LIFT STATION DESIGN STANDARDS

Prepared by
The Department of Water Management

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List of Abbreviations

ABC	Aggregate Base Course
AC	Alternating Current
ACH	Air Changes per Hour
ADF	Average Daily Flow
ANSI	American National Standards Institute
AOR	Allowable Operating Region
ARV	Air Release Valve
ASTM	American Society of Testing and Materials
ATS	Automatic Transfer Switch
AWG	American Wire Gauge
AWWA	American Water Works Association
BEP	Best Efficiency Point
CARV	Combination Air Release/Vacuum Relief Valve
CADD	Computer Aided Design and Drafting
CF	Cubic Foot
CMMS	Computerized Maintenance Management System
dB(A)	A-weighted Decibels
DC	Direct Current
DIP	Ductile Iron Pipe
DWM	Department of Water Management
EPR	Ethylene Propylene Rubber
FLUM	Future Land Use Map
FRP	Fiberglass Reinforced Plastic
Ft	Feet
ft/s	Feet per Second
GA	Gauge
GIS	Geographic Information System
gpm	Gallons per Minute
HOA	Hand-Off-Auto
hp	Horsepower
hr	Hour
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
I/O	Input/Output
lbs	Pounds
kV	Kiloivolts
LCD	Liquid-Crystal Display
LED	Light-emitting Diode
lf	Linear Feet
LPW	Lumens per Watt
mA	milliamp
MCC	Motor Control Center
NCAC	North Carolina Administrative Code
NC DEQ	North Carolina Department of Environmental Quality
NCGS	North Carolina General Statutes
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

No.	Number
NPDES	National Pollutant Discharge Elimination System
NPSH	Net Positive Suction Head
O&M	Operations & Maintenance
OSHA	Federal Occupational Safety and Health Act
P&ID	Process and Instrument Diagrams
PC	Personal Computer
PCF	Pounds per Cubic Foot
PDF	Portable Document Format
PE	Professional Engineer
PLC	Programmable Logic Controller
POR	Preferred Operating Region
psi	Pound per Square Inch
PWM	Pulse Width Modulating
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SSO	Sanitary Sewer Overflow
SUDS	Summary Utility Development Statement
TCP	Transmission Control Protocol
THWN	Thermoplastic, High Heat, Nylon Coated
TVSS	Transient Voltage Surge Suppression
UDO	Unified Development Ordnance
USA	Utilities Statement Application
V	Volt, Volume
VAC	Volts Alternating Current
VFD	Variable Frequency Drives
W/D	Wet-Pit/Dry-Pit
XLPE	Cross-linked Polyethylene

AUTHORITY AND SCOPE

North Carolina State General Statutes

In accordance with North Carolina General Statutes (NCGS) § 160A-312 (Authority to Operate Public Enterprises), the City of Durham (City) has the authority to acquire, construct, establish, enlarge, improve, maintain, own, and operate a public enterprise system. A public enterprise includes wastewater collection, treatment, and disposal systems. Further, NCGS fully authorizes the City to protect and regulate the wastewater collection, treatment, and disposal systems by adequate and reasonable rules provided such rules are adopted by ordinance. Additionally, in accordance with NCGS § 160A-77 (Code of Ordinances), the City has the authority to adopt and issue a code of its ordinances. The code may consist of two separate parts, the "General Ordinances" and the "Technical Ordinances." The technical ordinances may be published as separate books or pamphlets, and may include ordinances regarding the use of public utilities, buildings, or facilities operated by the City, the subdivision control ordinance, and other similar technical ordinances designated as such by the council such as a uniform development ordinance.

The Durham City Council has adopted a Sewer Use Ordinance that sets forth uniform requirements for direct and indirect users of the City's wastewater collection and treatment systems. In addition, the Durham City Council has adopt a Unified Development Ordinance that provides for orderly growth and development of the City and coordination of the water and sewer utilities within proposed subdivisions with existing or planned water and sewer utilities owned and operated by the City.

North Carolina Department of Environmental Quality

The City has been issued an NPDES operating permit for the wastewater collection system (Permit Number WQCS00005) by the North Carolina Department of Environmental Quality (NC DEQ). The NPDES permit specifies requirements for the City to operate and maintain the City's gravity sewers, pumping stations (lift stations), force mains, and all appurtenances. The operation and maintenance requirements specified in the permit are intended to protect public health and the environment by reducing the probability of system failure and the impact of system failure, where failure is characterized as a sanitary sewer overflow (SSO).

In accordance with 15A NCAC 02T.0306 (Local Programs for Sewer Systems), NC DEQ has delegated authority to the City to receive applications and approve and issue permits for the extension and expansion of the City's wastewater collection system. The approval authority applies to gravity sewers only. NC DEQ must permit sanitary sewer lift stations and force mains. Lift stations shall be fully permitted for City ownership, operation, and maintenance prior to the approval of any plat (for subdivide properties) or building permit (for non-subdivided properties). Consult the City's Reference Guide for Development for more information.

Director of the Department of Water Management (DWM)

Nothing in this document shall limit or restrict the authority of the Director or the Director's designee to modify or change facility or system requirements for a lift station project to accommodate the unique requirements of a specific project and to ensure compliance with the regulatory requirements placed upon the City to protect public health and the environment. If it is determined that modifications or changes to these standards are required for a specific

application, the Director or the Director's designee shall submit a written statement to the applicant describing the modification or change in facility and system requirements.

Purpose and Scope

The purpose of this document is to present the City's Lift Station Design Standards (Standards), which the City is authorized to issue and enforce in accordance with NCGS and in accordance with permits issued to the City by NC DEQ for the wastewater collection system. The Standards have been developed to provide continuous and uninterrupted sewer service in a manner that (a) protects public health and the environment, (b) reduces the probability of sewer system failures and the impact of sewer system failures, and (c) minimizes the overall life-cycle cost of the City's sewer lift stations.

These standards shall apply to projects where the City shall be the Owner of the asset.

SECTION 1: GENERAL

1.1 Applicability

Lift stations will only be allowed for developments greater than or equal to 150 units, which cannot be served by gravity sanitary sewer as deemed technically feasible by the DWM. All other developments must be served by gravity.

1.2 Design Standards

NC DEQ has established minimum design criteria for lift stations and force mains. Those requirements are presented in NCAC Title 15A, Subchapter 2T (Waste Not Discharged To Surface Waters). In addition, NC DEQ has published supplemental guidance for lift stations in a document titled, "Minimum Design Criteria for the Permitting of Pump Stations and Force Mains." Both of these documents published by NC DEQ and all future amendments, are adopted by reference and shall apply and be enforceable for all new lift stations proposed within the City, except as modified, clarified, or amended by this Lift Station Design Standards document.

Where a conflict arises between the requirements described in the two NC DEQ documents and the requirements described in this document, the more stringent requirement shall apply.

All equipment shall be as supplied from the manufacturer and not field modified.

1.3 Application Submittal Requirements

Reference Appendix A for complete submittal requirements and checklists.

The design submittal process will work as follows:

1. Fill out the Utilities Statement Application (USA) online at https://durhamnc.gov/FormCenter/Water-Management-16/Required-Utilities-Statement-Application-173.
    a. At the meeting resulting from the USA, submit the Intent to Construct a Lift Station Package.
    b. The DWM will evaluate the information. Once initial information is agreed upon, a Summary Utility Development Statement (SUDS) will be issued by the DWM.
2. After approval of the Intent to Construct a Lift Station Package and issuance of the SUDS, submit the Calculation Review Package.
3. After approval of the Calculation Review Package, submit the Construction Drawing Review Package.

SECTION 2: PUMP DESIGN AND OPERATION CRITERIA

The purpose of this section is to define the operating criteria and design methodology to be used by the applicant to select the appropriate type, size, and number of pumps required for a lift station.

2.1 Wastewater Characteristics

Due to the nature of the solid material that can be expected in the wastewater, all pumps shall be non-clog type sewage pumps suited for continuous duty designed and manufactured for use in conveying raw, unscreened sewage and shall be capable of passing solids a minimum of 3 inches in diameter regardless of mechanical means for solids reduction.

2.2 Allowable Lift Station and Pumping Equipment Types

The City has standardized on specific types of lift station configurations in an attempt to minimize the operation and maintenance costs associated with these facilities. This standardization has resulted in the acceptance of the following two (2) station configurations and associated types of pumping equipment.

1. Submersible Grinder Stations: These type stations shall consist of duplex pumping systems utilizing submersible grinder pumps installed within a precast concrete wet well having a separate below grade valve vault. Triplex (or greater) submersible pumping stations shall not be allowed.
2. Wet-Pit/Dry-Pit Stations: These type stations shall consist of separate wet well and drywell compartments utilizing vertical, non-clog type centrifugal wastewater pumps. These stations shall be used for all applications that fall outside the general criteria for submersible type stations listed here. Evidence that a submersible station capable of meeting the City's requirements is not possible shall be provided to DWM for review and written approval by DWM prior to review of construction drawings. Capsular or pre-fabricated steel lift stations of this type shall not be accepted.

No other pumping station configurations shall be allowed by the City unless approved in writing by the DWM. Lift station configurations not explicitly permitted above shall not be accepted for review without prior written approval.

Only lift stations with electric motors will be permitted. Pumps with diesel, natural gas, petroleum, or other types of motors are prohibited. Dry-prime pumps and air-ejector stations are prohibited. Field modifications to approved equipment is strictly prohibited.

The City has identified specific manufacturers to provide equipment suitable for complying with these Lift Station Design Standards. Specifically, these manufacturers provide equipment suitable for continuous conveyance of raw, unscreened wastewater with physical and chemical characteristics associated with residential, commercial, institutional, and industrial users. The list of acceptable equipment manufacturers is provided as Appendix B and is required to be followed.

2.3 Design Flow Criteria

Applicants shall select pumps that best match the service area conditions for the quality and quantity of flow at initial startup and buildout conditions to be served by the lift station. These

service conditions shall take into consideration both peak design flows (such as wet-weather peaking conditions) as well as typical daily flows (such as diurnal peaking conditions). The range of design flow conditions shall be established by the applicant using the following general approach:

2.3.1 Service Area Definition

The applicant must identify the following as part of the proposed lift station design:

- Limits of service area boundary at buildout
    - All pump stations shall be sized to service the entire sewershed and shall be regional by nature
- Current and proposed land use according to the Future Land Use Map (FLUM) within the service area boundary at buildout
- Existing and planned sanitary sewer system facilities within the service area boundary at buildout
    - Where an existing lift station is present upstream within the service area, it shall be abandoned via gravity as part of the new lift station construction contract. There shall no City participation in the cost of lift station abandonments unless explicitly authorized in writing by DWM.

2.3.2 Design Flow Development

Once the service area characteristics have been established and documented with the DWM, the full range of design flows at the lift station must be measured or calculated to appropriately select the type, size, and number of pumps for the lift station. The applicant shall define the Minimum Daily Wastewater Flow Rate, Average Daily Wastewater Flow Rate, and the Peak Hourly Wastewater Flow Rate at both initial startup and buildout conditions.

Calculations shall also determine the amount of capacity remaining after project completion and detail when upgrades need to be performed (if applicable) for complete buildout conditions.

2.3.2.1 Minimum Daily Wastewater Flow Rate

For lift stations serving existing collection systems (partially or fully), the minimum daily wastewater flow rate shall be determined using historical potable water use or existing collection system or pumping station flow data provided by the DWM.

For lift stations serving new collection systems, minimum daily flows may be estimated from calculated daily average flows using typical ratios for minimum to average flows based on the characteristics of the service area and consistent with other similar service areas served by the City as provided by the DWM.

2.3.2.2 Average Daily Wastewater Flow Rate

The average daily wastewater flow rate shall be determined in accordance with 15A NCAC 2T .0114.

2.3.2.3 Peak Hourly Wastewater Flow Rate

The peak hourly wastewater flow rate shall be calculated using peaking factors determined in accordance with Section 2.02 (4) of the *Minimum Design Criteria for the Permitting of Pump Stations and Force Mains* or higher as requested by the DWM. For reference purposes, peaking factors for varying tributary populations are presented in Table 2-1.

Table 2-1 - Peaking Factors [1]	
Tributary Population	Peaking Factor
100	4.24
250	4.11
500	3.97
1,000	3.80
2,000	3.59
4,000	3.33
6,000	3.17
8,000	3.05
10,000	2.95
15,000	2.78
20,000	2.65
25,000	2.56
>25,000	2.50

(1) Note: Based on formula presented in Section 2.02 (4) of the *Minimum Design Criteria for the Permitting of Pump Stations and Force Mains*

2.3.2.4 Alternative Design Flows

For multipurpose, industrial, and commercial projects, alternative means may be required to calculate design flows. If the standard methods for determining design flow rates herein do not appropriately or completely encompass the anticipated flows for a particular service area, the applicant may submit supplemental information to the DWM for review prior to construction drawing review. If the City determines that alternative design flows are appropriate, the approval may be granted in writing by the Director, or the Director's designee, and the applicant shall proceed with the lift station design based on the approved alternative design flows.

2.4 Hydraulic Analysis and Pump Selection

The applicant shall select the appropriate size and number of pumps required for the lift station by performing a hydraulic analysis of the system. The applicant shall perform the hydraulic analysis in accordance with Section 2.03 of the *Minimum Design Criteria for the Permitting of Pump Stations and Force Mains.* This analysis shall be the basis for establishing the number of pumps required and the design operating range (initial and buildout) for each pump to be provided. In addition to the criteria set forth above, the selection of pumping equipment shall also apply the following criteria:

- Pump capacity shall be based on the need to maintain a velocity of 2 ft/s in the force main.
- Pumps shall be selected such that all design operating points are on the pump curve.
- To the greatest extent possible, pumps shall be selected such that their operating efficiency is maximized during all hydraulic conditions that may exist. I.E. the curve of the selected pump shall wear back into the best efficiency range of the curve for buildout conditions.
- Based on pump design operating points, wet well shall be designed to provide $NPSH_A$ with a margin of safety over the required $NPSH_R$ value. The following margins of safety are required:
    - $NPSH_A > 1.3 \times NPSH_R$, if all design operating flows are within the pump's Preferred Operating Range (70 percent to 120 percent of the pump's best efficiency point)

  - $NPSH_A > 1.8 \times NPSH_R$, if any design operating flow is outside of the Preferred Operating Range but within the pump's Allowable Operating Range (AOR) as defined by the pump manufacturer
  - Selection outside of the pump's AOR for any operating point will not be allowed.
- Candidate pumps shall have a suction specific speed over the entire operating range at or below 10,000. Suction specific speed is calculated as follows:

$$S = \frac{n(Q_{BEP})^{0.5}}{NPSH_R^{0.75}}$$

Where: n = speed, rpm
Q_{BEP} = flow rate, gpm
$NPSH_R$ = net positive suction head required (ft)

The goal of the above criteria is to maximize the operating life of the pumping equipment by minimizing wear on critical pump components (seals, bearings, etc.) which worsens as pump operation moves farther from the pump's established Best Efficiency Point (BEP).

For variable speed pumping applications, the hydraulic analysis shall consider pump operation at reduced speed and establish minimum speed limitations based upon maintaining pump operation within the Preferred Operating Range (POR) at low flows. If it is determined that anticipated minimum flows to the lift station fall below the calculated minimum speed pumping rate, the pumping system controls shall include provision for pump cycling at the determined minimum pump speed.

2.5 Additional Operating Criteria

The following general criteria shall also apply to all lift stations and be used in the screening and selection of candidate pumping equipment.

Motors:

- Pumps shall operate at speeds of 1800 rpm or less, except if prior approval by the DWM is received. In certain cases motors speeds up to 3600 rpm may be approved by the DWM.
- Pump motors shall be non-overloading of the full pump performance curve under full speed operating conditions.
- Constant speed pumps shall be cycled such that the number of starts is minimized and resting times are maximized to avoid overheating and overstressing of the pump motor.
  - Refer to Section 2.04 of the *Minimum Design Criteria for the Permitting of Pump Stations and Force Mains* for additional requirements.

Wet Well Levels:

- Submersible pumps, including lifting brackets, shall be fully submerged for all normal operating set points.

Run Times:

- Lift stations shall be designed to operate for a maximum run time of 24-hr/peaking factor for duplex and 48-hr/peaking factor for triplex stations under average conditions.
- A maximum of 8 hours is required for stations with a peaking factor of 3 or less.
- No lift stations shall be designed to operate more than 10 hours per duplex and 20 hours for triplex stations under average conditions without written approval by the DWM and a critical analysis of alternatives.

Other:

- Pumps shall be designed for automatic pump alternation with operation at no more than 10 times per hour under the worst-case condition (influent flow equals half of pump capacity).

2.6 Downstream Capacity

Conduct an analysis of the hydraulic effects of the proposed new or upgraded lift station flows on downstream gravity sewer and/or lift station capacity.

SECTION 3: CIVIL AND MECHANICAL CRITERIA

The purpose of this section is to define the specific design requirements for each lift station site and associated structures based upon the pumping equipment selection performed in Section 2. The requirements of this section are intended to supplement the requirements presented in the *Minimum Design Criteria for the Permitting of Pump Stations and Force Mains*.

Standard details for lift station design are included in Appendix C.

3.1 Property Ownership Requirements

The applicant shall provide the City with sufficient (as determined by the DWM) real property necessary for the installation, operation, and maintenance of the lift station. The applicant shall install the lift station on a separately deeded parcel of land, and a fee simple title of the parcel shall be assigned to the City. Fee simple title of the lift station parcel shall be duly recorded with the Durham County Register of Deeds.

If it is not possible (as determine by the City-County Planning Department) for the applicant to assign fee simple title of the parcel of land to the City without creating a nonconforming lot as defined in the current Unified Development Ordinance (UDO), then the applicant shall grant the City a permanent easement for the parcel of land, and the easement shall be duly recorded with the Durham County Register of Deeds.

3.2 Site Development Requirements

Lift stations should not create nuisance conditions (noise, odor, light, visual, drainage, traffic, etc.) for adjacent properties, and site improvements shall be provided for all-weather access, security, and maintenance. The purpose of this section is to define the site design requirements for lift stations. The applicant is responsible for obtaining all site plans and permits as required by the City/County Planning Department, and all inspections and permits as required by the City/County Inspections Department. DWM does not issue permits or complete electrical or building inspections as required by the Inspections Department.

The selected site shall be at the lowest reasonable location in the drainage basin as determined by DWM.

3.2.1 Floodplain Requirements

Lift station structures as well as all mechanical and electrical equipment and appurtenances shall not be located in a 100-year floodplain. The 100-year floodplain elevation shall be noted on the applicant's drawings. All above ground equipment, electrical controls, and access hatches shall be located at least 2 feet above the 100-year floodplain.

3.2.2 Setback and Buffer Requirements

The applicant shall provide setbacks and buffers for the lift station in accordance with the City's Unified Development Ordinance. Show all designations on the drawings.

3.2.3 Access Roads Requirements

The applicant shall provide a suitably constructed, all-weather, access road to connect the lift station site to a publicly owned, hard surface road. The access road shall be permitted, designed, and constructed for the sole use of accessing the lift station from a publicly-owned road.

The specific requirements for lift station access road are as follows:

1. The access road driveway shall comply with NCDOT standards for horizontal and vertical sight distances.
2. The access road shall be a minimum of 30 feet wide.
3. The access road shall not exceed 200 feet in length.
4. If the access road is greater than 40 feet in length, then posts and chain shall be installed 30 feet from the edge of the right-of-way of the publicly owned road.
5. Hammerhead and rotated hammerhead turnarounds shall have a minimum 30-foot radius.
6. The access road shall have uniform horizontal (flat) and vertical (straight) alignments along the entire length from the publicly owned road to the lift station site.
7. The access road shall be graded to provide positive drainage away from roadway surface and station entrance, but shall not exceed 2 percent.
8. The maximum slope of the road shall not exceed 7%.
9. The roadway shall not be located below the 100-year floodplain.
10. The access road shall be designed and constructed to accommodate H20 vehicle loading conditions.
11. Access road shall match driveways in the subdivision or development.
    a. When concrete is used, the minimum design of the access road shall be 8-inch f'_c = 3600 PSI, 4-Inch compacted ABC, welded fire fabric (6x6, W2.9xW2.9, and 2-inch chair, plastic or steel, spacing per manufacturer's requirements).
    b. When asphalt pavement is used, the minimum design of the access road shall be 1-inch SF9.5A (final lift to be applied after successful start-up), 1.5-inch S9.5B, SF9.5A (installed prior to initial start-up), and 8-inch compacted ABC or 4-inch B25.0B.

The City shall receive a permanent roadway easement or fee simple acquisition of the roadway to be approved by the DWM.

Provide an exhibit detailing the ability for large vactor trucks (minimum size 8.5ft by 45ft) to access the site via the road using AutoTURN or similar software.

3.2.4 Landscaping Requirements

The applicant shall provide landscaping for the lift station in accordance with the City's Unified Development Ordinance. At a minimum, landscaping shall be compatible with the surrounding neighborhood. However, leyland cypress and poplar trees are not allowed for pumping station sites.

Within the lift station fence line, the entire area shall be provided with a 6-inch ABC base.

City vehicles must be able to pull within 4' of the wet well without obstruction.

3.2.5 Stormwater Management Requirements

The applicant shall provide stormwater management facilities in accordance with the City's Unified Development Ordinance. At a minimum, the site shall be graded to provide positive drainage away from the lift station wet well, mechanical and electrical equipment and appurtenances.

3.2.6 Water Service Requirements

The applicant shall provide a source of potable quality water for the lift station. The potable quality water shall be used for area washdown, equipment maintenance activities, and in some instances an eyewash station. At a minimum, the connection to the public water supply system shall include a 2-inch service connection to the public water main, a 5/8-inch water meter, a backflow preventer, and freeze protection equipment for the backflow preventer. The backflow preventer and freeze protection equipment for the backflow preventer are not required if a Woodford Model S3 yard hydrant is utilized.

The applicant shall obtain all easements required to install the water supply system for the lift station.

A freeze-proof yard hydrant with a 24-inch square concrete pad shall be provided.

3.2.7 Overflow Containment Basin

An overflow containment basin shall be provided. The basin shall hold at least 24 hours of storage at buildout conditions. All fill material shall be impermeable clay. Embankments shall be structural fill placed in 6-inch loose lifts, compacted to a minimum 95% maximum dry density per standard proctor test. A third-party soil technician shall witness all embankment construction, conducting multiple density tests per lift. Test reports, proctors and geotechnical engineering report/certification of compliance certified by a licensed engineer in the state of North Carolina shall be submitted to DWM prior to start-up testing.

3.3 Lift Station Site Security

3.3.1 General Requirements

The following general site security provisions shall be provided for all lift stations:

1. All entry points into lift station structures, vaults, panels, etc. shall be lockable.
2. The lift station shall be provided with adequate outdoor and indoor lighting to facilitate normal and emergency operation and maintenance activities during daylight and non-daylight hours.
    a. The applicant shall provide outdoor area lighting in accordance with the City's Unified Development Ordinance.
3. Safety placards for all lift station structures and equipment, as required by Federal, State, County, and City agencies shall be provided and be readily visible.

3.3.2 Fencing

Lift station sites shall be fenced to secure the site, and the fencing shall be a minimum of 8-feet in height as specified in standard detail PS-5.00. Fencing shall have brown privacy slats.

Applicant shall provide a 20-foot wide swing-gate assembly that can be secured with a lock and chain at all access points.

The fenced area of the lift station site shall be sized and configured to enclose all of the mechanical and electrical components required for the lift station and allow for multiple types and numbers of vehicles to enter and exit the site at the same time. The types of vehicles that must be accommodated within the fenced area of a lift station site include: large utility trucks; boom/crane truck; vactor truck; and tractor with 6,000 gallon tanker trailer. The size, layout and configuration of the fenced area for the lift station site shall be sufficient to allow all of these vehicles to be at the station at the same time, and for each vehicle to be able to turnaround

within the fenced area to exit the site. Provide an exhibit detailing this ability using AutoTURN or similar software.

3.4 Wet Well Requirements

3.4.1 General Requirements

General requirements include:

1. The wet well shall be designed such that the minimum wet well operating level can be maintained above the minimum submergence required above the bottom of the inlet to prevent the occurrence of vortexing within the wet well during normal operation. Provide calculations.
2. Wet wells shall be designed in conjunction with pump manufacturers to ensure proper spacing of piping and pumps for installation and maintenance as well as most efficient intake conditions. Provide documentation.
3. Lift station wet well shall be sized and configured to allow for maintenance and cleaning and eliminate the need for personnel to enter the wet well.
4. All penetrations to be cast with watertight flexible boots meeting ASTM C-923.
5. An upstream manhole a maximum of 100 feet away from the wet well influent shall be provided to allow the wet well to be completely isolated for maintenance.
6. The wet well active volume calculations may not consider influent gravity sewer volume. The influent sewer may not be designed to surcharge.
7. The wet well calculations shall include:
    a. Cycle time of pumps under ADF
    b. Number of pump starts per hour at ADF - Pumps shall be designed to operate between two and eight times per hour at ADF
    c. Response time = V_{above} pump on / ADF
    d. Response time for pump failure from pump on to overflow
        i. Minimum response time allowed is one hour
    e. Flotation calculations
        i. Calculations shall be provided for all below ground structures.
        ii. Calculations shall assume that the elevation of groundwater is the elevation of grade (complete submergence)
    f. Anything else specified in the *Minimum Design Criteria for the Permitting of Pump Stations and Force Mains*.

3.4.2 Circular Wet Wells

Lift station wet wells shall have conical bottoms that surround the pump volutes or suction piping closely. This configuration will promote the settling and depositions of debris to the bottom of the wet well near the inlet, allowing the accumulated debris to be removed more readily with each complete pump cycle.

Wet wells for submersible type lift stations shall be circular precast concrete structures unless otherwise approved by the DWM. All precast structures shall comply with ASTM C-478 at a minimum. They shall be sized to allow appropriate spacing for pumps as well as maintenance personnel entry with inside diameters ranging from 6 feet up to 12 feet.

3.4.3 Wet Wells for W/D Pit Stations

Wet wells shall be rectangular. Wet wells shall have flat bottoms at the individual pump intakes with sidewalls and fillets that confine the inlets to the maximum degree practical. The fillets shall be at least 45 degrees (60 degrees preferred) from the horizontal to promote solids to reach the

pump intake area. The interior of the wet well shall be free from defects, deformations, or other features that promote the deposition and accumulation of solids in the wet well.

The design shall also consider the following provisions:
1. Multiple wet well compartments that segregate the pumping units such that portions of the wet well may be taken out of service for maintenance or cleaning
2. Where wet well compartments are provided, an inlet structure shall be provided with separate wall-mounted isolation gates for each compartment

3.4.4 Wet Well Lining Criteria

The wet well shall have a sulfide-resistant, epoxy coating system. Application procedures for the epoxy lining system shall be in accordance with the manufacturer's recommendations, including materials handling, mixing, environmental controls during application, safety, and spray equipment. The epoxy liner, when cured, shall have the following minimum characteristics measured by the applicable ASTM standards referenced herein:
- Hardness, Shore D ASTM D-2240 70
- Tensile Strength ASTM D-638 >7,000 psi
- Flexural Strength ASTM D-790 >10,000 psi

The epoxy system shall be a spray applied, two component, 100% solids, solvent-free epoxy developed specifically for use in the wastewater environment.

3.4.5 Wet Well Testing

Wet wells shall be sealed at all joints inside and out. Wet well shall be vacuum tested for leakage per DWM manhole standards.

3.5 General Lift Station Mechanical and Piping Requirements

All lift station equipment shall be new; free from defects, deformations, and damage; and comply with the quality and craftsmanship standards defined in these standards to ensure long-life under the expected harsh, abrasive, and corrosive conditions.

On a periodic basis, it will be necessary to remove individual components (motors, pumps, pipes, valves, etc.) of a lift station for inspection, maintenance, repair, rehabilitation, and replacement. Accordingly, all lift station components shall be installed and arranged in a manner that provides sufficient working room and overhead clearance for individual components to be removed from service while the lift station remains operational. A minimum of 3 feet clearance between equipment and all other station elements is required unless a greater distance is specific within other applicable codes and regulations.

All fasteners shall be 316 stainless steel unless otherwise stated.

3.5.1 Pump Piping Requirements

Each pump shall be provided with separate suction and discharge piping systems designed in accordance with the following minimum requirements:
1. Suction and discharge piping shall be a minimum of 4-inch diameter unless approved by the DWM.
2. Suction and discharge piping shall be sized to maintain velocities between 2 and 8 feet per second.

3. Suction piping shall provide a minimum 5 diameters of straight, unobstructed (i.e. no flow disturbing fittings) run upstream from the pump.
    a. Suction piping for all wet well mounted suction lift stations shall be schedule 10 stainless steel at a minimum.
4. Reducers required for connection to the suction connection flange on the pump volute shall be long radius, concentric reducing elbows.
5. The pipe and fittings shall have a minimum of 12 inches of clearance from any wall or floor and there shall be a minimum 36-inch clearance between the piping of each pump or greater if required by the pump manufacturer.
6. All exposed fittings whether inside or outside the lift station shall be flanged joint ductile iron fittings. Applicants shall provide appropriate restraining joints for all piping.
7. Flexible couplings shall be provided on pump discharge piping and common headers to facilitate construction as well as routine maintenance and replacement of valves, etc.
8. With the exception of submersible pumps, restrained couplings shall be provided at the suction and discharge nozzles for all pumps that can accommodate both angular and parallel misalignment to prevent the transmission of pipe strain to the pump volute and limit nozzle loading in accordance with the pump manufacturer's requirements.

3.5.2 Valve Requirements

All lift stations shall be provided with sufficient valves to allow for proper operation and maintenance of the lift station during normal, peak, and emergency bypass conditions. Valves shall be suitable for use with raw, unscreened wastewater and shall be of a design suitable for its function, its installation location, as well as the normal and maximum operating pressures expected at the lift station.

1. A full-closing eccentric plug shut-off valve shall be provided on the suction (for W/D Pit stations) and discharge piping of each pump.
2. An outside-lever, swing check valve shall be provided on the discharge piping of each pump, between the pump and the shut-off valve. Check valves shall be installed in the horizontal position in order to prevent the accumulation of debris on the back side of the flap that may prevent the valve from opening. Check valves shall be located so that all working parts are readily accessible including the top cover that is removed periodically for maintenance.
3. Discharge piping shall be connected to check valves using a meg-a-flange connector in the valve vault.
4. Valves will not be placed inside the wet well.
5. All valves should be individually supported from below wherever possible. The use of flange supports that bolt directly to the valve flange are discouraged unless other means of thrust restraint are provided that limit the movement of the valve and potential damage to both the valve and support.
6. Valving shall be adequate to provide for all operating conditions, pump removal and replacement, bypassing, and equipment maintenance (i.e. flow meters, electrical components, phased construction, mechanical maintenance, etc.)
7. All valves shall open left, counter-clockwise.

3.5.3 Discharge Valve Vault Requirements for Submersible Lift Stations

Submersible lift stations shall be provided with a concrete valve vault located directly adjacent to the wet well. Valve vaults shall be provided with the following design features:

1. Valve vaults shall be constructed of epoxy coated precast concrete. All precast structures shall comply with ASTM C-478 at a minimum.

2. The minimum allowable interior size for valve vaults shall be 6'x6' for lift stations with 4"-6" force mains and 8'x8' for larger force mains.
3. Valve vaults shall be provided with a minimum 4' x 4' double leaf aluminum access hatch.
4. Manhole steps shall not be installed in valve vaults. An OSHA approved aluminum access ladder shall be installed from the access hatches to 1 foot above the floor inside the vault and extend 2 feet above the hatch when fully extended.
5. Provide at least 12 inches of clearance between valves and the wall.
6. Provide at least 36 inches of clearance between the valves for each pump discharge.
7. When vertical clearance is required, it shall be adequate for safe worker entry and exist without crouching.
8. All penetrations to be cast with watertight flexible boots meeting ASTM C-923.
9. The floor shall be tapered to a 18"x18"x12" sump pit

3.5.4 Lift Station Bypass Requirements

All lift station sites shall be provided with the necessary piping, fittings and valves to allow for bypassing of the lift station and wet well. The DWM will use the bypass assembly to bypass the lift station and wet well using portable pumping equipment. The following provisions shall be provided to accomplish the bypass:

1. A full-closing eccentric plug shut-off valve shall be provided in the yard (buried or in an epoxy coated vault) that allows the lift station to be completely isolated from the force main.
2. A bypass connection assembly consisting of a wye and riser extending above grade with a plug valve matching the sizing of the force main piping and a stainless steel cam-lock fitting.
    a. Or at the discretion of the DWM, inside a precast manhole complying with ASTM C-478.
3. Cam-lock fittings shall be 4-inch diameter for force mains less than 6-inches diameter and 6-inches in diameter for force mains equal to or greater than 6-inches in diameter. Larger diameter connections may be required for larger stations as required by the DWM.
4. Where a riser is provided that extends above grade, a concrete slab on grade shall be provided around the riser with bollards for protection.
5. Bypass location must not impede access to the wet well.
6. A wet well bypass manhole or similar structure. The bypass structure shall be located directly upstream of the lift station wet well along the influent sewer alignment, and within the fenced area of the lift station site.
    a. A small walkthrough gate shall be included or panel in fencing of sufficient size to allow hoses to be connected to a bypass if it is located outside of the fenced area with DWM approval.

3.5.5 Pig Launch and Retrieval Requirements

All lift station sites shall be provided with pig launch station and pig retrieval station. The pig launch shall be a wye-connection located in the force main cleanout chamber immediately downstream of the valve vault or lift station. It shall be isolated with a plug valve. The pig retrieval station shall be a basket-type with hanging attachment mounts in the force main discharge at a gravity sewer manhole.

3.6 Solids Removal and Reduction Provisions

For stations with a permitted design point of 1MGD and larger, additional solids removal will be required. The additional removal can be achieved by using grinders or mechanical bar screen.

3.6.1 Grinders

The grinder installation shall include the following provisions:

1. Grinders shall be channel mounted (at the end of the influent sewer pipe) and shall be supplied with fully submersible electric motors.
2. The power pack shall be installed above ground.
3. Head loss through the grinder shall be considered when setting the elevation of the grinder so as not to create backwater conditions in the influent sewer.
4. Grinders shall be sized for the design peak hourly wastewater flow rate for the lift station.
5. Grinders shall be located upstream from the wet well in the bypass manhole with a hatch adequately sized to provide easy removal of the rail-mounted grinder.
6. Grinders shall have means for removal without requiring entrance into the structure.
7. Grinders shall have a bypass around the manhole to the wet well.
8. Cassette type grinders are not acceptable.

3.6.2 Mechanical Bar Screens

Mechanical bar screens shall be included where necessary at the discretion of the DWM.

3.7 Odor Control Requirements

The type of odor control facilities at a lift station will be determined by the DWM on a case-by-case basis. The criteria for such determinations will include, but not be limited to, service area characteristics, current nuisance odor conditions, and other factors deemed necessary. Odor control facilities may include chemical dosing stations or nuisance odor treatment systems.

The DWM's current odor control approach is chemical feed of Bioxide. Accordingly, at a minimum, the applicant's basis of design shall include a chemical dosing station. The location of the chemical dosing station and associated appurtenances shall be shown on the applicant's plan submittal for the lift station. Provide the following:

1. 1,000 gallon odor control storage tank, minimum
2. Pumping/dosing system
3. Automated Dosing Controller

3.8 Ancillary Equipment and Lift Station Accessories

This section describes the ancillary equipment and lift station accessories required. The following systems shall be provided.

3.8.1 Flow Metering Requirements

Permanent flow metering shall be required at all lift stations. Flow monitoring and run time reporting software and hardware will be required at all proposed lift stations. All stations shall be provided with flow meters in accordance with the following requirements:

1. Flow meters shall be electromagnetic type with 316 stainless steel metering tube sized to maintain velocities within the recommended range provided by the manufacturer over the full range of anticipated station flows.
2. Flow meters shall be installed in an accessible location in the lift station dry well or outside within the fenced area inside an epoxy coated vault or manhole with adequate clearance for its removal.
3. The piping installation shall provide 5 diameters of straight pipe runs upstream and 2 diameters downstream from the meter, or additional lengths if required by the meter manufacturer.

4. Bypass piping shall be provided of equal or greater size than the flow meter piping with sufficient valving to allow the flow meter to be removed for maintenance without taking the station out of service.
5. Flow meter shall be equipped with a microprocessor based “smart” transmitter that is capable of converting and transmitting a signal from the flow tube with a 4-20 mA DC signal.
6. The flow meter shall have an integrated LCD readout capable of displaying flow rate and totalized flow.

3.8.2 Seal Water

Lift stations utilizing dry-pit pumps shall be provided with a supply of seal water for all pumps. The quality and quantity of the water supply shall meet the requirements of the pump manufacturer. Seal water supply pressure shall be a minimum of 5 psi above the maximum discharge pressure required by the pumps. All pumps shall be provided with one seal water supply panel to regulate seal water flow to the pump. As a minimum, the panel shall provide for isolation of flow to the pump, visual indication and manual adjustment of flow, and a solenoid valve for interlocking with the pumps.

3.8.3 Ventilation and Noise Control

Lift stations shall be adequately ventilated in accordance with local and state building codes as well as OSHA standards and NFPA 820. The design drawings shall clearly delineate the classification of each area and structure, in particular, Class 1 explosion hazard zones, as defined in the NFPA 820 code. At a minimum of six (6) air changes per hour (ACH) shall be provided for all below-grade dry-pit areas unless more is required by regulation.

Temperature (air conditioning) and humidity shall be controlled to a level appropriate for reliable operation of the electrical, instrumentation, and control equipment. Pump and vent fan operating noise levels shall be less than 85 dB(A). Contractor shall install moisture proof sound deadening insulation as necessary. A dehumidifier shall also be required in the dry-well.

Wet wells shall be provided with a gooseneck type vent with a stainless steel insect/bug screen. Vent elevations shall be a minimum of 2 feet above the 100-year flood elevation.

3.8.4 Access

Structures shall be designed so that access to perform both routine and emergency operations is convenient, unobstructed, and safe. Adequate access must be provided for removal and maintenance of all piping and equipment including pumps, meters, and other ancillary systems.

For wet-pit/dry-pit stations, the below-grade dry-well shall have a separate, dedicated access way for personnel and a separate dedicated access way for equipment. The personnel access way shall be by a stairway and not a ladder.

All access ways shall conform to OSHA standards as well as all applicable local and state building codes regarding design requirements.

3.8.5 Sump Pumps

All lift station structures other than the wet well shall be provided with a means to remove accumulated water and wastewater from the structure. All floor and walkway surfaces shall be sloped such that water and wastewater drains to a designated sump area under the influence of gravity.

A duplex sump pump system shall be installed in the designated sump within all dry pits and shall discharge into the wet well at an elevation greater than the high water alarm. The discharge piping of the sump pump shall be provided with a check valve and shut off valve. The sump pump shall be rated for heavy-duty sewage operation and with necessary head rating capable of both automatic and manual operation. The sump system shall provide sufficient capacity to pump water that may accumulate in the station because of a line break or seal water system failure.

For structures other than dry pits, means to remove accumulated water can include an appropriately sized drainage pipe draining to the wet well. The discharge for the drainage pipe shall be higher than the high water level alarm and be equipped with a buck-bill valve. The drain pipe shall be not allow backflow of wastewater and gasses from the wet well into the structure.

3.8.6 Interior Lighting

Any maintenance access structure that has a floor elevation that is more than 7-feet below grade with a single man way (riser) shall have electrical lighting provided. Lighting must meet the fire code rating for the vault space.

3.8.7 Cathodic Protection

All metallic dry wells shall include a cathodic protection system.

3.8.8 Hatches

All hatches shall be of sufficient size that the largest piece of equipment may be removed with a minimum of 6-inches of clearance on all sides.

Hatches shall be solid aluminum diamond plate with spring assist if more than 50 pounds of lifting weight is required. Hatches shall include recessed lifting handle, security lock pin, and factory installed safety slide bars to hold vertically open. All hatches shall be anti-slam.

3.8.9 Equipment Removal Provisions

3.8.9.1 General Requirements

Provisions shall be made so that the largest piece of equipment installed at the lift station may be removed using a mechanical lifting device. For small lift stations, this shall be accomplished by providing a permanent hoist or jib crane. For large W/D Pit type stations, this shall be accomplished by providing a trolley/monorail system. Provide manufactures cut sheet detailing pump and motor weights to confirm sizing.

3.8.9.2 Requirements for Submersible Pumps and Grinders

Lift stations shall be provided with a system that allows for the removal and installation of the pumps and grinders without requiring entry into the wet well or manhole and with clear vertical access.

1. Each pump and grinder shall be provided with a dual-guide rail system and lift-out chain section with guide cable.
2. Removal systems shall guide the pump or grinder system into its fully seated, operating position.
3. Both the guide rail and the lift-out chain shall be capable of withstanding the forces required to disengage the pump or grinder from the wet well or structure.
4. Both the guide rail and the lift-out chain shall be manufactured of type 304 stainless steel.

SECTION 4: FORCE MAIN CRITERIA

4.1 General

Force mains shall be routed in order to minimize the number of local highpoints in accordance with the following guidelines:

1. Rising and falling grades shall be maintained to minimize the need for air release/vacuum valves.
2. Rising and falling grades shall be maintained at all times to allow entrapped air to move to the nearest highpoint for release through the air release valve. No flat sections of pipe shall be allowed.
3. Deeper bury depth may be required to eliminate or locate air-release/vacuum valves away from residences or public areas.
4. Deeper bury depth may be required for air-release valve installation to prevent leakage and odors.

Force mains will not be approved to flow downhill into a receiving manhole. After the proposed force main passes over the last high point along its route a new gravity sewer line must be installed to convey the flow downhill to the existing sewer system. Exceptions to this requirement may be granted on a case-by-case basis by the DWM.

The following requirements exist for all force mains:

1. No reduction in size throughout the length of the force main is permitted
2. No tee's are permitted
3. Bends shall be made with 45 degree or less fittings
4. Deflections shall not exceed 3 percent
5. All valves shall be full port
6. Manifolded force mains are not permitted
7. Minimum cover shall be 5 feet above the top of pipe
8. In no case shall the depth of cover exceed 10 feet unless pre-approved in writing by the DWM Director, or the Director's designee
9. Force mains will not be allowed to directly discharge to another lift station
10. All valve box caps shall be marked SEWER
11. Alignments shall minimize the number of stream crossings.
12. The largest force main capable of providing at least 2 ft/s velocity shall be provided at startup.
13. Ten inch diameter pipe shall not be accepted for force mains.

Force main operation and design parameters identified herein must be met under initial and build out conditions.

Force mains shall be installed in DIPRA Type IV bedding at a minimum.

4.2 Pipe Materials

Force main piping shall be self-restrained ductile iron or PVC unless otherwise approved in writing by the DWM.

All wet well piping and force main piping prior to and including the bypass connection shall be ductile iron.

4.2.1 Ductile Iron Pipe

Force main piping shall be self-restrained ductile iron (ANSI/AWWA C151/A21.51). The minimum pressure class shall be 350 for diameters 4 inches through 12 inches and 250 for diameters 14 inches and larger. Higher pressure classes can be required as directed by the DWM.

Retrofit restraining devices are not allowed. Thrust blocks are not acceptable.

4.2.1.1 Internal Lining Requirements

All force mains shall be installed with a corrosion resistant internal lining. Lining shall be Protecto 401 ceramic epoxy or approved equal, unless otherwise approved by the DWM. When the DWM Director, or the Director's designee, waives the force main internal lining requirement, pipes shall have a standard cement mortar lining except at the locations specified below where the corrosion resistant lining shall always be provided:

1. At all high points for a minimum distance of 100 feet in each direction
2. At all locations where partially-full conditions may exist or where the force main may be exposed to air during static or operating conditions as determined by a hydraulic model of force main, plus an additional 40 feet in each direction
    a. Provide hydraulic model for review if requesting variance

4.2.1.2 External Coating Requirements

At a minimum, pipe shall be bituminous coated in accordance with AWWA C151.

4.2.1.3 Exterior Wrap

Buried pipe shall be installed with double polyethylene encasement. Polyethylene encasement shall have a minimum thickness of 8 mils and meet or exceed the minimum standards established by AWWA C105, current edition.

1. Polyethylene encasement shall meet minimum size requirements per Table 3 of section 15 of DIPRA's Installation Guide for Ductile Iron Pipe.
2. A 2-inch wide plastic adhesive tape shall be used for sealing seams, cuts, or tears in polyethylene encasement. Duct tape shall not be allowed.

4.2.2 PVC

PVC force mains shall be permitted by the City except where vacuum conditions may be present (all high points as defined elsewhere). Pipes can be PVC except at the locations specified below where DIP with corrosion resistant epoxy lining shall always be provided:

1. At all high points for a minimum distance of 100 feet in each direction
2. At all locations where partially-full conditions may exist or where the force main may be exposed to air during static or operating conditions as determined by a hydraulic model of force main, plus an additional 40 feet in each direction
    a. Provide hydraulic model for review when using PVC

PVC force mains shall have locator wire directly affixed to the pipe with attachments at appropriate intervals.

PVC materials shall comply with ASTM D1784 with a cell classification of 12454-B.

PVC force mains 4"-12" shall conform to AWWA C900 and the following requirements:

1. Outside diameter shall conform to ductile iron pipe.

2. Pipe shall be a minimum of pressure class 200 with a minimum standard dimension ration of DR14.
3. Pipe shall have plain end and elastomeric-gasket bell ends.
4. Fittings shall conform to AWWA C100 or C153 and have mechanical joints. Fittings shall be made of ductile iron. Interior of fittings shall be lined with Protecto 401 as specified above.

PVC force mains 14”-24” shall conform to AWWA C905 and the following requirements:
1. Outside diameter shall conform to Ductile Iron pipe.
2. Pipe shall be a minimum of pressure class 200 with a minimum standard dimension ration of DR14.
3. Pipe shall have plain end and elastomeric-gasket bell ends.
4. Fittings shall conform to AWWA C100 or C153 and have mechanical joints. Fittings shall be made of ductile iron. Interior of fittings shall be lined with Protecto 401 as specified above.

4.2.2.1 Reaction Blocking

All fittings or components subject to hydrostatic thrust shall be securely anchored by the use of concrete thrust blocks poured in place. The reaction areas required for these thrust blocks shall be part of the construction drawing submittal review process.

Material for reaction blocking shall be transit-mixed concrete. This concrete shall have a twenty-eight day compressive strength of 3000 psi. Any metal used to resist thrust which is not encased in concrete shall be “hot dipped” galvanized.

4.3 Diameter

Force mains shall be a minimum of 4 inches in diameter. The force main diameter shall be the largest standard available pipe diameter that permits a scour velocity of 2 ft/s under normal operating conditions.

4.4 Sizing (Velocity) Criteria

Wastewater velocity occurring in a force main shall be calculated using the continuity equation. Where the flow (Q) at all points in the force main is considered equal and the velocity (v) varies with the cross-sectional area (A). Thus $Q = v_1A_1 = v_2A_2$.

The maximum velocity in any portion of the force main shall be 8 feet per second under any condition.

4.5 Air-Release/Vacuum Valve Installations

4.5.1 Air-Release Valves

As a minimum, automatic air-release valves (ARVs) that are quick opening/slow-closing shall be provided at all high points along the force main. High points shall be defined as locations where the difference between the high point and adjacent low point exceeds ten feet.

Each air-release valve shall be provided with the following minimum features:

- flushing ports/connections
- installed in precast concrete manhole compliant with ASTM C-478. Manholes shall be located where they can be accessed for maintenance and shall not be located in the pavement of existing or proposed roadways.
    - configure such that the ARV can be worked on and removed without the need to remove the top of the manhole or vault.

- Offset ARVs are required
- A HDPE isolation valve shall be provided between the force main and the ARV.
- Provide the required seating head for the valve per manufacturer requirements to prevent leakage and reduce odor.

Refer to standard details for additional ARV vault requirements.

4.5.2 Combination Air Release and Vacuum Valves

Automatic CARVs shall be provided at the following locations:

1. At the ultimate high point along the force main alignment (when this location is not at the force main discharge)
2. At other critical high points along the alignment when necessary for surge control to mitigate sub-atmospheric pressures or column separation, which may occur, as determined by the transient analysis required and detailed elsewhere.

CARVs shall be of the quick-opening, slow-closing type and may be standard height or short body design with a minimum 2-inch diameter screw-threaded inlet.

Each CARV shall be provided with the following minimum features:

- flushing ports/connections
- installed in precast concrete manhole compliant with ASTM C-478. Manholes shall be located where they can be accessed for maintenance and shall not be located in the pavement of existing or proposed roadways.
    - configure such that the CARV can be worked on and removed without the need to remove the top of the manhole or vault.
- Offset CARVs are required
- An isolation valve shall be provided between the force main and the CARV.
- Provide the required seating head for the valve per manufacturer requirements to prevent leakage and reduce odor.

Refer to standard details for additional CARV vault requirements.

4.6 Transient Analysis

A transient analysis shall be required for each lift station and force main design as per State requirements. The analysis shall be provided to the DWM. The analysis should include results, at a minimum, for normal daily start-up condition (single pump), normal daily ADF (single pump) operation, and peak buildout design flow (all pumps operating simultaneously) under power failure conditions. Additional operating conditions shall be included in the analysis as requested by the DWM to cover the full range of possible scenarios for the station.

The analysis shall address the placement and sizing of air release/vacuum valves along the force main route, as well as the need for additional surge protection measures at the lift station site.

Where variable frequency drives (VFDs) and reduced voltage solid state motor starters (soft starts) are used, the analysis shall make recommendations for acceleration and deceleration time settings to be incorporated at start-up in order to minimize pressure variations during normal, daily station operation.

4.7 Force Main Discharge and Receiving Manholes

The force main discharge shall be designed to minimize turbulence and, where feasible, submerged force main discharges are preferred. The receiving manhole and the next 2 downstream manholes shall have a sulfide-resistant, epoxy coating system.

Application procedures for the epoxy lining system shall be in accordance with the manufacturer's recommendations, including materials handling, mixing, environmental controls during application, safety, and spray equipment. The epoxy liner, when cured, shall have the following minimum characteristics measured by the applicable ASTM standards referenced herein:

- Hardness, Shore D ASTM D-2240 70
- Tensile Strength ASTM D-638 >7,000 psi
- Flexural Strength ASTM D-790 >10,000 psi

The epoxy system shall be a spray applied, two component, 100% solids, solvent-free epoxy developed specifically for use in the wastewater environment.

4.8 Right-of-Way Requirements

The force main shall be located in a dedicated 30-foot wide utility easement or within the public road right-of-way. If within the right-of-way, 30-feet centered on the force main shall be devoid of other parallel utilities to ensure adequate space for constructability and maintenance.

SECTION 5: ELECTRICAL, INSTRUMENTATION, AND CONTROL CRITERIA

5.1 Hazardous Classification Areas

Applicant shall identify locations designated as hazardous classification areas per National Fire Protection Association (NFPA 820) with electrical equipment required per the National Electrical Code (NEC Article 500 and 501) and National Electrical Equipment Manufactures (NEMA). These designations shall be shown on electrical Construction Drawings.

Sections of wastewater lift stations may be classified as Class I, Division 1 (flammable gases or vapors normally exist) or Class I, Division 2 (flammable gases or vapors are present by accident or may be removed by high rate ventilation).

Class I, Division 1 hazardous area equipment ratings require explosion-proof motors, NEMA 4X enclosures, and conduit seal offs. MCCs and power panel ratings for indoor, non-corrosive locations shall be gasketed NEMA-12 enclosures to limit dust.

5.2 General Conditions

Equipment storage during construction and disposal of items removed during demolition shall be determined project by project. Coordinate requirements with the City.

All control panels shall be stainless steel with secondary (internal) door to house two elapsed time meters along with HOA switches, reset extensions, and cut out for breaker switches. The door is to provide separation between all controls and hot electrical components. Provide logbook pocket on side of outer door.

General equipment requirements are as follows:

1. Electrical conduit and raceway types shall be as indicated for each location:

Type	Indoor	Outdoor	Tunnels	Below Grade	Corrosive Locations
Galvanized Rigid Steel	☒	☐	☐	☐	☐
PVC Coated Galvanized Rigid Steel	☐	☒	☐	☐	☒
Rigid Aluminum	☐	☐	☐	☐	☐
PVC Coated Rigid Aluminum	☐	☐	☐	☐	☐
PVC Schedule 80	☒	☐	☐	☒	☐
Cable Tray	☒	☐	☐	☐	☐

2. Conduits shall be laid out in an orderly and workmanlike fashion. Conduits shall not be crossed.
3. Provide two 0.75 inch conduit to the valve vault for future use.
4. For outdoor and corrosive locations, 304 stainless steel, NEMA-4X non-corrosive control station and enclosures shall be installed. FRP stations and enclosures are permitted for indoor installation in non-corrosive environments.
5. Switching of power circuits shall utilize heavy-duty machine tool relays.
6. Underground marking tape for underground conduit raceway and ductbanks shall be metallic detectable warning tape.

7. Motors shall have elapsed-time indicators at the motor control centers (MCCs), when MCCs are used, and at the local equipment panel in all instances. SCADA monitoring shall be provided for motor run times.
8. Pushbuttons, selector switches, indicating lights, etc. shall be heavy-duty grade, match the rating of the equipment it is installed in and appropriate for the installed environment.
9. Provide separate power and control cabling from control system communication and instrumentation cabling. Common ductbanks with separate cable access boxes are permitted, with separate conduits provided and shielding between power and control circuits.
10. Miniature sealed ice cube type relays for control and instrument circuits shall be used and provided with LED indication light. Controls shall be 24V dc/ 120 VAC.
11. Spade wire connectors shall be used for the type of control and instrumentation wire termination method on terminal blocks and type of terminal blocks.
12. Terminal blocks shall be electrically finger-safe for each voltage and provide shielding as appropriate for each application to allow for safety of maintenance personnel and integrity of equipment.
13. Stations must be provided with sufficient 110V convenience outlets such that small power equipment may be operated throughout the site. If located in an outdoor area, the receptacles shall be of the ground fault interruptible type and shall be protected from the weather elements.
14. Control wires shall have numbered tags on both sides of the wires in the control cabinet and conduit runs.
15. All control components and cabinets shall be located above grade.
16. All panels shall be provided with a sun and rain shield.
17. Control station and instrument mounting stands shall be constructed of galvanized steel for indoor non-corrosive areas or stainless steel for outdoor installation and corrosive areas.
18. For capsular stations, the Department reserves the right to require a separate electrical control building depending on the size and complexity of the station proposed.
19. When buildings are required, doors shall have the following requirements:
    a. Aluminum door frame
    b. FRP door
    c. Continuous gear hinge

5.3 Electrical Labeling

1. Major equipment labeling, raceway, and conductor numbering system will be coordinated with the City's Computerized Maintenance Management System (CMMS) numbering system. If numbering system is not provided, raceways shall be provided with site unique identifiers using the following prefixes: E for power conduit raceways; C for control and communication raceways, T for telecommunication raceways, and I for analog instrumentation. The labels shall be [site abbreviation] – [wire type] – [number].
2. Cable tray shall be clearly labeled to differentiate between power tray and control and instrumentation tray. Power cable tray shall be labeled with appropriate voltage.
3. Material, color scheme, and size of device nameplates for field equipment, field instruments, and panel door with equipment or instrument number and description shall be appropriate for the installation. For indoor and non-corrosive installations, provide a white nameplate with black lettering. For outdoor or corrosive installations, provide a stainless steel nameplate.

5.4 Bubbler System

When used, the bubbler system is to be 0.75 inch PVC pipe mounted directly to the wet well wall with two point PVC pipe straps with either 0.25 inch stainless steel anchors or drive pin

concrete type acnhcors (1.5 inch long minimum). Anchor every 3 feet minimum. Pipe is to end 6 inches above the wet well floor.

5.5 Power Requirements

Lift stations shall be equipped with a constant utility power source as well as a backup generator power source for when interruptions in utility power source occur.

All lift stations shall be provided with 480V three-phase power. Phase inverters to achieve three-phase power may be requested as an exemption if the electrical utility cannot feasibly provide three-phase power to the site.

Overhead power lines will not be permitted within the fenced area of the lift station.

The main power feed shall be equipped with an above-grade, fused disconnect switch.

5.5.1 Sizing

Provide full voltage and current load requirements for the lift station site based on build out conditions expected for the lift station. All power equipment, wiring, and conduit shall be sized for the maximum projected size of a station.

All necessary spare conduits, panel space, and ancillary equipment shall be sized for the full station.

5.5.2 Selection

Select equipment protective devices to prevent equipment damage and system failures caused by faults, over-currents, lightning, and transient voltages. Select equipment with adequate momentary and interrupting capacity for the point in the system where it is used.

Select phase and ground fault protective devices and device settings that will function selectively to disconnect that portion of the system in trouble due to an electrical fault with as little disturbance to the rest of the system as possible.

Thermal overload relay protection heaters or settings are chosen per the NEC and are specific to the motor application requirements. Setting should be based upon motor full load current, not the service factor rating. The horsepower rating of each pump motor shall be at least 1.15 times that required by the pump when operating at all design operation conditions.

5.6 Equipment Requirements

Equipment requirements are as follows:

1. MCC’s shall be equipped with an SKF EP1000 External Port.
2. Main Disconnect shall be mounted outside of cabinet door.
3. Outdoor installation of power panels shall be NEMA 3R and corrosive installations shall be NEMA 4X 304 stainless steel or as appropriate for the corrosive environment.
4. Local lockable non-fused power disconnect switch at motors is required. A local disconnect may not have other sources feed through.
5. Power and control wires installed in ductbanks and cable tray shall be multi-conductor cable. Power distribution power wires shall be sized for full capacity.
6. Power and control circuitry (including step down transformers) shall be physically separated allowing inspection of control wires without exposure to power circuits.
7. Insulation Type:

a. Required for single conductor power cable and multi-conductor power and control cables, required in cable tray and ductbanks.
b. Definitions:
    i. PVC: polyvinyl chloride, plastic with nylon sheath skin (building wire)
    ii. XLPE: cross-linked polyethylene (industrial grade)
    iii. EPR: ethylene propylene rubber (heavy duty industrial grade)
c. Insulation:
    i. PVC (THWN) (building wire only: lights and outlets)
    ii. XLPE (XHHW) (motor, power distribution, underground conduit)
    iii. EPR (RHW) (heavy duty industrial grade – Direct buried, chemical areas)
d. Cable jacket:
    i. PVC (plastic – permitted for building wire)
    ii. XLPE (motor, power distribution, underground conduit)
    iii. EPR (direct buried, chemicals areas)
e. Stranded No. 14 AWG and larger power and control
f. Building wire for lights and receptacles: THWN
g. Minimum conductor size of No. 12 AWG for power
h. Minimum conductor size of No. 14 AWG for control
i. Minimum conductor size No. 16 twisted-shielded for instrumentation
j. Fiber Optic Cable: Coordinate with the City
    iv. Single Mode for long distances
    v. Multi-Mode for plants

8. 5KV and 15KV cable: Based on specific projects to be coordinated with the City

9. Conductor color coding as follows:

Wiring Color Standard (UL508A, NFPA 70 and NFPA 79 standards)

Description	Standard	System
Phase A	Brown	480Y/277 VAC; 3-Phase Power
Phase B	Orange	
Phase C	Yellow	
Neutral	Gray	
Ground	Green	
Description	**Standard**	**System**
Phase A	Black	208Y/120 VAC; 3-Phase Power
Phase B	Red	
Phase C	Blue	
Neutral	White	
Ground	Green	
Description	**Standard**	**System**
Phase A	Black	240/120 VAC; 3-Phase Power
Phase B (High Leg)	Red	4-Wire Delta Connected
Phase C	Blue	
Neutral	White	
Ground	Green	
Description	**Standard**	**System**
Phase A	Black	220 VAC; 1-Phase Power
Phase B	Red	
Neutral	White	
Ground	Green	
Description	**Standard**	**System**
Hot	Black	110 VAC; 1-Phase Power
Neutral	White	
Ground	Green	
Description	**Standard**	**System**
Hot	Black	110 VAC; Switch Leg
Hot	Blue	110 VAC; Traveler in 3-way or 4-way Switch
Hot	Green with Yellow Stripes	Isolated Ground

Control Circuits		
Description	**Standard**	**System**
Ungrounded Control	Black	Supply voltage
Ungrounded AC Control	Red	Less than Supply Voltage
Grounded AC Control	White with Yellow Stripe	
Ungrounded DC Control	Blue	DC+
Grounded DC current	White with Blue Stripe	DC-
Grounded AC current	White or Natural Grey	Less than Supply Voltage
Description	**Standard**	**System**
Signal, 2 conductors	Clear	+ Signal Output
	Black	- Signal Common
Signal, 3 conductors	Red	Power; 24VDC
	Clear	+ Signal Output
	Black	- Signal Common

10. Shielded twisted pair shall be 16 GA or greater as per manufacturer's requirements.
11. Power distribution substations, transformers, switchgear, switchboards, panel boards, motor control centers, variable frequency drives (VFD), etc.:
    a. Manufacturer is subject to City approval
    b. Electrical metering for voltage, ampere, watt, VAR, power factor meters:
        i. Stations with motor(s) 100 hp and larger should provide motor ampere metering
    c. Copper for equipment power bus or transformer coil windings
    d. Provide dry type transformers, manufacturer is subject to City approval
    e. Motor Starter Type:
        i. NEMA standard motor starters
    f. Soft Start Devices:
        i. Soft starts are preferred to VFD's wherever feasible and not in conflict with other requirements of these standards.
    g. Variable Speed Drives:
        i. Pulse Width Modulating (PWM):
            1. 6-Pulse, up to 50-horsepower, requires 3 percent reactor or harmonics filter for larger units
            2. 18-Pulse, over 50-horsepower, no harmonics filter required
            3. VFD's shall be equipped with integral PID loops
12. Reflective wave terminator or output reactor for long distance between motor and VFD required at distances over 99 feet from drive to motor
13. Devices shall be provided lightning and surge protection system (LP) and transient voltage surge suppression (TVSS) as follows:
    a. Service Entrance Section: LP
    b. Control Panels: TVSS
    c. Field Instruments: Surge protection

14. Standby Power System: Lift stations are required to have continuous standby power. A backup power system in the form of a diesel fuel operated generator system shall be designed as part of all pumping stations to supply the same amount of electrical power to the station (including all pumps, controls, alarms, and support systems) as supplied by the utility company. Such system shall be provided complete with all necessary automatic starting equipment, transfer switch, fuel tank, supply and return fuel oil piping, exhaust system/silencer, generator output circuit breaker, and all other necessary appurtenances for complete and operable system. Generators shall have auxiliary contacts as necessary for remote monitoring and control.
    a. Generators require run time in hours and per hour fuel consumption
    b. Generators shall be sited with a minimum 6-foot clearance on all sides for maintenance access including assurance that all access panels can be fully opened
    c. Fuel tanks: Unit belly tank sized to provide 48 hours of run time at 100 percent load – Fuel tanks shall be UL listed double wall with leak detection
    d. Temperature rise shall be within ratings as defined by NEMA, IEEE, and ANSI standards
    e. Generators shall be equipped with a 304 stainless steel, critical grade exhaust silencer. The silencer shall be equipped with a rain cap and all connections, pipes, bolts, etc. which shall be 316 stainless steel.
15. Automatic Transfer Switch:
    a. The automatic transfer control shall be listed by Underwriters Laboratories to Standard 1008 and to the applicable sections of the National Electrical Code.
    b. The complete automatic load transfer control shall be rated for continuous duty and for all classes of load.
    c. The ampere rating of the transfer switch shall be sufficient to handle the capacity of the loads being transferred.
    d. The controls and components shall be compatible with the electrical requirements of the standby system.
    e. When using a transfer switch with break-before-make contacts (open transition), the power utility and standby power will not be connected simultaneously.
    f. The transfer switch shall be mechanically interlocked so that it shall not be possible for the load circuits to be connected to the normal and emergency sources simultaneously.
    g. A local instrument and control panel shall be furnished and installed on the engine generator set to monitor and control the generator system.
    h. The generator and transfer switch shall be field programmable with a standard PC. Any proprietary software needed for maintenance and monitoring shall be provided to the City and any necessary training for field staff shall be the responsibility of the generator provider to deliver to City personnel.

5.7 Grounding

Design and show grounding for the electric distribution system and equipment. Refer to the guidelines and procedures given in IEEE Standard 142 "*Recommended Practice for Grounding of Industrial and Commercial Power Systems*" (the Green Book). An effective grounding system should be designed in compliance with Standard 142 for the following equipment, apparatus and structures:

1. Building structural steel
2. Power and convenience outlets
3. Electric motors
4. Electric raceways and cable trays, conduit boxes

5. Transformers
6. Power lighting panel
7. Lighting fixtures
8. Switchgear at all voltage levels
9. Motor controllers
10. Control stations
11. Electrical equipment enclosures
12. Project fencing, if applicable
13. Enclosure hinged doors equipped with direct ground wire

5.7.1 System Grounding

Connect the main bonding jumpers between the unit substation ground bus and ground electrode system. Solidly ground the transformer neutrals of wye-connected transformers through a grounding electrode conductor connected to the grounding electrode system. Consider resistance grounding for medium voltage distribution systems.

5.7.2 Equipment Grounding

Bond the noncurrent-carrying parts of electrical equipment, devices, panel boards, and metallic raceways to the grounding electrode system for personnel safety.

Install a separate grounding conductor sized in accordance with the National Electrical Code in metallic or nonmetallic raceways for all feeders and all branch circuits for a direct path for fault current to travel to trip the branch circuit breaker.

Bond electrical equipment twice at both ends of the ground buss. Grounding both ends of the ground bus of switchgear, MCCs, load centers to the grounding electrode system avoids losing a ground to energized equipment and double protection.

Bond the grounding cable for feeder circuits to the unit substation ground bus and to the panel board, MCC, or motor, at its termination. Connect branch circuit ground wire to separate ground bus in the panel board or motor control center and to the device it is serving.

5.7.3 Instrumentation Grounding

Ground shields of any shielded control cable at one point only, typically at the panel and not at the field instrument. Normally, provide a bond to ground at a control panel. Consult manufacturer’s literature to verify proper grounding requirements. Grounding both ends of a cable can cause circulating currents.

5.8 Instrumentation and Controls (SCADA)

All lift stations shall be controlled locally at the lift station site via hard-wired control. Remote monitoring of the lift station status and condition will be provided through the City’s SCADA (Supervisory Control and Data Acquisition) system. SCADA control of Lift Stations shall not be permitted.

5.8.1 Control Philosophy

Typical City lift stations are two pump systems utilizing a local pump control panel to manage the constant speed pumps based on five level settings using float switches or other means.

5.8.2 Instrumentation

At a minimum instrumentation shall be provided as follows:

1. Level monitoring and level indicating transmitters:
    a. Small Lift Stations (submersible) – Floats, discrete level control with and high level backup float
    b. Large Lift Stations (wet-pit/dry-pit) – Ultrasonic, continuous analog level (non-intrusive), with float backup and high level backup float
2. Full port magnetic flow meters flow-through type, shall be provided to monitor station flow. All meters shall have a permanent piped bypass to allow for removal and maintenance.
3. Pressure gages to be provided on pump outlets
4. Digital amp meter on motors

5.8.3 Indicator Lights

Indicating light color scheme for local controls and SCADA graphics:

Function	Standard
Run, On, Valve Opened	Red
Ready, Stop, Off, Valve Closed	Green
Normal, Power On	White
Abnormal, Alarm	Amber

Panel mounted indicating lights shall be LED, push-to-test type.

The alarm light shall be mounted to the side of the exterior sun and rain shield where it will be visible from the nearest road. The height of the alarm light shall be 18 inches above the top of the shield.

5.8.4 Control Devices

1. Selector Switches, E-Stop, Pushbuttons, etc. shall be:
    a. At local field panels, at motor control center, and at VFDs
    b. Selector switches: Hand-off-auto (HOA) with appropriate delay timers shall be installed exterior to the panels
2. Process equipment safety device interlocks (such as a pump low suction, check valve position, and high discharge pressure) are to be hardwired into the motor control circuit directly with indicator alarm lights at local control panel then to SCADA.
3. Pumps will have an integral flow switch in the control circuit with an adjustable trip timer. The flow switch shall be preset for 10 seconds.
4. Wet well level instrument process interlock to provide a hardwired low-low or high-high level cut-off to pump control panel with indicator alarm lights shall be provided. Valve interlocks and alarms shall be hardwired to the pump control panel and to PLC as necessary.
5. Location of operator control stations are:
    a. Control station (with selector switches and pushbuttons) at process equipment motor
    b. Operator interface station (only at large stations) at operator workstations on area control panels
6. All motor control circuits operate at 24V DC/ 120 VAC.
7. All remote terminal units (RTU) or programmable logic controller (PLC) control circuits shall operate at 24V DC using interposing relays for signal isolation.

5.8.5 Telemetry

Provide a fully functioning telemetry service, SCADA alarms, and control system. The facility will not be accepted by the City until communication has been operated for a minimum of 30 days without failure. The 30-day commissioning will restart after any communication failure when the root cause of the failure has been determined and resolved.

Wireless communication shall be provided Verizon Wireless. Dialer systems shall not be permitted. The City shall provide the Contractor with its communication standard equipment at the time of final construction document review.

- ETHERNET TCP/IP: Applicant to coordinate with the City for SCADA communications

Backup float shall be wired directly to the telemetry/autodialer and bypass any other communications equipment. All telemetry equipment shall be installed at or below eye level.

Primary control panel shall be mounted at ground level and external to any below ground structures. Secondary controls and service disconnects shall be installed at pump/motor.

Preference for PLC input and output modules:

	Analog:	Discrete:
24V DC	☒	☒
120V AC	☐	☒
Isolated	☒	☐
Relay Output	☐	☒

Interposing relays location shall be in RTU, PLC, or I/O cabinets.

Outdoor control panels shall be NEMA 4X. Heating or cooling of the panel shall be as recommended by the vendor/manufacturer. Applicant shall provide the heat calculations for all control panels.
Provide 25 percent spare capacity for I/O and field terminations in control panels.

In the event of a power supply loss at the lift station or a failure of the automatically-activated stand-by power generation source, the telemetry system shall be operated from a battery backup power source. This battery backup power source shall be provided with continuous charge.

5.8.6 Level Configuration

The basic configuration and sequence of operation of the selected level settings is presented below:

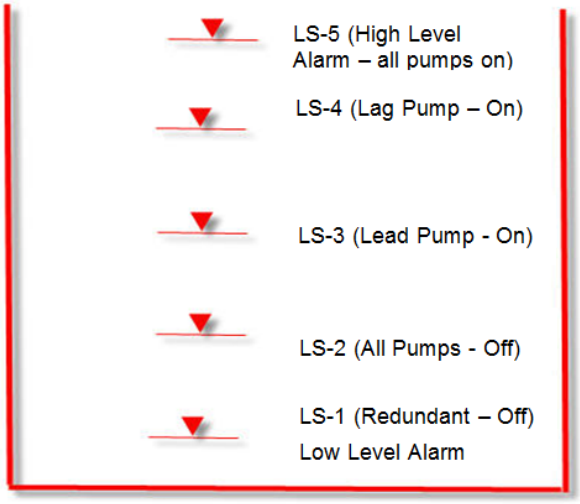

Figure 5-1 - Wet Well Level Setting Configuration

1. When the water level in the wet well reaches LS-3, the lead pump turns ON.
2. If the water level continues to rise and reaches LS-4, the lag pump turns ON.
3. LS-5 provides a high level alarm to the station's telemetry system. The LS-5 level is typically set at the same level as the LS-4 (Lag Pump – On) level setting. As per state standards an audible alarm and strobe shall be activated upon high level alarm. The strobe shall be visible from the nearest public street.
4. The lead and/or lag pumps shall continue to run until the water level falls to the LS-2 (All Pumps – Off) level setting.
5. LS-1 is a Redundant Off level setting, which will turn off the lead and lag pumps in the event of failure of the LS-2 level device. The LS-1 level shall be set at the pump minimum submergence as required by the pump manufacturer and at least 6-inches below the LS-2 level setting.
6. Other Lag Pumps, if used, will have their 'Lag Pump – On' level set to a level between LS-3 (Lead Pump - On) and LS-5 (High Level). The other lag pumps-on elevations are dependent on the field condition to avoid influent pipe surcharging as determined by the design engineer.
7. Note that the LS-2 (All – Pumps Off) level should be set at a location meeting the following criteria:
    a. The pump manufacturer's recommended pump off-elevation but no lower than minimum submergence plus 6-inches.
8. Pump-on and pump-off elevations shall be based on the calculation to limit the pump cycle time as described elsewhere.

5.8.7 Pump Operation

The pumps will operate in a traditional lead-lag sequence with alternation of the lead pump designation. This shall provide similar total run times for the pumps in service allow for even pump wear and to minimize the amount of solids accumulating in front of the lag pump.

The alternation shall occur after the All Pumps – OFF level setting (LS-2) is reached. The alternator is a hard-wired device located in the pump control panel and provided with an OFF-ON selector switch to maintain operation of the "good" pump if the other pump fails or is taken

out of service. Alternation shall be accomplished with a hard-wired alternator, timers are not acceptable.

HAND-OFF-AUTO selector switches shall be provided for each pump and shall be used to take a pump out of service (OFF position), to start a pump locally (HAND position), or to leave the pump under control of the wet well level detection devices (AUTO position).

There shall be an alternator disable switch and a lead pump selector switch for triplex stations.

At a minimum, the following signals shall be installed at the station in accordance with the City's wiring standard and monitored from the lift station and SCADA system:

- Wet Well Redundant Off Float Switch (Low Level Alarm – LS-1)
- Wet Well High Level Alarm (LS-5)
- High Water Level in the Dry Well Sump (if applicable)
- Loss of Utility Power
- Transfer Switch in Standby-by
- Transfer Switch Fault
- Generator Run
- Generator Common Fault
- Diesel Tank Leak Alarm
- Diesel Tank Low Fuel
- Pump No. 1 Run
- Pump No. 1 Fail
- Pump No. 2 Run
- Pump No. 2 Fail
- Pump No. X Run (if applicable)
- Pump No. X Fail (if applicable)
- Total Run Time Per Day Per Pump
- Cumulative Pump Run Time Per Pump
- Suction and Discharge Pressures
- Loss of Telemetry Transmission Line (if applicable)
- Loss of Phase
- In Station Flooding
- Flow Monitoring

5.9 Lighting

All lighting shall be LED with at least 40 lumens per watt.

Lighting products shall be provided as follows:

1. Outdoor: LED
    a. HOA selector switch (with auto function) for outdoor lighting control
2. Indoor: LED

SECTION 6: QUALITY ASSURANCE AND QUALITY CONTROL

6.1 Preconstruction Meeting

Schedule a pre-construction meeting with the DWM prior to the start of any construction for the pump station.

After the meeting, the contractor shall provide the following shop drawings for review at a minimum:

1. Pumps and Motors
2. Valves
3. Piping
4. Generator
5. Transfer Switch
6. Switchgear
7. Electrical Service
8. Control Panels (with interconnection diagrams)
9. PLC
10. Starters/ VFDs
11. Mounting/Shield
12. Grinders or Mechanical Bar Screen (if applicable)
13. Odor Control
14. Sump Pumps
15. Flow Meter
16. Precast Concrete Structures
17. Hatches
18. Fencing

All shop drawings shall be reviewed and stamped by a professional engineer in the state of North Carolina prior to submission to the DWM.

6.2 Inspection by City Staff, Department of Water Management

The contractor is required to provide at least 48-hour notice of the following activities to allow City staff the opportunity to be present for these inspections:

1. Rough in electrical conduit installation
2. Final electrical tie in
3. Generator startup and commissioning
4. Watertightness testing
5. Mechanical startup and commissioning to include
    a. Valve exercising
    b. Pump startup and drawdown testing
    c. Pump removal and reinstatement demonstration for submersible stations
6. Instrumentation commissioning
    a. Alarm tests
    b. Communications test
    c. Emergency equipment operations
    d. Startup calibration

7. Punch list walkthrough

The contractor shall provide a photo record of the following features:
1. Photo of lined wet well
2. Photo of sloped wet well bottom
3. Photo of wet well exterior showing sealed joints
4. 3rd party nuclear density test results at 1' intervals for all fill sections
5. Photo of exposed pigging station piping
6. Photo of all slabs with ruler adjacent to slab to demonstrate slab is poured to thickness shown on the plans
7. Photo of reinforcing steel in all poured slabs or sections, with a ruler demonstrating spacing
8. Photo of interior of force main showing Protecto 401 liner, shipping receipt acknowledging factory-applied liner was provided
9. Photo of base of each vault showing gravel subgrade provided

Failure to provide the Department of Water Management Staff the opportunity to perform any of the above inspections, reviews, and a photo record of the above items at a minimum will result in the City requiring the elements in question be removed and inspected before the lift station will be accepted.

6.3 Emergency Action Plan

The Contractor shall prepare an Emergency Action Plan in accordance with the requirements of the responsible Fire Marshall. This plan shall have received preliminary approval pending transfer of ownership to the City.

6.4 Project Closeout

Applicant shall be responsible for providing the following at the end of the construction.
1. Spare parts:
    a. Generator: one set air, oil, and fuel filters; one set accessory belts
    b. Pumps: one rotating assembly (impeller, key, nut, washer and mechanical seal) per pump & a spare impeller, key, nut, and washer of opposite rotation than assembly
    c. Spare parts shall be boxed for long term storage with parts numbers and identification labels.
    d. Items subject to damaging hazard will not be accepted if factory packaging has been opened
    e. Turn over all spare parts at final inspection
2. Operation, maintenance, parts, and electrical manuals/schematics
    a. One scanned and text recognized or fully digital version in .pdf format
    b. Three (3) paper sets
    c. At a minimum O&M manuals shall contain the information as stated in Section 6.01 of NC DEQ's "Minimum Design Criteria for the Permitting of Pump Stations and Force Mains"
    d. At a minimum O&Ms shall be provided for all equipment where a shop drawing was submitted.
3. Digital and paper copy of control programs
4. As-Built Drawings: engineered (PE) seal with all surveyed invert points as required
    a. 3 copies full size
    b. Digital pdf and CADD
    c. Office paper copies and laminated wiring diagrams placed in each control and power panel in a pocket inside door. Inked sketches are NOT acceptable.

    d. Provide a shapefile with the GIS coordinates of all air release valves, manholes, valves, and the force main routing. The Contractor shall coordinate with City GIS to ensure that the files are in an acceptable format and level of detail.

5. Approved arc flash labels on all 3-phase power equipment
6. Arc flash study per NFPA 70E
7. Factory pump test information
8. Certified system start-up and performance testing reports (includes drawdown testing)
9. Confirmation of utility billing (water, electric, telephone, internet, natural gas)
    a. Billing shall be to the developer until the station is accepted by DWM.
10. Warranties – warranties shall commence when the City accepts the lift station
11. Certificate of Compliance
12. Special conditions
13. Performance guarantees
14. Minimum 1 day training on all lift station operations and component maintenance
15. 3 ring binder of all critical documents from the construction including:
    a. A copy of the approved electrical permits and all comments and any additional City Inspections permits as required
    b. Copy of approved site plans, stormwater permits and operational requirements unique to the site
    c. Copy of approvals from State Regulatory agencies with authority over the project
16. Complete set of all shop drawings and submittals as provided by the Contractor
17. Topping off the fuel tank on the generator
18. Filling the Bioxide tank

SECTION 7: Appendix A: Design Submittal Requirements & Checklists

Design Submittal Requirements and Checklists

Intent to Construct a Lift Station Package Requirements:

- Basic site plan showing the project limits, number and location of units, and location of proposed lift station and force main
- Exhibit showing gravity sanitary sewer is not feasible
- Write-up stating proposed initial startup and buildout flow rates and proposed peaking factor
- Clear statement of any variances requested
- Variance from state-required minimum design criteria will not be granted
- Intent to Construct a Lift Station Checklist (filled out)
- Provide one (1) complete hard copy submittal set and one (1) PDF copy
- Provide redline comments from any previous submittals of the Intent to Construct a Lift Station Package

Intent to Construct a Lift Station Checklist

Requirement	True	False
Development greater than or equal to 150 units	☐	☐
Development cannot be served by gravity sanitary sewer	☐	☐
Proposed initial startup and buildout flow rates are determined	☐	☐
Peaking factor is proposed	☐	☐

All answers must be “True” and all information must be submitted before Calculation Review can commence. The list of submittal requirements and the checklist are provided for convenience. It is the applicant’s responsibly to read the Lift Station Standards in their entirety and provide any required information.

Calculation Review Package Requirements:

- Previously finalized Intent to Construct a Lift Station Package
- If any changes have occurred clearly identify them in a revision cloud
- Exhibit identifying current and proposed land use within the service area boundary
- Basic site plan indicating station and force main locations
- Write-up detailing complete calculations and pump selection as detailed in the Lift Station Standards
- Calculation shall consider intermittent high points
- Transient analysis
- If a wet-pit/dry-pit station is selected, provide evidence that and a submersible station was not possible
- Provide an analysis of the hydraulic effects of the proposed new or upgraded lift station flows on downstream gravity sewer and/or lift station capacity
- Clear statement of any variances requested
- Variance from state-required minimum design criteria will not be granted
- Provide one (1) complete hard copy submittal set and one (1) PDF copy
- Provide redline comments from any previous submittals of the Calculation Review Package

Calculation Review Checklist

Requirement	True	False
Service area boundary uses the FLUM to identify current and proposed uses	☐	☐
2T rules used to calculate flow rates	☐	☐
Calculations take into account both initial startup and buildout conditions	☐	☐
Pump can passing a minimum of 3 inch in diameter solid	☐	☐
Force main velocity is always at least 2 ft/s and below 8 ft/s	☐	☐
All design operating points are on the pump curve	☐	☐
The pump operating efficiency is maximized during all hydraulic conditions	☐	☐
Suction specific speed over the entire operating range at or below 10,000	☐	☐
Pump motor is 1800 rpm or less	☐	☐
Pump maximum daily run time not exceeded	☐	☐

All answers must be “True” and all information must be submitted before Construction Drawing Review can commence. The list of submittal requirements and the checklist are provided for convenience. It is the applicant’s responsibly to read the Lift Station Standards in their entirety and provide any required information.

Construction Drawing Review Package Requirements:

- Previously finalized Intent to Construct a Lift Station Package
- If any changes have occurred clearly identify them in a revision cloud
- Previously finalized Intent to Calculation Review Package
- If any changes have occurred clearly identify them in a revision cloud
- Fast-Track Application for Gravity Sewers, Pump Stations, and Force Mains filled out
- Permitted facilities shall not be placed into active service until NC DEQ receives the certificate of completion and other supporting documentation from the applicant and the City has accepted the station.
- Clear statement of any variances requested
- Variance from state-required minimum design criteria will not be granted
- Complete construction drawings
- Provide an exhibit with the entire force main profile on a single sheet with the lift station, discharge point, air release valves, hydraulic grade line, and key stations labeled clearly
- Truck access exhibit
- Truck staging and egress exhibit
- Provide two (2) complete hard copy submittal sets and one (1) PDF copy
- Provide redline comments from any previous submittals of the Construction Drawing Review Package

Construction Drawing Review Checklist

Requirement	True	False
Dead or easement provided for lift station site and access	☐	☐
100-year floodplain delineated on site plan	☐	☐
100-year floodplain elevation shown and all equipment is 2 feet above	☐	☐
Setbacks and buffers shown for the lift station site	☐	☐
All access road requirements are met	☐	☐
The truck access exhibit uses at least an 8.5ft by 45ft vehicle	☐	☐
City vehicles able to pull within 4ft of the wet well without obstruction	☐	☐
Sufficient room for multiple City vehicles to access to site simultaneously	☐	☐
2” water service connection provided	☐	☐
Freeze-proof yard hydrant provided	☐	☐
20-foot wide swing-gate assembly(s) provided	☐	☐
Manufacturer’s recommended arrangement drawings provided	☐	☐
Flotation calculations provided for all below grade structures	☐	☐
Wet well is epoxy coated	☐	☐
Minimum of 3 feet clearance between equipment provided	☐	☐
Sufficient straight run clearance provided for the magnetic flow meter	☐	☐
Bypass assembly provided	☐	☐
Pig launch and retrieval stations provided	☐	☐
Chemical dosing station for Bioxide provided	☐	☐
Flow meter provided with sufficient upstream and downstream clearances	☐	☐
Flow meter has a bypass provided	☐	☐
Hatches are sized correctly to allow for at least 6 inches of clearance on all sides	☐	☐
Minimum force main cover is 5 feet and maximum depth is 10 feet	☐	☐
Receiving and 2 downstream manholes are epoxy coated	☐	☐
Easements provided for force main where required	☐	☐
Hazardous classifications shown on electrical drawings	☐	☐
480V three-phase power is available	☐	☐
Electrical design is sized for the buildout condition	☐	☐
Control elevations shown on mechanical drawings	☐	☐
Generator sited with a minimum 6-foot clearance on all sides	☐	☐
UL listed double wall fuel tank with leak detection provides 48 hours of run time at 100 percent load	☐	☐

All answers must be “True” and all information must be submitted prior to approval. The list of submittal requirements and the checklist are provided for convenience. It is the applicant’s responsibly to read the Lift Station Standards in their entirety and provide any required information.

SECTION 8: Appendix B: Equipment Manufacturers List

B-1 Equipment Manufacturers List

Table B-1 identifies equipment manufacturers that are considered most suitable for the anticipated service in wastewater lift stations. It is recognized that equipment and products of equal quality and efficiency may be available from sources other than those identified, and no attempt is made to preclude the furnishing of similar quality items by other manufacturers. A manufacturers listing in this table does not guarantee that a given manufacturer's standard products are suitable for all applications. Alternate manufacturers may be proposed for the City's approval, with supporting information, demonstrating the alternate manufacturer's equipment is equal to the named manufacturers' equipment.

Table B-1 - Equipment Manufacturers List

Equipment	Manufacturers
Submersible Grinder Pumps	Under 1MGD: Xylem/Flygt, ABS/Piranha, KSB, Myers, Keen, Barnes, Pumpex, Ebara 1MGD and Over: Fairbanks Morse, Cornell
Vertical, Non-Clog Type Centrifugal Pumps	Fairbanks Morse, Flowserve, Smith and Loveless
Flow Meter, Electromagnetic	Siemens Sitrans F M Mag 5000
Access Hatch	Halliday, Bilco
Access Hatch Ladder	Bilco (LU-3 Stainless, LU-4 Aluminum)
Odor Control System	Evoqua
Wet Well, Valve Vault, & Manhole Epoxy Liner	Raven 405; Cor-Cote SC (Sherwin-Williams); Perma-shield H2S Series 434 and Perma-glaze Series 435 (Tnemec)
Exterior Pipe Wrap for DIP	North Town Company; AA Thread and Seal Tape, Inc.; Sigma Corp.
Plastic Adhesive Tape for Pipe Wrap	Calpico Vinyl, Polyken, U.P.C. Tape
Internal Pipe Lining – Ceramic Epoxy	Protecto (401)
Force Main Air Release Valves	H-Tec Model 986, stainless steel (minimum)
Electrical Cabinets & Enclosures	Hoffman NEMA 4X SS compliant cabinets
Soft Starts and Variable Speed Drives	Yaskawa (P-Series), ABB, GE, Square D
Packaged Diesel Engine Generator System (Transfer Switch to be provided by Generator Manufacturer)	Caterpillar, Cummins, Kohler
PLC	Allen Bradley (Pump Commander – CompactLogix L2 Series)
Ultrasonic Level Transmitter	Hydro Ranger
Photohelic	Dwyer
LED Lights	Cree or equal

Water-specific preapproved material/ products can be found at
http://durhamnc.gov/DocumentCenter/View/15306/Water-Pre-Approved-Product-List?bidId=
Sewer-specific preapproved material/ products can be found at
http://durhamnc.gov/DocumentCenter/View/15302/Sewer-Pre-Approved-Product-List?bidId=

SECTION 9: Appendix C: City Standard Details

PS-01.02 - Bypass Piping

PS-02.01 - Handrail and Mounting

PS-04.01 - Concrete Notes

PS-05.01 - Fence/Gates

PS-06.01 - Access Road

PS-09.01 - Concrete Slab

PS-10.01 - Air Relief Valve/CARV Installation Detail (Alternative 1)

PS-11.01 - Air Relief Valve/CARV Installation Detail (Alternative 2)

PS-14.01 - Submersible Lift Station Section

PS-15.01 - Submersible Pump Cable

PS-21.01 - Grounding Detail

Water-specific details can be found at
http://durhamnc.gov/DocumentCenter/View/15305/Water-Details?bidId= and
http://durhamnc.gov/DocumentCenter/View/15303/Common-Details?bidId=

Sewer-specific details can be found at
http://durhamnc.gov/DocumentCenter/View/15304/Sewer-Details?bidId= and
http://durhamnc.gov/DocumentCenter/View/15303/Common-Details?bidId=

LIFT STATION STANDARD DETAILS	
DETAIL#	**DETAIL SHEET OF:**
PS-01.02	BYPASS PIPING
PS-02.01	HANDRAIL AND MOUNTING
PS-04.01	CONCRETE NOTES
PS-05.01	FENCE/GATES
PS-06.01	ACCESS ROAD
PS-09.01	CONCRETE SLAB
PS-10.01	AIR RELIEF VALVE/CARV INSTALLATION (ALTERNATIVE 1)
PS-11.01	AIR RELIEF VALVE/CARV INSTALLATION (ALTERNATIVE 2)
PS-14.01	SUBMERSIBLE LIFT STATION SECTION
PS-15.01	SUBMERSIBLE PUMP CABLE
PS-17.01	RESERVED
PS-18.01	RESERVED
PS-19.01	RESERVED
PS-20.01	RESERVED
PS-21.01	GROUNDING DETAIL
PS-23.01	RESERVED

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LIFT STATION STANDARD DETAILS INDEX SHEET

SCALE:	DETAIL#
N.T.S.	PS-00.00
REVISION DATE:	SHEET#
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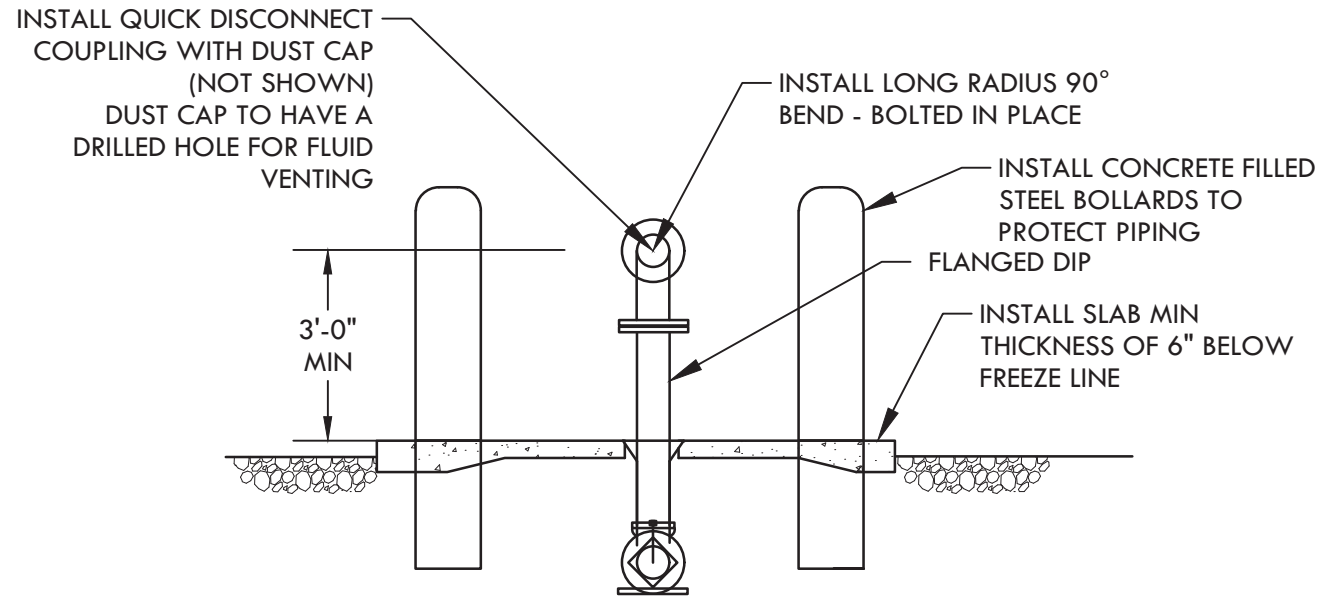
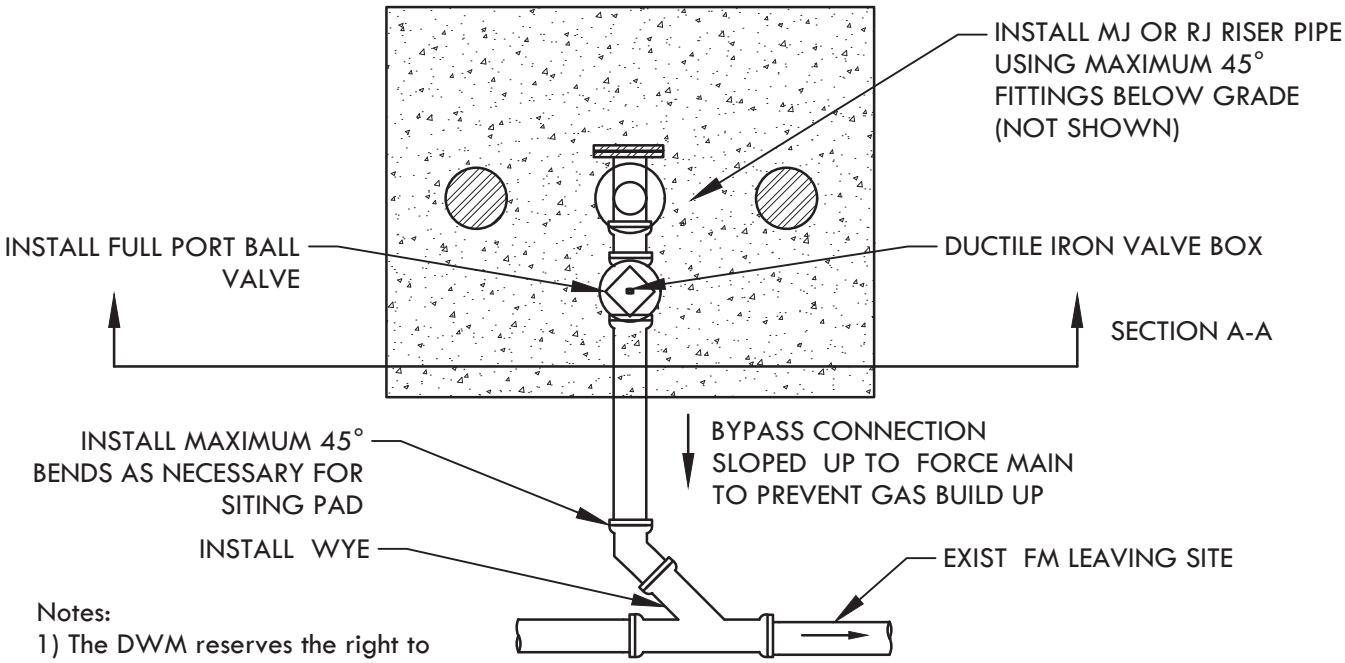


Section A-A



Notes:
1) The DWM reserves the right to request a below grade blind flange in a standard manhole where an above ground connection is not preferred.

Plan View

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LIFT STATION STANDARD DETAILS
BYPASS PIPING

SCALE:	DETAIL#
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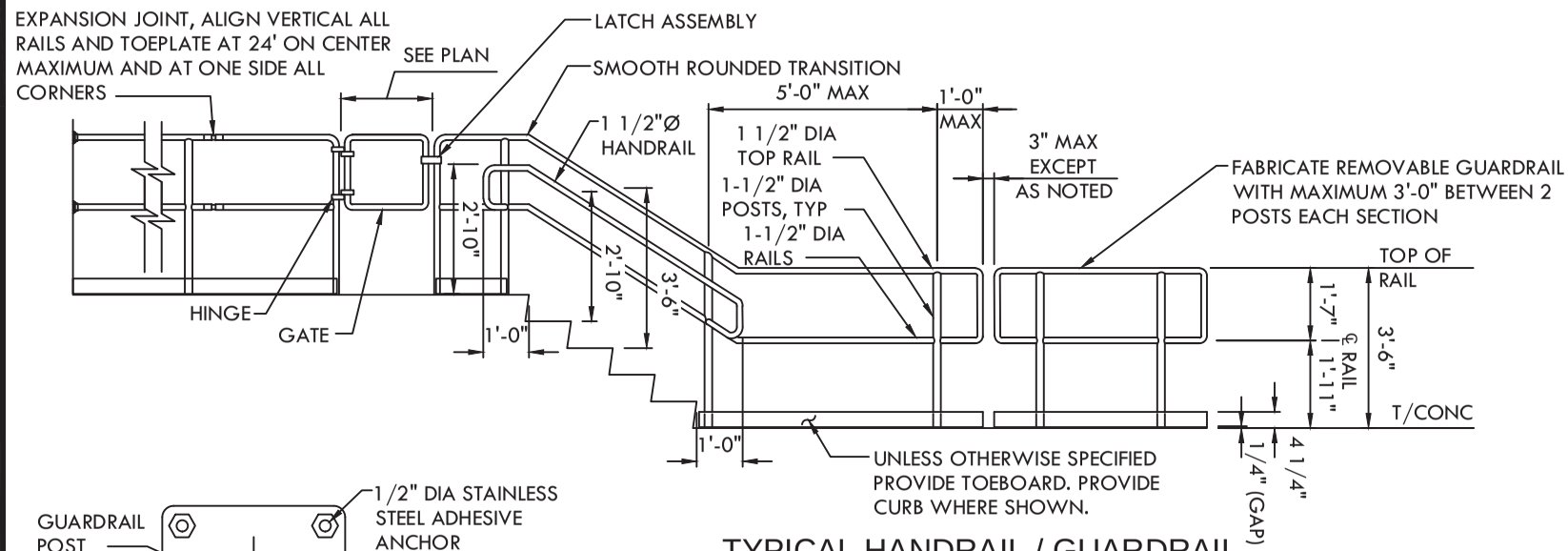
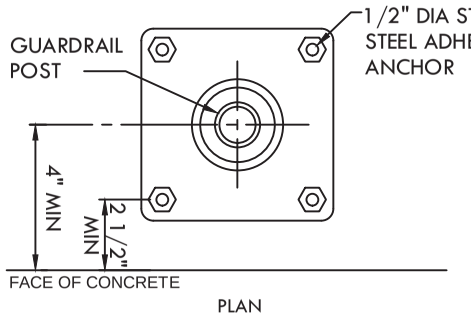
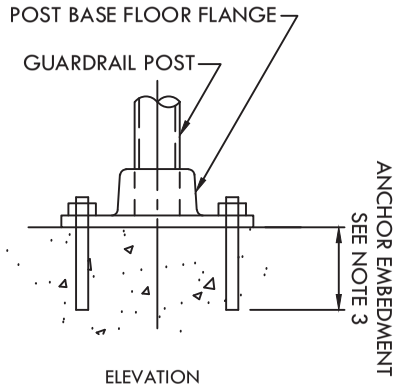


TYPICAL HANDRAIL / GUARDRAIL



PLAN



ELEVATION

BASE FLANGE MOUNT

NOTES:

1. UNLESS OTHERWISE NOTED, HANDRAIL, GUARDRAIL, AND MOUNTING APPURTENANCES SHALL BE ANODIZED ALUMINUM.
2. ALL FASTENERS SHALL BE STAINLESS STEEL, TYPE 316.
3. NUMBER OF ANCHORS AND SIZE OF ANCHORS ARE MINIMUM. PROVIDE LARGER ANCHOR SIZE IF NECESSARY TO MEET LOAD REQUIREMENTS. CONTRACTOR'S SUPPLIER AND ENGINEER ARE RESPONSIBLE FOR DESIGNING BASE BRACKET AND STAINLESS STEEL ANCHOR BOLT SIZE AND EMBEDMENT DEPTH INTO CONCRETE TO RESIST LOADS TAKING INTO ACCOUNT ANCHOR EDGE DISTANCES AND CONCRETE STRENGTHS AT THE POINT OF ATTACHMENT.
4. UNLESS SPECIFICALLY INDICATED OTHERWISE, GUARDRAIL MOUNTING MAY BE BY ANY SHOWN METHOD AS APPLICABLE.
5. RAILING POST LOCATION SHALL BE FIELD MEASURED AND RAILING FABRICATED TO FIT.
6. TOP AND MIDDLE RAILS SHALL BE CONTINUOUS EXCEPT AT GUARDRAIL SECTIONS SPECIFICALLY CALLED OUT ON DRAWINGS AS REMOVABLE GUARDRAIL.
7. THE SPACING OF EXPANSION JOINTS IN GUARDRAILS AND TOEBOARDS SHALL NOT EXCEED 24 FEET.
8. ALL ALUMINUM SURFACES IN CONTACT WITH CONCRETE, GROUT, OR DISSIMILAR METALS SHALL HAVE CONTACT SURFACE PROTECTED IN ACCORDANCE WITH SPECIFICATIONS.

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LIFT STATION STANDARD DETAILS

HANDRAIL AND MOUNTING

SCALE:	DETAIL#
N.T.S.	PS-02.01
REVISION DATE:	SHEET#
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1. A CERTIFIED LETTER OF COMPACTION FROM A GEOTECHNICAL ENGINEER LICENSED IN NORTH CAROLINA MUST BE COMPLETED PRIOR TO PLACEMENT OF CONCRETE.

2. CONCRETE MIX SHALL BE IN ACCORDANCE WITH ASTM C94 AND POSSESS THE FOLLOWING CHARACTERISTICS:

   (a) COMPRESSIVE STRENGTH OF AT LEAST 3,000 PSI AT 28 DAYS.

   (b) MINIMUM AGGREGATE SIZE OF 1-INCH.

   (c) AIR CONTENT OF 4 1/2% ± 1 1/2%.

   (d) WATER-CEMENT RATIO SHALL NOT BE GREATER THAN 0.44.

   (e) SLUMP SHALL BE 4" ± 1".

   (f) UNIT WEIGHT SHALL NOT BE LESS THAN 145 LB/C.F.

   (g) ACCELERATING ADMIXTURES IN COLD WEATHER OR RETARDING ADMIXTURES IN HOT WEATHER SHALL ONLY BE USED WHEN APPROVED IN WRITING BY D.W.M.

3. CONCRETE PLACEMENT SHALL BE IN ACCORDANCE WITH ACI 301 AND ACI 304R. CONCRETE TEMPERATURE AT TIME OF PLACEMENT SHALL BE A MINIMUM OF 55°F AND A MAXIMUM OF 90°F.

4. COLD WEATHER: NO CONCRETE SHALL BE PLACED UNLESS AMBIENT AIR TEMPERATURE IS AT LEAST 45°F AND RISING. CONCRETE SHALL BE PLACED IN ACCORDANCE WITH ACI 306R.

5. HOT WEATHER: NO CONCRETE SHALL BE PLACED WHEN AMBIENT AIR TEMPERATURE IS GREATER THAN 85°F. CONCRETE SHALL BE PLACED IN ACCORDANCE WITH ACI 305R.

6. CURING OF CONCRETE SHALL BE IN ACCORDANCE WITH ACI 308 AND ACI 318.

7. DEFECTIVE OR IMPROPERLY PLACED CONCRETE SHALL BE REPAIRED OR REPLACED AT CONTRACTOR'S/DEVELOPER'S EXPENSE.

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LIFT STATION STANDARD DETAILS
CONCRETE NOTES

SCALE:	DETAIL#
N.T.S.	PS-04.01
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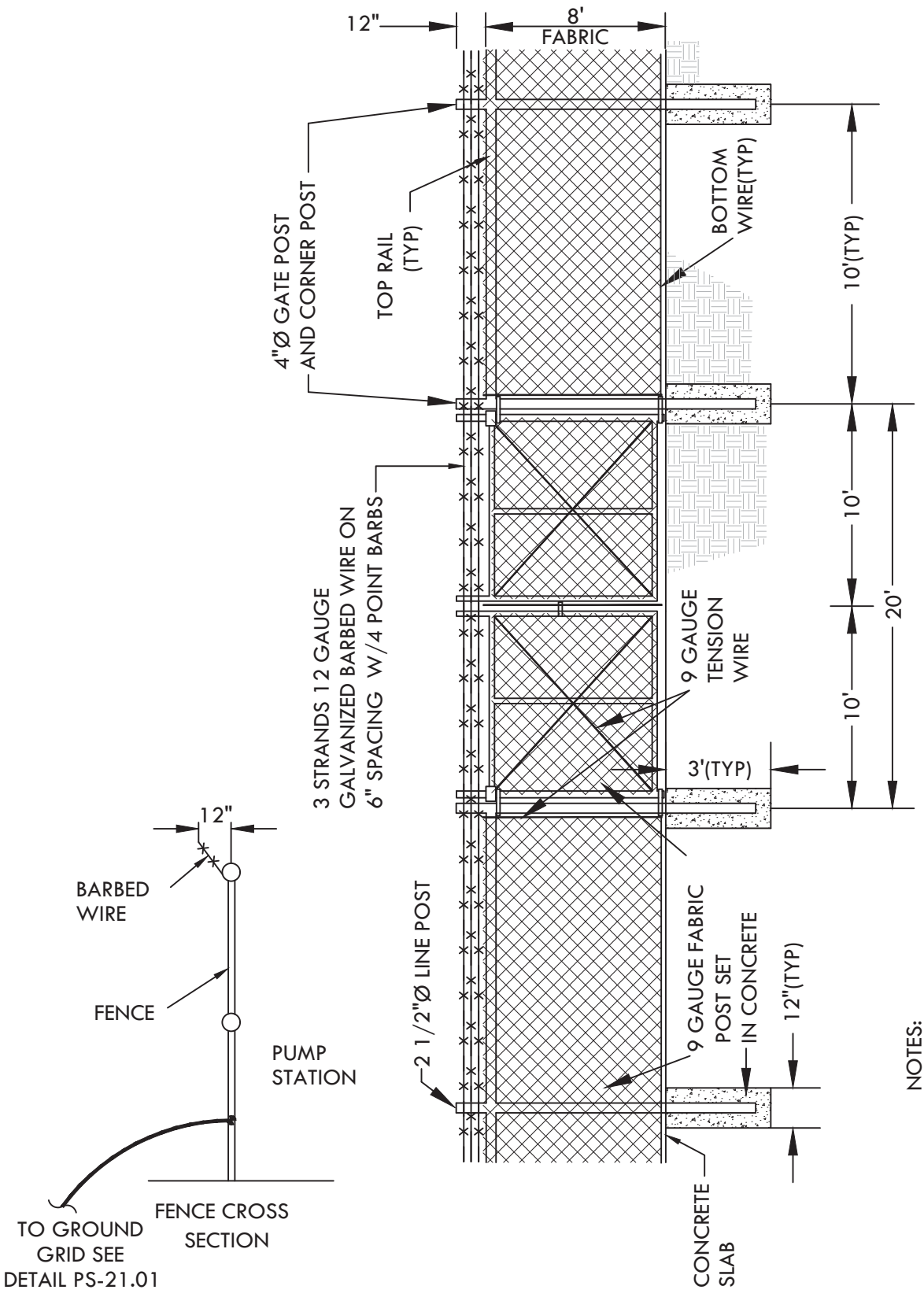

NOTES:

1. PVC FENCE SLATS REQUIRED. SLATS SHALL BE ARCHITECTURAL BROWN.
2. FENCE SHALL BE COMPATIBLE WITH SURROUNDING NEIGHBORHOOD IN ACCORDANCE WITH THE UDO.

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LIFT STATION STANDARD DETAILS
FENCE/GATES

SCALE:	DETAIL#
N.T.S.	PS-05.01
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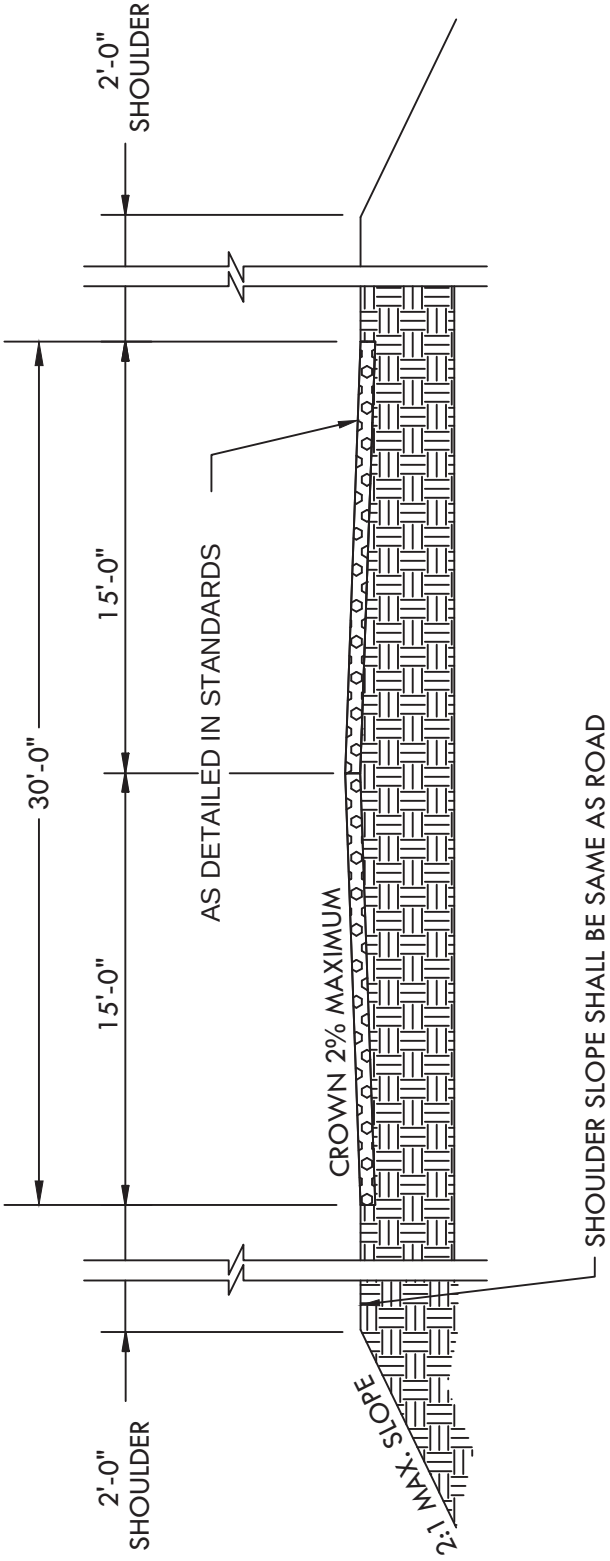

NOTES:

1. ENGINEER SHALL SUBMIT COPY OF PLAN AND PROFILE OF ACCESS ROAD FROM PUMP STATION SITE TO PUBLICLY OWNED ROAD.
2. ACCESS ROAD SHALL BE DESIGNED AND CONSTRUCTED TO ACCOMMODATE H2O VEHICLE LOADING.

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LIFT STATION STANDARD DETAILS
ACCESS ROAD

SCALE:	DETAIL#
N.T.S.	PS-06.01
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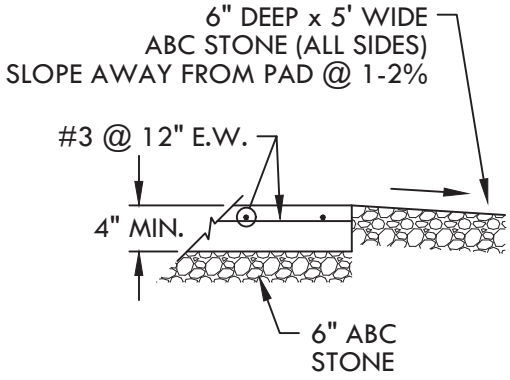
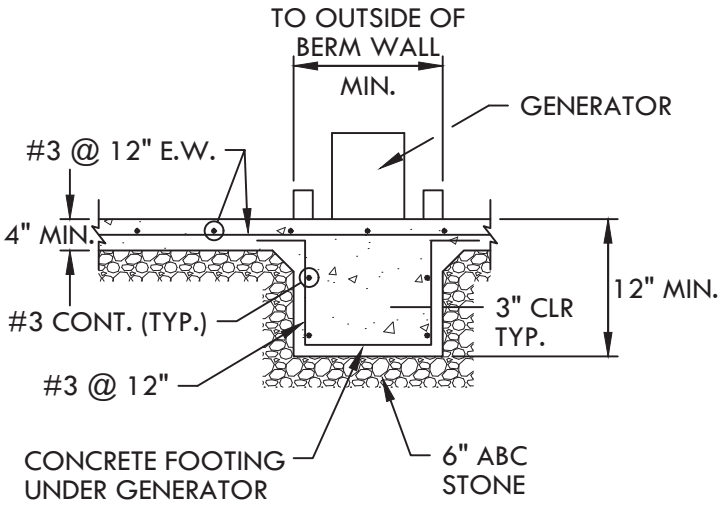
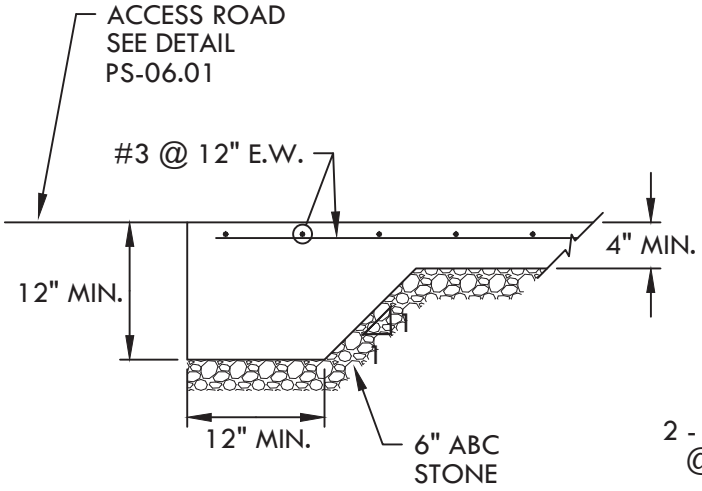


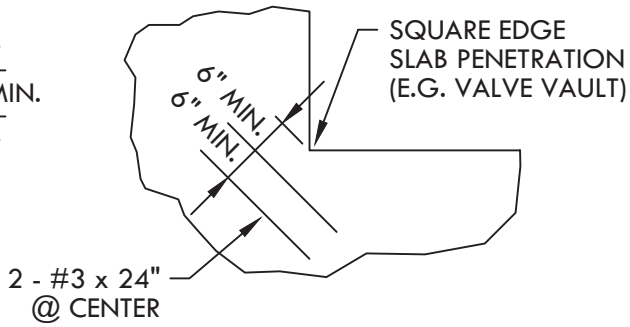
1 TYPICAL SLAB DETAIL
N.T.S.



2 GENERATOR FOOTING
N.T.S.



3 DRIVING SURFACE SLAB - NOT REQUIRED
N.T.S.



B PLAN-SQUARE EDGE PENETRATION AT SLAB (TYP)
N.T.S.

NOTE: SEE DETAIL PS-04.01 FOR CONCRETE NOTES.

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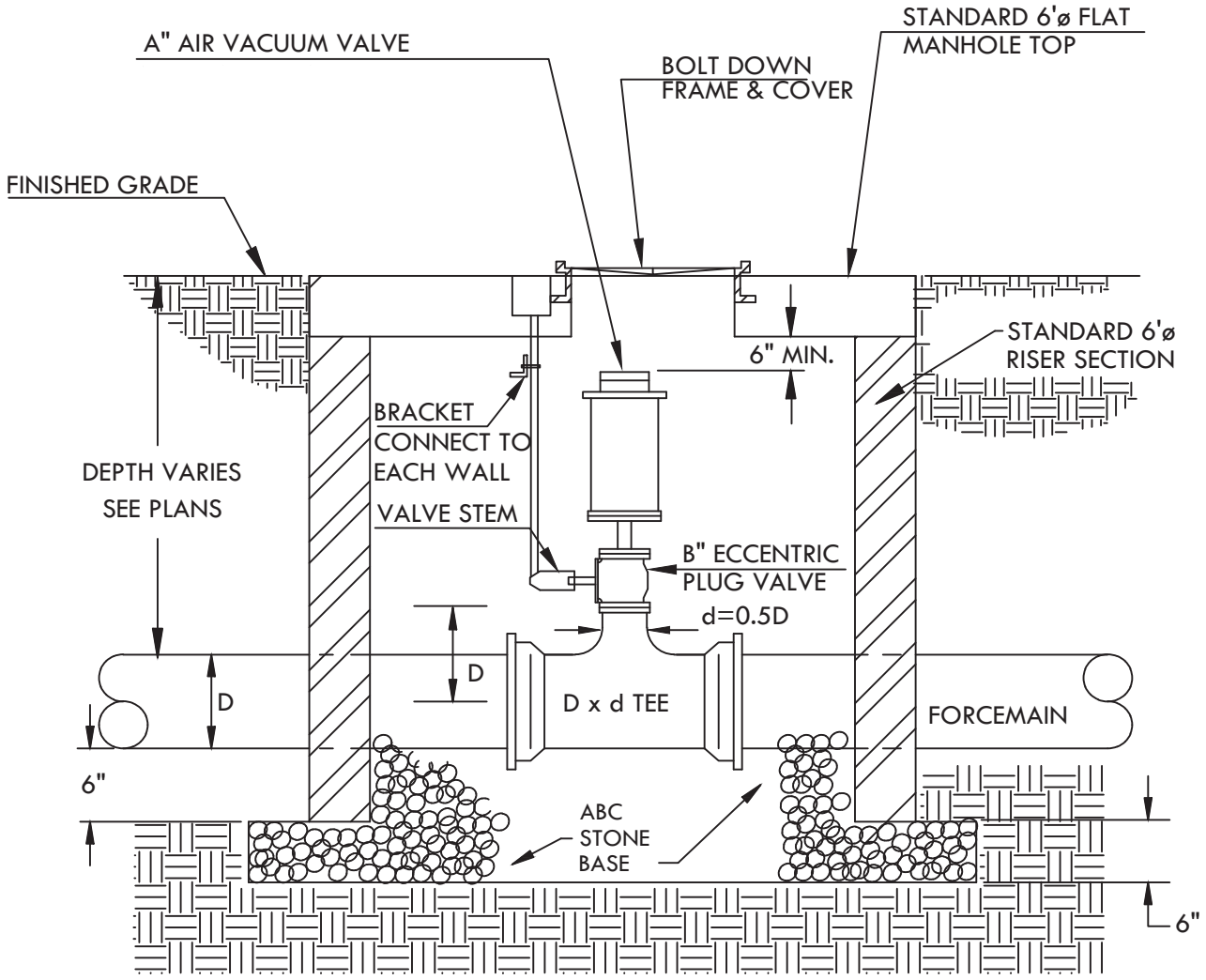
LIFT STATION STANDARD DETAILS
CONCRETE SLAB

SCALE:	DETAIL#
N.T.S.	PS-09.01
REVISION DATE:	SHEET#
9/17/18	1 of 1

"A" - TO BE SIZED PER ARV MANUFACTURERS SPECIFICATIONS.
"B" - TO BE SIZED PER ARV MANUFACTURERS SPECIFICATIONS.



NOTE: PIPE SHOULD BE BURIED TO A DEPTH THAT WILL ACCOMMODATE THE MINIMUM REQUIREMENTS OF THIS STANDARD AND THOSE OF THE SPECIFIED ARV.

D = FORCEMAIN SIZE

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LIFT STATION STANDARD DETAILS

AIR RELIEF VALVE/CARV INSTALLATION (ALTERNATIVE 1)

SCALE:	DETAIL#
N.T.S.	PS-10.01
REVISION DATE:	SHEET#
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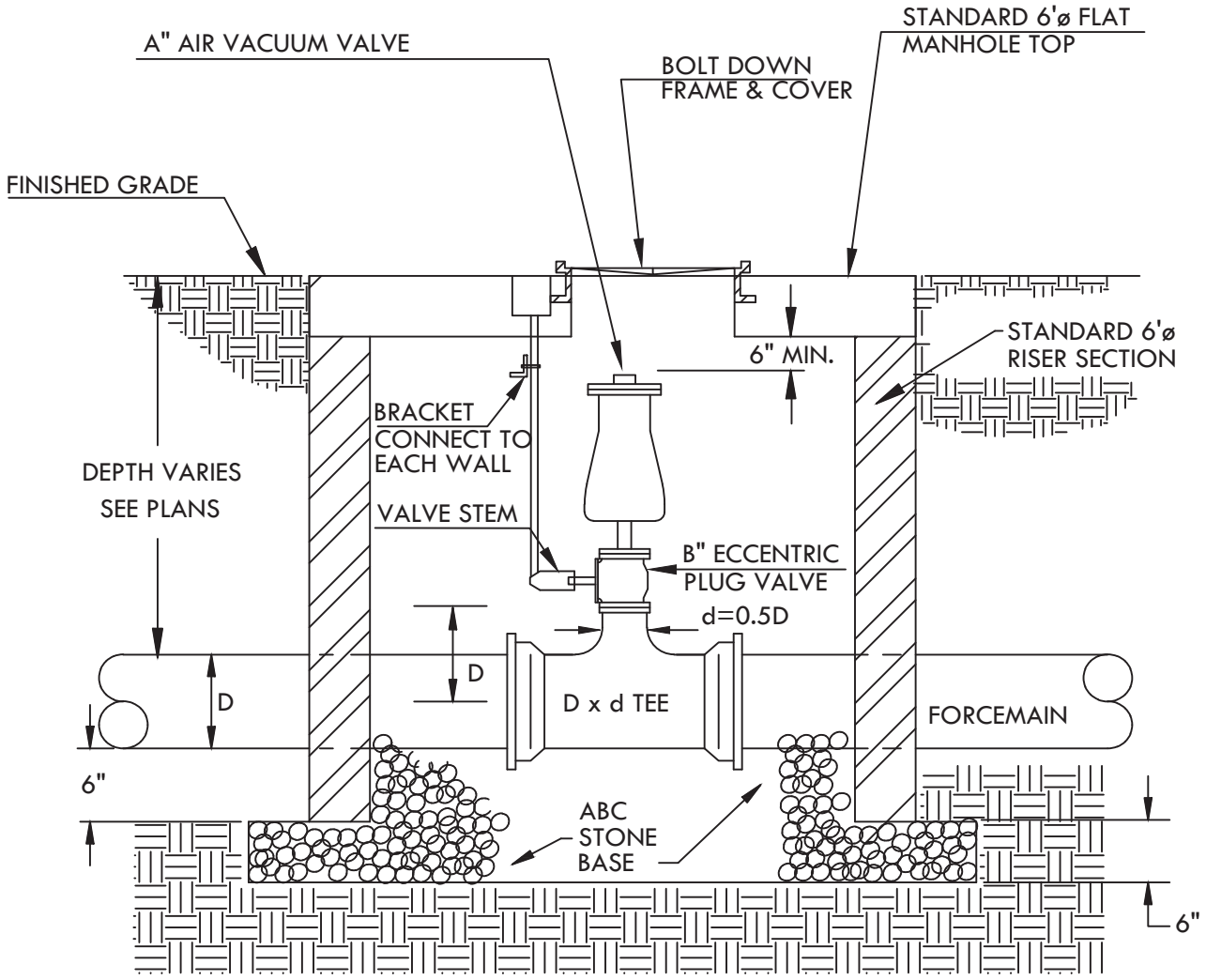
"A" - TO BE SIZED PER ARV MANUFACTURERS SPECIFICATIONS.
"B" - TO BE SIZED PER ARV MANUFACTURERS SPECIFICATIONS.



NOTE: PIPE SHOULD BE BURIED TO A DEPTH THAT WILL ACCOMMODATE THE MINIMUM REQUIREMENTS OF THIS STANDARD AND THOSE OF THE SPECIFIED ARV.

D = FORCEMAIN SIZE

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LIFT STATION STANDARD DETAILS

AIR RELIEF VALVE/CARV INSTALLATION (ALTERNATIVE 2)

SCALE:	DETAIL#
N.T.S.	PS-11.01
REVISION DATE:	SHEET#
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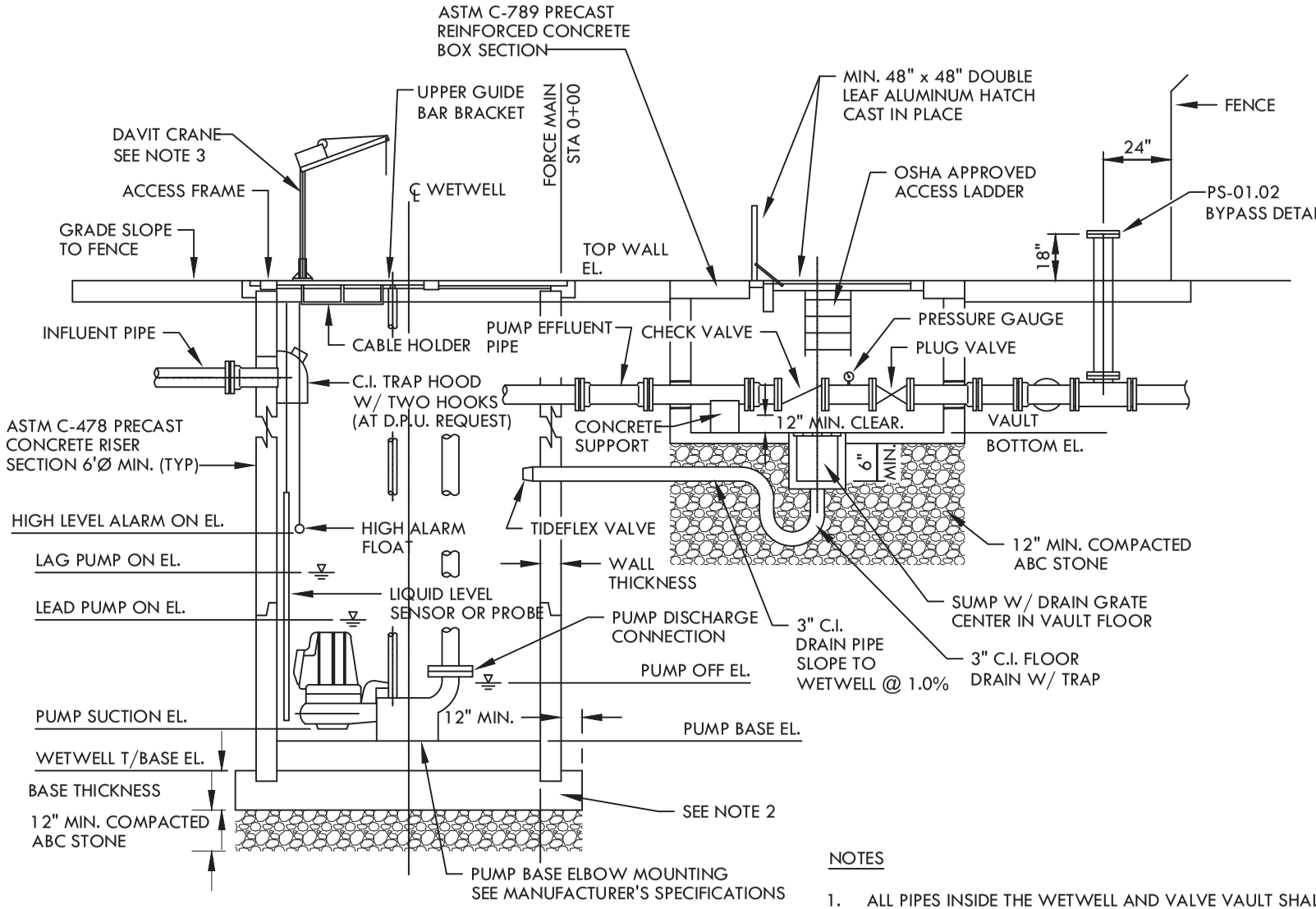

NOTES

1. ALL PIPES INSIDE THE WETWELL AND VALVE VAULT SHALL BE FLANGED FITTINGS.
2. WETWELL BASE SHALL BE PRECAST CONCRETE IN ACCORDANCE WITH ASTM C-478.
3. 2-TON MIN. DAVIT CRANE, MIN. LIFTING CAPACITY AT MIN. 6'-0" REACH.
4. NOT SHOWN: TOP SLAB OF ALL STRUCTURES SHALL BE 10-INCHES ABOVE GRADE.

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LIFT STATION STANDARD DETAILS
SUBMERSIBLE LIFT STATION SECTION

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SCALE:	DETAIL#
N.T.S.	PS-14.01
REVISION DATE:	SHEET#
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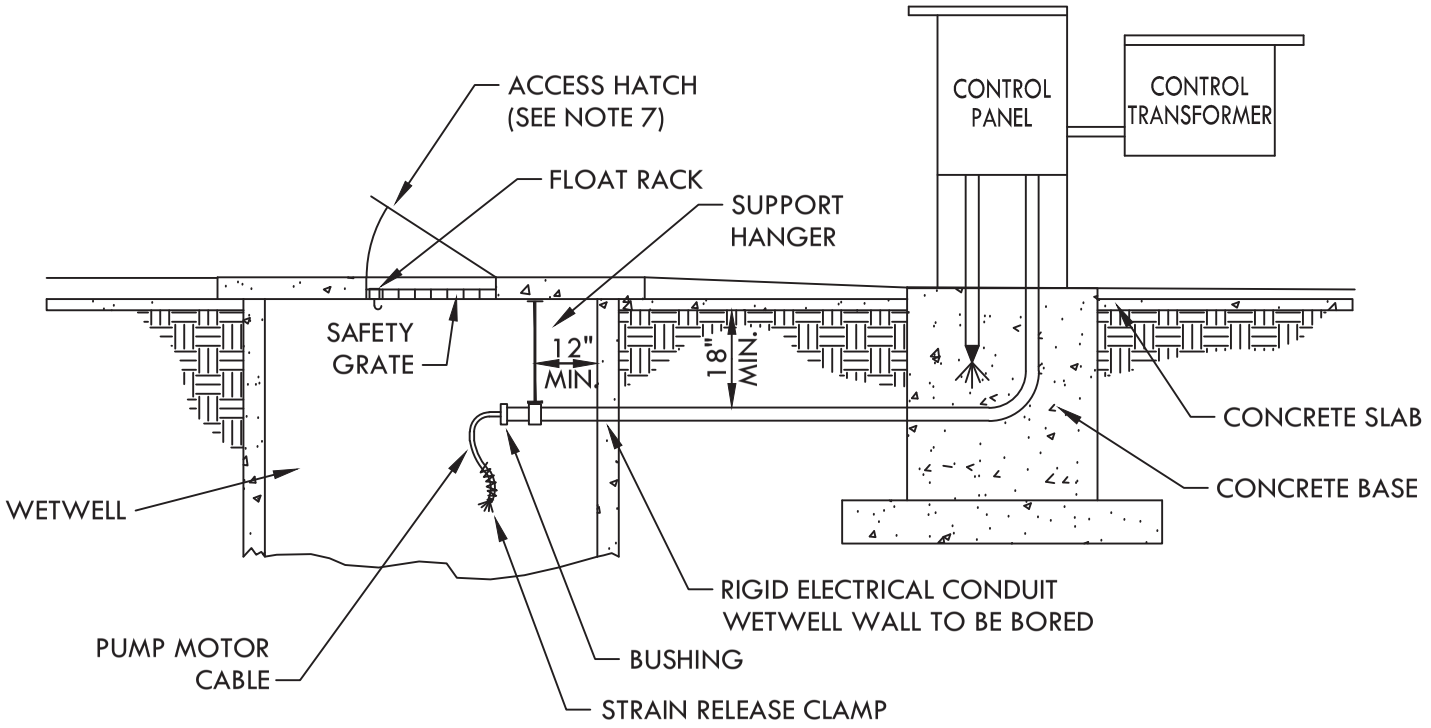
NOTES:

1. RIGID CONDUITS SHALL BE STUBBED INTO WALL OF WETWELL 18" MIN. BELOW GROUND LEVEL TO PROVIDE ACCESS TO CABLES AND CONTROL WIRING TO CONTROL PANEL.
2. THE HOLE IN THE WETWELL WALL FOR THE CONDUIT STUBS SHALL BE SIZED AND BORED FOR THE CONDUIT TO FIT. THE HOLE SHALL BE GROUTED.
3. WHEN CONDUIT STUB IS 12" OR OVER IN LENGTH, THE STUB SHALL BE SUPPORTED BY HANGERS.
4. THE STUBS INSIDE THE WETWELL SHALL NOT PROTRUDE OR INTERFERE WITH THE CLEARANCE OF THE ACCESS HATCH'S OPENING, NOR HINDER THE REMOVAL OF THE PUMPS.
5. THE CABLES SHALL HAVE A STRAIN RELEASE CLAMP MOUNTED TO THE CONDUIT STUB BY A BUSHING OR SHALL BE FIXED TO THE WETWELL STRUCTURE WITH HANGERS.
6. FLOAT SWITCHES SHALL BE INSTALLED THE SAME WAY AS THE PUMP CABLES ARE INSTALLED.
7. LOCATE HINGES ON ACCESS HATCH SO THAT THE HATCH DOOR SWINGS TOWARDS THE CONTROL PANEL WHEN LIFTED.



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LIFT STATION STANDARD DETAILS
SUBMERSIBLE PUMP CABLE

SCALE:	DETAIL#
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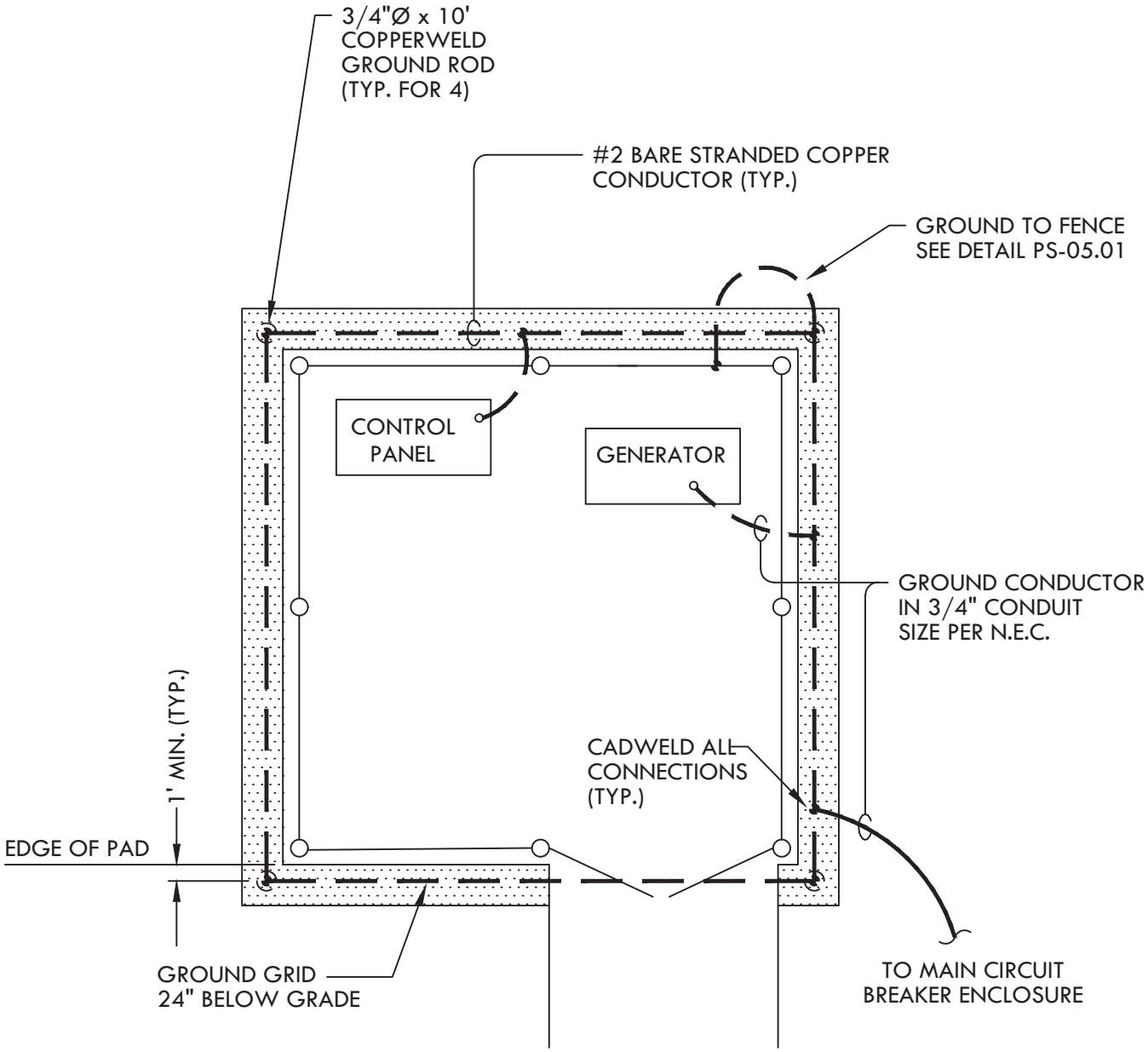

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LIFT STATION STANDARD DETAILS
GROUNDING DETAIL

SCALE:	DETAIL#
N.T.S.	PS-21.01
REVISION DATE:	SHEET#
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