	ton	1,087	-	419	-	-	58.07	/ton	1,505
03-21-10.60	2225	Reinforcing, crane cost for handling, add to above, walls, cols, beams	25.9	ton	1,181	-	455	-	-	63.12	/ton	1,636

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
03345 _Concrete Walls Lower level 10' tall x 2' Thick										
03-31-05.35	0350	Structural concrete,ready mix,normal weight,4500 psi,includes local aggregate,sand,portland cement and water,excludes all additives and treatments	311.1 cy	-	59,506	-	-	-	191.27 /cy	59,506
03-31-05.70	5350	Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material	311.1 cy	11,143	-	1,880	-	-	41.86 /cy	13,023
03-35-29.60	0700	Concrete finishing, walls, sandblast, light penetration	4,000.0 sf	8,099	3,230	1,009	-	-	3.08 /sf	12,338
		_Concrete Walls Lower level 10' tall x 2' Thick	**296.3 cy**	**92,188**	**111,279**	**3,762**			**699.40 /cy**	**207,230**
03345 _Concrete Walls Upper Level 1' thick x 25' Tall to 31' Tall										
03-11-13.85	9460	Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning	23,008.0 sfca	158,705	17,343	-	-	-	7.65 /sfca	176,048
03-11-13.85	8620	C.I.P. concrete forms, pilasters/piers, plywood, 2 use, includes erecting, bracing, stripping and cleaning	1,920.0 sfca	16,053	5,813	-	-	-	11.39 /sfca	21,866
03-15-05.95	3050	Form oil, up to 800 S.F. per gallon, coverage, includes material only	66.5 gal	-	1,671	-	-	-	25.13 /gal	1,671
03-21-10.60	0700	Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	33.3 ton	27,768	53,899	-	-	-	2,453.28 /ton	81,667
03-21-10.60	2010	Reinforcing in place, unloading & sorting, add - walls, cols, beams	33.3 ton	1,396	-	537	-	-	58.07 /ton	1,933
03-21-10.60	2225	Reinforcing, crane cost for handling, add to above, walls, cols, beams	33.3 ton	1,517	-	584	-	-	63.12 /ton	2,101
03-31-05.35	0350	Structural concrete,ready mix,normal weight,4500 psi,includes local aggregate,sand,portland cement and water,excludes all additives and treatments	503.4 cy	-	96,280	-	-	-	191.27 /cy	96,280
03-31-05.70	5350	Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material	503.4 cy	18,030	-	3,041	-	-	41.86 /cy	21,071
03-35-29.60	0700	Concrete finishing, walls, sandblast, light penetration	12,944.0 sf	26,209	10,453	3,265	-	-	3.08 /sf	39,927
		_Concrete Walls Upper Level 1' thick x 25' Tall to 31' Tall	**479.4 cy**	**249,677**	**185,458**	**7,428**			**923.14 /cy**	**442,563**
03355 Slab over Metal Decking (Standard Flute Depths) 122' x 92'										
05-35-13.50	6000	Metal decking, non-cellular composite, galv, 3" deep, 16 gauge	11,224.0 sf	15,018	61,761	665	-	-	6.90 /sf	77,443
05-35-13.50	7200	Sheet metal edge closure form, to 12", w/2 bends, 16 ga	428.0 lf	1,111	3,064	190	-	-	10.20 /lf	4,365
03-21-10.60	0400	Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	5.6 ton	4,843	9,087	-	-	-	2,482.05 /ton	13,929

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
03355 Slab over Metal Decking (Standard Flute Depths) 122' x 92'										
03-21-10.60	2050	Reinforcing in place, unloading & sorting, add to above - decks	5.6 ton	235	-	91	-	-	58.07 /ton	326
03-21-10.60	2220	Reinforcing steel, crane cost for handling, maximum, add	5.6 ton	672	-	259	-	-	165.91 /ton	931
03-31-05.35	0402	Concrete, ready mix, regular weight, elevated decks, 5000 psi	163.7 cy	-	39,888	-	-	-	243.69 /cy	39,888
03-31-05.70	1400	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includes vibrating, excludes material	163.7 cy	5,025	-	848	-	-	35.88 /cy	5,873
03-35-29.30	0275	Finishing elev slab, manual screed, bull float, machine float & trowel	11,224.0 sf	10,903	-	508	-	-	1.02 /sf	11,411
03-39-13.50	0310	Curing, sprayed membrane curing compound, elevated decks	112.2 csf	1,211	1,924	-	-	-	27.93 /csf	3,135
03-35-29.30	2300	Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add	11,224.0 sf	7,619	2,866	-	-	-	0.93 /sf	10,485
		Slab over Metal Decking (Standard Flute Depths) 122' x 92'	**155.9 cy**	**46,637**	**118,590**	**2,559**			**1,076.32 /cy**	**167,786**
03370 _Equipment Pad Generator										
03-11-13.65	3050	C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning	61.6 sfca	255	86	-	-	-	5.53 /sfca	341
03-15-05.12	5200	Chamfer strip, wood, 3/4" wide	61.6 lf	55	10	-	-	-	1.05 /lf	65
03-21-10.60	0600	Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.3 ton	373	555	-	-	-	2,707.20 /ton	929
03-21-10.60	2420	Reinforcing steel, in place, dowels, deformed, 2' long, #5, A615, grade 60	62.0 ea	178	116	-	-	-	4.74 /ea	294
03-21-10.60	2005	Reinforcing in place, unloading & sorting, add to above - slabs	0.4 ton	16	-	6	-	-	58.07 /ton	23
03-31-05.35	0405	Concrete, ready mix, regular weight, slabs/mats, 5000 psi	7.7 cy	-	1,877	-	-	-	243.69 /cy	1,877
03-31-05.70	4350	Structural concrete, placing, slab on grade, pumped, up to 6" thick, includes vibrating, excludes material	7.7 cy	255	-	43	-	-	38.64 /cy	298
03-35-29.30	0020	Concrete finishing, floors, monolithic, screed finish	208.0 sf	72	-	-	-	-	0.35 /sf	72
		_Equipment Pad Generator	**7.7 cy**	**1,205**	**2,644**	**49**			**505.95 /cy**	**3,898**
03370 _Equipment Pads Electrical Equipment										
03-11-13.65	3000	C.I.P. concrete forms, slab on grade, edge, wood, to 6" high, 4 use, includes erecting, bracing, stripping and cleaning	125.5 lf	377	66	-	-	-	3.53 /lf	443
03-15-05.12	5200	Chamfer strip, wood, 3/4" wide	125.5 lf	112	20	-	-	-	1.05 /lf	132
03-21-10.60	0600	Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.4 ton	422	628	-	-	-	2,707.14 /ton	1,050

Phase	Item	Description	Quantity		Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit		Total Net Amount
03370 _Equipment Pads Electrical Equipment												
03-21-10.60	2420	Reinforcing steel, in place, dowels, deformed, 2' long, #5, A615, grade 60	126.0	ea	362	235	-	-	-	4.74	/ea	597
03-21-10.60	2005	Reinforcing in place, unloading & sorting, add to above - slabs	0.5	ton	20	-	8	-	-	58.08	/ton	28
03-31-05.35	0405	Concrete, ready mix, regular weight, slabs/mats, 5000 psi	4.4	cy	-	1,061	-	-	-	243.69	/cy	1,061
03-31-05.70	4350	Structural concrete, placing, slab on grade, pumped, up to 6" thick, includes vibrating, excludes material	4.4	cy	144	-	24	-	-	38.64	/cy	168
03-35-29.30	0020	Concrete finishing, floors, monolithic, screed finish	235.0	sf	82	-	-	-	-	0.35	/sf	82
		_Equipment Pads Electrical Equipment	**4.4**	**cy**	**1,518**	**2,010**	**32**			**818.05**	**/cy**	**3,560**
04220 Interior Walls Upper Level 28' Tall												
04-22-10.28	0350	Concrt block,high strngt,hollow,3500 psi,12"8"16",inclds mortar and horzntl joint rnfrcng every other course,excluds scffldn,grout and verticl rnfrcng	4,144.0	sf	39,861	21,949	-	-	-	14.92	/sf	61,810
04-05-19.26	0250	Masonry reinforcing bars, truss type steel joint reinforcing, mill standard galvanized, 12" wide	31.1	clf	775	1,227	-	-	-	64.42	/clf	2,002
04-05-19.26	0020	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615	6,216.0	lb	3,876	5,973	-	-	-	1.58	/lb	9,849
04-05-19.26	0060	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615	3,232.3	lb	2,481	3,106	-	-	-	1.73	/lb	5,587
04-05-16.30	2000	Grout, for bond beams, lintels and concrete masonry unit (CMU) cores, C476, includes material only	1,740.5	cf	9,202	12,140	515	-	-	12.56	/cf	21,858
04-05-16.30	0800	Grout, door frames, 3' x 7' opening, 2.5 C.F. per opening	1.0	opng	31	17	2	-	-	50.01	/opng	50
04-05-16.30	0850	Grout, door frames, 6' x 7' opening, 3.5 C.F. per opening	2.0	opng	82	49	5	-	-	67.91	/opng	136
04-05-19.26	X9000	Allow - shoring and bracing at CMU walls (percentage wall area)	828.8	sfwa	592	334	-	-	-	1.12	/sfwa	926
04-05-23.13	0180	Control joint, PVC, 12" wall	1,000.0	lf	2,078	4,383	-	-	-	6.46	/lf	6,461
07-19-19.10	0300	Silicone water repellants, sprayed on CMU, 2 coat	8,288.0	sf	1,287	7,872	-	-	-	1.11	/sf	9,159
07-92-10.10	1800	Caulking & Sealants, butyl based, bulk, in place, 77 LF per gallon, 1/2" x 1/2"	1,000.0	lf	1,946	646	-	-	-	2.59	/lf	2,592
		Interior Walls Upper Level 28' Tall	**4,144.0**	**sf**	**62,212**	**57,697**	**522**			**29.06**	**/sf**	**120,430**
05121 _Elevated Aluminum Platform, aluminum structure												
05-14-23.05	0020	Aluminum, structural shapes, under 1 ton, 1" to 10" members	8,064.9	lb	11,131	35,842	5,023	-	-	6.45	/lb	51,996
05-14-23.05	0020	Aluminum, structural shapes, under 1 ton, 1" to 10" members	4,368.8	lb	6,030	19,416	2,721	-	-	6.45	/lb	28,166
05-14-23.05	0020	Aluminum, structural shapes, under 1 ton, 1" to 10" members	16,920.0	lb	23,352	75,195	10,539	-	-	6.45	/lb	109,086

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
05121 _Elevated Aluminum Platform, aluminum structure										
05-12-04.40	BC-0006	Aluminum plate, structural, for bases & connections, shop fabricated	2,325.1 lb	1,712	24,064	775	-	-	11.42 /lb	26,551
05-12-04.40	BC-2200	Bolt, hex head, 316SS, 3/4" dia x 2" L, incl nut & washer	1,296.0 each	8,931	7,107	-	-	-	12.38 /each	16,038
03-82-16.10	0700	Concrete impact drilling, for anchors, up to 4" D, 1" dia, in concrete or brick walls and floors, includes bit cost, layout and set up time, excl anchor	376.0 ea	5,021	88	-	-	-	13.59 /ea	5,109
05-05-19.10	1435	Chemical anchor, 1" diameter x 11-3/4" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	376.0 ea	20,797	6,232	1,963	-	-	77.11 /ea	28,992
03-62-13.50	0350	Grout, non-shrink, for column and machine bases, non-metallic, 2" deep	127.8 sf	2,634	2,505	-	-	-	40.20 /sf	5,140
05-53-13.10	0148	Floor grating, aluminum, 2-1/4" x 3/16" bearing bars @ 1-3/16" OC, cross bars @ 4" OC, over 300 S.F., field fabricated from panels	1,370.0 sf	3,557	92,064	157	-	-	69.91 /sf	95,778
05-53-13.10	0400	Floor grating, aluminum, field fabricated from panels, for straight banding, add	279.0 lf	-	1,812	-	-	-	6.50 /lf	1,812
05-52-13.50	0220	Railing, pipe, aluminum, dark anodized finish, 3 rails, 3'-6" high, posts @ 5' OC, 1-1/2" diameter, shop fabricated	558.0 lf	10,574	71,245	468	-	-	147.47 /lf	82,288
05-53-13.10	0700	Floor grating, aluminum, field fabricated from panels, for straight toe plate, add	558.0 lf	-	7,156	-	-	-	12.82 /lf	7,156
05-12-04.40	BC-0011	Stair, field fabricated no landings, aluminum, 3'-6" W, incl railing, stringers, grating treads w/ safety nosing, per riser	110.0 risr	22,230	104,350	11,647	-	-	1,256.62 /risr	138,228
05-51-33.13	0400	Ladder, shop fabricated, aluminum, 20" W, bolted to concrete, excl cage	60.0 vlf	1,833	3,595	81	-	-	91.82 /vlf	5,509
		_Elevated Aluminum Platform, aluminum structure	**1,370.0 sf**	**117,802**	**450,672**	**33,374**			**439.31 /sf**	**601,848**
05200 Steel Joists, Joist Girders and Trusses										
05-21-19.10	8000	Open web trusses, factory fabricated WT chords, average cost	92.7 ton	73,205	604,428	24,034	-	-	7,566.29 /ton	701,667
07-81-16.10	X9040	Sprayed fireproofing, avg cost per ton, open web joist, girders, truss	92.7 ton	10,783	16,585	855	-	-	304.35 /ton	28,224
		Steel Joists, Joist Girders and Trusses	**92.7 ton**	**83,989**	**621,013**	**24,889**			**7,870.63 /ton**	**729,891**
		03.1 Structural PS		**775,414**	**1,874,311**	**78,136**				**2,727,860**
03.2 Structural Tank										
03330 Tank Foundation 4' Thck average										
31-22-16.10	1100	Fine grading, fine grade for slab on grade, machine	1,003.3 sy	1,288	-	787	-	-	2.07 /sy	2,075
03-05-13.25	1050	Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only	668.9 cy	-	21,779	-	-	-	32.56 /cy	21,779

Phase	Item	Description	Quantity		Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit		Total Net Amount
03330 Tank Foundation 4' Thck average												
03-21-10.60	0600	Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	117.1	ton	127,359	189,527	-	-	-	2,707.15	/ton	316,886
03-21-10.60	2005	Reinforcing in place, unloading & sorting, add to above - slabs	117.1	ton	4,907	-	1,890	-	-	58.07	/ton	6,797
03-21-10.60	2215	Reinforcing in place, crane cost for handling, add to above, slabs	117.1	ton	5,334	-	2,054	-	-	63.12	/ton	7,388
03-31-05.35	0350	Structural concrete,ready mix,normal weight,4500 psi,includes local aggregate,sand,portland cement and water,excludes all additives and treatments	1,404.7	cy	-	268,667	-	-	-	191.27	/cy	268,667
03-31-05.70	2900	Structural concrete, placing, foundation mat, direct chute, over 20 C.Y., includes vibrating, excludes material	1,404.7	cy	12,725	-	200	-	-	9.20	/cy	12,926
03-35-29.30	0200	Concrete finishing, floors, monolithic, screed, float and hand trowel finish	9,030.0	sf	11,896	-	-	-	-	1.32	/sf	11,896
03-39-13.50	0300	Curing, sprayed membrane curing compound	90.3	csf	974	1,734	-	-	-	29.99	/csf	2,708
03-35-29.30	2350	Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add	9,030.0	sf	6,947	3,580	-	-	-	1.17	/sf	10,527
		Tank Foundation 4' Thck average	**1,337.8**	**cy**	**171,430**	**485,287**	**4,931**			**494.60**	**/cy**	**661,648**
03345 _Concrete Wall - Dividing Wall												
03-11-13.85	9260	Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning	358.0	sfca	2,195	270	-	-	-	6.89	/sfca	2,465
03-15-05.95	3050	Form oil, up to 800 S.F. per gallon, coverage, includes material only	1.0	gal	-	24	-	-	-	25.12	/gal	24
03-21-10.60	0700	Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.5	ton	415	805	-	-	-	2,453.30	/ton	1,219
03-21-10.60	2010	Reinforcing in place, unloading & sorting, add - walls, cols, beams	0.5	ton	21	-	8	-	-	58.09	/ton	29
03-21-10.60	2225	Reinforcing, crane cost for handling, add to above, walls, cols, beams	0.5	ton	23	-	9	-	-	63.10	/ton	31
03-31-05.35	0350	Structural concrete,ready mix,normal weight,4500 psi,includes local aggregate,sand,portland cement and water,excludes all additives and treatments	7.0	cy	-	1,331	-	-	-	191.27	/cy	1,331
03-31-05.70	5350	Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material	7.0	cy	249	-	42	-	-	41.86	/cy	291
03-35-29.60	0700	Concrete finishing, walls, sandblast, light penetration	358.0	sf	725	289	90	-	-	3.08	/sf	1,104
		_Concrete Wall - Dividing Wall	**6.6**	**cy**	**3,627**	**2,719**	**149**			**979.71**	**/cy**	**6,495**
46999 Precast Tank 3MG												

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
46999 Precast Tank 3MG										
33-16-36.16	0600	Aboveground water utility storage tanks, prestress concrete, 3,000,000 gallons, excludes foundation., pipes or pumps Quoted by CROM 5-17-2022	1.0 ea	-	-	-		2,396,520	2,396,520.00 /ea	2,396,520
33-16-36.16	----	Add for the Flushing well	1.0 ea					43,200	43,200.00 /ea	43,200
		Precast Tank 3MG	**1.0 LS**					**2,439,720**	**2,439,720.00 /LS**	**2,439,720**
		03.2 Structural Tank		**175,058**	**488,006**	**5,080**		**2,439,720**		**3,107,863**
04.1 Architecture Design 1										
09999 Architecture Finishes - Tank										
07-00-00.01	----	Roofing Quoted by Guernsey Tingle 8/1/2022	1.0 LS					186,146	186,145.56 /LS	186,146
03-00-00.01	----	Exterior of Tank Quoted by Guernsey Tingle 8/1/2022	1.0 LS					198,745	198,744.84 /LS	198,745
		Architecture Finishes - Tank	**1.0 LS**					**384,890**	**384,890.40 /LS**	**384,890**
09999 Architectural Finishes - PRS										
08-00-00.01	----	EXTERIOR WALLS Quoted by Guernsey Tingle 8/1/2022	1.0 LS					317,949	317,948.76 /LS	317,949
08-00-00.01	----	EXTERIOR WINDOWS Quoted by Guernsey Tingle 8/1/2022	1.0 LS					101,029	101,028.60 /LS	101,029
08-00-00.01	----	EXTERIOR PERSONNEL DOORS Quoted by Guernsey Tingle 8/1/2022	1.0 LS					20,943	20,943.36 /LS	20,943
08-00-00.01	----	EXTERIOR SPECIALTY Doors Quoted by Guernsey Tingle 8/1/2022	1.0 LS					10,989	10,989.00 /LS	10,989
08-00-00.01	----	ROOFING Quoted by Guernsey Tingle 8/1/2022	1.0 LS					201,312	201,312.00 /LS	201,312
08-00-00.01	----	PARTITIONS Quoted by Guernsey Tingle 8/1/2022	1.0 LS					42,103	42,102.72 /LS	42,103
08-00-00.01	----	INTERIOR PERSONNEL DOORS Quoted by Guernsey Tingle 8/1/2022	1.0 LS					20,943	20,943.36 /LS	20,943
08-00-00.01	----	WALL FINISHES Quoted by Guernsey Tingle 8/1/2022	1.0 LS					30,978	30,977.64 /LS	30,978
08-00-00.01	----	FLOORING & FLOOR FINISHES Quoted by Guernsey Tingle 8/1/2022	1.0 LS					17,658	17,658.00 /LS	17,658
08-00-00.01	----	CEILING & CEILING FINISHES Quoted by Guernsey Tingle 8/1/2022	1.0 LS					39,366	39,366.00 /LS	39,366
		Architectural Finishes - PRS	**1.0 LS**					**803,269**	**803,269.44 /LS**	**803,269**
32999 Landscaping and Site Development										
32-00-00.01	----	Lanscaping Quoted by Guernsey Tingle 8/1/2022	1.0 LS					70,523	70,522.92 /LS	70,523
32-00-00.01	----	Site Imporvements Quoted by Guernsey Tingle 8/1/2022	1.0 LS					11,682	11,682.36 /LS	11,682
		Landscaping and Site Development	**1.0 LS**					**82,205**	**82,205.28 /LS**	**82,205**
		04.1 Architecture Design 1						**1,270,365**		**1,270,365**

Phase	Item	Description	Quantity		Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit		Total Net Amount
05.0 HVAC, Plumbing												
22999 Plumbing Allowance												
22-05-00.10	BC-0001	Allowance - Piping, Building Service/Domestic	1.0	ls	-		-	11,000	-	11,000.00	/ls	11,000
		Plumbing Allowance	**1.0**	**LS**				**11,000**		**11,000.00**	**/LS**	**11,000**
23999 HAVC Equipment												
23-34-03.00	BC-0091	Fans, in-line cntfgl, sply/exhaust, 1,520 CFM, 16" dia conn	1.0	ea	700	1,204	931	-	-	2,835.43	/ea	2,835
23-83-33.10	6020	Electric heating, unit heater, heavy duty, 480 volt, 4 kW, includes fan & mounting bracket	2.0	ea	200	1,154	-	-	-	676.65	/ea	1,353
23-81-43.10	1080	Heat pump,air air split system,7.5 ton cooling,33 mbh heat @ 0degf,includs outside cndnsng unit only,excluds intrcnn tubing,curbs,pads and ductwork	1.0	ea	2,489	4,172	-	-	-	6,660.53	/ea	6,661
23-81-26.10	1030	Split ductless system, cooling only, single zone, ceiling mount, 3 ton cooling	2.0	ea	1,866	11,200	-	-	-	6,533.20	/ea	13,066
23-37-15.40	2520	Louver, aluminum, extruded, with screen, mill finish, dual combination, manual operation, intake or exhaust	140.0	sf	4,441	7,291	-	-	-	83.80	/sf	11,732
23-37-15.40	2520	Louver, aluminum, extruded, with screen, mill finish, dual combination, manual operation, intake or exhaust	100.0	sf	3,172	5,208	-	-	-	83.80	/sf	8,380
		HAVC Equipment	**1.0**	**LS**	**12,869**	**30,229**	**931**			**44,028.51**	**/LS**	**44,029**
23999 Misc. HVAC Allowance												
23-05-00.00	BC-0001	Allowance - HVAC $5.00/sf	9,272.0	sqft	-	-	-	50,996	-	5.50	/sqft	50,996
		Misc. HVAC Allowance	**1.0**	**LS**				**50,996**		**50,996.00**	**/LS**	**50,996**
		05.0 HVAC, Plumbing			**12,869**	**30,229**	**931**	**61,996**				**106,025**
06.0 Process Pipe												
40120 Piping DI Flanged 30" in PS												
40-05-19.20	A301002 200000	Pipe Plain End-Ductile Iron--C-151 30 Inch (750mm)	211.0	lf	-	64,814	-	-	-	307.17	/lf	64,814
40-05-19.20	A302412 000000	Fitting Flanged & Bolted-Ductile Iron-Ell90-Non-Specific 30 Inch (750mm)	1.0	ea	-	10,394	-	-	-	10,394.47	/ea	10,394
40-05-19.20	A302416 000000	Fitting Flanged & Bolted-Ductile Iron-Reducer 1 Dia-Non-Specific 30 Inch (750mm)	1.0	ea	-	12,322	-	-	-	12,322.04	/ea	12,322
40-05-19.20	A302414 000000	Fitting Flanged & Bolted-Ductile Iron-Tee-Non-Specific 30 Inch (750mm)	11.0	ea	-	232,906	-	-	-	21,173.23	/ea	232,906
40-05-19.10	A302426 000000	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Non-Specific 30 Inch (750mm)	4.0	ea	-	8,627	-	-	-	2,156.65	/ea	8,627
40-05-19.10	A302424 000000	Fitting Flanged & Bolted-Cast Iron-Flange Blind-Non-Specific 30 Inch (750mm)	1.0	ea	-	4,706	-	-	-	4,706.28	/ea	4,706
40-05-05.00	L303466 010000	Pipe Erection-Handle Fittings-Metal-Std 30 Inch (750mm)	14.0	ea	2,801	-	-	-	-	200.09	/ea	2,801

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
40120 Piping DI Flanged 30" in PS										
40-05-62.00	A306437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 30 Inch (750mm)	3.0 ea	-	196,853	-	-	-	65,617.82 /ea	196,853
40-05-51.00	L304062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 30 Inch (750mm)	3.0 ea	1,685	-	-	-	-	561.63 /ea	1,685
40-05-19.10	A303002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 30 Inch (750mm)	4.0 ea	-	759	-	-	-	189.86 /ea	759
40-05-19.20	L304002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 30 Inch (750mm)	211.0 lf	24,318	-	-	-	-	115.25 /lf	24,318
40-05-05.00	A303400 006200	Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 30 Inch (750mm)	4.0 ea	610	4,509	-	-	-	1,279.72 /ea	5,119
40-05-07.00	A306044 000000	Pipe Support 30 Inch (750mm)	2.0 ea	274	249	-	-	-	261.79 /ea	524
40-05-07.00	A306045 000000	Hanger Rod 30 Inch (750mm)	2.0 ea	229	1,620	-	-	-	924.18 /ea	1,848
40-05-07.00	A306043 000000	Hilti-Chemical Anchor - Pipe Support Size 30 Inch (750mm)	8.0 ea	305	648	-	-	-	119.10 /ea	953
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	1,657.2 sqft	1,071	1,626	-	-	-	1.63 /sqft	2,696
40-05-05.00	L309048 000000	Field Testing-Hydrotest-Non-Specific 30 Inch (750mm)	211.0 lf	2,413	-	-	-	-	11.43 /lf	2,413
40-05-05.00	XL60906 4009000	Pipe Erection-Handle Pipe-Construction Equipment	40.0 mh	2,586	-	2,479	-	-	126.64 /mh	5,065
40-05-05.00	XL60906 4010000	Pipe Erection-Handle Fittings and Valves-Contruction Equipment	40.0 mh	2,586	-	2,479	-	-	126.64 /mh	5,065
22-20-03.00	BC-0227	Pipe coupling, sleeve-type, Dresser style, 30"	3.0 ea	2,483	9,219	3,302	-	-	5,001.02 /ea	15,003
27-20-03.00	BC-0031	30" Magnetic flowmeters, 150# AWWA flanges	2.0 ea	287	51,843	-	-	-	26,065.38 /ea	52,131
		Piping DI Flanged 30" in PS	**211.0 lf**	**41,648**	**601,095**	**8,260**			**3,085.32 /lf**	**651,003**
40120 Piping DI Flanged 16" in PS										
40-05-19.20	A201002 200000	Pipe Plain End-Ductile Iron--C-151 16 Inch (400mm)	63.0 lf	-	4,798	-	-	-	76.16 /lf	4,798
40-05-19.20	A202416 000000	Fitting Flanged & Bolted-Ductile Iron-Reducer 1 Dia-Non-Specific 16 Inch (400mm)	2.0 ea	-	5,770	-	-	-	2,884.87 /ea	5,770
40-05-19.20	A202414 000000	Fitting Flanged & Bolted-Ductile Iron-Tee-Non-Specific 16 Inch (400mm)	3.0 ea	-	14,624	-	-	-	4,874.66 /ea	14,624
40-05-19.10	A202426 006100	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Cls 125 16 Inch (400mm)	2.0 ea	-	575	-	-	-	287.63 /ea	575
40-05-19.10	A202424 006100	Fitting Flanged & Bolted-Cast Iron-Flange Blind-Cls 125 16 Inch (400mm)	1.0 ea	-	489	-	-	-	488.98 /ea	489
40-05-05.00	L203466 010000	Pipe Erection-Handle Fittings-Metal-Std 16 Inch (400mm)	6.0 ea	720	-	-	-	-	120.05 /ea	720
40-05-62.00	A206437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 16 Inch (400mm)	3.0 ea	-	37,709	-	-	-	12,569.65 /ea	37,709
40-05-51.00	L204062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 16 Inch (400mm)	3.0 ea	816	-	-	-	-	272.13 /ea	816
40-05-19.10	A203002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 16 Inch (400mm)	2.0 ea	-	152	-	-	-	75.94 /ea	152

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
40120 Piping DI Flanged 16" in PS										
40-05-19.20	L2040020000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 16 Inch (400mm)	63.0 lf	3,803	-	-	-	-	60.37 /lf	3,803
40-05-05.00	A203400006200	Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 16 Inch (400mm)	1.0 ea	76	281	-	-	-	356.92 /ea	357
40-05-07.00	A206044000000	Pipe Support 16 Inch (400mm)	1.0 ea	95	62	-	-	-	157.58 /ea	158
40-05-07.00	A206045000000	Hanger Rod 16 Inch (400mm)	1.0 ea	46	405	-	-	-	450.66 /ea	451
40-05-07.00	A206043000000	Hilti-Chemical Anchor - Pipe Support Size 16 Inch (400mm)	3.0 ea	114	168	-	-	-	94.18 /ea	283
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	263.9 sqft	170	259	-	-	-	1.63 /sqft	429
40-05-05.00	L209048000000	Field Testing-Hydrotest-Non-Specific 16 Inch (400mm)	63.0 lf	384	-	-	-	-	6.10 /lf	384
40-05-05.00	XL609064009000	Pipe Erection-Handle Pipe-Construction Equipment	20.0 mh	1,293	-	1,240	-	-	126.64 /mh	2,533
40-05-05.00	XL609064010000	Pipe Erection-Handle Fittings and Valves-Contruction Equipment	20.0 mh	1,293	-	1,240	-	-	126.64 /mh	2,533
		Piping DI Flanged 16" in PS	**63.0 lf**	**8,813**	**65,292**	**2,479**			**1,215.61 /lf**	**76,583**
40120 Piping DI Flanged 20" in PS										
40-05-19.20	A221002200000	Pipe Plain End-Ductile Iron--C-151 20 Inch (500mm)	80.0 lf	-	8,733	-	-	-	109.16 /lf	8,733
40-05-19.20	A222412000000	Fitting Flanged & Bolted-Ductile Iron-Ell90-Non-Specific 20 Inch (500mm)	1.0 ea	-	5,141	-	-	-	5,140.74 /ea	5,141
40-05-19.20	A222414000000	Fitting Flanged & Bolted-Ductile Iron-Tee-Non-Specific 20 Inch (500mm)	3.0 ea	-	25,260	-	-	-	8,420.05 /ea	25,260
40-05-19.10	A222426000000	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Non-Specific 20 Inch (500mm)	4.0 ea	-	3,834	-	-	-	958.51 /ea	3,834
40-05-19.10	A222424006100	Fitting Flanged & Bolted-Cast Iron-Flange Blind-Cls 125 20 Inch (500mm)	1.0 ea	-	869	-	-	-	869.28 /ea	869
40-05-05.00	L223466010000	Pipe Erection-Handle Fittings-Metal-Std 20 Inch (500mm)	5.0 ea	715	-	-	-	-	142.92 /ea	715
40-05-62.00	A226437016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 20 Inch (500mm)	1.0 ea	-	20,594	-	-	-	20,594.34 /ea	20,594
40-05-51.00	L224062006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 20 Inch (500mm)	1.0 ea	317	-	-	-	-	316.94 /ea	317
40-05-19.10	A2230021900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 20 Inch (500mm)	4.0 ea	-	416	-	-	-	103.97 /ea	416
40-05-19.20	L2240020000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 20 Inch (500mm)	80.0 lf	6,092	-	-	-	-	76.15 /lf	6,092
40-05-05.00	A223400006200	Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 20 Inch (500mm)	1.0 ea	76	495	-	-	-	571.70 /ea	572
40-05-07.00	A226044000000	Pipe Support 20 Inch (500mm)	1.0 ea	137	93	-	-	-	230.66 /ea	231

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
40120 Piping DI Flanged 20" in PS										
40-05-07.00	A226045 000000	Hanger Rod 20 Inch (500mm)	1.0 ea	46	467	-	-	-	512.94 /ea	513
40-05-07.00	A226043 000000	Hilti-Chemical Anchor - Pipe Support Size 20 Inch (500mm)	3.0 ea	114	187	-	-	-	100.41 /ea	301
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	418.9 sqft	271	411	-	-	-	1.63 /sqft	682
40-05-05.00	L229048 000000	Field Testing-Hydrotest-Non-Specific 20 Inch (500mm)	80.0 lf	610	-	-	-	-	7.62 /lf	610
40-05-05.00	XL60906 4009000	Pipe Erection-Handle Pipe-Construction Equipment	20.0 mh	1,293	-	1,240	-	-	126.64 /mh	2,533
40-05-05.00	XL60906 4010000	Pipe Erection-Handle Fittings and Valves-Contruction Equipment	20.0 mh	1,293	-	1,240	-	-	126.64 /mh	2,533
22-20-03.00	BC-0161	Pipe coupling, sleeve-type, Dresser style, 20"	1.0 ea	603	2,551	802	-	-	3,956.12 /ea	3,956
		Piping DI Flanged 20" in PS	**80.0 lf**	**11,567**	**69,052**	**3,281**			**1,048.75 /lf**	**83,900**
40120 Piping DI Flanged 10" and 8" in PS										
40-05-19.20	A161002 200000	Pipe Plain End-Ductile Iron--C-151 8 Inch (200mm)	88.0 lf	-	2,234	-	-	-	25.39 /lf	2,234
40-05-19.20	A171002 200000	Pipe Plain End-Ductile Iron--C-151 10 Inch (250mm)	32.0 lf	-	1,016	-	-	-	31.73 /lf	1,016
40-05-19.20	A162412 000000	Fitting Flanged & Bolted-Ductile Iron-Ell90-Non-Specific 8 Inch (200mm)	3.0 ea	-	2,761	-	-	-	920.25 /ea	2,761
40-05-19.10	A162426 006100	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Cls 125 8 Inch (200mm)	8.0 ea	-	511	-	-	-	63.89 /ea	511
40-05-19.10	A172426 006100	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Cls 125 10 Inch (250mm)	4.0 ea	-	366	-	-	-	91.58 /ea	366
40-05-05.00	L163466 010000	Pipe Erection-Handle Fittings-Metal-Std 8 Inch (200mm)	3.0 ea	201	-	-	-	-	66.85 /ea	201
40-05-65.23	A166435 016200	Valve Flanged & Bolted-Cast Steel-Check-Cls 150 (PN20) 8 Inch (200mm)	3.0 ea	-	13,670	-	-	-	4,556.81 /ea	13,670
40-05-62.00	A166437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 8 Inch (200mm)	3.0 ea	-	11,291	-	-	-	3,763.79 /ea	11,291
40-05-62.00	A176437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 10 Inch (250mm)	3.0 ea	-	15,978	-	-	-	5,326.12 /ea	15,978
40-05-51.00	L164062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 8 Inch (200mm)	6.0 ea	851	-	-	-	-	141.78 /ea	851
40-05-51.00	L174062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 10 Inch (250mm)	3.0 ea	550	-	-	-	-	183.40 /ea	550
40-05-19.10	A163002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 8 Inch (200mm)	8.0 ea	-	276	-	-	-	34.47 /ea	276
40-05-19.10	A173002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 10 Inch (250mm)	4.0 ea	-	177	-	-	-	44.13 /ea	177
40-05-19.20	L164002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 8 Inch (200mm)	88.0 lf	2,354	-	-	-	-	26.75 /lf	2,354
40-05-19.20	L174002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 10 Inch (250mm)	32.0 lf	1,229	-	-	-	-	38.42 /lf	1,229
40-05-07.00	A166044 000000	Pipe Support 8 Inch (200mm)	2.0 ea	152	62	-	-	-	107.38 /ea	215

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
40120 Piping DI Flanged 10" and 8" in PS										
40-05-07.00	A176044 000000	Pipe Support 10 Inch (250mm)	1.0 ea	76	31	-	-	-	107.36 /ea	107
40-05-07.00	A166045 000000	Hanger Rod 8 Inch (200mm)	2.0 ea	61	374	-	-	-	217.38 /ea	435
40-05-07.00	A176045 000000	Hanger Rod 10 Inch (250mm)	1.0 ea	30	343	-	-	-	373.10 /ea	373
40-05-07.00	A166043 000000	Hilti-Chemical Anchor - Pipe Support Size 8 Inch (200mm)	4.0 ea	91	125	-	-	-	54.01 /ea	216
40-05-07.00	A176043 000000	Hilti-Chemical Anchor - Pipe Support Size 10 Inch (250mm)	1.0 ea	23	37	-	-	-	60.25 /ea	60
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	268.1 sqft	173	263	-	-	-	1.63 /sqft	436
40-05-05.00	L169048 000000	Field Testing-Hydrotest-Non-Specific 8 Inch (200mm)	88.0 lf	268	-	-	-	-	3.05 /lf	268
40-05-05.00	L179048 000000	Field Testing-Hydrotest-Non-Specific 10 Inch (250mm)	32.0 lf	122	-	-	-	-	3.81 /lf	122
40-05-05.00	XL60906 4009000	Pipe Erection-Handle Pipe-Construction Equipment	20.0 mh	1,293	-	1,240	-	-	126.64 /mh	2,533
40-05-05.00	XL60906 4010000	Pipe Erection-Handle Fittings and Valves-Contruction Equipment	20.0 mh	1,293	-	1,240	-	-	126.64 /mh	2,533
22-20-03.00	BC-0216	Pipe coupling, sleeve-type, Dresser style, 8"	3.0 ea	731	2,591	-	-	-	1,107.53 /ea	3,323
22-20-03.00	BC-0217	Pipe coupling, sleeve-type, Dresser style, 10"	3.0 ea	863	3,989	1,147	-	-	1,999.71 /ea	5,999
		Piping DI Flanged 10" and 8" in PS	**120.0 lf**	**10,363**	**56,096**	**3,626**			**584.04 /lf**	**70,085**
40120 Piping DI Flanged 16" and 12" in PS										
40-05-19.20	A181002 200000	Pipe Plain End-Ductile Iron--C-151 12 Inch (300mm)	120.0 lf	-	5,331	-	-	-	44.43 /lf	5,331
40-05-19.20	A201002 200000	Pipe Plain End-Ductile Iron--C-151 16 Inch (400mm)	50.0 lf	-	3,808	-	-	-	76.16 /lf	3,808
40-05-19.20	A182412 000000	Fitting Flanged & Bolted-Ductile Iron-Ell90-Non-Specific 12 Inch (300mm)	4.0 ea	-	6,981	-	-	-	1,745.31 /ea	6,981
40-05-19.10	A182426 006100	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Cls 125 12 Inch (300mm)	10.0 ea	-	1,363	-	-	-	136.30 /ea	1,363
40-05-19.10	A202426 006100	Fitting Flanged & Bolted-Cast Iron-Flange Thr-Cls 125 16 Inch (400mm)	8.0 ea	-	2,301	-	-	-	287.63 /ea	2,301
40-05-05.00	L183466 010000	Pipe Erection-Handle Fittings-Metal-Std 12 Inch (300mm)	4.0 ea	406	-	-	-	-	101.46 /ea	406
40-05-65.23	A186435 016200	Valve Flanged & Bolted-Cast Steel-Check-Cls 150 (PN20) 12 Inch (300mm)	4.0 ea	-	31,571	-	-	-	7,892.74 /ea	31,571
40-05-62.00	A186437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 12 Inch (300mm)	4.0 ea	-	26,077	-	-	-	6,519.17 /ea	26,077
40-05-62.00	A206437 016200	Valve Flanged & Bolted-Cast Steel-Plug-Cls 150 (PN20) 16 Inch (400mm)	4.0 ea	-	50,279	-	-	-	12,569.65 /ea	50,279
40-05-51.00	L184062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 12 Inch (300mm)	8.0 ea	2,078	-	-	-	-	259.77 /ea	2,078
40-05-51.00	L204062 006200	Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 16 Inch (400mm)	4.0 ea	1,088	-	-	-	-	272.12 /ea	1,088

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
40120 Piping DI Flanged 16" and 12" in PS										
40-05-19.10	A183002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 12 Inch (300mm)	10.0 ea	-	546	-	-	-	54.59 /ea	546
40-05-19.10	A203002 1900SC	Shop Fabrication-Cast Iron-Shop Cut & Thread & Attach Flange-Class C 16 Inch (400mm)	8.0 ea	-	608	-	-	-	75.95 /ea	608
40-05-19.20	L184002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 12 Inch (300mm)	120.0 lf	5,680	-	-	-	-	47.34 /lf	5,680
40-05-19.20	L204002 0000P1	Pipe Erection-Straight Run-Ductile Iron-Non-Specific 16 Inch (400mm)	50.0 lf	3,019	-	-	-	-	60.37 /lf	3,019
40-05-07.00	A186044 000000	Pipe Support 12 Inch (300mm)	2.0 ea	191	62	-	-	-	126.44 /ea	253
40-05-07.00	A206044 000000	Pipe Support 16 Inch (400mm)	1.0 ea	95	62	-	-	-	157.56 /ea	158
40-05-07.00	A186045 000000	Hanger Rod 12 Inch (300mm)	2.0 ea	61	748	-	-	-	404.27 /ea	809
40-05-07.00	A206045 000000	Hanger Rod 16 Inch (400mm)	1.0 ea	46	405	-	-	-	450.65 /ea	451
40-05-07.00	A186043 000000	Hilti-Chemical Anchor - Pipe Support Size 12 Inch (300mm)	5.0 ea	114	218	-	-	-	66.47 /ea	332
40-05-07.00	A206043 000000	Hilti-Chemical Anchor - Pipe Support Size 16 Inch (400mm)	2.0 ea	76	112	-	-	-	94.18 /ea	188
09-91-06.41	BC-0001	Coatings & paints, B & C coating system E-1 (Epoxy, metal pipe)	586.4 sqft	379	575	-	-	-	1.63 /sqft	954
40-05-05.00	L189048 000000	Field Testing-Hydrotest-Non-Specific 12 Inch (300mm)	120.0 lf	549	-	-	-	-	4.57 /lf	549
40-05-05.00	L209048 000000	Field Testing-Hydrotest-Non-Specific 16 Inch (400mm)	50.0 lf	305	-	-	-	-	6.10 /lf	305
40-05-05.00	XL60906 4009000	Pipe Erection-Handle Pipe-Construction Equipment	20.0 mh	1,293	-	1,240	-	-	126.64 /mh	2,533
40-05-05.00	XL60906 4010000	Pipe Erection-Handle Fittings and Valves-Contruction Equipment	20.0 mh	1,293	-	1,240	-	-	126.64 /mh	2,533
22-20-03.00	BC-0166	Pipe coupling, sleeve-type, Dresser style, 12"	4.0 ea	1,431	6,263	1,903	-	-	2,399.11 /ea	9,596
22-20-03.00	BC-0219	Pipe coupling, sleeve-type, Dresser style, 16"	4.0 ea	1,908	7,277	2,537	-	-	2,930.31 /ea	11,721
		Piping DI Flanged 16" and 12" in PS	**170.0 lf**	**20,012**	**144,587**	**6,919**			**1,008.92 /lf**	**171,517**
		06.0 Process Pipe		**92,402**	**936,122**	**24,565**				**1,053,089**
07.0 Equipment										
11999 Bridge Crane										
41-22-13.13	0625	Overhead bridge crane, under hung hoist, electric operating, 2 girder, 25 ton, 50' span	1.0 ea	11,664	77,840	839	-	-	90,342.90 /ea	90,343
41-22-13.10	0210	Crane rail, box beam bridge, running track only, 104 lb per yard, 20' piece, excl. equipment	76.0 lf	1,555	2,426	69	-	-	53.29 /lf	4,050
		Bridge Crane	**1.0 LS**	**13,219**	**80,266**	**908**			**94,392.71 /LS**	**94,393**
46999 Drain Pumps										
46-06-18.00	BC-0106	Pump, cntfgl, horiz mtd, end suct,vert splt,sgl stg 35HP,6"D Quoted by Sherwood-Logan 5-19-2022	3.0 ea	6,598	1,680	58,000	-	162,000	76,092.60 /ea	228,278

Phase	Item	Description	Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Net Amount
46999 Drain Pumps										
46-06-18.00	BC-0166	Pump, cntfgl, horiz mtd, horiz splt, sgl stg, 140HP,12"D Quoted by Sherwood-Logan 5-19-2022	4.0 ea	13,639	2,240	18,138	-	583,200	154,304.20 /ea	617,217
		Drain Pumps	**1.0 LS**	**20,237**	**3,920**	**76,138**		**745,200**	**845,494.61 /LS**	**845,495**
46999 OC Equipment Allowance										
46-06-00.00	BC-0066	Odor control tower, complete w/ media	1.0 ea	5,176	100,800	5,110	-	-	111,086.00 /ea	111,086
46-06-00.00	BC-0071	Odor control , radial blower	1.0 ea	2,911	33,600	2,044	-	-	38,555.42 /ea	38,555
		OC Equipment Allowance	**1.0 LS**	**8,087**	**134,400**	**7,155**			**149,641.42 /LS**	**149,641**
46999 Vac-Flush System										
46-06-00.00	----	Vac-Flush System	1.0 LS					286,934	286,934.40 /LS	286,934
		Vac-Flush System	**1.0 LS**					**286,934**	**286,934.40 /LS**	**286,934**
		07.0 Equipment		**41,543**	**218,586**	**84,200**		**1,032,134**		**1,376,463**
08.0 Electrical and I&C										
26002 _Electrical, Instrumentation, and Controls Subcontract										
26-00-00.02	BC-0006	EI&C Subcontract, from electrical estimate report	1.0 ls	-	-	-	3,474,198	-	3,474,197.82 /ls	3,474,198
		_Electrical, Instrumentation, and Controls Subcontract	**1.0 ls**				**3,474,198**		**3,474,197.82 /ls**	**3,474,198**
		08.0 Electrical and I&C					**3,474,198**			**3,474,198**
		01 Total		**3,096,399**	**6,723,466**	**2,084,558**	**3,536,194**	**6,465,256**		**21,905,872**

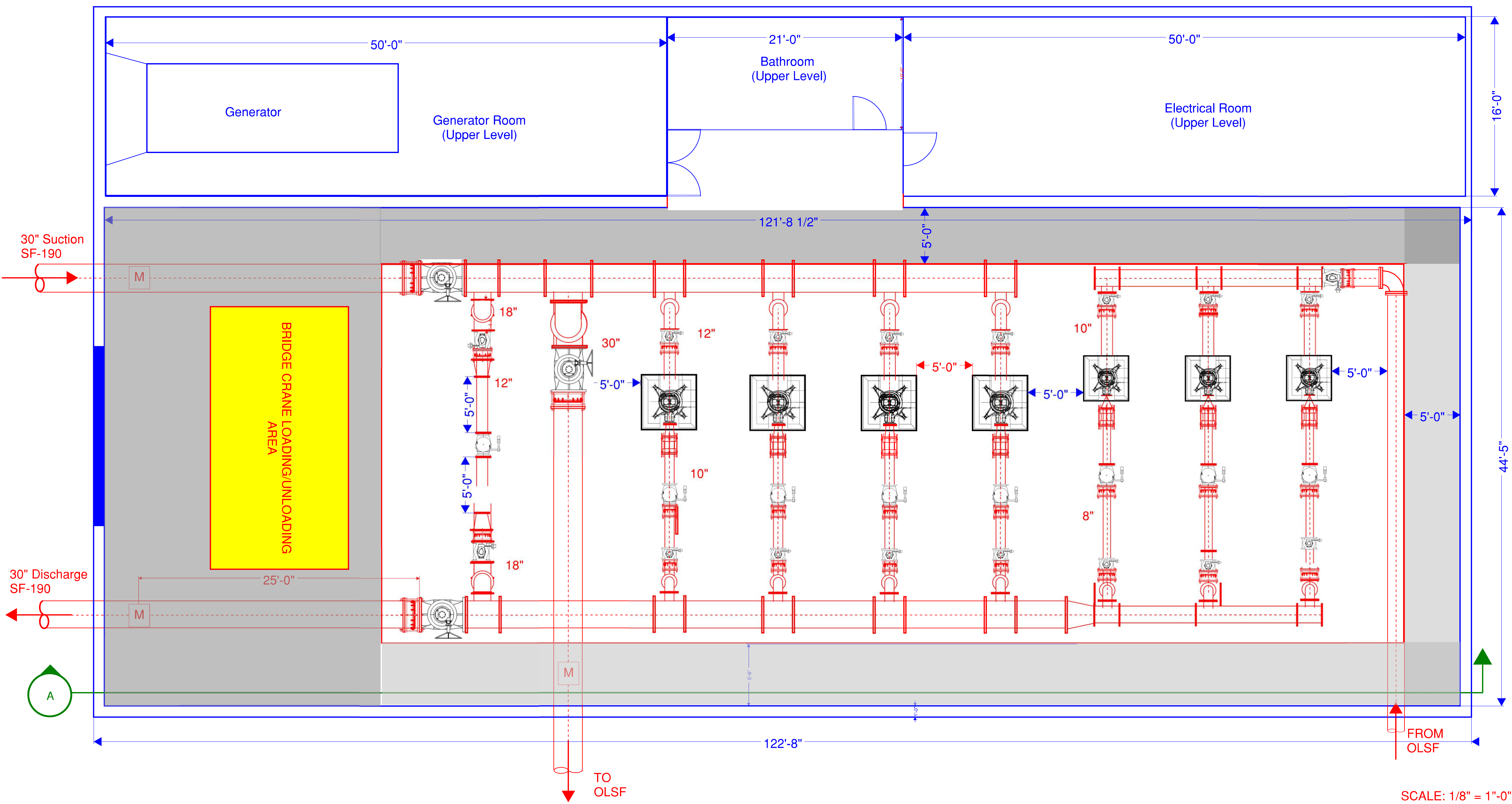
Estimate Totals

Description	Rate	Hours	Amount	Totals
Labor		39,002 hrs	3,096,399	
Material			6,723,466	
Subcontract			3,536,194	
Equipment		115,694 hrs	2,084,558	
Other			6,465,256	
			21,905,873	21,905,873
Material Sales Tax - Exempt				
Other - Process Eqp Sales Tax - Exempt				
Net Markups				21,905,873
Contractor General Conditions	15.00 %		3,285,881	
			3,285,881	25,191,754
Start-Up, Training, O&M	2.00 %		503,835	
			503,835	25,695,589
Undesign/Undevelop Contingency	20.00 %		5,139,118	
Unknown Market Condtions	10.00 %		2,569,559	
			7,708,677	33,404,266
Bldg Risk, Liability Auto Ins	2.00 %		668,085	
			668,085	34,072,351
Payment and Performance Bonds	1.50 %		511,085	
			511,085	34,583,436
CMAR Fee	10.00 %		3,458,344	
			3,458,344	38,041,780
Escalation to Midpoint (ALL)	15.66 %		5,957,343	
			5,957,343	43,999,123
BC CACI Fee	10.00 %		4,399,912	
Gross Markups			4,399,912	48,399,035
Total				48,399,035

Appendix H: PRS Alternative Sketches

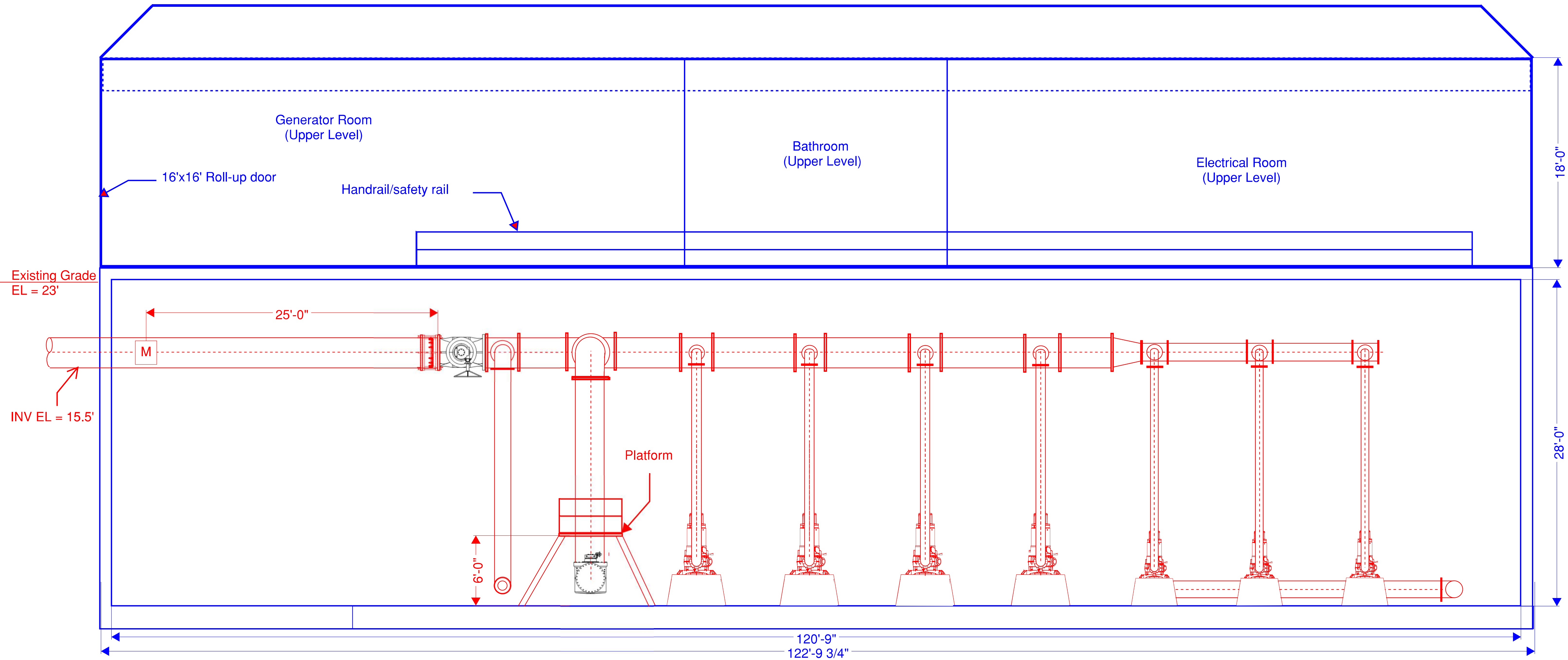
DEEP STATION ALTERNATIVE SKETCHES

DEEP ALTERNATIVE #1 - PLAN VIEW



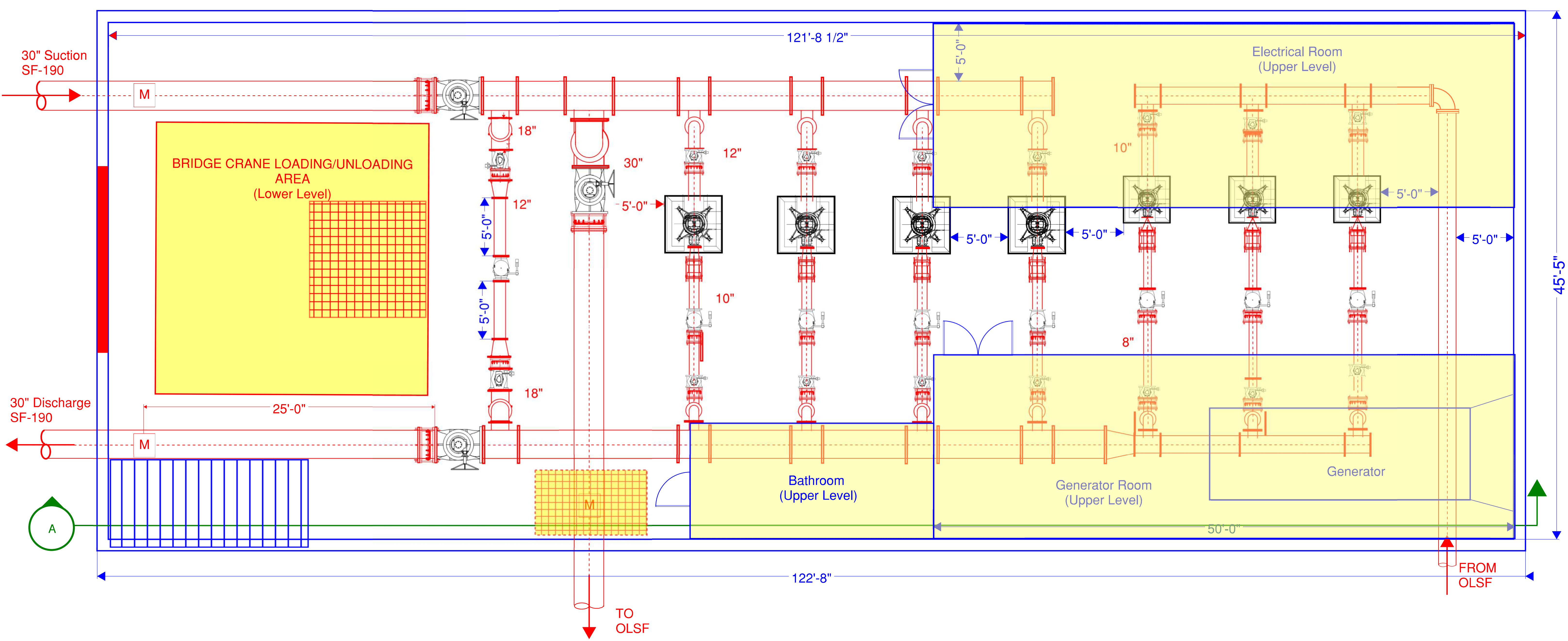
SCALE: 1/8" = 1'-0"

DEEP ALTERNATIVE #1 - SECTION VIEW



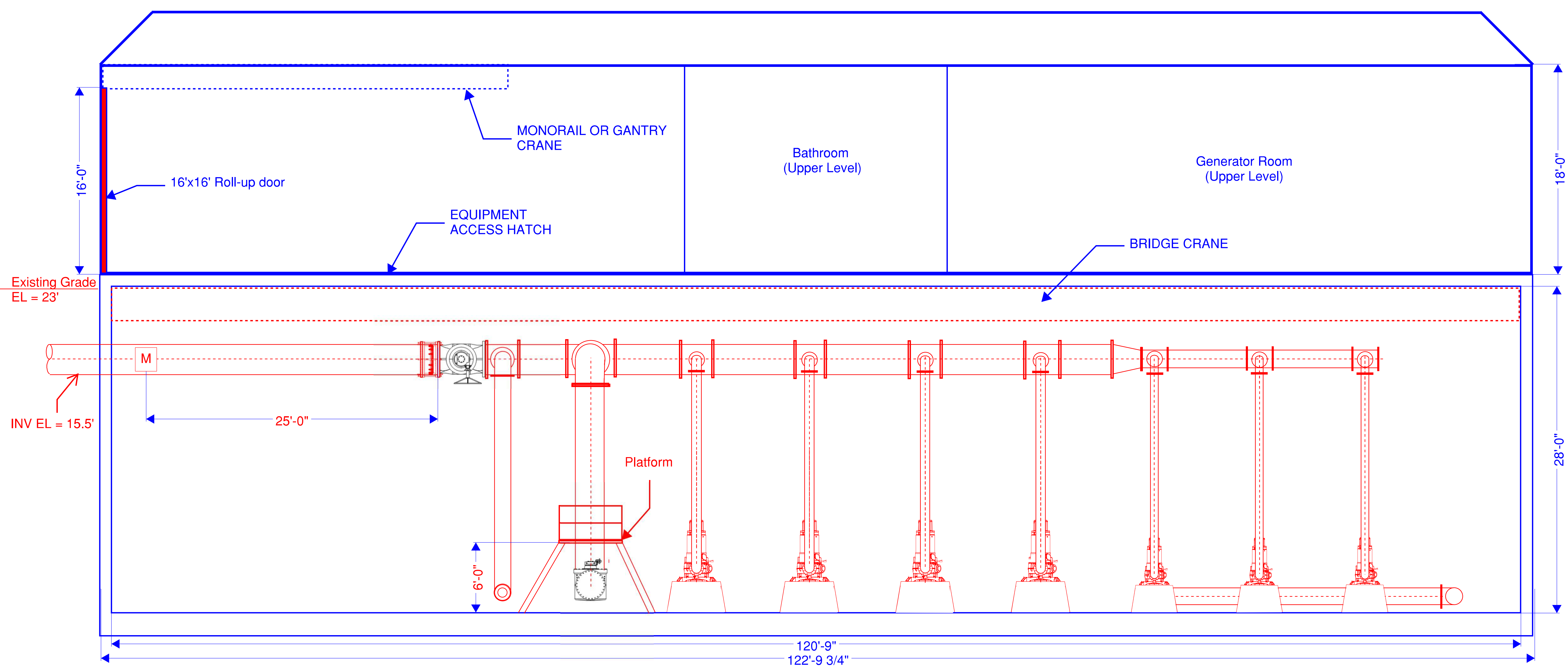
SCALE: 1/8" = 1"-0"

DEEP ALTERNATIVE #2 - PLAN VIEW



SCALE: 1/8" = 1'-0"

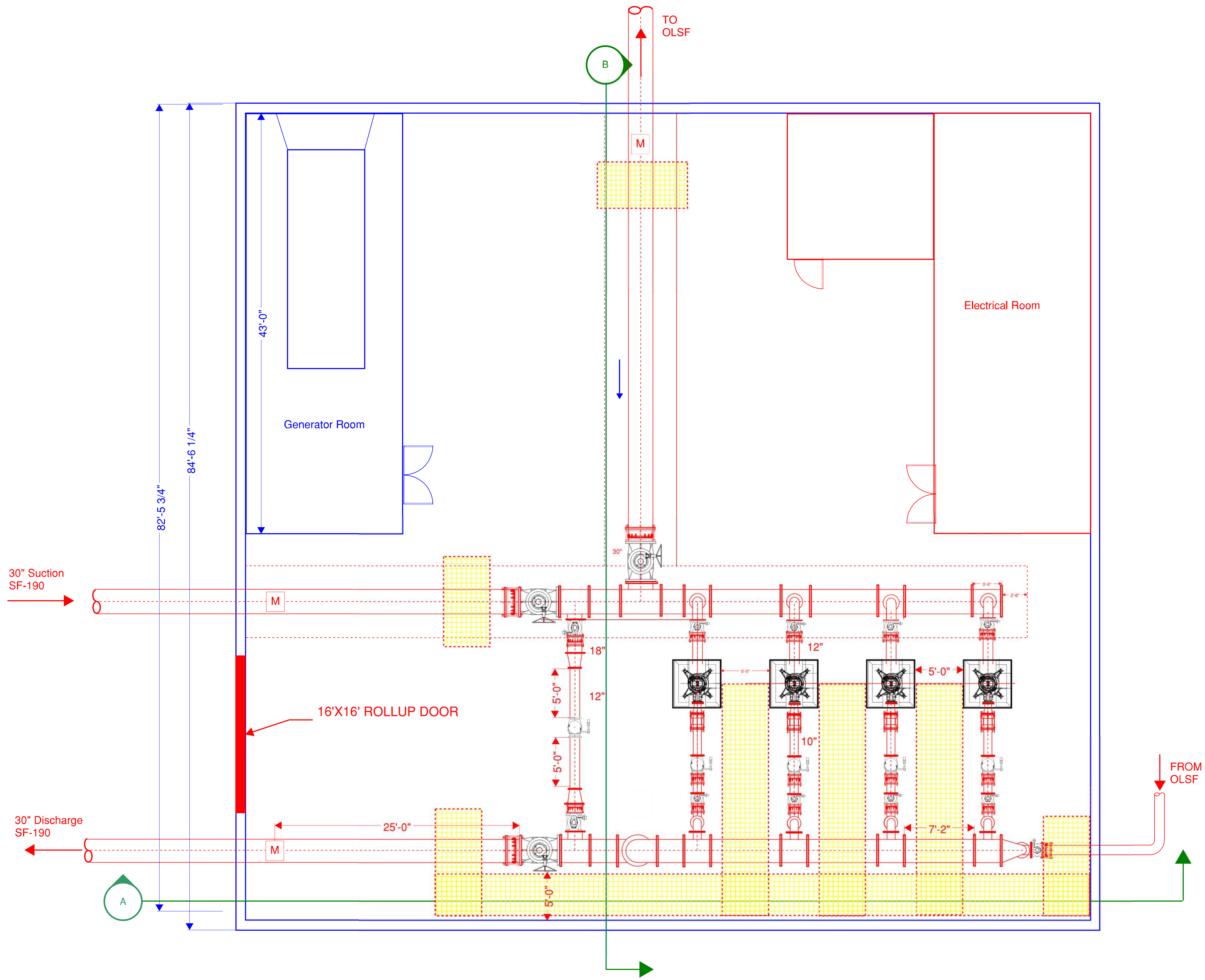
DEEP ALTERNATIVE #2 - SECTION VIEW



SCALE: 1/8" = 1"-0"

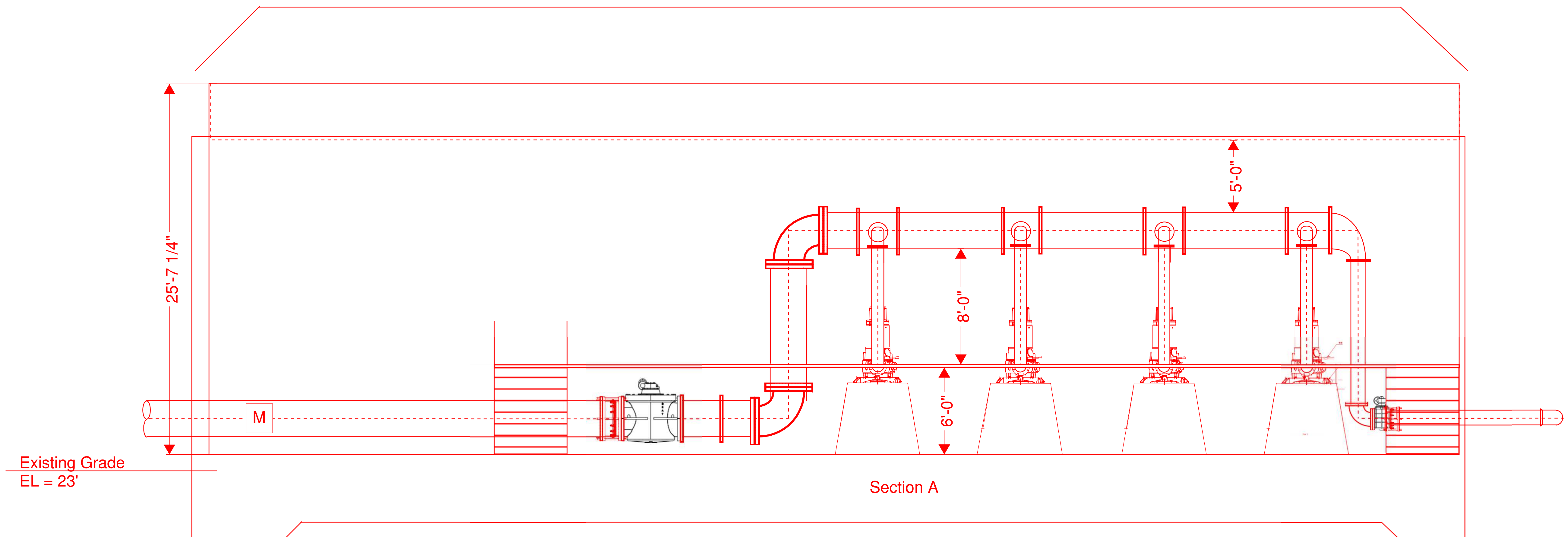
ABOVE GRADE STATION ALTERNATIVE SKETCHES

ABOVE GRADE ALTERNATIVE #1 - PLAN VIEW

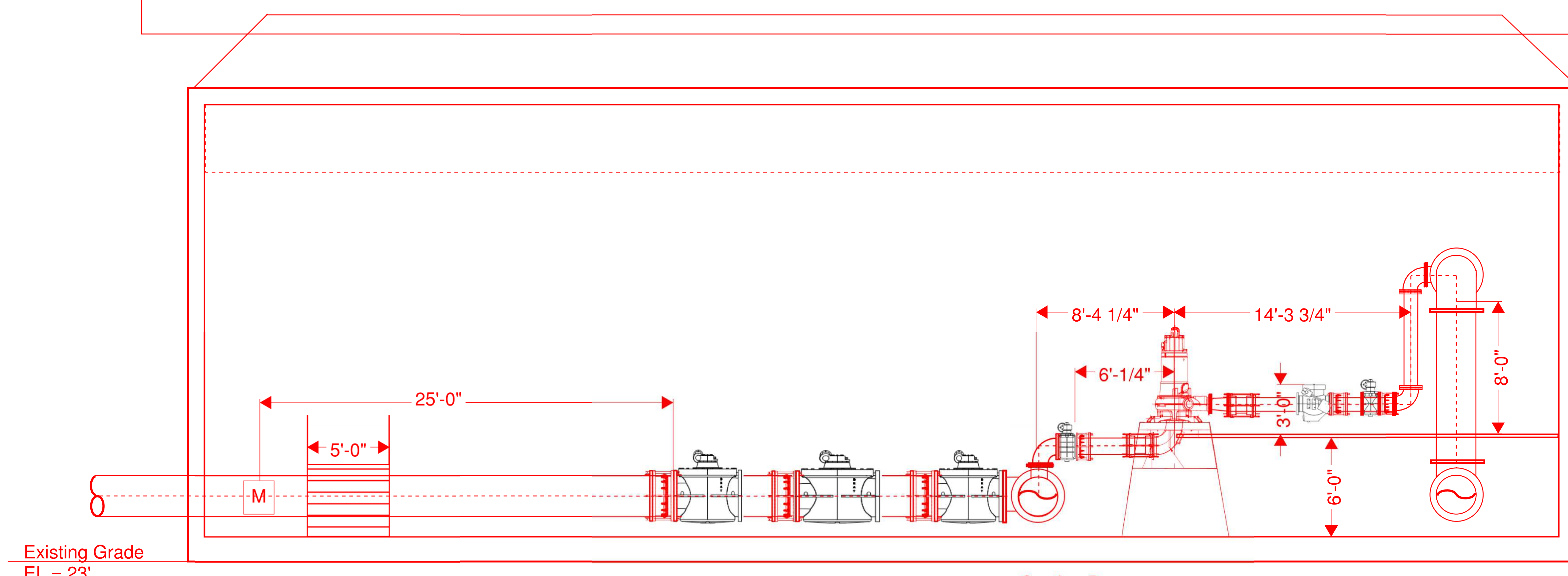


SCALE: 1/8" = 1'-0"

ABOVE GRADE ALTERNATIVE #1 - SECTION VIEWS



Section A

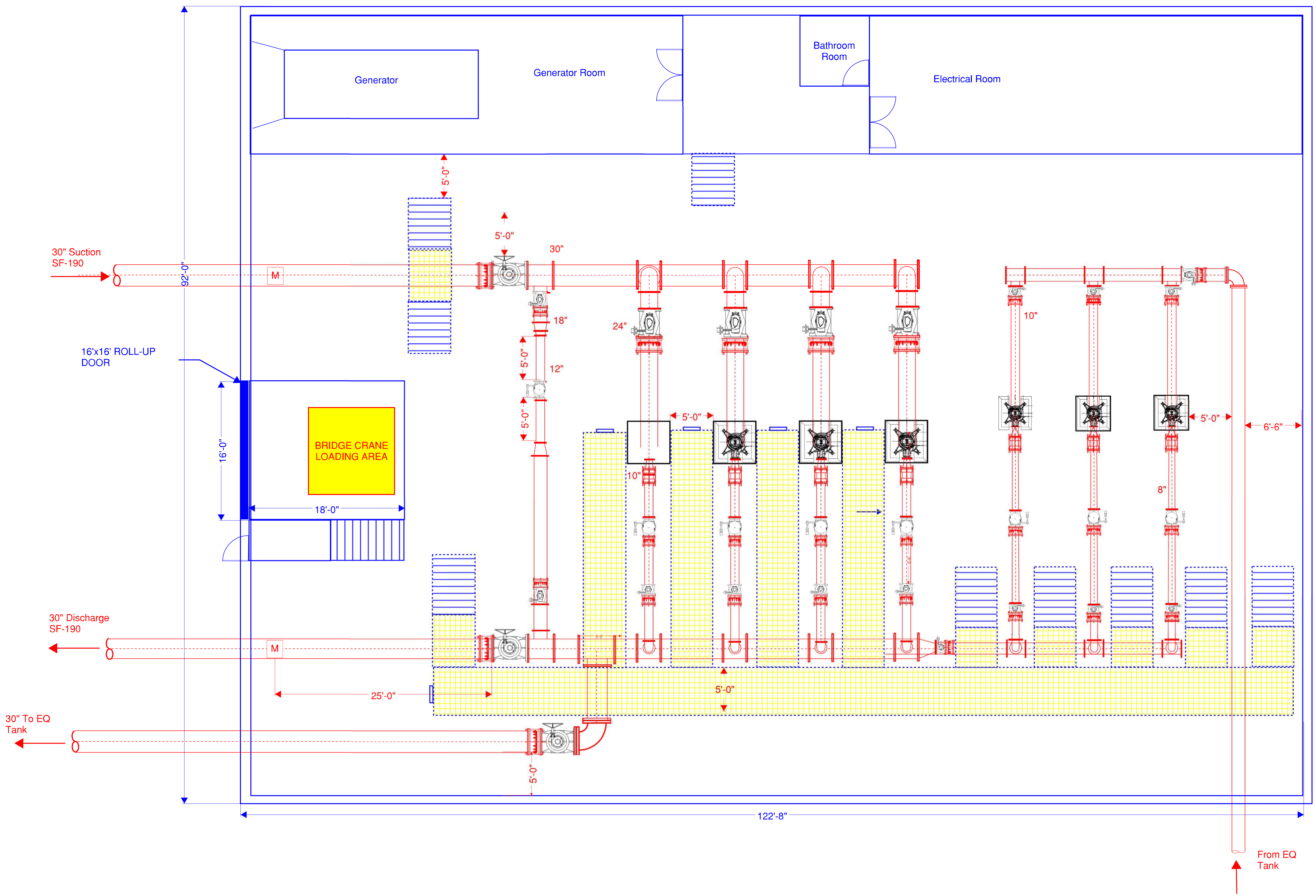


Section B

SCALE: 1/8" = 1"-0"

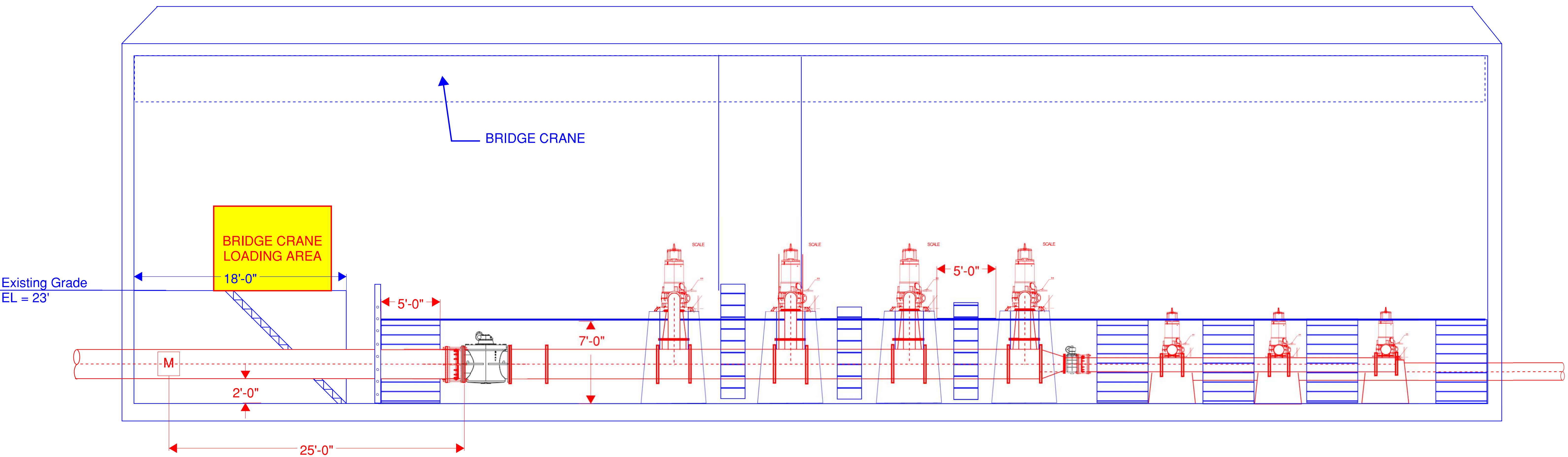
BELOW GRADE ALTERNATIVE SKETCHES

BELOW GRADE ALTERNATIVE #1 - PLAN VIEW



SCALE: 1/8" = 1'-0"

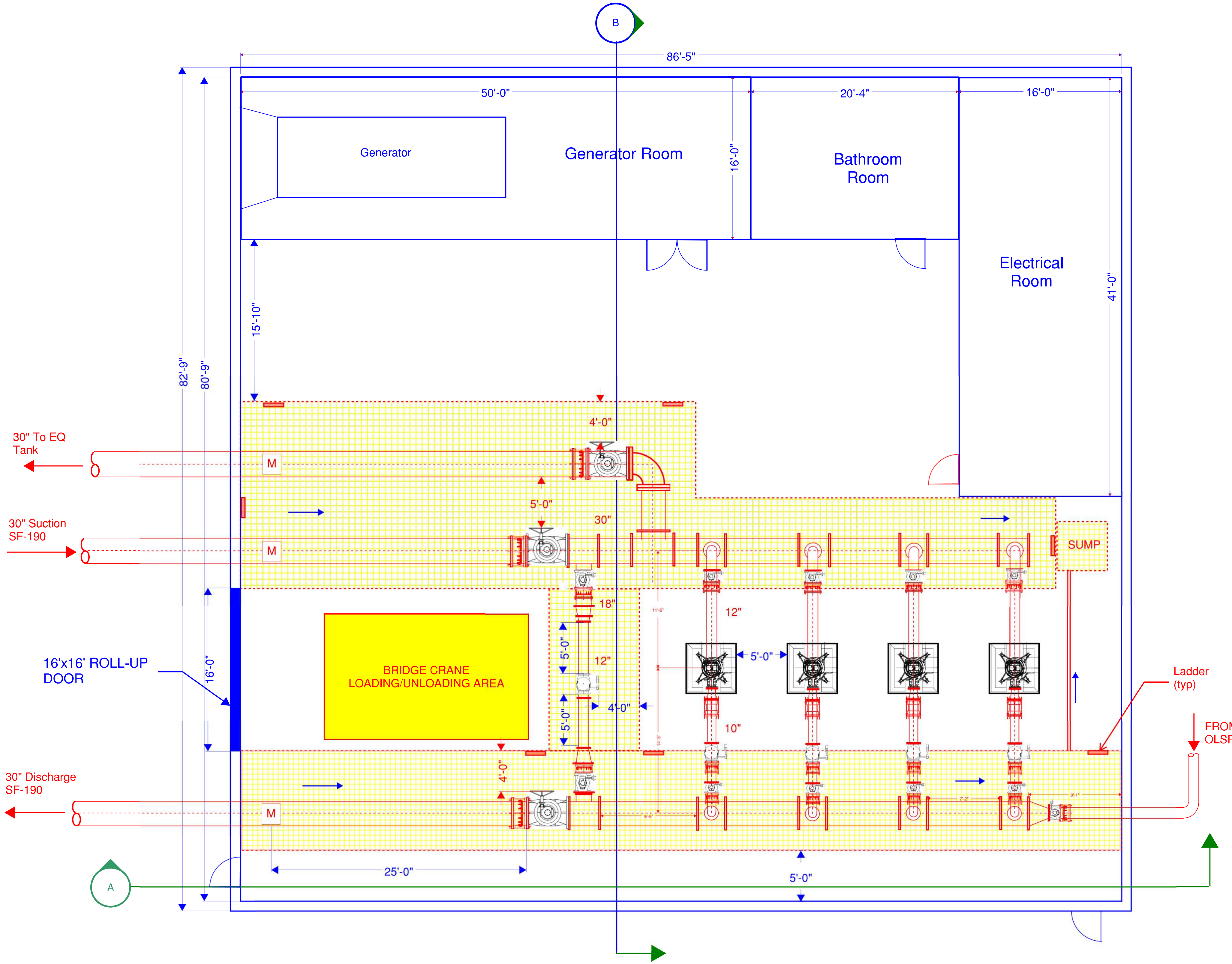
BELOW GRADE ALTERNATIVE #1 - SECTION VIEW



Section A

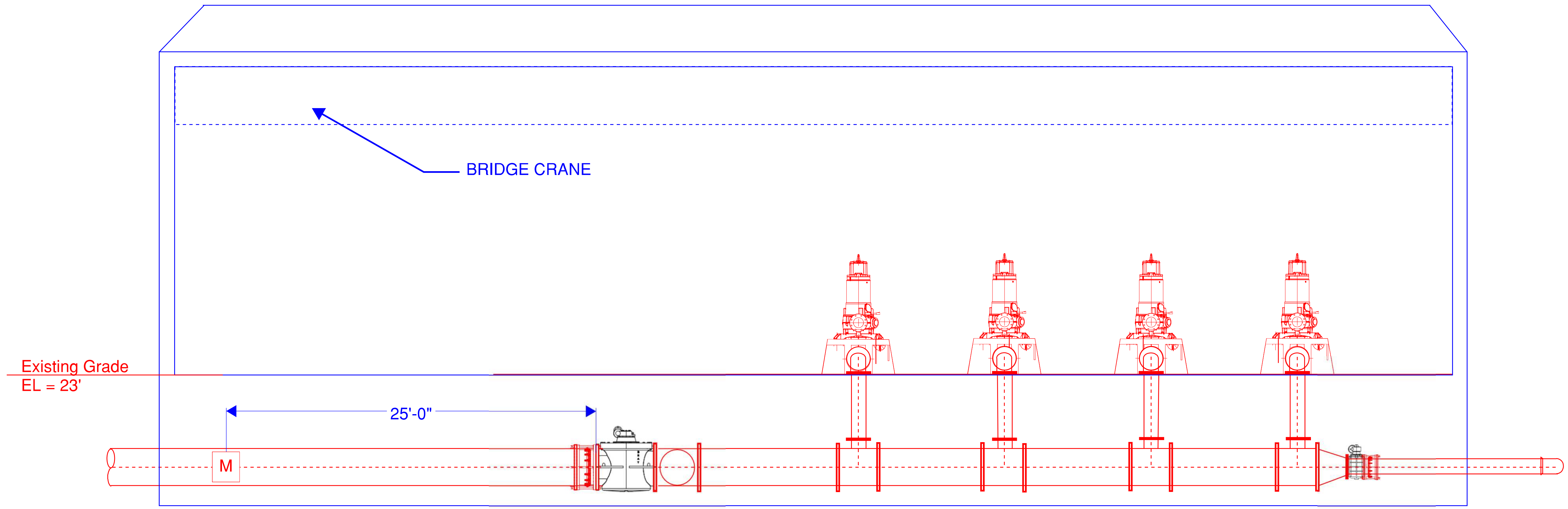
SCALE: 1/8" = 1"-0"

BELOW GRADE ALTERNATIVE #2 - SECTION VIEW

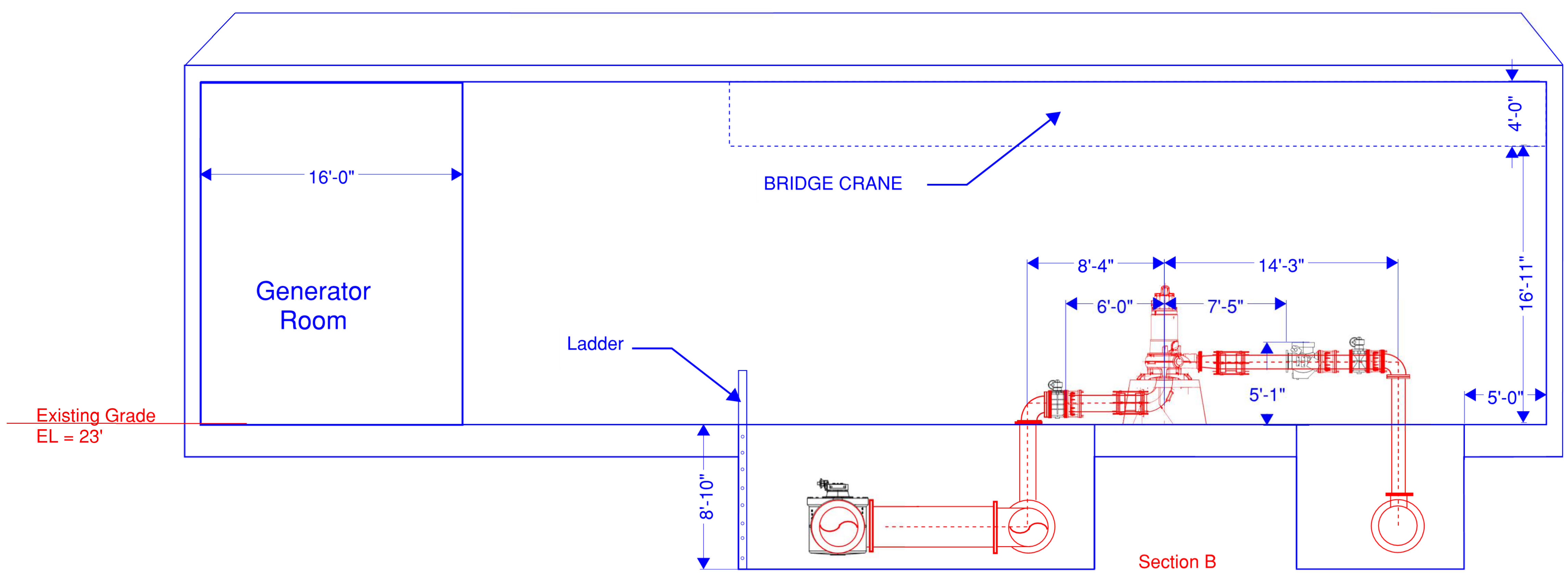


SCALE: 1/8" = 1"-0"

BELOW GRADE ALTERNATIVE #2 - SECTION VIEW



Section A

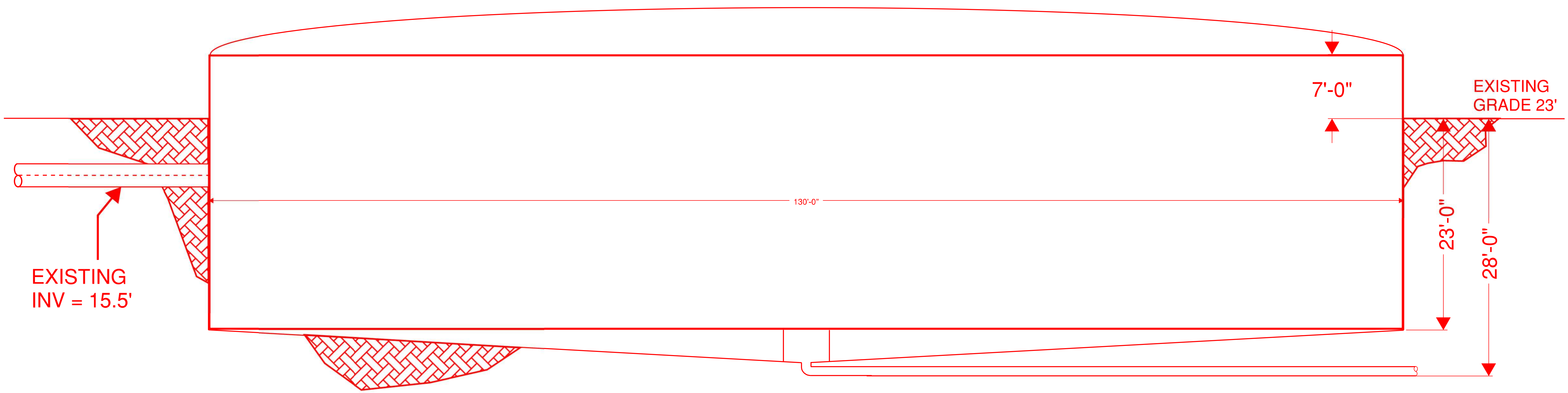


Section B

SCALE: 1/8" = 1"-0"

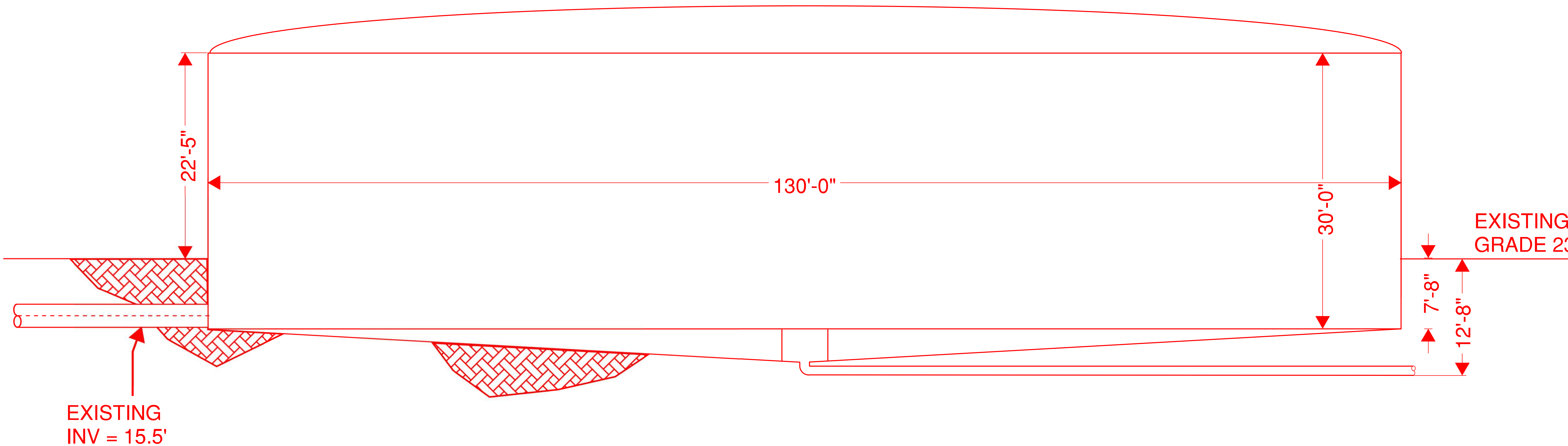
TANK
ALTERNATIVE
SKETCHES

ALTERNATIVE #1 - 28' BELOW GRADE



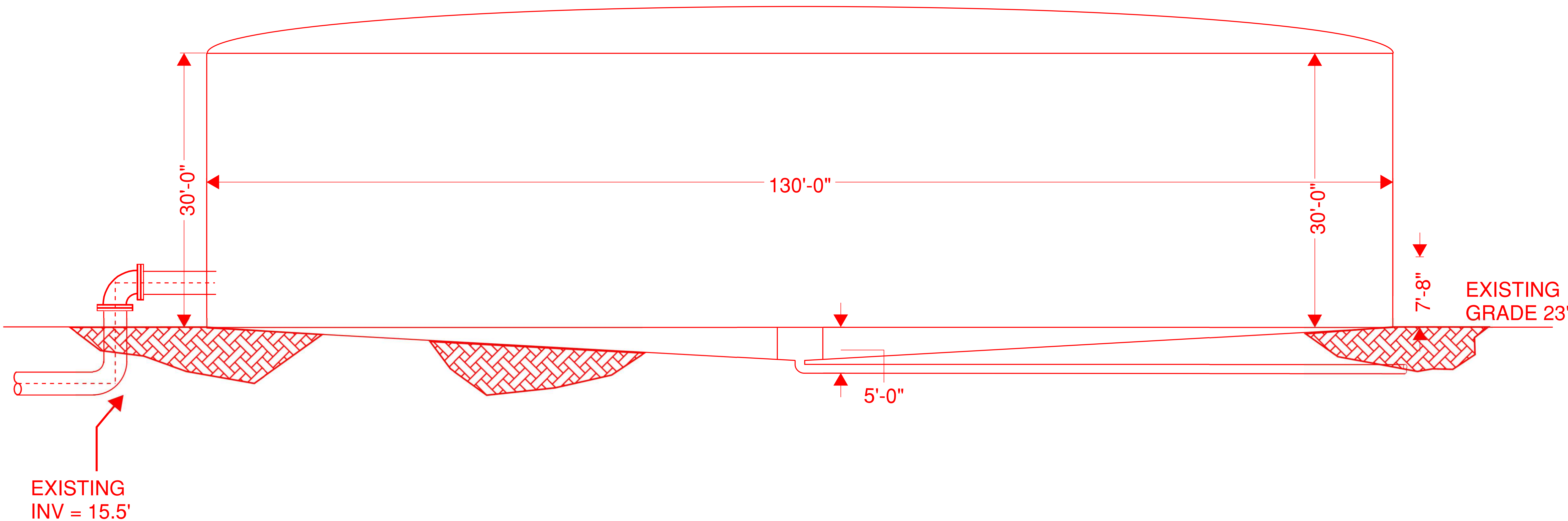
SCALE: 1/16" = 1"-0"

ALTERNATIVE #2 - 10' BELOW GRADE

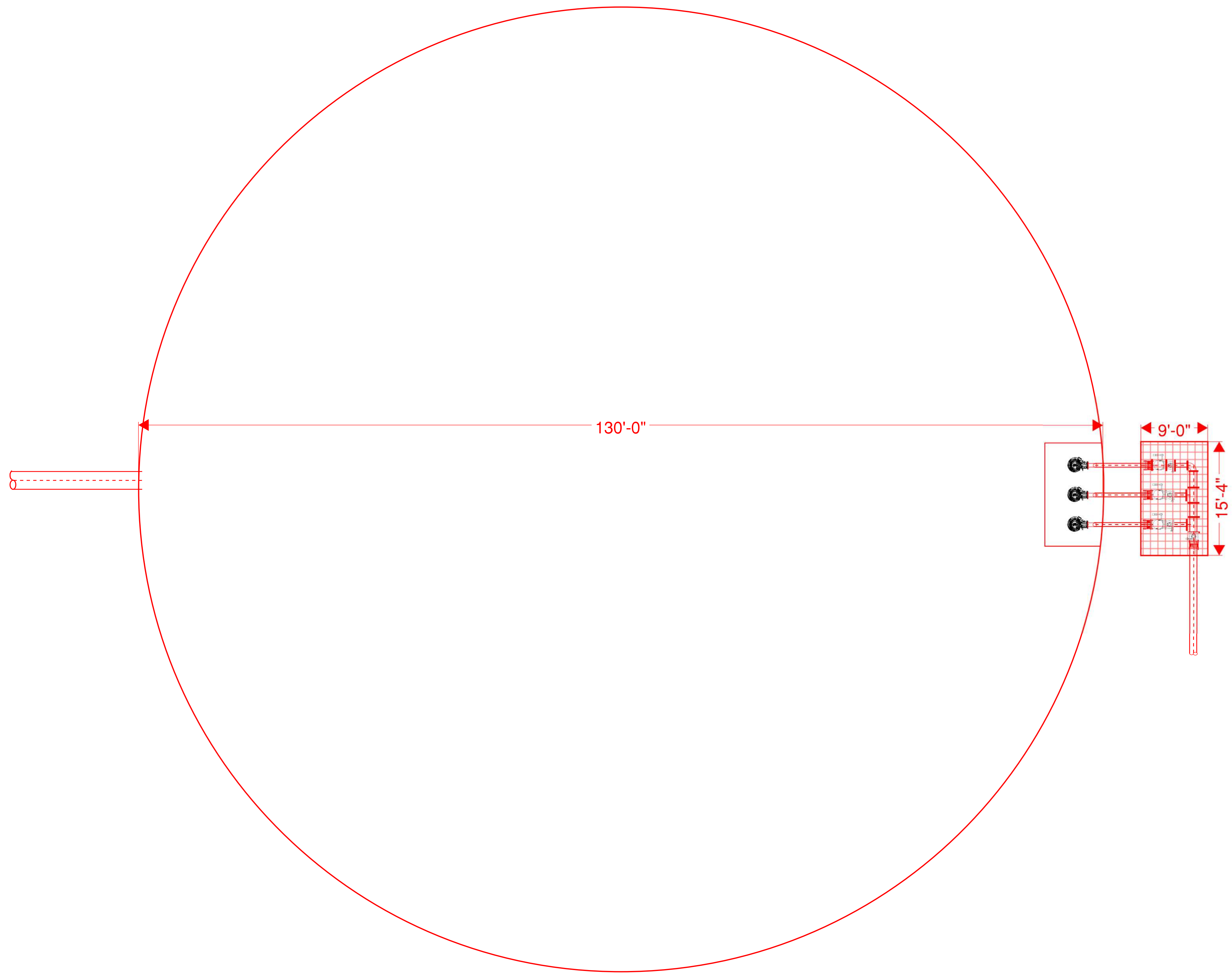


SCALE: 1/16" = 1"-0"

ALTERNATIVE #3 - AT GRADE

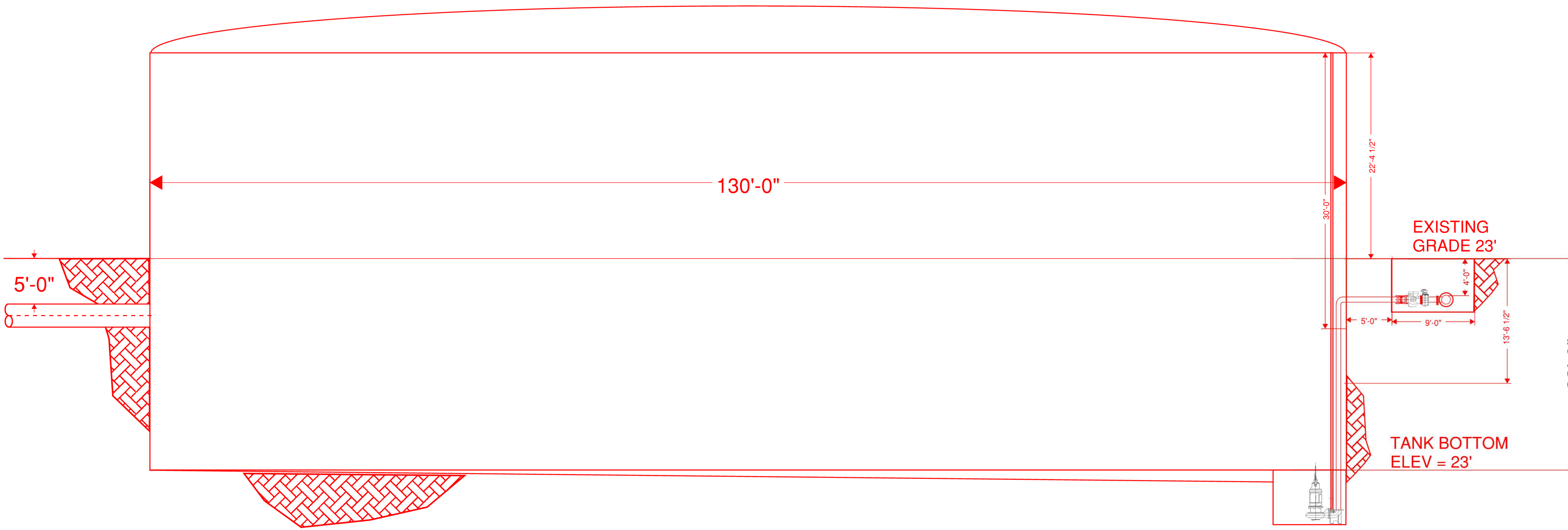


SCALE: 1/16" = 1"-0"



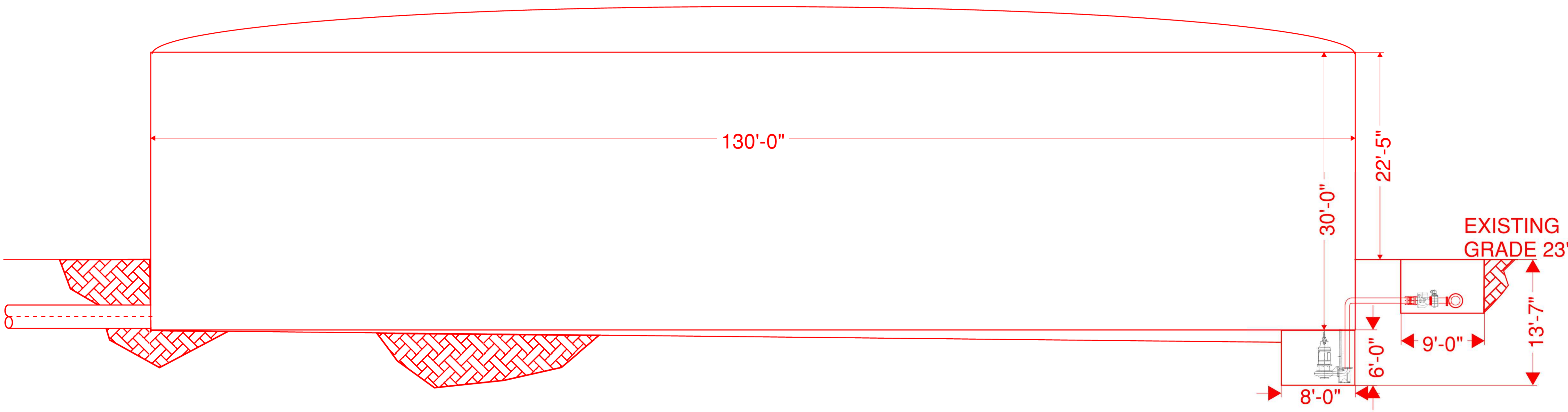
SCALE: 1/16" = 1"-0"

ALTERNATIVE #4 - 28' BELOW GRADE
W/ SUBMERSIBLE PUMPS



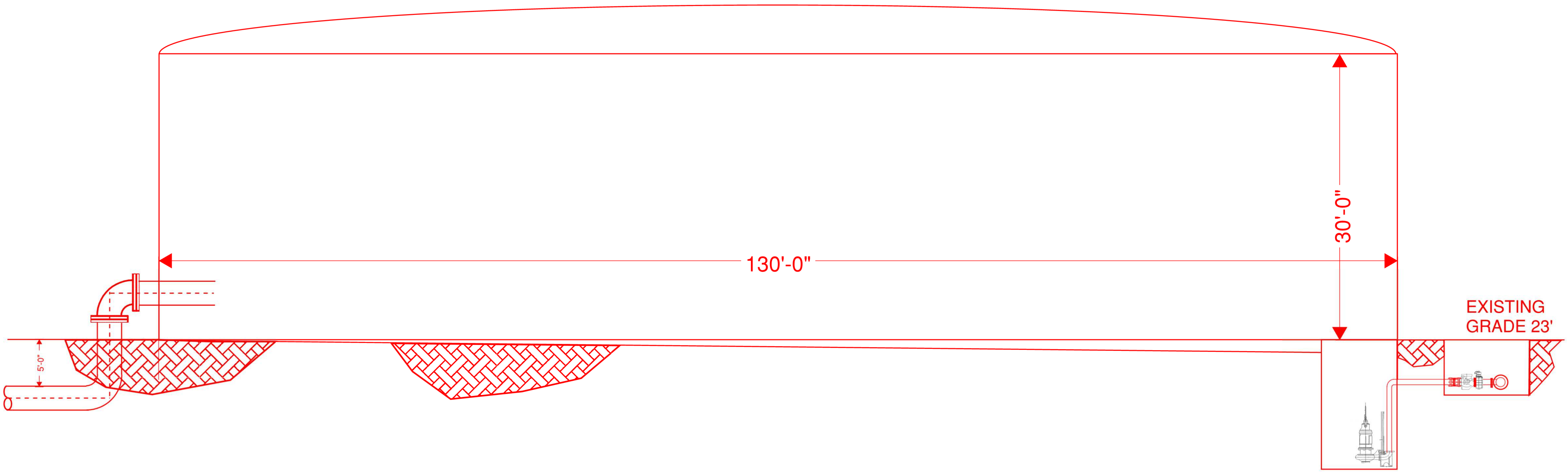
SCALE: 1/16" = 1"-0"

ALTERNATIVE #5 - BELOW GRADE W/ SUBMERSIBLE PUMPS



SCALE: 1/16" = 1"-0"

ALTERNATIVE #6 - AT GRADE W/ SUBMERSIBLE PUMPS



SCALE: 1/16" = 1"-0"