CITY UTILITIES
DESIGN STANDARDS MANUAL

Book 3
Sanitary (SA)
SA8 Lift Station and Force Main Design

June 2015

SA8.01 Purpose

This Chapter establishes the minimum standards and technical design criteria for all City of Fort Wayne sanitary lift stations and force mains. All variances from the Standards must be approved prior to commencement of design in compliance with Chapter GR3 - Variances.

Design criteria in this Chapter govern the planning and design of small lift stations with maximum peak not exceeding 700 gallons per minute and/or total dynamic head not exceeding 80-feet. For proposed construction expansion of lift stations exceeding the above ranges, City Utilities Engineering shall be consulted for additional design requirements. This Chapter covers the following items:

1. Discussion of Lift Station Justification and Life Cycle Cost Analysis
2. Basic Elements of Design
   - Lift Station Location Criteria
   - Lift Station Type
   - Lift Station Hydraulic Design
   - Pump Design Criteria
   - Wet Well Design
   - Electrical Design
   - Telemetry
   - Operating Set Points
   - Valve Vaults, Combination Air Valve Structures, and Meter Vaults
   - Valves, Meter and By-Pass Connection
   - Ventilation of Structures
   - Emergency Operation
   - Force Main Design Criteria
3. Covered in Other Chapters
   - Plan Requirements and Submittals (Chapter SA4 – Drawings and Submittals)
   - Design Flow (Chapter SA5 – Sewer Design)
   - Low Pressure Sewer Systems (Chapter SA9 – Low Pressure Sewer Systems)

SA8.02 Lift Station Justification and Life Cycle Cost Analysis

The need for a sanitary lift station is required to be justified according to one or more of the following criteria:

- The lift station is recommended by City Utilities Engineering.
- The elevation of a proposed service area is too low to be served by an existing, on- or off-site, gravity sewer.
- The proposed sanitary lift station has been determined to be a cost effective alternative to an on- or off-site gravity sewer through a life cycle cost analysis.

1. Life Cycle Cost Analysis

   The life cycle cost analysis between a lift station and a gravity sewer shall include both economic and non-economic factors. Refer to Chapter GR11- Life Cycle Cost Analysis.

SA8.03 Lift Station Location Criteria

Lift station locations will be evaluated by City Utilities Engineering on a case-by-case basis. At a minimum, the lift station shall be located to assure the following:

1. Adequate Access

   The lift station shall be located to assure that adequate access is available for operation and maintenance activities. Consideration should be given to the following structure and appurtenance locations:

   A. Wet Well, Valve Vault , By-Pass Structure, Concrete Pad for Control Panel and Generator

      - Distance from adjacent property lines
      - Distance from public right-of-way
      - Distance from private paved streets or paved areas
      - Distance from adjacent structures or buildings

   B. Access Drive

      - Distance from adjacent property lines

   Lift stations shall not be located in inaccessible areas such as rear yards. See Exhibit SA8-1 Lift Station Details for lift station site plan options.

2. Protection Against Flooding

   Wastewater lift stations should remain fully operational and accessible during a 25-year flood event. In addition, lift station structures and electrical and mechanical equipment shall be protected from physical damage during a 100-year flood event (Title 327 IAC 3-6-10).

3. Parking Requirements

   Adequate space for the off-street parking of two vehicles shall be provided. The entrance to the parking area shall be a minimum of ten (10) feet wide. The parking area must be constructed of stone or other approved materials.

4. Lighting Requirements

   Site shall include light and pole by control panel. Light shall be (2) 21LED bar, shoebox, bronze finish, integral photocell, mounted on a 15-foot tall square steel pole. Pole shall be mounted to concrete pole base.

5. Required Lift Station Items
   - Wet Well
   - Valve Vault
   - By-Pass Structure (Portable Pump Connection)
   - Telemetry
   - Power/Control Panel with Concrete Pad
   - Light Pole by Control Panel
   - Access Drive
   - Force Main
   - Drain Line from Valve Vault and By-Pass Structures
6. Optional Lift Station Items (to be considered based on site selection)
   - Fencing
   - Gates
   - Metering Pit/Metering Piping
   - On-Site Generator and Concrete Pad
   - Chemical Tank

SA8.04 Lift Station Type

- Lift stations shall be (at a minimum) duplex with submersible type pumps in a wet well.
- Lift stations shall operate automatically under normal conditions but shall be capable of manual control.
- All pumps shall be submersible type for handling raw, unscreened wastewater.
- The pump type, number, and configuration shall be consistent with flows and accessibility. Pumps and their respective control systems shall be compatible. In instances in which only two pumps are provided, the pumps shall be of equal capacity. Units shall have capacity such that, with any unit out of service, the remaining unit(s) will have capacity to handle the design peak hourly flow.
- Pumps shall automatically alternate between pumping cycles.
- Both pumps shall be allowed to operate simultaneously at high level set point.
- Valves shall not be located in the wet well. A separate valve vault is required.

SA8.05 Lift Station Hydraulic Design

1. Pumping Capacity

   The pumping capacity shall be calculated as follows:

   $$Q = \frac{DesignFlow}{1{,}440}$$

   Where:

   Q = pumping rate, gallons per minute (gpm)

   Design Flow in gallons per day (gpd) = ADF*4

   Use Average Daily Flow as determined in Chapter SA5 –Sewer Design.

   Each pump in a duplex station shall have a pumping capacity of Q.

   City Utilities Engineering may require the pumping capacity to be increased or decreased, if deemed necessary.

2. Initial Pumping Capacity

   Because proposed improvements may only be a portion of the lift station build-out service area, City Utilities Engineering may allow or require the pumping capacity to be reduced for the proposed improvements if the following conditions are met:

   - The area of the proposed improvements is less than 50% of the lift station build-out service area.
   - The required Pumping Capacity for the proposed improvements is less than 50% of the required Pumping Capacity for the lift station build-out service area.

   At a minimum, each pump shall be sized to accommodate the Design Flow of the proposed improvements plus 20%.

   Meeting the above criteria does not guarantee a reduction will be allowed.

   The specific equipment requirements and allowable reductions will be at the discretion of City Utilities Engineering. Only the pumps, motors, and relevant control panel equipment will be considered for allowable reductions. The wet well, valve and meter vaults (if required), piping, valves, and force main shall be sized for the lift station build-out service area.

3. Total Dynamic Head Calculations

   The Total Dynamic Head (TDH) shall be calculated for the pumping capacity of the lift station.

   The TDH is the sum of the static head, friction losses and minor losses for a given pumping rate in a defined pumping system. TDH shall be calculated as follows:

$$TDH = h_s + h_f + h_m$$

Where:

TDH = Total Dynamic Head, feet

h_s = Static Head, feet

h_f = Piping friction losses, feet

h_m = Minor losses, feet

The above variables shall be calculated as follows:

- h_s = Static Head, feet

  Static Head = Force Main Discharge Elevation – Pump Off Elevation

  When the high point in a force main is not at the discharge elevation, the elevation of the high point shall be evaluated to determine if the pump performance characteristics are adversely affected.

- h_f = Piping friction losses, feet

  Piping friction losses shall be calculated using the following Hazen Williams formula for friction loss:

$$h_f = 10.44L \frac{Q^{1.85}}{C^{1.85} * D^{4.8655}}$$

Where:

D = inside pipe diameter, inches

Q = pumping rate, gpm

C = pipe roughness coefficient (100, 120, & 140)*

L = force main length, feet

* A roughness coefficient of C = 120 shall be used to determine the friction losses at the Operating Point. However, due to changing force main conditions over time, the h_f and the TDH shall also be calculated using C = 100 at the Pump Off elevation and C = 150 at the Pump On elevation.

Minor losses are due to pipe fittings and shall be calculated as follows:

$$h_m = \frac{KV^2}{2g}$$

Where:

h_m = Minor losses, feet

K = proportionality constant (see Figure SA8.1)

V = velocity, ft/sec

g = acceleration due to gravity = 32.2 ft/sec^2

Figure SA8.1 Typical K Values

Fitting	K
Check Valve	2.5
Plug Valve	1.5
Tee	0.9
90° Elbow	0.3
45° Elbow	0.2

From Crane Co. as published in Chicago Pump Hydraulics Booklet

Minor losses may also be calculated using the equivalent lengths of pipe method. See Exhibit W5-6 Minor Losses/Equivalent Length Nomograph for equivalent lengths of common fittings.

4. Pump Selection

- The pump capacity and system TDH, as calculated previously, shall be used to create the system curve when selecting the pump model. The operating point is defined as the point where the designed system curve (C = 120 at Design Flow) intersects the pump manufacturer's performance curve.
- The pump, motor, and impeller shall be non-overloading throughout the entire operating range for all roughness coefficients.
- The system head curves for each roughness coefficient shall be plotted on the pump performance curve to determine the operating characteristics.
- Plot the pump curve in parallel in the case where both pumps, or multiple pumps are allowed to operate simultaneously.
- The operating point shall fall within the envelope between 70% and 120% of the pump manufacturer's Best Efficiency Point (BEP), based on flow rate. For example, it the selected pump has a BEP of 300 gpm at 50' TDH, the designed system curve should intersect the manufacturer's pump performance curve somewhere between 210 gpm and 360 gpm regardless of TDH. If the system curve intersects the pump performance curve outside of that range, a different pump should be evaluated.
- Engineering judgment may be used when evaluating pump alternatives. If justified, City Utilities Engineering may require a different operating point or an alternate pump to be used.

5. Net Positive Suction Head Available ($NPSH_A$)

The ($NPSH_A$)is the total absolute suction head in feet of the liquid being pumped, less absolute vapor pressure of the liquid being pumped, measured at the impeller eye of a submerged pump. (Cameron Hydraulic Data)

The formula for calculating ($NPSH_A$) is:

$$NPSH_A = H_a - H_{vp} + H_{st} + H_f$$

Where:

H_a= The absolute pressure on the surface of the liquid in the wet well

H_{vp}=Absolute vapor pressure of the liquid at the pumping temperature

H_{st}= The vertical distance between the surface of the liquid in the wet well and the centerline of the pump

H_f= Friction losses in the suction piping

Net Positive Suction Head Required ($NPSH_A$)is the minimum pressure required at the suction port of the pump to keep the pump from cavitating.

$NPSH_A$ is a function of the system and must be calculated, whereas $NPSH_R$ is a function of the pump and must be provided by the pump manufacturer. The ratio of $NPSH_A$ to $NPSH_R$ shall be greater than or equal to 1.5.

SA8.06 Pump Design Criteria

1. Pump Openings

   Pumps handling raw wastewater shall, at a minimum, be capable of passing spheres 3-inches in diameter. Pump suction and discharge openings shall be at least 4- inches in diameter.

2. Intake

   Each pump shall have an individual intake. Wet well and intake design shall be such as to avoid turbulence near the intake and to prevent vortex formation.

3. Pump Guide Rail System

   A guide rail system shall be provided for the easy removal of the pump and motor assembly for inspection and service. The system shall not require a person to enter the wet well to remove the pump and motor assembly. Two rails of corrosion resistant stainless steel, or other approved material, shall be provided for each pump. The guide rails shall be positioned and supported by the pump mounting base. The guide rails shall be aligned vertically and supported at the top by attachment to the access hatch frame. One intermediate stainless steel guide rail support is required for each 20-feet of guide rail length.

   All pumps shall be equipped with sliding brackets or rail guides. A stainless steel lifting chain of adequate length for the wet well depth shall be provided for each pump. The rails and rail guides shall allow the complete weight of the pump unit to be lifted on dead center without binding and stressing the pump housing. The system shall allow the pump to automatically align the pumping unit to the discharge connection by a simple downward movement of the pump.

SA8.07 Wet Well Design

1. Wet Well Sizing

A circular concrete wet well shall be provided. The wet well shall be designed for peak hourly flow for the lift station build-out service area. The number of pump starts per hour shall generally not exceed five (5) starts per hour. The maximum detention time in the wet well shall average no more than thirty (30) minutes.

The wet well volume for optimal operation shall be computed as follows:

$$V = \frac{(\emptyset Q)}{4}$$

Where:

V = required capacity (gallons)

$\emptyset$ = minimum time of one pumping cycle (minutes) from start to start. (Ideally $\emptyset$ = 15 minutes, but 12 minutes $\leq \emptyset \leq$ 30 minutes is acceptable in certain instances).

Q = pump capacity (gpm); use peak flow for lift station build-out service area

Detention times shall be computed for both initial average flow and lift station build-out service area average flow.

The wet well volume shall be based on a maximum drawdown range of 4-feet.

2. Buoyancy

Buoyancy shall be analyzed on the wet well to determine whether additional methods of restraint are necessary. Mechanical equipment, water weight, and other temporary loads shall not be included in the analysis. A minimum safety factor of 1.25 shall be used.

Buoyancy force, opposing force and factor of safety shall be computed as follows:

- Buoyancy Force = (Displaced Volume) X (Unit Weight of Water)
- Opposing Force = Weight of Barrels + Weight of Bottom Slab + Weight of Top Slab + Net Weight of Saturated Soil Over Bottom Slab Extension + Any Additional Constraints (excluding electrical and mechanical components).
- Factor of Safety = (Opposing Force) / (Buoyant Force) $\geq$ 1.25.
- If the factor of safety is not $\geq$ 1.25, restraint measures shall be employed. City Utilities shall be consulted in these instances.

3. Floor Slope

   The wet well floor shall have a minimum slope of 1 to 1 to the hopper bottom. The horizontal area of the hopper bottom shall be no greater than necessary for proper installation and function of the pump intake.

4. Connection to Wet Well

   For proposed lift stations, only one incoming connection to the wet well shall be allowed. The connection shall be of sufficient depth to provide service to the lift station build-out service area. The inlet pipe shall be located between the pumps and on the wall opposite the discharge pipe(s).

5. Hydrogen Sulfide Protection

   Coat interior surface of the wet well with an approved material to mitigate concrete deterioration caused by hydrogen sulfide gas.

SA8.08 Electrical Design Criteria

1. Codes and Standards

   All lift station designs shall meet or exceed the following applicable codes and standards:

   - International Building Code (IBC)
   - National Electrical Code (NFPA 70)
   - Underwriters Laboratories, Inc. (UL)
   - National Fire Protection Association (NFPA)
   - National Electrical Manufacturers Association (NEMA)
   - National Electrical Contractors Association (NECA)
   - Occupational Safety and Health Administration (OSHA)

2. Phase, Starters and Voltage Selection

   Figure SA8.2 shall be used in selecting the appropriate phase, starter, and voltage for the lift station pumps. Selections shall be coordinated with the pump supplier to meet the pump requirements.

Figure SA8.2 Electrical Design Matrix

	Phase		Starters[3]			Voltage[2]		
HP	Single Phase	3-Phase	Across the Line	Soft Start	VFD	208V	240V	480V
<4	X		X				X	
5-15	X[1]	X	X			X	X	X
16-25		X[2]		X				X
>25		X[2]			X			X

1 – VFD for Phase conversion shall be used
2 – Coordinate available power with local utility
3 – Starter selection shall be coordinated with pump supplier

SA8.09 Telemetry

1. General Telemetry

   City Utilities uses radio, fiber, and cellular service to transfer signals from lift stations back to the WPCP. Radio telemetry covers a majority of CU stations. CU has standardized on MDS SD-9 radios. If there is a need or desire to deviate from radio communication as outlined below, CUE must be contacted prior to proceeding. In addition to CU specifications, all local codes relating to antenna height requirements, aircraft flight paths, and other pertinent issues must be adhered to.

2. Propagation Study

   a. A propagation study is required to determine the required antenna height and which mounting method shall be used. The propagation study should be performed during a season when trees have full leaf development. The following information is required to initiate a propagation study:

      - Site plan outlining where equipment is to be placed
      - Latitude/Longitude
      - Physical address

   b. A propagation study shall accomplish and identify the following which should be included in a comprehensive report:

      - Existing transmitter and antenna at the master/repeater location by transmitting a calibrated 900MHz signal (licensed) for one end of every path
      - Site information including color photographs, coordinates, site drawings, and recommended installation method
      - Signal strength tested in the recommended antenna location at a minimum of four heights
      - Antenna height and gain; acceptable Received Signal Strength Indication (RSSI) shall be in the range of -60 dBm to -85 dBm. Readings outside of this range require approval from CUE prior to installation
      - Detailed drawings of typical antenna system recommended for installation

3. Typical Antenna Mounting Methods (in order of preference)

   a. Low profile antenna - For areas where good line of site and signal can be obtained from the top of the enclosure.

   b. Mast pipe on enclosure - Areas requiring height under 25-feet can utilize a 2-inch aluminum mast pipe attached to the back of the stand-alone enclosure or riser.

   c. Fiberglass pole – Areas requiring height in excess of 25-feet especially where aesthetics are of great concern. Color selection should involve CUE.

d. Tripod tower structure - Areas requiring height in excess of 25-feet. This requires a concrete base pad that needs to be designed based on loads and soil conditions .

SA8.10 Operating Set Points

1. Control Settings

   All pumps shall stop at the wet well level equal to the minimum level recommended by the manufacturer of the proposed pumps. A minimum drawdown range of at least 3- feet but not greater than 4- feet is desirable between the high level alarm and the pump "stop elevation". The increment in levels between the multi-pump start points shall be a minimum of 1-foot . All pumps shall shut off a minimum of 1- foot below the last pump start elevation. The high water alarm level shall be at or below the invert of the lowest influent pipe invert and at least 1-foot above the last pump start elevation.

2. High Water Alarm

   The high water alarm shall be set at or below the invert of the inlet pipe. Pipes shall not be used for storage during normal lift station operation.

3. Alarm Beacon Light

   Provide an alarm beacon light which shall be energized on high water alarm condition only. The beacon light shall be watertight, suitable for outdoor installation and provided with a red lens mounted externally on the top center of the pump control panel. The light source shall be high intensity strobe type, with light intensity of 1,000,000 peak candle power.

SA8.11 Valve Vaults, Combination Air Valve Structures, and Meter Vaults

1. Valve Vault

   A circular concrete valve vault with an access hatch shall be provided and located next to the wet well to house the pump discharge valves. The arrangement shall provide for easy access to the equipment for maintenance purposes.

   Provisions shall be made to drain or remove accumulated water from the valve vault to the wet well using a sloped floor, floor drain, drain pipe with P-Trap and a check valve or duckbill in the wet well. Refer to Exhibit SA8-1 Lift Station Details.

   Pressure Gauge: Provide a pressure gauge on the tee fitting of the valve vault piping.

2. Combination Air Valve Structure

   A circular concrete structure with an access hatch or manhole lid shall be provided for combination air release/vacuum valves. A combination air release/vacuum valve shall be placed at high points in the force main to prevent air locking. Long, horizontal runs and changes in slope may require combination air release/vacuum valves.

A combination air release/vacuum valve may be required at low points in the force main.

The location of the combination air release/vacuum valves shall be discussed with City Utilities Engineering prior to design.

Each air release valve and air vacuum valve that exhausts above ground must be equipped with an exhaust pipe extended to a downward facing elbow covered with a corrosion-resistant, 24-mesh screened opening at an elevation of eighteen 18- inches above ground level.

Automatic air release/vacuum valves shall not be located in areas within the 100-year flood plain or where flooding may occur, unless the automatic air release/vacuum valve is equipped with an exhaust pipe as described in the paragraph above with extension above the 100-year flood elevation.

Refer to Standard Drawing STR-21-1 for air release structure detail.

3. Meter Vault and Sample Point Structure

All customers that will be billed through a monthly billing according to a contract are required to install meters and sampling points. These installations will be addressed on a case-by-case basis as required by City Utilities Engineering.

The structure to house the meter and provide for sampling shall be configured for easy access to the metering equipment and easy access for sampling. The structure shall be a circular concrete structure with an access hatch.

Provisions shall be made to drain or remove accumulated water from the meter vault to the wet well using a sloped floor, floor drain, drain pipe with P-Trap and a check valve or duckbill in the wet well. Refer to Standard Drawing PS-1 Lift Station Meter Pit.

SA8.12 Valves, Meters, and By-Pass Connection

1. Valve orientation

All plug and check valves shall be installed horizontally in a valve vault separate from the wet well. The arrangement shall provide for easy access to the equipment for maintenance purposes. The check valve shall be located between the shutoff valve and the pump.

All valves shall be capable of withstanding normal pressure and surge.

2. Check Valves

Check valves shall be suitable for the material being handled, shall be equipped with an external lever and weight and have an anti-slam design.

3. Plug Valves

Plug valves shall eccentric design with resilient plug facings.

4. Combination Air Release/Vacuum Valves

   Air release valves are generally to exhaust pockets of air accumulated during operation and air vacuum valves are to exhaust or admit air during filling or draining of the force main. Consequently, an air release valve shall be placed at high points in the force main to prevent air locking. Long, horizontal runs and changes in slope may require combination air release/vacuum valves. Low points may require air vacuum valves. The location of any type of air valve shall be discussed with City Utilities Engineering prior to design. Combination air valves shall be used as a basis of design for all points along a force main.

5. Metering Equipment

   In cases where metering is required, consult with City Utilities Engineering for orientation of meter, type of meter and readout requirements.

6. By-Pass Connection

   For emergency by-pass of the lift station using a portable pump, a tee off of the force main with a connection for by-passing shall be provided.

   Provisions shall be made to drain or remove accumulated water from the by-pass riser pipe using a ¾-inch diameter drain line sloped to drain to the wet well.

   The by-pass configuration shall consist of the following:

   - A shut off plug valve located between tee by-pass riser pipe
   - Riser pipe to two feet above grade with female Bauer socket connection for portable pump

   Refer to Standard Drawing PS-2 Lift Station By-Pass (portable pump connection).

SA8.13 Ventilation of Structures

Ventilation shall be provided for wet wells, valve vaults, and air release/vacuum valve structures.

- No interconnection of ventilation systems shall exist between wet wells and valve vaults.
- Goose neck or mushroom style static vents shall be placed through the top slab of the structure. A minimum 6-inch diameter vent pipe shall be used.

SA8.14 Emergency Operation

1. General

   A lift station shall be provided with the equipment necessary for emergency operation by two of the following:

- Dual utility feeds from separate substations with automatic transfer switch
- Standby generator and automatic transfer switch. Natural gas is preferred over diesel driven engines.
- Receptacle for portable generator and manual transfer switch
- On-site standby pump
- Connection for portable standby pumping. See Standard Drawing PS-2 Lift Station By-Pass (Portable Pump Connection).

2. Automatic Transfer Switches

   Automatic Transfer switches shall meet the following requirements:

   - Service Entrance Rated, listed to UL 891 for Dead-Front Switchboards.
   - Circuit breaker sized for 100A, 200A or 400A with solid neutral.
   - NEMA 3R enclosure with strip heater
   - Microprocessor controller capable of the following:
     - In-phase monitor to transfer motor loads
     - Engine exerciser to automatically test backup generator each week, with or without load
     - Selective load disconnect
     - Serial communication port

3. Manual Transfer Switches

   Manual transfer switch shall meet the following requirements:

   - Service Entrance Rated double-throw switch with dual element fuses.
   - Fuse size shall be 100A, 200A or 400A.
   - NEMA 3R enclosure.
   - Generator receptacle shall be attached to bottom of transfer switch

4. Portable Generator Receptacles

   Receptacles at stations shall be male type connection with reversed contacts. Plugs on Utility portable generators are all female type connection with reversed contacts.

SA8.15 Force Main Design Criteria

1. General

   The following criteria shall apply to force mains:

   - Velocities in force mains shall be kept between two (2) and eight (8) ft/s. For design, the goal is at least 3 ft/s.
   - Minimum acceptable diameter shall be 4- inches.
   - Force mains shall not drain between pumping cycles.
   - Force mains shall be designed to resist hydraulic forces.
   - Force mains shall be designed to resist surge.

- Force mains shall be designed to enter the gravity sewer system at a point not more than 2- feet above the flow line of the receiving manhole.
- Tracing wire shall be specified for all force mains.

2. Force Main Pressure and Surge Analysis (Water Hammer)

Surge or water hammer is an increase in pressure in a pipe caused by a sudden change in velocity (i.e. stopping or starting a pump or closing of a valve). The maximum surge pressure encountered is a function of wave velocity, a, as follows:

$$a = \frac{4660}{\left(1 + \left(\frac{kd}{Et}\right)\right)1/2}$$

Where

a = wave velocity

k = fluid bulk modulus (300,000 psi for water)

d = pipe inner diameter (inches)

E = modulus of elasticity of pipe (400,000 psi for PVC, 24,000,000 psi for ductile iron, 111,000 psi for polyethylene)

t = pipe wall thickness (inches)

The maximum surge pressure, P, is computed as follows:

$$P = \frac{(aV)}{2.31g}$$

Where P = surge pressure (psi)

V = maximum change in velocity

g = acceleration due to gravity (32.2 ft/s)

a = wave velocity

Total pressure is computed by the following formula:

Total Pressure = Maximum Surge Pressure + Static Pressure = P + h_s

The total pressure must be less than the rated pressure, including surge allowance, of the pipe.

3. Hydrogen Sulfide Prevention/Odor Control

The need for hydrogen sulfide prevention and/or odor control shall be considered when the detention time in the force main is greater than 6 hours. When hydrogen sulfide prevention and/or odor control is warranted, City Utilities Engineering shall be consulted prior to design of control measures.

A chemical container located at the lift station site with chemical feed to the wet well may be required.