NEW BRAUNFELS UTILITIES

LIFT STATION DESIGN CRITERIA

February 2024

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SECTION 1: INTRODUCTION

1.01 Purpose

These guidelines are for wastewater lift stations. They provide requirements, criteria, and considerations for the consistent and uniform design of lift stations within NBU's wastewater system.

1.02 General

1. Prior to the design of a lift station, the Design Engineer will be required to have a pre-design meeting with NBU staff to determine the design's minimum requirements. NBU departments to be present include, at a minimum:
   a. Water Engineering;
   b. Water Treatment and Compliance;
   c. Predictive Maintenance (PDM);
   d. Supervisory Control and Data Acquisition (SCADA);
   e. Safety;
   f. Fiber;
   g. Facilities; and
   h. Information Technology (IT) and Security.
2. The Design Engineer will need to justify the construction of a lift station by preparing a present-value analysis (PVA) of the lift station/force main system. The PVA must show that the lift station system cost, plus 30-years of operational and maintenance expense, will be less than the cost of gravity sewer mains. A lift station will only be considered a viable option if the cost analysis shows that gravity sewers are not physically or economically feasible. Lift stations will not be allowed where an acceptable gravity route exists. The PVA is to be submitted with the Basis of Design Report (BODR) and the construction plans. The BODR shall be in accordance with **Attachment 1**.
3. For developer-driven development in the CoNB and its ETJ, a lift station application shall include a BODR, PVA, final construction plans, and a complete set of specifications prepared under the direction of a qualified Texas Licensed Professional Engineer who, as the Design Engineer, is responsible for a complete and coordinated set of construction drawings.
4. NBU lift station projects shall be planned and designed using planning data, empirical flow data, and information developed by the Design Engineer and supplemented by the CoNB Planning Department. Lift stations and force mains are to comply with the requirements of these guidelines and also meet or exceed the requirements of the latest edition of Texas Commission on Environmental Quality (TCEQ) 30 TAC Chapter 217, Design Criteria for Wastewater Systems.

5. The determination of design flows for current and future conditions shall be coordinated with NBU and the CoNB Planning Department for all lift station projects and shall be presented in the BODR.
6. Lift stations located over the Edwards Aquifer Recharge, Contributing, and Transition Zone are to be designed and constructed in accordance with TCEQ 30 TAC 213, Edwards Aquifer.
7. The design of lift stations and their ancillary facilities are to conform to all applicable local, state, and federal regulations and national standards including, but not limited to those of:
    a. American Association of State Highway and Transportation Officials (AASHTO);
    b. American Concrete Institute (ACI);
    c. American Institute for Steel Construction (AISC);
    d. American National Standards Institute (ANSI);
    e. American Society for Testing and Materials (ASTM);
    f. American Water Works Association (AWWA);
    g. City of New Braunfels Code of Ordinances;
    h. Environmental Protection Agency (EPA);
    i. Hydraulics Institute (HI);
    j. Institute of Electrical and Electronics Engineers (IEEE);
    k. National Electric Code (NEC);
    l. National Electrical Manufacturers Association (NEMA);
    m. National Fire Protection Association (NFPA);
    n. Occupational Safety and Health Act (OSHA);
    o. NBU safety standards; and
    p. Texas Commission on Environmental Quality (TCEQ).
8. The firm pumping capacity of all lift stations shall be such that the expected peak wet weather flow can be pumped to its desired destination. Firm pumping capacity is defined as the lift station total pumping capacity with the largest pumping unit out of service.
9. Unless otherwise stated, this entire lift station design guidance shall apply to bringing existing lift stations up to this standard.

1.03 Definitions

1. The following terms used in this guideline are defined as indicated below unless the context clearly states otherwise.

a. Backflow Preventer – A device installed in potable water piping to prevent the flow of non-potable water into a potable system.

b. Best Efficiency Point – The discharge rate at which an impeller of a given diameter rotating at a given speed operates at maximum efficiency.

c. Bypass – The intentional diversion of a wastewater stream.

d. Collection System – Pipes, conduits, lift stations, force mains, and all other constructions and devices used to transport wastewater to a wastewater treatment facility.

e. Control Building/Room – A structure within a pumping station that typically includes electrical equipment, system control equipment, and motors.

f. Design Engineer – The Engineer of Record and/or engineering firm selected for the project design.

g. Design Life – The length of time that an engineering structure or device is intended to function without failing.

h. Discharge Head – Static head plus friction head-loss (in discharge piping) plus velocity head-loss as measured or calculated at the end of the discharge piping.

i. Firm Capacity – The maximum flow rate achievable, under design conditions, with the largest pumping unit out of service.

j. Flooded Suction – Condition in which the pump volute is below the low water level of the wet well.

k. Force Main – Piping, external to the lift station and filled with liquid under pressure, through which the station discharges.

l. High Water Level – Water surface elevation corresponding with “All Pumps On” level and is no higher than the elevation required to prevent sanitary sewer overflows in the upstream collection system.

m. Influent – Liquid that flows into a process or confined space. This term may also be used to identify items or properties associated with influent.

n. Intake – A structure from which the pumps take suction.

o. Invert – The inside bottom of a pipe.

p. Lift Station – A structure that collects wastewater and uses pumps to raise it to a higher elevation.

q. Low Water Level – Water surface elevation corresponding with the “All Pumps Off” level.

r. Net Positive Suction Head (NPSH) – Absolute dynamic head of the pumped liquid at the suction eye of a pump.

s. Net Positive Suction Head Available (NPSHA) – The NPSH at which the pump in a given system operates at a given discharge rate.

t. Net Positive Suction Head Required (NPSHR) – The minimum NPSH at which a pump can properly operate for a given discharge rate.

u. Operating Point – The head (pressure) and discharge rate at which a pump operates in a system. It is the intersection of the pump curve and the system curve.

v. Runout – Region on the pump curve at which the pump discharge head decreases rapidly. It occurs typically near the maximum discharge flow.

w. Shut-off Head – The head developed by a pump at zero discharge rate (for example, against a closed discharge valve).

x. Static Head – The difference in elevation between the surface of the pool from which the pump draws water and the elevation at which the outlet discharges.

y. Submersible Pump – A pump or pump/motor combination that is suitable for fully submerged operation.

z. System Head Curve – Curve of total dynamic head versus flow for all flow rates within the capability of the pumping station.

aa. Total Dynamic Head (TDH) – The total equivalent height that wastewater is to be pumped considering all losses within the pipe at a given discharge rate.

bb. Wet well – The portion of a pumping station that stores the wastewater being pumped.

SECTION 2: LIFT STATION CONFIGURATION

2.01 New Lift Station Construction and Replacement Design

1. The Design Engineer shall complete designs in accordance with these guidelines and applicable regulatory requirements, best practices, and national standards.
2. General Lift Station Configuration Guidance
   a. It is NBU's preference that all sanitary sewer lift stations be of the submersible type; see **Figure 1**. The layout of these lift stations shall account for the need to install a wet well, electrical service/control equipment, an electrical transformer, an onsite electrical emergency generator, and provide onsite parking. However, NBU recognizes that local circumstances may preclude the use of this type of lift station and a wet pit/dry pit configuration may be more appropriate. As such, the Design Engineer shall conduct a review of the conditions affecting lift station design and provide recommendations regarding lift station configuration.
   b. Prior to the development of construction plans, an electronic copy of the BODR shall be submitted to NBU for review and acceptance of the lift station design and all related line work. The BODR, at a minimum, shall include the following:
      i. Justification for the proposed lift station. The report must clearly show that gravity lines are not available and are not physically or economically feasible, and that the number of proposed lift stations has been minimized. As stated in Section 1, this analysis must include a cost-benefit review of gravity sewers versus the lift station and include 30 years of anticipated operation and maintenance cost in the analysis. It must also include all engineering calculations that justify the proposed lift station sizing.
      ii. A master development plan for the service area of the proposed lift station. This plan shall include a map showing the location of the lift station, its service area, and the boundaries of the sewer drainage basin in which it is located. It must also show the location of the nearest existing wastewater interceptor serving the basin and/or the discharge point as dictated by NBU.
      iii. In those instances where a wet pit/dry pit lift station is proposed, the Design Engineer must submit cost comparisons for submersible lift stations versus wet pit/dry pit lift stations. The cost analysis should include initial construction cost, as well as estimates regarding operation and maintenance costs for a period not to exceed ten (10) years beyond initial construction.
   c. Upon NBU acceptance of the BODR, the Design Engineer shall develop plans that fully describe all construction requirements associated with the new lift station.
   d. The Design Engineer shall also prepare, edit, and supplement the NBU Standard Specifications, as needed, for the specific project. The Design Engineer shall delete, via strikethroughs, references to materials or equipment included in the specifications that are not used for the specific project.

e. Design documents must be sealed and signed by a Texas Licensed Professional Engineer qualified to perform wastewater lift station design.

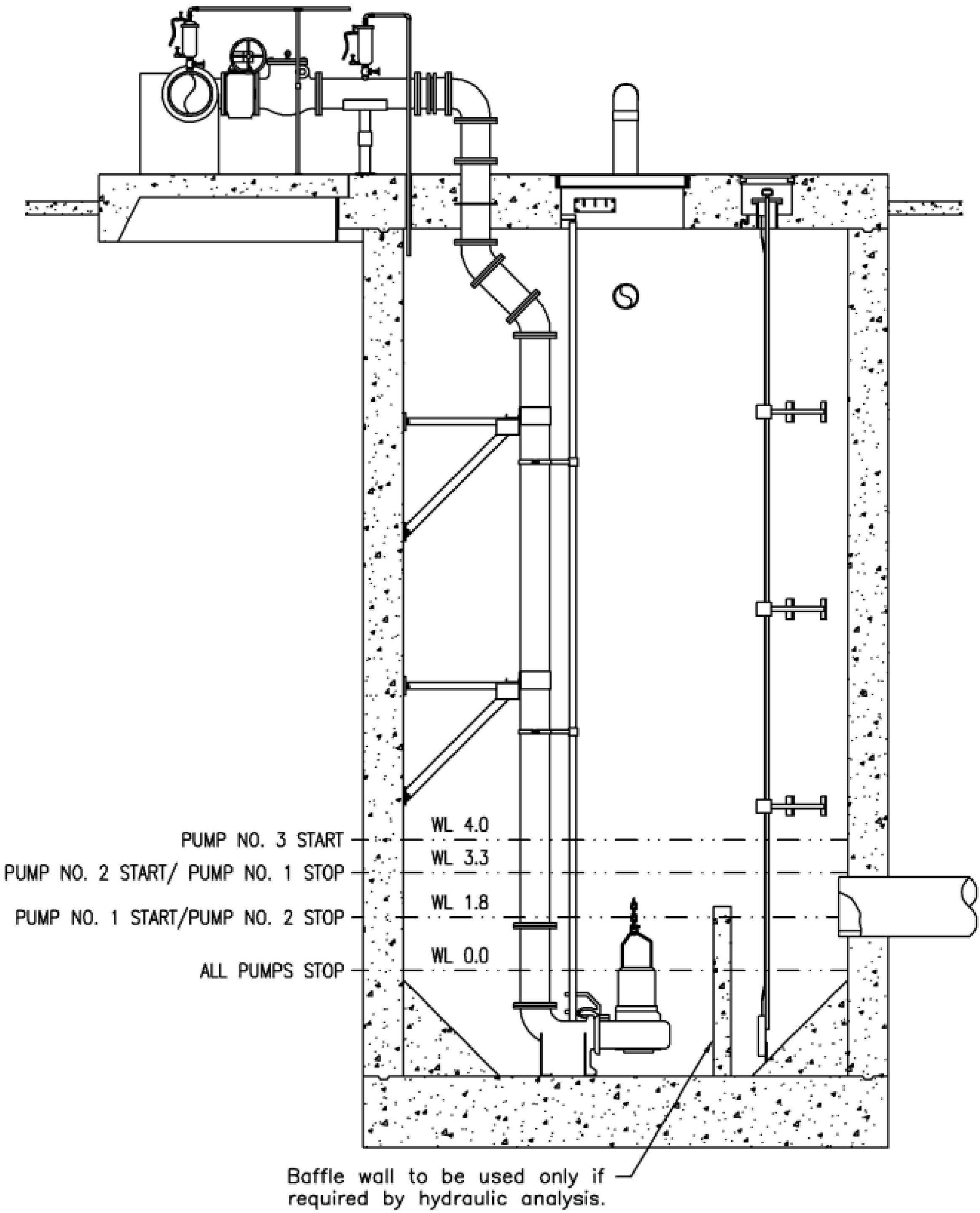

Figure 1. General elevation of a wastewater lift showing pump level controls. Note: influent pipe invert should be above "all pumps on" level.

SECTION 3: SITE REQUIREMENTS

3.01 Lift Station Site Selection and Use

1. The evaluation of sites for selection and use for wastewater lift stations shall address the following:

   a. Visual impact on the neighborhood. Sufficient setback from the property line to the fence line should be provided to accommodate a buffer. In all cases, the setback from property lines, as required by CoNB ordinances, should be followed.

   b. Site access. Access to areas of the site to allow for staging and positioning of vehicles and equipment needed to install and remove pumping equipment from the wet well is to be provided. Where possible, access paths from the right of way to the lift station gate shall be straight with no 90-degree turns required to enter the site (e.g. at the ends of cul-de-sacs or knuckles). Alternatives will be evaluated on a case-by-case basis. Paved areas shall be sufficient to accommodate lifting and maintenance equipment and vehicles. Access areas are to be paved and shall have suitable cross sections that are designed in accordance with anticipated traffic requirements, local soil conditions, and the recommendations of a qualified professional geotechnical engineer. Maximum running slope of the access path shall be 10%, with no greater than 8% grade break.

   c. Safety and security. All lift station sites are to be selected with site safety and site security in mind.

      i. The Design Engineer shall contact the NBU Security Department to verify security requirements for the new lift station.

   d. Structure depth. Structure depth and its potential impact on adjacent areas, including construction activities that include excavation and material storage, is to be evaluated. Note that structure depth is to be minimized in order to minimize facility cost.

   e. Location of the site with respect to FEMA floodplain and floodway zones. Lift stations are to be located outside of the 100-year floodplain in accordance with TCEQ requirements or, if this cannot be accommodated, flood-proofed against the impacts of a 100-year storm.

2. The site of the lift station is to be located on a full parcel of land, with transfer of ownership and title to NBU upon acceptance of the lift station. The lift station site shall not be located in:

   a. Street rights-of-way;

   b. Easements;

   c. Areas where future maintenance access, security, or odor mitigation could become difficult; or

   d. Sites that cannot be accessed during a regulatory flood event as per the latest TCEQ regulation and based on the most recent FEMA floodplain map for the area. The lift station site shall be at least two (2) feet above the calculated ultimate 1% floodplain elevation.

3. At least 5-feet of clearance between the property lines of a lift station site and its perimeter wall line is to be provided.
4. To the maximum extent possible, lift stations are to be oriented such that sources of potential odor release, such as wet well vents, do not adversely affect adjacent areas where sensitive equipment, such as electrical switchgear, communication/SCADA equipment, or building air intakes are located.
5. Lift stations located in residential areas shall be placed on an entire utility lot.

3.02 Access

1. Design the site pavement geometry in a manner that will allow a 45-foot long, non-articulating vehicle to safely turn around within the site (Refer to **Figure 2**).
2. Lift stations shall be accessible by vacuum truck during all weather conditions, including a 25-year, 24-hour rainfall event.
3. Sites with proposed chemical storage tanks shall provide appropriate pavement geometry such that a chemical delivery truck does not block the main roadway when making a delivery.
4. Lift station facilities are to be located on a site such that overhead power lines will not interfere with the use of cranes for pump removal.
5. Pavements within the lift station site will be reinforced concrete meeting HS-20 loading requirements. At a minimum, pavement thicknesses should be designed in accordance with site conditions as defined by the project’s geotechnical engineer and shall accommodate the loading exerted by the largest service/delivery truck expected to visit the site and the frequency of their expected visits.

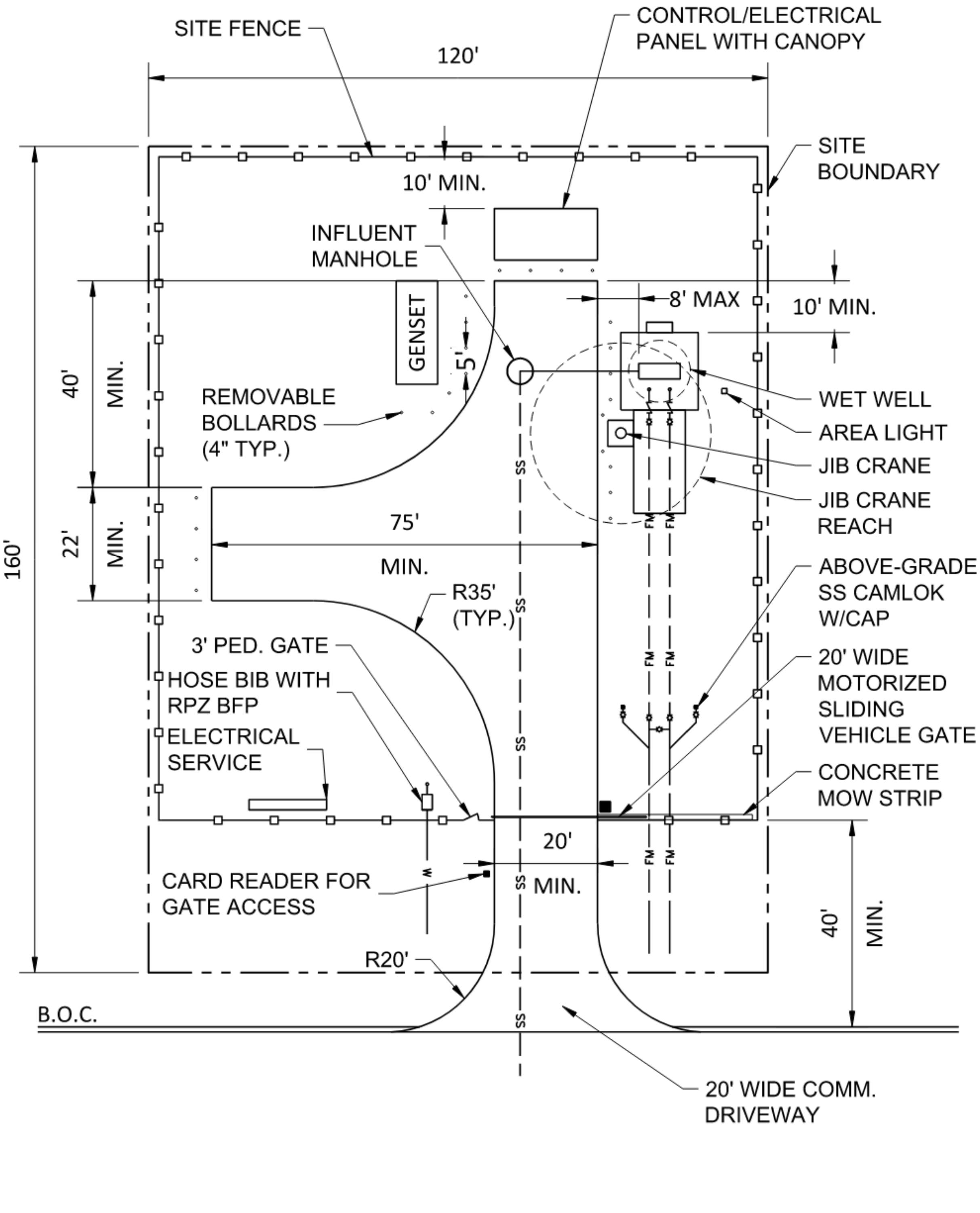

Figure 2. Acceptable lift station site configuration.

3.03 Site Security

1. The site security system shall meet all requirements of the latest version of TCEQ Chapter 217 and the requirements of New Braunfels Utilities.
2. At a minimum, site security shall be provided by a full-perimeter 8-foot high concrete or Fencecrete-style wall of an architectural style consistent with the area in which the lift station is located. Site access shall be provided through a 20-foot wide, single leaf, automated, sliding security gate per NBU Standard Detail 431. The gate will be controlled by security badge reader(s) or passcode that will activate the gate upon successfully reading an active NBU security badge or passcode fastened to a gooseneck mount. The wall shall also include a pedestrian gate, easily accessed from the entrance drive and secured with a chain and padlock.
3. Access Control
   a. Single gates and doors shall be controlled via Open Options DController or approved equal. Multiple gates and doors shall be controlled via Open Options Intelligent Two-Door Controller or approved equal.
4. The site will be equipped with security cameras that will provide 24-hour observation of critical areas within the lift station site. Camera(s) shall be Axis Q6010-E models or approved equal. Such areas include:
   a. Lift station entrance and exit locations.
   b. Process areas to include wet wells, external pump locations, generators, and SCADA control cabinets.
   c. Parking areas within the lift station site.
5. Network devices shall be Cisco IE3300 with appropriate SFP modules and expansion modules as necessary, and must be approved by NBU IT Department.
6. Site signage required shall include the following information at a minimum:
   a. Name of site, “authorized personnel only” warning, and “video surveillance” notice posted on entrance(s) to the site.
   b. Confined space warnings on applicable confined spaces.
   c. Other safety and security signage as required to TCEQ and NBU safety standards.
7. Other intrusion prevention measures will be considered on a case-by-case basis.

3.04 Landscaping

1. At a minimum, the lift station design shall provide landscaping that meets the requirements described below.
   a. All disturbed areas outside the lift station security wall are to be revegetated using hulled Bermuda seed hydromulching applied at a rate equal to 45 lbs/acre.

b. There is to be no landscaping within the security wall. All areas beyond the limits of required pavements are to be covered with crushed stone base to the lines and grades indicated on the Drawings or established by the Design Engineer.

3.05 Floodplain/Floodway

1. The Design Engineer shall design the lift station in accordance with the drainage design criteria of the City of New Braunfels, latest revision.
2. Stormwater systems are to be designed to meet the requirements of a 25-year storm frequency and shall allow drainage from a 100-year storm to safely pass through the site without causing damage to civil, mechanical, electrical, or communication systems within the lift station. Such systems should also be designed to be prevent the release of contaminants that may be inadvertently spilled on drainable surfaces within the lift station site.
3. Care should be taken so that stormwater runoff from the lift station site does not create adverse impacts for adjacent and downstream properties.
4. The lift station design shall include storage capacity, backfill requirements based on the site geotechnical report, buoyancy calculations, pump and valve selections, force main capacity calculations, gravity main capacity calculations, electrical and SCADA requirements, and meet the design report requirements for TCEQ. Buoyancy calculations shall show a minimum 1.5 factor of safety for the lift station wet well.

3.06 Odor Control

1. Odor control systems should be considered and addressed in the BODR. The Design Engineer shall provide engineering calculations that define the level of potential hydrogen sulfide generation in the force main and wet well. As a standard practice, the wet well retention time and force main flush time should not exceed 180 minutes. If needed, the following odor control methods should be considered:
   a. Chemical feed systems should be considered for new lift stations that have discharge force mains longer than 2,000 feet. These systems include ferrous sulfate or calcium nitrate that may be fed directly into an upstream manhole, the lift station wet well, or the force main in that order of preference. These systems typically consist of chemical storage tanks, chemical metering pump(s), pump calibration equipment, and associated piping and controls. An eye wash station shall also be provided.
   b. Other systems that may be considered include:
      i. Activated carbon cannisters for use on the wet well vent pipe.
      ii. Biofilters.

3.07 Corrosion Control

1. The lift station design shall include provisions for corrosion control protection for structural steel systems and fasteners, HVAC systems, electrical and mechanical

systems, and all other components that may be affected by the corrosive environment within the lift station.

2. Pumps, Piping, and Valve Corrosion Protection

   a. Exposed ferrous surfaces of pumps, piping, and valves located outside of the wet well shall receive a 100-percent solids epoxy coating system with a top coat system of urethane, suitable for the environment to which it is exposed. The coating shall be applied in accordance with the manufacturer's instructions. Acceptable manufacturers include Tnemec, Carboline, and Sherwin-Williams.

   b. Ferrous surfaces of pipes and fittings within the wet well, except SS 316 and PVC, shall receive a 100% solids coal tar epoxy coating system applied in accordance with manufacturer's instructions. Acceptable manufacturers include Tnemec, Carboline, and Sherwin-Williams. Color coding for internal piping shall be as set forth in the table shown below.

   c. Force mains shall be (a) ASTM D2241 SDR 21 PVC, (b) AWWA C900 PVC DR 21, (c) DR-11 HDPE, or (d) ductile iron. All plastic pipe shall be rated for minimum 200 psi.

Lift Station Internal Piping Color Codes

Equipment to Coated	**Color**
Force main and sanitary sewer	Green
All other conduits and piping	Gray

SECTION 4: LIFT STATION HYDRAULIC DESIGN

4.01 System Head and Pump Capacity Curves

1. System Head Curves

   a. Piping head losses shall be calculated in accordance with the Hydraulic Institute Standards in connection with head losses through the lift station piping and valves.

   b. The Hazen-Williams "C" factors used in the calculation of friction head losses shall be based on the lift station and force main pipe material and condition.

      i. The Design Engineer shall confirm the appropriate "C" factors over the design life of the force main and develop and analyze hydraulic system curves for the low water, high water, and flooded wet well levels.

      ii. Data points for the system capacity curve shall be provided in tabular form and graphed with pump head capacity curve on the same graph. Two system capacity curves shall be plotted, using Hazen Williams values for (1) new and (2) aged pipe (typical values: C=140 and C=100).

   c. The pump motors shall be non-overloading over the entire range of pumping, including the ability to pump into the force main under a flooded wet well condition. For NBU CIP projects, the Design Engineer shall coordinate the flooded wet well level with the NBU project manager. The water surface elevation for the flooded condition will be the lower of lowest adjacent influent upstream manhole rim or the underside of the top slab of the lift station wet well.

   d. Pump curves shall be plotted through the full range of operation including the shut-off head and the runout at the lowest total dynamic head condition per the manufacturer's product recommendations. Pump curves shall be plotted for each pump, and each combination of pumps up to firm capacity; the "all pumps on" scenario shall be excluded from the pump curves combinations. Pump curves shall also be shown for alternate impellers, if smaller impellers are provided for flows lower than the ultimate design flow.

   e. The Design Engineer should select and specify pumps for the best and most efficient operating point. When two (2) or more pumps are operating together for the maximum flow condition, care should be taken to assure that each pump will not operate near its shut-off or runout point. For best results, pumps should not be operated at less than 75% of the best efficiency point flowrate nor be extended to beyond 115% of that flowrate. This requirement may be achieved by changing the pump selection or force main size, or both.

   f. The Design Engineer shall calculate static head for "Pump On" and "Pump Off" elevations in the wet well.

   g. The Design Engineer shall provide calculations confirming the NPSH (available) is greater the NPSH (required) for the selected pump(s), as recommended by the

Hydraulic Institute, in order to prevent cavitation. The NPSH shall be calculated using the following equation:

$$NPSH_A = P_B + H_S - P_v - H_{fs}$$

where:

*P_B = absolute barometric pressure (ft)

H_S = minimum static suction head (ft)

*P_v = absolute vapor pressure of liquid (ft), and

H_{fs} = friction loss in suction (ft).

*A barometric pressure of 33.4 ft and a vapor pressure of 1.4 ft may be used. These values are based on the following assumptions: an altitude of 500 feet above sea level, a water temperature of 85°F and a specific gravity of water of 0.996 at 85°F.

h. The maximum time to flush the force main shall be calculated on the basis of average dry weather flow. Flush time shall be calculated using the following equations:

$$T_{flush} = (t_f + t_e) * \frac{Force\ main\ length}{\left(\frac{t_c}{2}\right) * v_{fm} * 60}$$

where:

i = average dry weather flow (gpm)

V = active volume of the wet well (gallons)

t_f = V/i = time to fill wet well (min)

q = flowrate of pump(s) (gpm)

t_e = V/(q-i) = time to empty wet well (min)

v_{fm} = flow velocity in the force main (feet per second)

t_c = pump cycle time (min)

4.02 Wet Well Design

1. The wet well shall be at least 72 inches in diameter. A hatch and safety grating shall be required over each pump. The hatch and safety grating shall comply with NBU specification section 523.
2. The wet well design must allow for a flooded suction condition of the pump motor regardless of the pump motor design under all operating conditions. The wet well must also provide additional volume for an emergency condition that includes a power failure of 60 minutes at peak daily flow. This condition begins with the “Lead Pump-On” level within the wet well, and is measured to 2-ft below the wastewater spill level elevation,

which is determined by the manhole located upstream of the wet well with the lowest top elevation or by the wet well top slab elevation, whichever is lower.

3. Preferably, wet wells shall have one influent sewer entering the wet well, with an upstream influent manhole on the lift station site within 100 feet of the wet well. The inflow pipe shall be straight for a minimum length of 10 pipe diameters before entering the wet well. The gravity sewer from this upstream manhole to the wet well will be the next larger nominal diameter above the diameter of the gravity sewer entering the influent manhole.

4. The wet well lid shall be constructed with provisions to allow for (1) installation of an aerator; or (2) installation of a flush-mounted cap with 2-inch port for future installation of an aerator by NBU. The aerator equipment or flush-mounted cap and port shall be designed to prevent trip hazards to personnel.

5. The bottom of the wet well shall have a minimum slope of 10 percent towards the pump intake and shall have a smooth finish in order to become a self-cleaning wet well. There shall be no projections in the wet well that create deposition of solids. Anti-vortex baffling shall be included on all lift stations with peak flow greater than 3 mgd.

6. Wet wells shall be constructed of polymer concrete meeting the requirements of NBU specifications. Wet wells constructed of Portland concrete cement with corrosion-resistant linings or coatings shall not be permitted. Concrete wet wells shall be Armorock, US Composite Pipe, or approved equal.

7. Minimum Wet Well Volume

   a. The formula for the active wet well volume is:

$$V = \frac{T(\text{min}) * \text{Q(peak)}}{4 * 7.481}$$

   where:

   T(min) = minimum cycle time (min)

   Q(peak) = pump capacity (gpm), and

   V = active volume of the wet well (ft^3).

8. Wet Well Testing. An exfiltration test must be performed immediately after the wet well has been backfilled and compacted. Exfiltration must not exceed 0.142 gallons per hour per foot of diameter per foot of depth. The test must be done by plugging the gravity invert and filling up the wet well with water to either 1-ft below the wet well top slab, or up to the manhole lid with the lowest elevation below the top slab. This level must be clearly marked on the wet well wall. After filling, the wet well is left to stabilize for 48 hours before conducting the test. After stabilization, the wet well is refilled to the mark left on the wall. The test is then run for two hours, minimum, and no water is added. After two hours, the wet well is refilled to the mark. The amount of water necessary to reach the mark is carefully measured. The maximum allowable water loss is determined by the following equation:

$$Water\ Loss\ (gallons) = 0.0142tDh$$

where:

t = test time (2 hours)

D = wet well diameter (ft), and

h = water level depth within the wet well after 2 hours (ft).

If the test fails, the Design Engineer must work with the Construction Contractor to determine what corrective actions may be necessary to make the wet well watertight.

4.03 Wet Well Levels

1. Wet well levels for pump operation should be set to minimize the vertical drop of wastewater into the wet well. All “Pump On” levels shall be set below the invert of the influent sewer so as not to surcharge the influent sewer. All “Pump On” levels are to have a minimum separation between levels of one (1) foot. All “Pump Off” levels shall be at least six (6) inches above the top of the pump casing. For lift stations with more than two (2) pumps, the “Pump Off” levels shall be staged with a minimum separation of one (1) foot between levels.
2. Minimum cycle times shall be accomplished without the water surface elevation at the “all pumps off” level dropping to be less than 6-inches above the top of the pump motor.
3. Wet Well Detention Time. Detention times in the wet well shall be calculated for (a) peak wet weather flow, (b) peak dry weather flow, (c) average dry weather flow, and (d) minimum dry weather flow (maximum detention time) using the following equation.

$$T_d = t_f + t_e$$

where:

V = volume of the wet well between “pump on” and “pump off” elevations (gal)

i = flow into the station corresponding to maximum wet weather flow, maximum dry weather flow, or average dry weather flow (gpm)

q = pump capacity (gpm)

t_f = V/i = time to fill the wet well (min)

t_e = V/(q-i) = time to empty the wet well (min)

4.04 Lift Station Bypass

1. The Design Engineer shall design a connection to the discharge force main to permit connection of a portable pump discharge for use in emergency conditions or during lift station maintenance.
   a. The design shall provide an influent manhole within the lift station site located within 100 feet of the wet well to serve as a dewatering pump suction well.
   b. The Design Engineer shall provide a bypass wye and valve within the lift station site past the discharge manifold. The valve shall be located a maximum of 20’ upstream

of the wye on the force main. The design shall include bypass piping connected to the wye and an isolation valve.

4.05 Water Hammer

1. Surge control measures shall be provided when pressures, including those due to water hammer, exceed the pressure rating of the pipe. Calculations for water hammer showing maximum pressures, which would occur upon total power failure while pumping, shall be provided using the following equation:

$$p = \frac{a * v}{2.31 * g}$$

$$a = \frac{12}{\{\left(\frac{w}{g}\right) * \left[\left(\frac{1}{k}\right) + \left(\frac{d}{E * t}\right)\right]\}^{0.5}}$$

where:

p = water hammer pressure (psi)

a = pressure wave velocity (fps)

w = specific weight of water (62.4 lb/ft^3)

g = acceleration of gravity (32.2 ft/s^2)

k = bulk modulus of water (300,000 psi)

d = inside diameter of pipe (in)

E = Young’s modulus of pipe (psi)

t = pipe wall thickness (in)

v = flow velocity in pipe (fps)

L = length of force main (ft)

SECTION 5: MECHANICAL DESIGN

5.01 General

1. This section describes procedures for designing cooling, ventilation, and plumbing systems for NBU wastewater lift stations.
2. The wet well of the lift station is an unoccupied structure. The submersible pumps located within the wet well are to be capable of removal through the use of a rail-guided system without the necessity of entering the wet well. Pump removal by use of guide cables is not authorized.
3. Valving is not to be located within the wet well. Access to valves is to comply with OSHA section 1910.
4. Buildings that contain control and electrical equipment are to be provided with proper cooling equipment to prevent overheating and equipment malfunction caused by heat gain.
5. The mechanical design of the lift station shall comply with applicable criteria from the latest versions of TCEQ, Chapter 217 and NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
6. All exposed piping from the isolation valve to the discharge header shall be flanged piping without thrust-rod tie elements.
7. A permanent motorized jib crane or monorail/bridge crane system will be required on the site if weight of equipment to be maintained (including pumps, motors, valves, etc.) produces a moment in excess of 3,200 lbs at 6 feet of boom.
8. Each pump shall have a separate suction pipe, and suction piping shall have a velocity of three (3) to five (5) feet per second. All suction pipes inside the wet well shall be equipped with a flare-type, down-turned intake. The distance between the bottom of the flare and the floor shall be between D/3 and D/2, where D = diameter of the flare inlet.

5.02 Pump Selection

1. Note that pump selection shall be based on the hydraulic requirements of the lift station and force main, as discussed in Section 4, and as presented in the BODR. In addition to the hydraulic requirements, pump selection shall also be based on consideration of the overall serviceability record of the pumps and the cost of external maintenance service contracts.
2. All pumps shall be electrically motor driven, centrifugal non-clogging pumps with minimum 4-inch diameter suction and discharge openings. The minimum number of pumps that are required in a lift station shall be as shown below.

Peak Wet Weather Flow Capacity	Minimum Number of Pumps
500 gpm or less	2 pumps: 1 lead, 1 standby
501 gpm to 1200 gpm	3 pumps: 1 lead, 1 lag, 1 standby
1200 gpm to 3000 gpm	4 pumps: 1 lead, 2 lag, 1 standby
Over 3001 gpm	5 pumps: 1 lead, 2 lag, 2 standby

3. Self-priming pumps must be capable of priming without reliance upon separate priming systems, an internal flap valve, or any external means for priming. They shall include inspection and cleanout plates located on both suction and discharge sides of each pump to facilitate locating and removing blockages and will vent air back into the wet well during priming.
4. Pumps with the highest efficiencies at all operating points shall be used.
5. If pumps are equipped with smaller impellers during start-up to handle flows lower than the ultimate design flows, impellers sized to handle the design flow shall also be provided upon final acceptance.
6. Pump motors shall provide for continuous operation and inverter-duty type at full nameplate load while the motor is fully submerged, partially submerged, and totally non-submerged.
7. Pumps shall be capable of meeting all system hydraulic conditions without overloading the motors. Pump duty points for nominal design flow shall be within 75 and 115 percent of the pump’s flowrate at its best efficiency point.
8. The minimum pump cycle times shall not be less than those shown in the table below.

Pump Horsepower	Minimum Wet Well Cycling Based on Peak Wet Weather Flow	Minimum Wet Well Cycling Based on Average Daily Flow
Less than 30	10 minutes: 3 minutes for fill, 7 minutes for empty	13 minutes: 10 minutes for fill, 3 minutes for empty
Between 30 and 75	17 minutes: 6 minutes for fill, 11 minutes for empty	22 minutes: 17 minutes for fill, 5 minutes for empty
Over 75	25 minutes: 8 minutes for fill, 17 minutes for empty	32 minutes: 25 minutes for fill, 7 minutes for empty

9. For NBU CIP projects, the Design Engineer will include at least three (3) different pump manufacturers and provisions for product substitutions of an “APPROVED EQUAL” in the project specifications, in coordination with NBU Water Engineering.

10. Submersible Lift Stations

a. The submersible lift station configuration is the preferred configuration for NBU wastewater lift stations.

b. The lift station shall consist of submersible centrifugal wastewater pumps, stainless steel 316 guide rail system, wet well access, discharge seal and elbow, motor control center, starters, level control system, SCADA monitoring system, data transmission system (fiber optic cable), and all hardware necessary to provide a functional system. Every integral component of the guide system shall be stainless steel 316. Flanged discharges are not acceptable.

c. Pump impellers shall be non-clog and constructed of stainless steel or ductile iron. NBU may require vortex or recessed impellers for high clog potential applications. Mechanical seals shall be tungsten carbide.

d. Motor insulation shall be Class H, inverter duty type, and have a minimum service factor of 1.15.

e. The pump duty point shall be within 75% to 115% of the pump's flowrate at its best efficiency point for one and two pumps in operation as defined in the BODR. Approved pump manufacturers include Flygt, Gorman Rupp, and KSB. Substitutions may be allowed upon review and coordination as a result of the pre-design meeting.

f. Pumps shall be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well.

g. The Design Engineer should calculate the suction specific speed of the pumps using the following formula:

$$SSS = \frac{R * (Q)^{0.5}}{H^{0.75}}$$

where:

SSS = suction specific speed (rpm)

Q = flow at the best efficiency point (gpm)

H = net positive suction head required at maximum impeller speed (ft)

R = speed of pump and motor (rpm)

h. In order to ensure the pump shaft does not bend an excessive amount, the engineer shall calculate the stiffness ratio of the shaft using the following equation. The stiffness ratio shall not exceed 60 in^{-1}:

$$Stiffness\ Ratio = L^3/D^4$$

where:

L = distance from the impeller centerline to the centerline of the inboard bearing (in)

D = diameter of shaft (in)

i. Calculate the brake horsepower using the most efficient pumps for the application, using the following equation:

$$BHP = \frac{P}{pump\ efficiency}$$

where:

BHP = braking horsepower (hp)

P = water horsepower (hp)

Calculate the electrical horsepower required using the most efficient motors for the application, using the following equation:

$$EHP = \frac{BHP}{motor\ efficiency}$$

Calculate the power required in kilowatts using the following equation:

$$EkW = (EHP) * 0.746$$

Calculate daily power consumption in kilowatt-hours using the following equation series:

$$E = [(EKW_1) * (t_1) + (EKW_2) * (t_2) + (EKW_3) + (t_3) + ...]$$

where:

E = total power consumption (kWh per day)

EKW_n = power required for pumps 1, 2, . . . , n (kW)

t_n = estimated pump run time for pumps 1, 2, . . . , n (hours per day)

Calculate the estimated cost of power consumption over the life of the station using the following equation:

$$C = (E) * (\$0.06/kWh) * (T)$$

where:

C = cost of power over the life of the station ($)

E = power consumption (kWh/day)

T = time the station is expected to be in service (days)

j. Stress and thrust calculations for internal station piping and bends shall be provided for stations with flows over 1,000 gpm.

5.03 Valves

1. Isolation valves shall be plug valves for service in a force main application when the liquid being pumped contains gritty material. Gate valves are not to be used in

wastewater applications as the gritty material prevents proper gate seating. Acceptable manufacturers include Clow, Mueller, and Kennedy.

2. Check valves.
    a. Check valves shall be swing-type with external lever, suitable for use in wastewater applications, as wafer body valves are not to be used for wastewater applications. Ball-type check valves are not permitted.
    b. For pump systems that generate downstream pressures of 30 psi or less, the maximum velocity through a non-spring loaded or counter-weighted check valve should not exceed 3 fps. It may be increased to 5 fps for check valves that are spring loaded or counter weighted to prevent valve slamming. For pump systems that have heads greater than 30 psi, cushioned swing check valves should be used. However, please note that cushioned swing check valves do not eliminate pressure surges when the valve is suddenly closed as they only reduce the slamming noise.
3. Air/Vacuum Release Valves - The location and sizing of air/vacuum release valves along force main routes and at the lift station discharge piping shall be determined by the Design Engineer and described in the BODR. As a rule, they shall be mounted on a common header and be located at all high points along force mains. They shall be rated for raw wastewater use and have a minimum 2" inlet and be provided with flush ports. They shall be sized for intended system hydraulics with related sizing calculations to be included in the BODR.
4. Surge Relief Valves
    a. Surge relief valves are typically installed at lift stations to protect the pumps, piping, valves, and other equipment from potential damage caused by surge pressures. If required, surge relief valves should be sized to release excess surge flows through the valve either on the basis of system flow or so that pressure measured at the relief valve will be lower than the lowest pressure rating of the equipment they are protecting.
    b. Surge relief valves are to be located downstream of the pump control valve/check valve or on the main discharge header as close to the pump(s) as practical. Surge relief valves typically discharge back into the wet well.
    c. Consideration should be given to providing two (2) or more, smaller sized valves having a total combined capacity equal to or greater than a single larger sized valve.
    d. Whenever several valves are provided, it is advisable that each valve's pressure setting be slightly higher than the adjacent valve allowing the valves to open in sequence instead of all at once. It should be noted that all surge relief valves are field adjustable and their pressure relief setting range is determined when the valves are ordered from the manufacturer.

5.04 Plumbing

1. A potable water supply is to be provided for use during repairs and for washing down equipment. Water should be provided through a 1-inch diameter supply line and meter. A non-freeze type hose bib is to be located near the wet well.
2. All potable water is to be metered and supplied through a reduced pressure backflow preventer for the protection of NBU water mains from possible contamination due to cross-connections.
3. All above-grade water supply piping, fittings, and appurtenances are to be insulated and protected against freezing caused by cold weather. The complete backflow preventer assembly shall be provided with a "Hot Box"-type vandal-proof enclosure and equipped with provisions for servicing and checking the equipment contained within it. Insulated enclosures are to be constructed of stainless steel or anodized aluminum.

5.05 Air Conditioning

1. Control buildings, if required, will house motor control centers, electrical panels, transformers, and other equipment for operating pumps located in wet wells.
2. Removing heat by forced ventilation should be considered when it is not possible to maintain indoor temperatures not exceeding 100 degrees at all times. If this is not possible, then controlling indoor temperatures shall be accomplished by providing mechanical cooling units.
3. Mechanical cooling units shall be designed to meet the following requirements:
   a. Mechanical units will be provided with a protective coating to prevent corrosion. The coating is to cover all parts that are in contact with outdoor air including the casing, heat transfer coils, refrigerant tubing, and other associated electrical equipment. Mechanical cooling units shall be wall-mounted package type units.
   b. When sizing the cooling unit, all instantaneous sources of heat gain must be accounted for. The design basis for the cooling system shall consider all pumps running with the outdoor temperature equal to 100 degrees, Fahrenheit (F). Cooling units shall be sized to maintain an indoor temperature of 85 degrees (F) or less at a 40 percent specific humidity at maximum heat gain.
4. Solar and transmitted heat gain calculations must be in accordance with the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook of Fundamentals. The outdoor temperature listed in the ASHRAE Guide must be adjusted for outdoor temperatures encountered in New Braunfels, Texas.
5. Unit selection should be based on a terminal wall-mounted heat pump type mechanical cooling unit having a minimum 13,000 BTUH sensible cooling capacity at 105 degrees (F) outdoor air temperature at 77 degrees (F) wet bulb temperature and an air temperature of 85 degrees (F) dry bulb and 66 degrees (F) wet bulb entering the cooling coil.

6. The air conditioning unit is to be controlled through a room-type thermostat set to maintain the room air temperature at approximately 80 degrees (F). The unit fan shall run continuously when the unit control switch is in the “on” position.

5.06 Ventilation

1. Avoid ventilation through panels due to resulting corrosion issues. Use 316 stainless steel panels instead of aluminum panels at exterior locations. All ventilation fans are to be coated with a corrosion resistant material.
2. Wet Well Ventilation
   a. The ventilation for a wet well is to be designed as a passive system in which the air volume decreases or increases based on rising and falling water levels. Air is pulled into the wet well as water levels within the wet well fall and it is expelled from the wet well as water levels rise. The passive ventilation pipe is sized to allow an inflow volume of air equal to the maximum liquid pumping rate out of the well; however, the air flow velocity through the vent pipe is not to exceed 60 feet per minute (fpm). In no case, shall the vent pipe diameter be less than 6 inches. Also, vents shall have stainless steel insect screens of 16-gauge 316SS mesh that are easily replaced, and be designed so that they do not allow rain to enter the wet well.

SECTION 6: ELECTRICAL DESIGN

6.01 Design Standards

1. Design electrical systems in conformance with the National Electric Code (NEC) as adopted by the City of New Braunfels.
2. Design electrical systems in conformance with the City of New Braunfels Building Code. Lighting systems are to be designed in accordance with the Illuminating Engineering Society (IES) Handbook.
3. Design facilities in accordance with the National Fire Protection Code (NFPA) 820 for ventilation according to NEC hazardous area classification requirements and the requirements in paragraph 5.06, above.
4. Design lightning protection requirements in accordance with NFPA 780.

6.02 Basis of Design

1. The Design Engineer shall prepare a Preliminary Electrical Design Report (PEDR) that establishes the basis of electrical design. This may be a standalone report, or a section within the overall BODR. The report shall confirm the following:
   a. Number and size of pumps (gpm, horsepower, and electrical demand in kilowatts).
   b. Location of electrical junction box(s) above grade or in vault.
   c. Emergency power systems with automatic transfer switch systems for alternate power generation and distribution in an emergency.
   d. Provides a motor starting analysis and maximum short circuit calculations. Lists maximum short circuit amperage on the drawings and specifies the method of calculation (i.e. point to point or IEEE).
   e. The Design Engineer shall specify that the Contractor shall provide a Power System Study and arc fault labeling according to NEC 110.24. The Power System Study specification section shall be included with the construction bid documents.

6.03 Electrical Drawing Set

1. As a minimum, electrical construction plans shall contain the following electrical drawings:
   a. Electrical Symbols Legend, Lighting Fixture Schedule and Abbreviations.
   b. Electrical Site Plan, including grounding and outdoor lighting around the property.
   c. Power and Control Rack Plan and Details.
   d. Underground Conduit Routing Plan.
   e. Electrical Design Details.
   f. If applicable, Control Building Plan and Details (for sites with control buildings).

g. Control Cabinet Enclosure.
h. Control Cabinet Elevations.
i. Control Cabinet Equipment Layout and Schedule.
j. Process and Instrumentation Diagram(s).
k. Control System Wiring Diagrams.
l. Motor Control Center (MCC) and Programmable Logic Controller (PLC) Power Schematic Wiring Diagrams.
m. Communication Diagram.
n. Single Line Diagram.
o. Cable and Conduit Schedule.
p. Device Rating Schedule.
q. MCC Elevation.

6.04 Electrical Equipment

1. Electrical services shall be 277/480-volt, 3-phase, and 4-wire, unless otherwise accepted by NBU. Minimum service size shall be 200 amps. The general lighting and power transformer shall be at least 10 KVA, and shall be housed with a load center in a separate stainless-steel enclosure. Requests for a smaller electrical service shall be reviewed by NBU and considered for approval on a case-by-case basis. All enclosures shall be white enameled stainless steel 316, rated NEMA 4X with level door closures and aluminum dead-front covers. The pump control enclosure shall be of the double door type so as to locate all 480V equipment on the right side and all 120V equipment on the left side. Single-phase systems are not allowed. Use the following color scheme:

Wiring Color Scheme

480Y/277 Volts		**120/240 Volts**		**24Vdc**	
Phase A	Purple	Phase A	Black	Positive	Orange
Phase B	Brown	Phase B	Red (Orange)	Negative	White with Orange
Phase C	Yellow	Phase C	Blue		
Neutral	White	Neutral	White		
Ground	Green	Ground	Green		

2. Conductors for power shall be stranded copper, rated for 75 degrees (Centigrade), with insulation suitable for dry and wet locations. Sizing of cables is to be done in

accordance with NEC requirements. Power conductors are to be continuous and field splices are not allowed.

3. Wire size for controls shall be #14 AWG copper stranded rated for 90 degrees (Centigrade). Wire size for SCADA controls shall be #16 AWG copper stranded rated for 90 degrees (Centigrade).
4. Due to the potential presence of hydrogen sulfide gas, as well as other corrosive gases, greases, oils, and other constituents present in wastewater, all mounting hardware shall be type 316 stainless steel and seal-offs are to be installed in conduits leading into pump control panels and junction boxes. Also, all enclosures and disconnects shall be lockable with a padlock.
5. The main electrical disconnect shall be housed in either a separate NEMA 4X, stainless steel enclosure and shall be equal to Square D, Class 3110, 600-volt class, heavy duty, service rated safety switch, NEMA 4X, with all copper current carrying parts, Model H36_DS. Provide with fusing class size based on the characteristics of the motor loads served and the available fault current. The main electrical disconnect shall be a time delay fuse or a time delay circuit breaker. Provide a surge arrestor in a separate NEMA 4X, SS316 enclosure mounted on a service pole mounting rack or other suitable support acceptable to NBU. Approved manufacturers include Square D, Siemens, General Electric, and Cutler-Hammer.
6. Electrical equipment shall comply with the latest version of the NFPA National Electrical Code (NEC) requirements for Class 1, Group C and D, Division 1 locations. Additionally, equipment located in wet wells shall be suitable for use in corrosive environments. Each and every flexible cable is to be provided with watertight seals and separate strain relief. High water float switches shall be normally open and will be of the non-mercury type.
7. Free-standing electrical services and automatic transfer switches shall be housed in heavy duty electrical weatherproof, NEMA 4X, stainless steel weatherproof enclosures securely mounted onto a rack located at least 24 inches above the ground. Provide a 120-volt, 20-amp duplex, GFI, receptacle in an “in-use” weatherproof box equipped with a clear cover. Light switches shall also be installed in a weatherproof box with an “in use” clear weatherproof cover.
8. All electrical equipment is to be protected from the 100-year flood event as well as any potential flooding that may occur from the wet well. Electrical equipment shall require a freeboard of at least two (2) feet. If the electrical equipment is raised significantly above the 100-year floodplain elevation, then a platform is to be designed and constructed for access. The platform is to be equipped with handrails for safety and is to have adequate working clearance around the electrical equipment to support required maintenance activities. Steps, equipped with handrails, are to be installed for access.
9. As a minimum, MCCs shall be mounted on a concrete housekeeping pad. All electrical equipment and connections located in wet wells and dry wells shall be rated for Class 1, Division 1 service and shall be explosion-proof.

10. Automatic transfer switches, motor controls, dry-type transformers, load centers, SCADA monitoring systems, and wiring gutters shall be mounted on a single rack protected from rainfall. The mounting rack shall be constructed of type 316 stainless steel strut, 1-1/2 inches, minimum; mounted on a 4-inch diameter galvanized tube that has a minimum pipe wall thickness of ½ inch. Acceptable manufacturers include UNISTRUT, Kindorf, and B-Line. Close all exposed tube ends with appropriately sized plug caps. The electrical service pole is not to be used for supports.
11. A permanent on-site generator shall be required on-site per Texas Senate Bill 3 (87^{th} Legislature, 2021-2022). The generator shall be of the automatic type. Typically, the generator will be diesel fueled. However, if the station is located on the Edwards Aquifer or in the Edwards Aquifer Recharge Zone or its contributing zones and if natural gas service is available, the generator shall be fueled by natural gas.
12. For diesel-fueled generators, the diesel tank shall be base tanks integrated into the generator unit by the manufacturer, provided with double-wall containment, and be sized to provide 10 hours of continuous running time at 100 percent load. The generator's concrete base slab is to be designed to incorporate spill containment to capture any fuel spillage that may occur. The generator shall be provided with 4 feet of all-around clearance and it is to be equipped with a noise control package to minimize sound emissions while it is running. The sound attenuation system will result in measured sound levels not exceeding 78 dB at a distance of 20 feet away from the generator. The Design Engineer is to provide a load analysis with the sequence of motor starting in order to know the motor starting loads and motor running loads. The generator shall have a motor starting capacity sufficient to limit the voltage dip to no more than 15% for any motor starting condition. This analysis is to be included in the BODR. Acceptable generator manufacturers include Kohler, Onan, Caterpillar, and Generac, or as otherwise approved during the pre-design meeting.
13. Provide terminal blocks and panel wiring for future remote start and stop contacts.
14. All underground electrical conduits shall be gray, rigid nonmetallic conduit. Field-manufactured bends are not acceptable. Only fabricated conduit bends are allowed. Buried conduit shall have a cover depth not to exceed 18 to 24 inches. All exposed conduit shall be rigid aluminum.
15. Provide general illumination levels equal to 1.0 foot-candle, on average, in lift station equipment areas. Use LED fixtures for general illumination. Site lighting is not to interfere with camera resolution, including camera aperture. Lighting is to point away from any cameras on site.
16. Motors shall be controlled with variable frequency drives (VFDs) as manufactured by ABB. Acceptable VFD model includes ACQ580 equipped with the Ethernet IP Communication Module, or NBU-approved equal. VFDs must be rated for operation at temperatures equal to 50 degrees (Centigrade) or higher. NBU may allow soft starters in lieu of VFDs upon review and approval during the pre-design meeting.

   a. When VFDs are required, the pump control panel must be insulated and provided with a closed loop, climate controlled, air conditioning unit of 2200 BTUs at 95 degrees (Fahrenheit) operating at 120 volts. The preferred climate control unit shall be McLean model T20-0216-G100, or approved equal.

17. Grounding systems shall have a maximum ground resistance of 5 ohms. The Design Engineer will incorporate special soils, such as graphite compounds if needed to improve ground resistance capabilities. Ground moisturizing ports shall consist of 1-inch PVC, schedule 80 pipe (when buried in soil) or 1-inch, schedule 40, galvanized pipe (when embedded in concrete). The function of the moisturizing port is to allow water to be injected into the soil during dry weather to increase the soil moisture content in order to maintain its resistivity.

18. Special considerations for submersible stations include the following:

    a. Design the electrical system, control and alarm circuits to allow for disconnection outside the wet well. Terminals and connectors shall be protected from corrosion by location outside the wet well in a NEMA 4X stainless steel enclosure.

    b. Locate the motor control center outside the wet well, readily accessible and protected by conduit seals to prevent the atmosphere of the wet well from entering the control center.

    c. Pump motor cables shall meet the requirements of the NEC for cords in wastewater pumping stations. Power cord terminal fittings shall be corrosion-resistant and constructed in a manner to prevent moisture entry into the cable. They shall also be provided with strain relief devices.

SECTION 7: STATION CONTROLS, INSTRUMENTATION, AND MONITORING

7.01 General

1. Primary level monitoring and pump control must be of the submersible level transmitter type. Acceptable controller manufacturers include PMC and Drexelbrook. Preferred equipment includes the PMC VersaLine PMC1 Model VL2000 Series with SW2000 Sink Weight with a Mercoid Model PBLT2 submersible level transmitter. Equivalent level monitoring and pump control equipment is also acceptable; however, it must meet the following requirements:
   a. Equipment weight must not exceed 4 pounds.
   b. Level sensors must include a 10-pound weight made of carbon steel and the instrument is to be solidly fastened to the weight to prevent it from being dragged into a pump intake.
   c. A stainless-steel stranded cable is to be securely fastened to the instrument so that it can be easily removed from the wet well.
   d. A 120 Vac/24 Vdc power supply is to be included in the pump control panel to supply power to the submersible level transmitter.
2. Using this control system, the lift station shall be capable of discharging all anticipated incoming flow. The lead pump is turned on at the first control elevation and the lag pump will start with a rising liquid level at the second control elevation. The lead and lag pumps will continue to operate until the pump control elevation is reached. The lead and lag shall automatically alternate between the two pumps at the completion of each pumping cycle. This operational scheme is for a 2-pump lift station; however, the same logic shall apply for a 3-pump, 4-pump, and 5-pump lift station.
3. NBU lift stations will also be equipped with a secondary wastewater level monitoring and pump control system based on the use of float switches. This system must be capable of sensing the operational status of the primary system and, upon failure of the failure of the primary system, automatically become active.

   In this system, when the float goes from hanging straight down to floating, the switch within the float closes and the pump becomes active. When it is floating and rolls down (i.e. hangs freely at the end of its cord) the switch opens and the pump ceases to operate. Floats are to be set from the bottom of the wet well and go up per the following functions:
   a. The lowest float turns all pumps off.
   b. The second float up turns the lead pump on.
   c. The third float up starts the lag pump.
   d. The top float signals to the operator that there is a high-water condition within the wet well.

4. The force main is to be equipped with a discharge pressure transmitter. It shall have a 150-psi pressure range, and is to be calibrated to accurately measure the station's operating and surge pressures. It shall operate at 24 Vdc, 4-20 mA output, and is to be located before the final valve in the station discharge pipeline inside the station perimeter wall surrounding the lift station site. The pressure sensor shall be fitted with a glycerin-filled diaphragm seal, an isolation ball valve, and freeze protection. Approved equipment includes Rosemount Model 2088G2S22A1B4E5M5 or NBU-approved equal. The pressure transmitter will be powered from the 24Vdc power supply located within the SCADA panel. The level transmitter and the high-level float switch is to be placed in an area of the wet well that is removed from the effects of the influent flow being received.
5. The lift station shall be capable of discharging all anticipated incoming flow. The lead pump is turned on at the first control elevation and the lag pump will start with a rising liquid level at the second control elevation. The lead and lag pumps will continue to operate until the pump control elevation is reached. The lead and lag shall automatically alternate between the two pumps at the completion of each pumping cycle. This operational scheme is for a 2-pump lift station; however, the same logic shall apply for a 3-pump, 4-pump, and 5-pump lift station.
6. A discharge pressure gage rated for corrosive service is to be installed at the discharge of every pump within the lift station. The gages are to meet the following requirements: Dial, Grade 1A, ASME B40.100, +/- 1 percent full scale accuracy, liquid-filled, type 316 stainless steel bourdon tube, glass safety lens, full blowout protection, weatherproof, hermetic seal and with a standard ¼ inch NPT connection. The pressure gage shall be provided with a glycerin-filled diaphragm seal and isolation ball valve. The pressure gage rating shall be 3 times greater than the operating pressure at firm pumping capacity at the location of the gage. Vacuum gages shall meet the same requirements as pressure gages and are to be installed at the end of each suction pipe of each pump.
7. Elapsed time meters are to be installed on the inner panel of the pump control enclosure for each pump in the station. Meters are to be five-digits and shall indicate tenths of hours and be non-resetting. Operating power shall be 120 volts. Approved manufacturers include Cramer, Hobbs, Honeywell, and Reddington.
8. A flow meter, specifically designed for wastewater force mains, is to be installed in an approved vault on the discharge force main downstream of the lift station within the fence surrounding the lift station site. Flow meters shall be Endress and Hauser Promag 400 with Ethernet/IP or approved equal.

SECTION 8: SUPERVISORY CONTROL AND DATA ACQUISITION

8.01 General

1. The Design Engineer will develop a control system for the lift station using a fiber optic cable-based system. Both the BODR and the station construction plans must include the NAD83 State Coordinates of the proposed lift station site.
2. Any design and construction of a fiber optic cable-based system is to be approved by NBU. These systems are to consider the following requirements and shall be in accordance with **Attachment 2**:
    a. National Electric Safety Code (NESC) standards must be followed for pole attachments for overhead and underground installations.
    b. Standards are available through the NBU Electrical Engineering Department. Contact NBU for more details.
    c. Fiber optic cable is to be installed 12" below the neutral.
    d. Underground fiber optic cable shall include a tracing wire for future location of the fiber conduit.
    e. Demarcation and interception of fiber is determined by NBU and is to be included in the final design after NBU review and approval.
    f. Fiber optic cable used in NBU systems shall be Single-Mode, Loose Tube, Dielectric type fiber. Fiber count is determined at the time of the design, but is minimum 12 strands if the demarcation is a pedestal.
    g. Patch panels will be 24-port enclosures (unless otherwise approved by NBU).
    h. As-builts must be presented at the completion of the installation and are to be prepared in accordance with NBU requirements which are available through the NBU GIS department
    i. Fiber optic cable shall be planned with a route that connects the site to another site where data can be transmitted on the appropriate NBU network.
3. Preferred equipment includes the following:
    a. Programmable logic controllers (PLCs) are to be Allen Bradley CompactLogix 5370.
    b. Network devices are to be Cisco IE3300 with appropriate SFP modules and expansion modules as necessary, and must be approved by NBU IT Department.
    c. Flow meters are to be Endress+Hauser electromagnetic flow meters with Ethernet/IP communication.
    d. HMI's are to be minimum 15", and to be Maple Systems model CMT3162X.
    e. UPS are to be Phoenix Contact QUINT DC-UPS with Ethernet capability.

f. Battery packs are to be Phoenix Contact QUINT series.

4. The SCADA system shall monitor each pump for all the following, but not limited to: Pump Hand/Off/Auto Status, Pump Run, Pump Stator Leak, Motor High Temp, Motor Overload, and Pump Lost Prime (if self-priming pumps). In addition, the SCADA system shall monitor all the following, but not be limited to: Low Level Alarm, High Level Alarm, Utility Power On, Generator Power On, Transfer Fail, Force Main Continuous Pressure, Wet Well Continuous Level, and SCADA Panel Continuous Internal Temperature.
5. The SCADA panel must include isolation relays for all digital inputs. Isolation relays must be located within the SCADA panel to separate 120Vac circuits or others from SCADA 24Vdc.
6. A 4-20mA temperature transmitter with heart communications must be installed within the SCADA enclosure and be wired to the PLC analog input board for internal panel temperature monitoring. The temperature transmitter must be provided with a resistance temperature detector (RTD) sensor and transmitter. Temperature transmitters manufactured by Rosemount are acceptable.
7. SCADA enclosure minimum dimensions shall be minimum 36-inches wide by 48-inches high by 16-inches deep, or larger to be determined by NBU. Construction shall be white enameled stainless steel 316, rated NEMA 4X. All internal panel surfaces shall be insulated with 1-inch thick semi-rigid foil-faced fiberglass insulating sheets, and be climate controlled by including both a 200-watt minimum space heater and an A/C unit rated for 2,200 BTU@ 95 degrees (F) minimum and operating at 120Vac. Approved space heaters include the McLean model T20-0216-G100, or NBU-approved equal. The Design Engineer must exercise caution regarding the minimum required clearance around the heater.
8. SCADA panels shall be provided with a QUINT4-UPS/24DC/24DC/20/EIP uninterruptible power supply. The power supply shall provide reliable power for a minimum of 2 hours. It will be used exclusively for the 24Vdc loads within the SCADA panel and the pressure transmitter is to be located in the header. The wet well level controller and any other 24Vdc load located within the Pump Control Panel and automatic transfer switch shall not be powered by the SCADA power supply.
9. Power supply units shall be model QUINT4-PS/3AC/24DC/20.
10. Energy storage units shall be model UPS-BAT/PB/24DC/12AH.
11. Install a DIN rail mounted transient voltage surge protector and lightning arrestor inside the SCADA panel. Approved manufacturer is Phoenix Contact, model Combotrab 2856702, or NBU-approved equal.
12. Control Narrative: the Design Engineer, at a minimum, shall design a process control narrative in accordance with the “General Lift Station Process Control Narrative” provided in **Attachment 3**.
13. Rockwell PlantPax 4.0 object library (or later) shall be used for all PLC programming logic.

SECTION 9: EMERGENCY PROVISIONS

9.01 General

1. Lift stations shall be designed to ensure that no discharges of untreated wastewater will occur at the lift station or any point upstream due to a loss of power or mechanical failure. All lift stations will be provided with enhanced service reliability features as follows:
   a. Dual force mains shall be required out of the lift station. Each force main shall be able to convey the full capacity of the lift station, and the lift station shall be configured such that each parallel force main runs one-at-a-time and enable ease of switching from one force main to another.
   b. The wet well emergency storage capacity of lift stations shall be based on 60 minutes of peak daily flow for all lift stations.
   c. The use of spill containment structures as the only means of enhancing service reliability is prohibited. Spill containment may be used in addition to one of the service reliability options discussed herein, provided a detailed management plan for cleaning and maintaining the spill containment structure is presented in the BODR. Additionally, any spill containment structure shall be fenced with an 8-foot security fence and a lockable gate.

SECTION 10: MANUALS

1. The Design Engineer will require the Contractor to provide four (4) hard copies and one (1) electronic copy in .pdf format of the Lift Station Operation and Maintenance manual. At a minimum, it shall include information on all mechanical and electrical equipment specified for the lift station.
2. In addition to the Operation and Maintenance manuals, four copies of all installation manuals associated with the lift station are to be provided. Please note that equipment installation should not occur until the installation manuals have been received by NBU.

SECTION 11: ABANDONMENT OF LIFT STATIONS

11.01 General

1. If a new project will abandon existing lift stations, the plans and specifications shall provide for appropriate facilities associated with lift station closure and abandonment. At a minimum, the plans will include the location, sequence, details, and methodology for closing and abandoning the lift station in accordance this section. Abandonment is to be considered permanent. Temporary abandonment will be considered on a case by case basis.

11.02 Wastewater Mains and Services Within the Lift Station Site

1. The abandonment of wastewater mains located within the lift station site will consist of meeting the requirements of the project plans and specifications which shall present and describe the approved method of abandonment. Typically, this will include filling the mains with pumpable grout.
2. Wastewater service lines and appurtenances that are not to be used in the future are to be cut and plugged at the sewer main.
3. The abandonment of force main valves is to be accomplished by removing the valve casing to the top of the subgrade or 24 inches below the surface, whichever is greater, and filling the remaining casing with concrete such that the abandoned valve is not identifiable from the surface. The pavement repair, if required, shall follow the requirements of the City of New Braunfels or TxDOT.

11.03 Manholes

1. Abandoned manholes at the lift station location shall be removed to a level not less than four (4) feet below grade or removal of the cone, whichever may be deeper. The inlets and outlets of the manhole are to be securely plugged. Inlet and outlet pipes are to be cut and plugged outside of the manhole, and the remaining structure is to be filled with cement-stabilized sand.

11.04 Lift Stations

1. The abandonment of lift stations shall consist of removing all pumps, motors, couplings, valves, and controls from the dry well and/or wet well, as well as all buildings and appurtenances above finished grade. NBU shall have the opportunity to evaluate infrastructure to be salvaged. The empty dry well and/or wet well is then cleaned to remove any wastewater residue that may be within them. Wastewater from the cleaning process is to be contained and then properly disposed of by discharging it into the NBU sewer after it has been tested to be sure it does not contain any hazardous materials.
2. Both the wet well and dry well are to be excavated and cut down five (5) feet below grade, filled with cement-stabilized sand, and then covered with top soil to grade. The associated force main shall also be properly abandoned to include cutting and plugging both ends and filling the force main with grout.

3. Service roads and parking pavements are to be removed, including subgrades. Excavated pavement areas are then to be filled with topsoil and regraded such that these areas properly drain. The restored area is then to be revegetated. Revegetation of disturbed areas is to be completed in accordance with the project plans and specifications.

ATTACHMENT 1 – BASIS OF DESIGN REPORT OUTLINE

A Basis of Design Report (BODR) for the proposed lift station and force main shall be prepared that includes the following information shown in the table below.

Required BODR Data

Section Number	Section Description
1	Purpose, scope, and justification of lift station project and force main.
2	Project location.
3	Map of the area to be served (include current and future areas to be served by the lift station and force main.
4	Lift station site layout and force main plan.
5	Lift station configuration selection.
6	Wet well design calculations to include: a. Wet well intake design, b. Wet well sizing, c. Wet well ventilation sizing, d. Pump operating levels.
7	Hydraulic design calculations to include: a. System curves, b. Pump capacity curves, c. Discharge piping and valve sizing, d. Force main sizing.
8	Force main alignment, including valve sizing and valve locations.
9	Air release valve sizing and locations.
10	Odor control.
11	Geotechnical investigation report.
12	Floodplain/floodway analysis.
13	Electrical and instrumentation design.
14	Engineering cost estimate (previously submitted PVA) a. Lift station, b. Force main.

ATTACHMENT 2 – SPECIFICATIONS FOR FIBER OPTIC CABLE INSTALLATION

Construction General Rules

1. Costs associated with the project are to be presented in a unit price format.
2. Aerial fiber cable is to be installed 12" below the NBU system neutral.
3. Contractors are to be aware that any work performed at or above 30" from the distribution system neutral (and/or grounded equipment cases) is considered to be in supply space by National Electrical Safety Code (NESC). As such, they are to be qualified to perform such work as it may be needed for this project.
4. In areas the Contractor is performing work in the NESC Supply Space, the Contractor shall utilize an insulated aerial bucket truck. Workers physically inside the NESC Supply space are to be equipped with appropriate safety equipment that shall include a hard hat, safety glasses, and insulated gloves, as a minimum.
5. All materials shall be provided by the Contractor.
6. All equipment necessary for the construction work shall be provided by the Contractor.
7. Any materials removed as part of the project are to be removed by the contractor off-site and not returned to NBU.
8. Strain insulators shall be installed upon all downguys. Downguys and anchors, installed as part of the project, are to be installed prior to any pole-to-pole cable.
9. Fiber cable shall be sagged exactly similar to the NBU system neutral.
10. Fiber cable shall be positioned on the same side as the NBU system neutral. Installation issues associated with this requirement can be discussed on a per case basis, but must be approved by NBU.
11. Messenger wire shall be electrically bonded to each NBU pole that it is attached to.
12. Contractor shall have the freedom to recommend changes to NBU regarding snowshoe placement and the volume of fiber optic cable to be stored on snowshoes so that materials may be fully utilized at any time.
13. The Contractor shall have freedom to recommend any guy and anchor additions to NBU for any reason.
14. Any immediate hazards or problems encountered in relation to this project, especially those related to NBU field equipment and/or energized conductors, are to be promptly reported to NBU Systems Control, (830) 608-8800.
15. Any damage incurred on the fiber optic cable while it is being strung or stored on the work site is the sole responsibility of the Contractor and is to be remedied to the satisfaction of NBU. Resolution may include splicing and addition of splice enclosures.

16. Any damage done to other facilities, either NBU equipment or other communication (AT&T, Time Warner, etc.) shall be the financial responsibility of the Contractor.
17. Ductile iron poles and medium grade steel must be drilled for all new attachments of fiber optic cable.
18. Lashing shall be double to the ¼" steel stranded messenger cable.
19. For every pole, on the cable itself, a blue wrap around tag marked "NBU Fiber Optic Cable" will be placed.
20. Marked as-built drawings shall be returned to NBU at the completion of the project. Project will not be considered complete until as-built are returned.
21. NBU shall be responsible for all permitting, including TxDOT and Railroad.
22. Any and all necessary traffic control shall be Contractor-provided.
23. Any and all necessary insurance requirements to enter and perform work in a public or private Right-Of-Way shall be Contractor-provided.
24. Midpoint splicing may be accomplished for lengthy fiber optic extension runs; however, midpoint splicing is not required by NBU.

Fiber Optic Cable & Testing

1. The proposed fiber optic cable strand count is 12 strands minimum but subject to increase based on site location and nearest point of connection to the fiber system.
2. Fiber Cable shall be single-mode, loose-tube, non-armored cable.
3. Bidirectional optical time domain reflectometer ("OTDR") and unidirectional power loss testing shall be performed on all fiber strands involved in project. Test reports shall be provided to NBU along with the project as-builts.

ATTACHMENT 3 – GENERAL LIFT STATION PROCESS CONTROL NARRATIVE

Lift Pumps

1. When a pump is not in auto mode or has an alarm, the pumps shall show up as "not Ready" on the OIT display.
2. The contactor shall program a control function for the total run time of each pump under normal conditions that is capable of a reset to zero and a preset setpoint.
3. There shall be 3 modes of control: local-Manual/Hand, SCADA-Manual/Hand, and SCADA-Auto. Local-Manual controls shall be hardwired controls at the VFD. SCADA-Auto shall be programmed in the PLC at the site so the lift station can operate independently. Normal operations for the pumps will be SCADA-Auto mode.
4. Lift pumps should have a stagger delay if 2 or more are called to run at the same time.
5. The number of lift pumps called for shall be dictated by stages defined by wet well level setpoints. A start and stop setpoint shall be defined for each stage.
6. The fail alarm statuses shall have a timed delay setpoint.
7. SCADA shall display the following alarm statuses:
    a. VFD common fault
    b. Motor start fault
    c. Motor high winding temperature
    d. Pump high cycle time
    e. Pump control panel E stop
    f. Wet well transmitter out of range
8. <u>In SCADA-Manual Mode:</u>

    When in SCADA-Manual Mode, an operator shall be able to start and stop the pump as necessary. The Hand/Off/Auto switch at the VFD is set to Auto (SCADA Control) and the OIT selector switch set to "Hand" to operate the pump.

9. <u>In SCADA-Auto Mode (Normal Operation):</u>

    The Hand/Off/Auto (physical)switch at the VFD is set to Auto (SCADA Control) and the OIT selector switch set to "Auto" (Soft HOA) to enable pump control off of setpoints in the PLC logic.

    With any return of power, the PLC shall be programmed to automatically sequence the restart of the pump. The sequencing restart shall be configured such that only 1 pump starts at a time.

10. <u>Backup Float Control</u>: In backup float control mode, the pumps shall be called to run off of a high level and low level wet well float. These floats are hardwired in to control the pumps. The PLC will operate a relay that will interrupt the hardwired circuit when in PLC control.
    a. Pump control is switched from PLC control to back up float control under the following circumstances:
        i. Level sensor fail
        ii. High level float

        iii. PLC power fail
        iv. I/O Fault
    b. OIT must display a status for PLC Control or Backup Float Control with support for switching between them
11. Control Logic at the Variable Frequency Drive (VFD):
    a. Normal Start Sequence: The start sequence is initiated by the start pushbutton located at the 480V VFD motor controller, the physical HOA switch set to “Hand”, or by a start signal from SCADA.
        i. Start permissive:
            1. Pumps cannot start if the wet well level is low*
            2. All statuses that will cause an emergency stop need to be cleared.
    b. Normal Stop Sequence: The normal stop sequence is initiated by the stop push button located at the 480V VFD or a stop signal from SCADA.
    c. Emergency Stop Sequence: An emergency stop will cause the motor to stop immediately.
        i. As a result of emergency stop scenarios listed below, pumps will not automatically restart:
            1. When called by the E. Stop pushbutton located at the VFD
            2. VFD failure
    d. SCADA shall display and log the following values:
        i. Motor frequency (Hz)
        ii. Mains voltage
        iii. Mains voltage phase 1-2
        iv. Mains voltage phase 2-3
        v. Mains voltage phase 3-1
        vi. Main Current
        vii. Outlet pressure value
12. Pump Alternation
    a. When enabled, pumps should alternate on an all stop basis in SCADA auto mode.

Stand-by Generator

1. SCADA shall display the following:
    a. Fuel tank Level
    b. Common Alarm
    c. Run Status
    d. Runtime

Miscellaneous

1. PLC Alarms:
    a. PLC major fault
    b. PLC minor fault
    c. PLC IO fault
2. RTU UPS Alarms:

a. RTU UPS Common Alarm
b. Loss of Normal 120V Power alarm
c. All points for information on battery health

3. Power Monitoring Unit:

The contractor shall coordinate with the owner for what information and alarms need displayed and logged. As a minimum SCADA shall display the following:

a. KWh, KVARh, KVAh
b. 3 phase voltages (per phase and average)
c. 3 phase currents (per phase and average)
d. Frequency (Hz)