LIFT STATION
DESIGN & CONSTRUCTION
GUIDELINES

January 2012

OPERATIONS & MAINTENANCE ENGINEERING
LIFT STATION MAINTENANCE
INSTRUMENTATION AND CONTROLS

2800 U.S. Hwy.281
San Antonio, TX 78212

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SAN ANTONIO WATER SYSTEM
LIFT STATION DESIGN GUIDELINES
TABLE OF REVISIONS

Section	Revision	Date
A. General Requirements	1. Modified wording to comply with current SAWS Utility Service Regulation.	01/11/2012
	8. Referenced pavement standard AASHTO HS 20-44. Clarified that turnarounds shall meet the same pavement standards as access road.	01/11/2012
	16. Clarified paragraph. Added recommendations for phased developments.	12/22/2011
	20. Added requirements for service poles.	10/11/2011
	11. Updated chain link fence height from 6 to 8 feet in height.	7/28/2011
	22. Added requirement for lift stations to be locates at sufficient distance from developed areas to limit detection of odors.	4/1/2011
	15. Updated canopy dimensions to extend 5.0 feet to the front and 3.5 feet to the back. Added requirement of structural requirement for canopy to withstand winds of up to 90 MPH.	12/13/2010
	2. Updated to reflect new TCEQ Chapter 217 and latest SAWS Utility Service Regulations.	11/22/2010
	3. Modified wording to require submersible type lift stations, but self priming and package lift stations will be evaluated by SAWS on a case-by-case basis. Updated Table 1.	11/22/2010
	4. Added requirement for lift station design to comply with NEC 2011, NESC 2007 and OSHA 2007, or latest editions. Made reference to standard drawings for location of the required grades.	11/22/2010
	5. Updated TCEQ reference Chapter 213, Subchapter A §213.5(c)(3)(C) for design of lift stations located over EARZ.	11/22/2010
	21. Added requirement to protect lift station from storm runoffs.	11/22/2010
	6. Updated the requirement for the lift station firm pumping capacity to be greater than the expected peak wet weather flow.	10/20/2010
B. Wet Well Design	13. Updated paragraph about lightning and ventilation of dry wells.	12/22/2011
	6. Updated requirement for lining the interior surface of concrete wet wells	11/15/2011
	8. Updated requirements for wet well backfilling	11/15/2011
	16. Added requirement for distance between wet well bottom and gravity invert pipe to be between 5 and 7 feet. Added requirement for drop pipe for distances greater than 7 feet.	6/17/2011
	2. Clarified that the spill level elevation is determined by wet well top elevation or the manhole with the lowest top elevation, whichever is lower.	11/22/2010
	4. Updated requirement for baffles for peak wet weather flows of 3 MGD or greater.	11/22/2010
	18. Added wet well testing requirement and test criteria.	11/22/2010
C. Pumping	8. Updated submersible pump requirements. 1.15 minimum SF.	01/12/2012

Section	Revision	Date
Equipment Design	9. Updated self priming pump requirements. Added requirement of prime loss protection via vacuum switches. 1.15 Minimum SF.	01/12/2012
	1. Added reference for table 3 for minimum number of pumps required and minimum sphere pass required. Updated minimum sphere pass requirement in Table 3	11/22/2010
	6. Updated Table 4 referring to wet well cycling.	11/22/2010
	7. Clarified paragraph.	11/22/2010
	10. Updated package lift station requirements.	11/22/2010
	5. Added requirement for pump duty point to be within 75% and 115% range of pump flow at Best Efficiency Point (BEP). Clarified that this condition shall be satisfied for one and two pumps operating.	6/24/2010
	2. Clarified that semi-chopper, vortex or grinder pumps might be accepted on case-by-case basis. Clarified that 2-pole motors will be reviewed and approved by SAWS. Added Table.	6/20/2010
D. Station Piping	1. Clarified if self priming pumps are approved.	11/22/2010
	5. Updated requirement for suction flow velocity to be within 3.0 and 3.5 feet per second.	11/22/2010
E. Station Valves	2. Added requirement of check valve on by-pass quick connector.	11/22/2010
	4. Added requirements for air release valves.	11/22/2010
	5. Added requirements for surge relief valves.	11/22/2010
F. Force Main	7. Clarified that minimum force main size to be 4-inch (except for grinder pumps), force main velocity to be within 3.0 and 3.5 feet per second for one pump, and maximum flow velocities of 4.8 feet per second for two pumps and 6 feet per second for three pumps; and the allowance of flow velocities of up to 2.0 feet per second as long as a flushing velocity of 5.0 feet per seconds can be generated with three or more pumps in operation.	3/10/2011
	1. Updated requirement for force mains to be buried at least 4 feet below ground.	11/22/2010
	2. Added requirement of detector tape.	11/22/2010
	5. Added requirement of air release valves on all high points, minimum size of 2 inches, rated for sewage.	11/22/2010
	6. Updated force main discharge requirement to be via drop manhole to minimize turbulence.	11/22/2010
	8. Added requirement for HDPE force mains to be DIPS size.	11/22/2010
	9. Added requirement for double barrel force mains.	11/22/2010
	10. Added requirement for force mains to withstand surge pressure generated by instantaneous stoppage under maximum pumping conditions.	11/22/2010
	11. Added requirement of average flush time analysis.	11/22/2010
	12. Added requirements of air release valves.	11/22/2010
	13. & 14. Added force main testing requirements.	11/22/2010
	15. Added requirements for isolation valves on force mains.	11/22/2010

Section	Revision	Date
G. Electrical Equipment	11. Updated requirement to limit generator voltage dip to no more than 15%.	3/28/2012
	25. Added Requirement for wiring schematics to be provided to SAWS.	7/19/2011
	24. Added requirement for electrical conduit filling percentage limit. Added multiplying factor to size conduits for motor power cables.	6/27/2011
	9. Updated pipe supports of mounting rack and canopy to be minimum 4-inch diameter, ½-inch thick hot dip galvanized structural steel tube.	3/9/2011
	7. Clarified that receptacles and light switches shall be weather proof "in-use" type with clear cover.	1/19/2011
	11. Emphasized the preference for diesel generators. Added requirement for diesel tank. Add requirement for generator load analysis.	12/16/2010
	1. Added requirement for motor control panel to be double door and separation of 120V and 480V loads within enclosure. Also added requirement for conductor color code for different voltage systems.	11/22/2010
	3. Added requirement for conductor size for motor controls and SCADA panels.	11/22/2010
	10. Updated requirements for quick coupling disconnect connectors for portable generators.	11/22/2010
	15. Updated requirement for exposed conduits to be rigid aluminum and added requirement for conduits to be embedded in concrete to avoid tripping hazards.	11/22/2010
	17. Clarified the requirement of the Hand-Off-Auto selector switches. Added requirement for self priming pumps to have a local non-fused disconnect with auxiliary contacts at motor per NEC.	11/22/2010
	20. Remarked the requirement of alternating controls, the separation of 120V and 480V loads,	11/22/2010
	21. Added the criteria for establishing when soft starters are required, soft starter operation requirements and cooling unit requirement for panel.	11/22/2010
	23. Added requirements for the grounding system.	11/22/2010
H. Station Controls, Instrumentation and Monitoring	1. Added requirement for submersible pressure transmitters and deleted requirement for ultrasonic level transmitters. Added criteria for submersible level transmitters.	3/8/2011
	4. Made reference to new Table 3. Clarified that the example was for a 2 pump type lift station, but the logic applies for 3 or more pump type lift stations.	12/16/2010
	2. Clarified that pressure transmitter must have an LCD display and must be calibrated to read the operating and surge pressures and must display the pressure in psi.	11/22/2010
	5. Clarified criteria and requirements for pressure gauges.	11/22/2010

Section	Revision	Date
I. SCADA	1. Added requirements of radio path study. Change coordinate system requirement from GPS to NAD83 State Coordinates.	01/12/2012
	11. Added requirements for transient voltage surge suppression and lightning arrestor.	10/19/2011
	12. Added requirements for tower ground resistance.	10/19/2011
	2. Added procedure to follow if a straight radio path is not achievable directly from the lift station.	11/22/2010
	3. Added criteria for SCADA repeater stations if required.	11/22/2010
	4. Updated SCADA alarms.	11/22/2010
	5. Added requirement of interposing or isolation relays within the SCAD panel.	11/22/2010
	6. Added the requirement for the radio to be located within the SCADA panel and be two way communication type.	11/22/2010
	7. Added the requirement for monitoring the SCADA panel internal temperature via SCADA.	11/22/2010
	8. Added the requirement for the SCADA panel to be climate controlled with AC and heater units.	11/23/2010
	9. Added requirements for tower location, accessibility and clearance of electric overheads.	11/23/2010
	10. Added requirements for uninterruptible power supply.	11/23/2010
J. Emergency Provisions	8. Added requirement to by-pass motor soft starters.	6/17/2011
	4. Clarified paragraph.	2/23/2011
	5. Clarified paragraph.	2/23/2011
	2. Made reference to Section G, paragraph 10.	2/22/2011
	7. Added requirement for check valve on emergency by-pass.	1/6/2011
K. Safety Requirements	7. Moved emergency eyewash and shower requirement from Section A "General Requirements" to Section K "Safety Requirements".	11/21/2011
	8. Moved wet well hatch and safety grate requirements from Section A "General Requirements" to Section K "Safety Requirements".	11/21/2011
	9. Move ladder requirements from Section B "Wet Well Requirements" to Section K "Safety Requirements".	11/21/2011
	1. Added requirement of overhead lines clearance.	11/23/2010
	2. Added the requirement of eliminating tripping hazards.	11/23/2010
	3. Added the requirement of arc flash analysis.	11/23/2010
	4. Moved the requirement of bollards from General Requirements to Safety Requirements.	11/23/2010
	5. Added requirement of provisions for installation of portable handrails around wet well hatches.	11/23/2010
	6. Added requirements for dry vaults.	11/23/2010
L. Submittal Requirements	1. Added the requirement of calculations for NPSH and total suction lift. Also required to utilize pipe material factor for loss calculations.	01/12/2012
	12. Added formulas and example of force main flush calculations.	2/24/2011
	2. Added formulas for calculations of total suction lift and definition of total suction lift.	11/23/2010

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LIFT STATIONS

Section A. General Requirements

1. As required by the current version of the San Antonio Water System Utility Services Regulations (USR), a consultant or developer who proposes to construct a lift station and force main system shall prepare a present value analysis of the cost of constructing gravity mains compared to the cost of the lift station/force main system. This analysis shall show that the lift station installation cost plus 30 years of operational and maintenance expenses would be less than the cost of the gravity mains. Lift stations will only be considered a viable option if the cost analysis clearly shows that the gravity sewers are not economically feasible. Lift stations will not be allowed where an acceptable alternative gravity route exists.

2. Design the lift station to consider the potential for expansion to build-out densities. The design of the lift station shall incorporate a wet well sized for the ultimate capacity of the water shed. The lift station design shall consider both the total number of acres and number of Equivalent Dwelling Units (EDU) to be developed, as stated in the Water and Sewer Commitment submitted to SAWS. The flow capacities are determined in accordance with applicable chapters and sections of Texas Commission on Environmental Quality (TCEQ) Chapter 217 "Design Criteria for Sewerage Systems" dated August 28th 2008 or the latest edition thereof, and in accordance with the assumptions and requirements of San Antonio Water System Utility Service Regulations, January 6th 2009 or the latest edition thereof.

3. All sanitary sewer lift stations shall be submersible type. Suction lift self primer and package type lift stations may be approved by SAWS on a case-by-case basis depending on station size/capacity, wet well depth, head requirements and motor horsepower. Table 1 outlines the allowable design criteria for each type of pump station:

TABLE 1
PUMPING STATION DESIGN CRITERIA

Station Type	Maximum Motor Horsepower	Maximum Wet Well Depth
Suction-lift/Self-priming* (If approved on a case-by-case basis)	No restrictions	17 feet
Submersible**	No restrictions	No Restrictions
Packaged Lift Stations (If approved on a case-by-case basis)	5 HP	13 feet

* Design Engineer will evaluate Total Suction Lift and NPSH values at all different operating points (i.e. one pump running, two pumps, three pumps, etc.) to ensure the pumps will not cavitate in any scenario. Maximum wet well depth shall not exceed 17 feet. Total suction pipe length shall not exceed 22 feet.
** The 5 feet distance could be greater depending on pump size and SAWS approval.

4. All lift stations shall be designed to meet the requirements of these SAWS Lift Station Design and Construction Guidelines, and also meet or exceed the requirements of TCEQ 217.60, 213 Subparts A and B (for lift station over Edwards Aquifer Recharge, Transition or Contributing Zones), 2011 NFPA National Electrical Code (NEC), 2007 National Electrical Safety Code (NESC), Occupational Safety and Health Administration (OSHA) 2007 or latest editions, and contemporary industry practices. A lift station application shall include final construction plans, a design engineering report and complete set of specifications prepared by or under the direct supervision of a Texas Licensed Professional Engineer. All design information shall be signed, sealed, and dated by a Texas Licensed Professional Engineer. The lift station site layout shall show the proposed grades. See SAWS Standard Lift Station Drawings for location of required proposed grades.

5. Lift stations located over the Edwards Aquifer Recharge, Contributing and Transition Zone shall be designed and constructed to ensure that bypassing of any sewage does not occur (TCEQ Chapter 213, Subchapter A §213.5I(3)I). All lift stations shall be designed to meet the requirements of these Design Guidelines and SAWS Standard Design Drawings; and meet or exceed TCEQ Chapter 217, Subsection C from §217.59 to §217.68.

6. The firm pumping capacity of all lift stations shall be such that the expected peak flow can be pumped to its desired destination. Firm pumping capacity is defined as lift station total pumping capacity with the largest pumping unit out of service, or with either one or two pumps out of service (see Table 3). **The firm pumping capacity shall be greater than the expected Peak Wet Weather Flow.**

7. Lift Station site layouts shall consider clearances for unimpeded maintenance operations. The area surrounding the lift station components including, but not limited to, the wet well, pump and motor slabs, valve slabs, generator, electric service rack and tower shall be large enough to permit heavy equipment and vehicles ample room to maneuver. The lift station site shall be designed to allow maintenance vehicles to have direct access to the wet well, electric controls, generator and tower.

8. **Access Road Design in Residential or Commercial Developments:** The lift station shall have an access road, either temporary or permanent, located in a dedicated right-of-way or permanent easement. The access road surface, either temporary or permanent, shall have a minimum width of 16 feet and the pavement shall meet AASHTO HS 20-44 standard. Crushed stone, flexible base or similar materials are not considered all weather materials and will not be accepted. The access road surface, either temporary or permanent, shall be designed to be above the water level caused by a 25-year storm event. The design of the access road, either temporary or permanent, shall include plan, section and profile sheets of the access road, and drain pipes and details. The design shall limit the slope to no more than 8 percent (8%) and grade break to 3 percent (3%) and provide soil erosion protection to prevent collection of sedimentation along the access road. Inside the boundary of a proposed residential development, design of the access road, either temporary or permanent, shall minimize turns and achieve the straightest possible alignment. If a straight access road is not provided, SAWS will determine whether or not an adequate turnaround is required to allow a 55 foot 18 wheeler tanker truck to safely turn around depending on wet well size, influent flow and site location. The turnaround shall meet the same pavement standard for the access

road. In a phased development, a temporary access road alignment shall be reviewed and approved by SAWS prior to the initial phase of development. SAWS written approval is required prior to any modifications to the temporary access road. Lift Stations access within a proposed commercial development shall be closely coordinated with SAWS early in the design. SAWS preference is for an exclusive driveway and paved access road that will be for SAWS use only. This access road shall have a straight horizontal alignment, and shall be paved and configured to preclude the public from blocking SAWS access to the station. It shall be a minimum of 16 feet wide without any interference with, but not limited to vehicles, landscape, curbs, posts, bollards, fences, parking stalls, striping, and above grade appurtenances, etc. If these design conditions cannot be satisfied, then the lift station may have to be designated as a private lift station, and maintenance of all sewer facilities within the commercial boundary shall be maintained by the property owner or a legally designated association.

9. Provide 2-8 foot gates for a 16-foot clearance to allow access by large maintenance equipment. Lift stations with relatively long driveways must include pole gates at the entrance of the driveway. Turnarounds may be required for stations constructed along heavily traveled streets. Allow sufficient space for large maintenance vehicles to have unhindered access to the wet well, generator, tower, by-pass and on-site manhole. Entries located parallel to the roadway should also be considered. Lift stations are not allowed within the street right-of-way.

10. The lift station, including all electrical and mechanical equipment, shall be protected from a 100-year flood event including wave action, and remain fully operational during such event. Provide a letter dated, signed and sealed by a Texas Professional Engineer certifying the site is protected from such an event. Attach floodplain evaluations if required by SAWS.

11. Provide protection of the lift station, including mechanical and electrical equipment, from access by any unauthorized person. The lift station shall be enclosed within an intruder resistant fence consisting of a chain link fence 8 feet minimum in height, with a 1-foot section above consisting of 3 strands of barbed wire "up-riggers." Privacy fences shall complement the character of the lift station location and will be evaluated on a case-by-case basis.

12. Provide a reinforced concrete base slab, or other appropriate feature, sized adequately to counteract buoyancy, and provide supporting design calculations. The concrete slabs of top of wet well, electrical rack, tower foundation and generator (when required) shall be 4" to 6" higher than the adjacent pavement.

13. The lift station site shall be completely paved. The pavement section shall be either concrete (preferred) or asphalt pavement meeting the ASSHTO HS 20-44, and the design shall be prepared by a Texas Professional Engineer. The design and construction shall be in accordance with all applicable City of San Antonio's Pavement Specifications for Construction, and if needed, includes additional reinforcement of the subgrade and base. The pavement design shall consider loading exerted by a 55 foot, 18 wheeler, and 80,000 pound tanker truck. The pavement shall be shaped to the lines, grades, and typical sections that are on the approved construction plans. If trees are to remain in the paved area, leave a circular

pervious area with a minimum 12-inch clearance around tree, and make sure the trees will not impede maintenance vehicle access.

14. Design shall provide for ¾-inch minimum freeze proof water service with hose bib vacuum breaker attached to the hose connection. It shall be located within 10-foot radius of wet well.

15. Design shall provide for a galvanized steel supported canopy over electrical service rack that will provide a minimum 7.0 foot vertical clearance, and 5 feet front span and 3.5 feet back span horizontal from the face and rear of the panel rack respectively. Due to the variety of soil conditions in the region, Design engineer must perform soil, foundation and structural analysis to ensure the canopy structure will withstand winds of up to 90 MPH. The canopy detail shown in the standard drawings is provided for illustration purposes and reflects the foundation minimum dimensions.

16. Provide engineering calculations of potential for hydrogen sulfide generation in force main and wet well, and provide recommendations to prevent and/or control generation of odors. As a standard practice, wet well retention time, and force main flush time shall not exceed 180 minutes. If the development is phased, this analysis shall be made for both initial and final phases. It is recommended for Design Engineers to coordinate with SAWS during the early stages of the lift station design, this way different alternatives can be evaluated. It is SAWS preference to keep all pumps the same size and not to depend on Variable Frequency Drives for initial conditions, but is some cases this may be the only solution. Parallel force mains of different size must be evaluated to satisfy conditions for initial and final development.

17. All exposed pipe, valves, and fittings <u>outside the wet well</u> shall receive after installation a 100% solids epoxy coating system with a top coat system of urethane, suitable for the environment. Prior to application, prepare surfaces in accordance with manufacturer's instructions. Any reference to cleaning in the manufacturer's instructions shall be understood to refer to the applicable SSPC specifications. Thickness, mixing and application shall be in accordance with manufacturer instructions. Apply finish coat in accordance with the color-coding set forth in Table 2, below. Approved manufacturers are Tnemec, Carboline, Sherwin-Williams, PPG, and M.A.B. Paints.

18. All pump discharge pipe and fittings <u>within wet well, except SS 316 and PVC,</u> shall receive after installation, a 100% solids coal tar epoxy coating system. Thickness, mixing and application shall be in accordance with Manufacturers instructions. Prior to application, prepare surfaces in accordance with manufacturer's instructions. Any reference to cleaning in the manufacturer's instructions shall be understood to refer to the applicable SSPC specifications. Approved manufacturers are Tnemec, Carboline, Sherwin-Williams, PPG, and M.A.B. Paints.

19. For appropriate landscaping of the Lift Station Site (outside the fence), comply with the City of San Antonio (when within the City limits) requirements, per UDC Section 35-510, as it may apply.

20. Service pole shall be located within lift station site at a location where electric overhead wires do not cross over the lift station site. Locate service pole as indicated in Standard Drawings preferably; alternate locations must be evaluated and approved by SAWS. Service pole must be located 20 feet away from the SCADA tower structure.

21. Lift station site shall be located or designed in a manner that will be protected from storm runoff entering the lift station site, and that will allow storm water to drain away from lift station site.

22. Lift station shall be placed at a sufficient distance from developed areas and designed with adequate odor control measures to limit the detection of odors within the developed area to an acceptable level.

23. Engineer shall ensure the specifications require the Contractor to submit minimum 3 hard copies and one electronic copy (in pdf) of the Operation and Maintenance Manuals of all equipment to the SAWS Inspector. Operation and Maintenance Manuals shall detail the following, but not limited to, technical data, performance levels, specifications, parts description, installation, operation and maintenance of electrical, mechanical, and instrumentation components.

TABLE 2
SAN ANTONIO WATER SYSTEM LIFT STATION COLOR CODES

TYPES OF EQUIPMENT	COLOR
1. Pump Suction Piping (if required)	Gray – Pantone Number 431 U
2. Header and Force Main Piping	Gray – Pantone Number 431 U
3. Pump/Motors and Mounts (if apply)	Gray – Pantone Number 431 U
4. Potable Water Line	Avalon Blue – Pantone Number 558 C
5. Compressed Air Line (where used)	Green – Pantone Number 349
6. Power Conduit	Orange – Pantone Number 166
7. Control/Instrumentation Conduit	Yellow – Pantone Number 109
8. Recycle water pipe	Purple – Pantone Number 521 C

End of Section A

Section B. Wet Well Design

1. **Dimensions:** Minimum 72" in diameter; larger as necessary to accommodate submersible pumping equipment, piping, supports, emergency storage volume and to support pump cycle times as indicated in Table 4. Depth of wet wells shall consider, but not limited to all the following: emergency storage volume, adequate submergence of submersible pumps, and suction piping for self priming or dry pit pumps (if approved). Fiberglass reinforced polyester (FRP) wet wells shall be installed for diameters up to 18 feet, unless prior arrangements have been made with and approved by SAWS to install precast concrete wet wells, and dry vaults.

2. **Emergency Storage:** Size the wet well to provide sufficient volume within the wet well, excluding the capacity of sanitary collection system upstream from the lift station. Emergency storage capacity shall be supported by engineering calculations. Design wet well emergency storage for the following capacities, using Average Daily Flow:

   For lift stations within Edwards Aquifer Recharge and Contributing Zones: 60-minutes of wet well storage plus a generator, or

   2) For lift stations over the Edwards Aquifer Transition Zone: SAWS staff will evaluate the site location, water stream proximity, remoteness, and geographical features to determine if the lift station site shall be treated as if it were over the EARZ, or

   3) For lift stations outside the Edwards Aquifer Recharge, Contributing and Transition Zones: 60-minutes of wet well storage plus a generator, or 120 minutes of wet well storage without generator. SAWS will evaluate and determine if a generator is required. (See Section J "Emergency Provisions").

   For calculation purposes, the wet well emergency storage level begins at the Lead Pump On level until wet well level is 2 feet below spill level elevation. Spill level elevation is determined by the manhole upstream of wet well with the lowest top elevation, or by the wet well top slab elevation, whichever is lower.

3. The lift station design shall minimize odor potential. Locate incoming wet well gravity pipe to reduce turbulence. Minimize detention times in wet well during all phases of development. If detention times are greater than 180 minutes, SAWS may require odor control measures based on evaluation of, but not limited to phasing considering construction phasing, prevailing wind direction, and proximity to neighborhoods. If odor control measures are needed, it shall consist of a chemical drum scrubber with top mounted blower to absorb odorous compounds for oxidizing. The drum scrubber shall be designed to operate at 99.5% gas removal. The design specification shall be prepared by the drum scrubber and media supplier. Approved manufacturer is Purafil, or a SAWS-SAWS-approved equal.

4. The wet well floor shall be sloped toward the pump intakes and have a smooth finish (see Standard Drawings) in order to become a self cleaning wet well. There shall be no wet well projections that will allow deposition of solids under normal operating conditions. Include

anti-vortex baffling on all lift stations with greater than 3 MGD (2,083 gpm) Peak Wet Weather Flow.

5. When permitted by SAWS, construction of concrete wells shall include a full monolithic structure or a precast wet well structure with monolithic base. Design engineer shall evaluate the thicknesses of wet well wall and slabs, but the following thicknesses shall be met as minimum: wet well wall thickness 10 inches, wet well base slab 12 inches and wet well top slab 10 inches.

6. Line interior of concrete wet wells with a 100% pure calcium aluminate premix lining system. Surface preparation, thickness, mixing and application shall be in accordance with the manufacturer's instructions. Wet well joints shall be sealed per the manufacturer's recommendations. Approved manufacturer is Sewpercoat, or SAWS-SAWS-approved equal.

7. The bottom of the excavation for the wet well structure shall be a level subgrade approximately 18 inches of crushed stone below the bottom of the wet well structure and native soils shall be compacted with excavation equipment for the installation of 6 inches of flexible base to support the base of the structure. Compaction of native soil and flexible base shall achieve minimum ninety-eight (98%) of the maximum dry density as determined by the TXDOT testing method Tex 113-E.

8. 3,000 psi reinforced concrete shall be installed around wet well exterior to an elevation of 1/3 the total depth of the wet well structure, as measured from the well bottom up. The remaining 2/3 shall be backfilled with flowable fill. Wet well manufacturer shall design the wet well thickness.

9. Use 16 mesh 316 Stainless Steel screens on passive ventilation, gooseneck type, to prevent the entry of birds or insects into wet well. Mechanical and electrical equipment in the wet well shall be NFPA Class 1, Division 1 construction type. Size the passive ventilation to vent at a rate equal to the maximum pumping rate of the station and not exceed 600 fpm through the vent pipe. The minimum air vent size shall be 4-inch diameter, and it shall be made of stainless steel 316. Vent outlets shall be at least 1 foot above the 100-year flood elevation. All screening shall be installed in a manner that will allow for future replacement.

10. When dry wells are approved, provide permanent mechanical ventilation and lighting, if required by SAWS.

11. Connection between wet well and dry well ventilation systems is not allowed.

12. Provide multiple air inlets and outlets in dry wells over 15 feet deep. Do not use dampers on exhaust or fresh air ducts. Avoid screens that are finer than #10 sieve or other obstructions within air ducts to prevent clogging.

13. When dry wells are approved by SAWS, provide manual lighting/ventilation switches to override automatic controls installed for any intermittently operated lighting/venting equipment. The location of these switches will be at the Dry Well entrance.

14. Incorporate hoisting equipment, or access for hoisting equipment, for removal of pumps, motors, valves, etc. into the design. SAWS will determine if hoisting equipment shall be included in the design, depending on size of equipment. When required by SAWS, hoisting equipment will include overhead crane.

15. All accessory hardware in wet well including but not limited to chains, cables, bolts, nuts, fasteners, brackets, anchor bolts, washers, cable holders and slide rails, shall be 316 stainless steel.

16. The distance between the bottom of the wet well and the bottom of the gravity invert pipe shall be between 5 and 7 feet. If distances greater than 7 feet are required the gravity invert pipe must tie to wet well via drop pipe per SAWS Standard Drawings.

17. Fiberglass reinforced polyester (FRP) wet wells shall be manufactured from commercial grade unsaturated polyester resin or vinyl ester resin, with fiberglass reinforcements. The wet well shall be manufactured in one-piece including body, bottom and top, and it shall be sit over a concrete slab design to counteract buoyancy forces. Design engineer shall design the top concrete slab. Approved manufacturers are L.F. Manufacturing, and Containment Solutions, or SAWS-SAWS-approved equal

    a. The resins used shall be a commercial grade unsaturated polyester resin.

    b. The reinforcing materials shall be commercial Grade "E" type glass in the form of mat, continuous roving, chopped roving, roving fabric or a combination of the above, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.

    c. If reinforcing materials are used on the surface exposed to the contained substance, it shall be a commercial grade chemical-resistant glass that will provide a suitable bond with the resin and leave a resin rich surface.

    d. Fillers, when used, shall be inert to the environment and wet well construction. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used. The resulting reinforced plastic material shall meet the requirement of this specification.

    e. The exterior surface shall be relatively smooth with no sharp projections. Handwork finish is acceptable if enough resin is present to eliminate exposed fiber. The exterior surface shall be free of blisters larger than 1/2 inch in diameter, delamination and exposed fiber.

    f. The interior surface shall be resin rich with no exposed fibers. The surface shall be free of grazing, delamination, and blisters larger than 1/2 inch in diameter, and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to 6 square feet if they are less than 3/4 inch in diameter and less than 1/16 inch deep.

    g. The bottom to be fabricated using fiberglass material. Bottom to be attached to wet well pipe with fiberglass layup to comply with A.S.T.M.-D3299 specifications.

Reinforcement, if needed, shall be fiberglass channel laminated to wet well bottom per A.S.T.M.-D3299.

h. The fiberglass wet well top shall be fabricated using fiberglass material. Top to be attached to wet well pipe with fiberglass layup to comply with A.S.T.M.-D3299 specifications. Reinforcement, if needed, shall be fiberglass channel laminated to wetwell bottom per A.S.T.M.-D3299.

i. Influent pipe shall be Kor-N-Seal or Inserta-Tee (refer to Standard Drawings for details). Sleeve shall be either PVC or Fiberglass Pipe, and it shall be installed and tested by the manufacturer. Installation of stubouts to be fiberglass layup to comply with A.S.T.M.-D3299 specifications.

j. Require wet well be designed for the project service conditions (initial and ultimate build out), assuming fully saturated soil external loading and buoyant uplift, with related design calculations included in the engineering report.

k. The (FRP) wet well shall be installed in strict accordance with the wet well manufacturer's recommendations.

l. Each wet well shall be marked with the following information.

(1) Manufacturer's name or trademark
(2) Manufacturing special number
(3) Total length and nominal diameter

18. Wet Well Testing. An Exfiltration test must be performed immediately after the wet well has been backfilled and compacted. Exfiltration shall not exceed 0.0142 gal/hr per foot diameter per foot depth. The test must be done by plugging the gravity invert and filling up the wet well with water to either 1-foot below the wet well top slab, or up to the manhole lid with the lowest elevation below top slab. (<u>This level must be clearly temporarily marked in the wet well internal wall</u>). Once the wet well is filled, it must be left for stabilization for 48 hours minimum prior to beginning the Exfiltration test. After the stabilization period, the wet well must be refilled up to the mark to begin the test. The test shall be done for two hours minimum, and no water may be added to the wet well during the test period. The Exfiltration test must be determined by measuring the amount of water required to raise the wet well level back to the mark at the end of the test period. The maximum allowable water loss to pass the test is determined by the following equation:

$$\text{Water Loss (gallons)} = 0.0142tDh$$

Where:

t = test time period (2 hours)
D = wet well diameter (in feet)
h = water level depth within wet well (in feet)

If the Exfiltration test fails the Design Engineer must work with the Contractor to determine all the necessary corrective actions to reduce the exfiltration. Once the repairs are completed the test shall be repeated. The wet well will pass the test when the exfiltration is equal or less then the allowable water loss. SAWS Inspector, Contractor and Design Engineer shall witness the complete Exfiltration test. Design Engineer shall provide a certified letter showing the results of the exfiltration test to SAWS inspector. The certification letter shall include a description of all steps taken to complete the exfiltration test, including water loss, wet well level mark, and any corrective actions taken if a prior test failed.

End of Section B

Section C. Pumping Equipment Design

1. Provide the required number of pumps, and adequate controls to alternate all pumps (See Table 3 for minimum number of pumps required).

2. All pumps, regardless of station design, shall be electric, centrifugal non-clogging units capable of passing incompressible spheres as indicated in Table 3 (Minimum Sphere Pass), and shall have no less than 4-inch diameter suction and discharge openings. Semi chopper, vortex or grinder pumps may be accepted on case-by-case basis. 2-Pole motors may be approved by SAWS on case-by-case.

TABLE 3
MINIMUM NUMBER OF PUMPS REQUIRED

Peak Wet Weather Flow	Minimum Number of Pumps	Minimum Sphere Pass
500 gpm or less	● 2 Pumps: 1 Lead, 1 Standby †	3-inch
Between 501 and 1200 gpm	▲ 3 Pumps: 1 Lead, 1 Lag, 1 Standby †	3-inch
Between 1201 and 3000 gpm	▲ 4 Pumps: 1 Lead, 1 Lag, 2 Standby ‡	3-inch
Over 3001 gpm	■ 5 Pumps: 1 Lead, 2 Lag, 2 Standby ‡	4-inch

NOTES: All pumps including Standby must alternate constantly.
● Lead Pump will discharge more than the Peak Wet Weather Flow.
▲ Lead Pump with Lag Pump will discharge more than the Peak Wet Weather Flow.
■ Lead Pump with Lag Pumps will discharge more than the Peak Wet Weather Flow.
† One standby pump required only.
‡ Two standby pumps required due to magnitude of flow.

3. Self priming pumps (if approved) shall include inspection and cleanout plates located both on suction and discharge sides of each pump, to facilitate locating and removing blockage-causing materials unless the pump design accommodates easy removal of the rotation elements.

4. Specify pump motors suitable for continuous operation and inverter-duty type (suitable for soft starters and variable frequency drives) at full nameplate load while the motor is completely submerged, partially submerged, totally non-submerged for submersible pumps.

5. Pumps shall be capable of meeting all system hydraulic conditions without overloading the motors. In addition, a minimum of 5-hp motor is required, unless prior arrangements have been made and approved by SAWS. Submit pump head capacity and system curves to SAWS, along with the lift station plans. Base the curves on the total of static head, friction losses through force mains, headers and pump risers. Pump duty point for nominal design flow shall be within 75% and 115% range of pump's flow at Best Efficiency Point (B.E.P). This condition shall be satisfied for at least one and two pumps in operation. Points outside this range will be evaluated by SAWS and may be approved based upon performance, average energy consumption per month (kW-hr/month), etc.

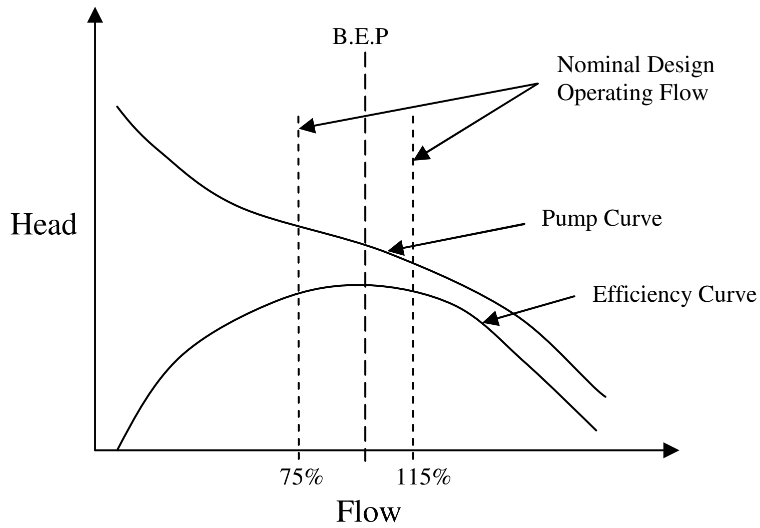

FIGURE 1: PUMP DUTY POINT BETWEEN 75% and 115% RANGE OF FLOW AT B.E.P.

6. Based on peak flow, pump cycle time shall not be less than those in Table 4.

TABLE 4
MINIMUM WET WELL LEVEL CYCLING

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

NOTE:
- Wet well cycling is determined by the wet well internal volume established by the wet well internal diameter, and the distance between Lead Pump On and Pump Off levels.
- Fill time is the time that takes the wet well level to rise from Pump Off to Lead Pump On.
- Empty time is the time that takes a pump to drop the wet well level from Lead Pump On to Pump Off while wet well inflow is active. (Pump Run Time).

7. All lift stations shall operate automatically based on the water level in the wet well. Locate wet well level control device as indicated in Standard Drawings. Level control device and float switch shall be fully accessible without the need for personnel entering the wet well.

8. Submersible Pumping Stations.

   a. The lift station shall consist of submersible centrifugal sewage pumps, stainless steel 316 guide rail system, wet well access, discharge seal and elbow, motor control center, starters, liquid level control system, SCADA monitoring system, and all hardware necessary to provide a complete working system. Every integral component of the guide system shall be stainless steel 316, which includes the following but not limited to: guide rails, brackets, fittings, bolts, nuts, fasteners, adapters, attachments, etc. Flanged discharges are not allowed.

b. Impellers shall consist of cast stainless steel or ductile iron. Mechanical Seals shall consist of Tungsten Carbide. Silicon Carbide seals will be evaluated and approved by SAWS on case-by-case basis.
c. Motor insulation shall be Class H, be inverter duty type, and have a minimum service factor of 1.15.
d. Pump duty point shall be within 75% to 115% range of pump's flow at Best Efficiency Point (BEP) for one and two pumps in operation as to achieve the maximum efficiency possible, and no substitutions will be accepted after SAWS approval of the Lift Station construction plans and Engineering report. Designer shall consider different combinations of pumps, impellers and pipe sizes including discharge and force main piping in order to achieve the pump operating criteria and maximum efficiency. The Utility Services Regulations, Section 11.4.4 requires Energy Calculations which mean the engineering report shall prove the proposed pump is the most efficient option. Exemptions may be considered on a case-by-case. Approved pump manufacturers are ITT Flygt, Hydromatic, and KSB.
e. Sealing of the pump unit to the discharge connection shall be a machined metal to metal water tight, hydraulically sealed contact.
f. The proposed elevation of all critical components shall be shown in the Drawings including, but not limited to pump intake line inverts, control and alarm levels, top of the wet well, top of the dry well, influent line invert(s).
g. Pumps shall be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well.
h. All electrical equipment/panels and controls shall be above ground.
i. All cables shall be continuous (no splices allowed), and intended for wastewater service applications.

9. Non-packaged Suction Lift/Self-priming Stations. (If Approved)

a. Suction lift stations shall meet all applicable requirements in this standard, as well as those required by TCEQ Chapter 217. The lift station shall consist of self-priming, horizontal, centrifugal, sewage pumps, wet well access, discharge seal and elbow, motor control center, starters, liquid level control system, SCADA monitoring system and all hardware necessary to make a complete working system. Supply and warranty will be through a single company. Approved pump manufacturers are Wemco, Hydromatic, and Gorman Rupp.
b. Impellers shall consist of ductile iron or cast stainless steel. Mechanical seals shall consist of Tungsten Carbide.
c. Pump duty point shall be within 75% to 115% range of pump's Best Efficiency Point (BEP) for both one and two pumps in operation as to achieve the maximum efficiency possible, and no substitutions accepted after SAWS approval of the Lift Station construction plans and Engineering report. Designer shall consider different combinations of pumps, impellers and pipe sizes including discharge and force main piping in order to achieve the pump operating criteria and maximum efficiency. The Utility Services Regulations, Section 11.4.4 requires Energy Calculations which mean the engineering report shall prove the proposed pump is the most efficient option. Exemptions may be considered on a case-by-case.

d. Suction-lift pump stations using dynamic suction lifts exceeding the limits outlined in the following paragraphs will not be approved. Detailed calculations shall include static suction lift as measured from the "lead pump off" elevation to the centerline of the pump suction, friction and other dynamic head losses altitude correction, required net positive suction head and a safety factor of 4 feet.
e. The pump equipment pad or compartment shall be above grade or slightly offset and shall be physically located either on top of or as close as possible to the wet well to prevent the humid and corrosive atmosphere from entering the compartment. Wet well access shall be provided through another opening on the wet well cover, 3 feet x 4 feet minimum dimensions.
f. Self-priming pumps shall be capable of priming and repriming at the "lead pump on" elevation. Self-priming and repriming shall be automatically accomplished within 60 seconds under design operating conditions. Vacuum switches rated for raw sewage and weather proof shall be installed at the suction pipes. Vacuum switches will have adjustable vacuum set points, and will be wired to the SCADA monitoring system to indicate that a pump has lost prime. A timer will be incorporated in the control system to allow the pump to reprime within 5 minutes. If at the end of the 5 minutes the pump hasn't reprimed, the timer will take the pump out of service, but only in the automatic mode. The control system shall allow any pump to run manually regardless of the prime condition, vacuum switch condition or timer condition.
g. Suction piping shall not be smaller than the discharge pipe, and shall not exceed 15 feet in total vertical lift with zero horizontal suction pipe length. Wet well slab design shall consider structural loading due to static and dynamic loading exerted by the pump and any deadweight. Request to design a separate slab for the pump shall be reviewed by SAWS and considered for approval on a case by case basis. The total suction lift and required net positive suction head at design operating conditions and at "all pumps off level" shall not exceed the total suction lift and net positive suction head available of the pump. Recommend a minimum 2-foot difference.
h. Use "T" fittings on the individual suction lines, instead of 90-degree elbows, at the last turn before the pumps, to facilitate suction line cleaning.
i. A ¾-inch bleeder valve and piping shall be installed on the discharge side of the pump housing and terminate back into the top of the wet well for priming and cleaning of the pumps. Piping shall be schedule 40 PVC
j. Use flanged fittings for piping at the pumps to facilitate pump removal.
k. Provide heavy duty and supported pulley guards.
l. Electric motors shall be in compliance with the NEMA Premium Efficiency specification, and shall have insulation Class H, be inverter duty type and shall have a minimum service factor of 1.15.
m. Electric motor shall be totally enclosed, fan cooled.
n. Pump and motor configuration shall be belt drive with drive end of motor (rotating counter clock-wise) opposing driven end of pump (rotating clock-wise), and motor located above pump on adjustable hinged mounting base allowing access to pump. Minimum number of belts is 2 for motors up to 10 HP, 3 belts for motors larger than 10 HP and up to 30 HP, 4 belts for motors larger than 30 HP.
o. Motor base shall be hinged, bolt adjustable and manufactured as a primed single frame. Motor base size shall accommodate NEMA mounting dimensions. The motor and base fit shall provide tolerance for alignment, ease of belt adjustment and tensioning

without removal of guards, as well as simple removal and replacement of belts, sheaves, and pumps. Equipment shall be supported by concrete or steel frame support bases used as part of the noise and vibration isolation of the equipment. Motor manufacturer shall furnish the support bases and properly size them for the mounted motor and base and grout as necessary for stable footing.

10. Packaged Lift Stations (If Approved).

    a. Approved manufacturers are ITT Flygt, Hydromatic, Gorman-Rupp, KSB
    b. Station design shall satisfy all the requirements listed in this guideline Check with SAWS for possible exemptions.
    c. All pumps, motors, internal valves and piping, level indicators, control switches, SCADA monitoring system, ladder, alarms, blower and dehumidifier shall be manufactured and assembled as a package unit. Supply and warranty will be through one company.

End of Section C

Section D. Station Piping

1. Each pump shall be separated and immersed according to manufacturer recommendation, and have a separate suction pipe (for non-submersible pumps if approved). Pipe reducers installed at discharge base of submersible pumps or suction port of non-submersible pumps shall be eccentric type. Eccentric reducers installed horizontally on suction pipes shall be installed with flat side up to preclude air entrapment. Reducers installed at discharge header shall be concentric reducer. Pipes in wet wells of suction lift pumps shall be equipped with a turndown type flared intake and consist of ductile iron or SS 316.

2. The design shall consider surge effects and provide protection where necessary. Surge relief shall be contained in the system. If a surge relief valve is needed, it shall be installed in the exact position shown in the Standard Drawings. Design engineer must include in design the detail shown in sheet DD-903-03, 1 of 5 and fill the blanks.

3. Floor drains from valve vaults to wet wells shall be designed to prevent gas from entering the valve vault (if valve/pump vaults are approved). Such designs shall include flap valves, "P" traps, submerged outlets, or a combination of these devices. Sump pumps may be required in lieu of floor drains. Consult with SAWS for sump pump requirements.

4. Provide metal manufactured pipe supports for pipes as indicated in Standard Drawings, and where else needed.

5. Lift station piping shall be D.I. and shall have flanged connections to allow for removal of pumps and valves without interruption of the lift station operations. Wall penetrations shall be designed to allow for pipe flexure while excluding exfiltration or infiltration. Pipe suction velocities (if self priming pumps are approved) shall be between 3.0 and 3.5 feet per second at pump nominal design flow.

6. Use forty-five (45) degree cast iron elbows for pump discharge piping turns where the force main bends toward the ground.

7. Discharge and common header pipe shall be installed 3 feet above concrete slab, measured from slab surface to pipe center line.

End of Section D

Section E. Station Valves

1. Gate Valves: Install a gate valve on the upstream side of each check valve. Gate valves shall be resilient wedge, flanged joints, conforming to the applicable requirements of ANSI/AWWA C509, and shall be handled and installed in accordance with the recommendations set forth in the appendix to ANSI/AWWA C509 and the recommendations of the manufacturer. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. If the full-closing valve is other than a rising stem gate valve, the valve shall include a position indicator to show its open or closed position. Approved manufacturers are Clow F-6102, Mueller A-2360, Kennedy 4561/4701, and American Flow Control – Series 2500.

2. Check Valves: A flanged, non-slamming check valve shall be installed on the discharge side of each pump and on by-pass quick connector, followed by a full-closing isolation valve on each pump. Check valves shall be swing type with an external lever and minimum pressure rating of 250 psi. Approved check valve manufacturers are Clow Style 106LW, Mueller #2600-6-01, Kennedy IBBM Swing Check Valve, American "50" Line with Weight and Lever.

3. Butterfly valves, tilting disc check valves, or other valves utilizing a tilting disc in the flow line are not allowed.

4. Air/Vacuum Release Valves: shall be mounted on common header and all high points along force mains. Air/Vacuum release valves shall be rated for raw sewage, have a minimum 2" inlet, and be provided with flush ports. Valves shall be sized for intended system hydraulics, with related sizing calculations included in engineering report. Air release valves shall be mounted on isolation valves. The air release pipe shall be a minimum of 1-inch PVC Sch. 40, and it shall be installed in a manner that doesn't represent a tripping hazard, and it shall be solidly fastened; unless embedded in concrete slab, and shall discharge into wet well. Liquid shall not accumulate within air release pipe. Air/Vacuum release valves shall have a PVC or stainless steel 316 body. Approved manufacturer is A.R.I Model S-020 or equivalent.

5. Surge Relief Valves: When required, surge relief valve size shall be selected based on Firm Pumping Capacity flow. It shall be rated for raw sewage service, and it shall have isolation valve on the inlet side. Opening setting shall not exceed 5 psi above normal operating pressure of the system at header when firm pumping capacity flow is being discharged. Surge relief pipe shall be routed back to either wet well or manhole next to wet well. Engineering report must include analysis and reference information showing how the valve was selected. When the analysis shows dangerous surge pressure at firm pumping capacity, a surge relief valve will be included in the design in addition to the soft starters.

End of Section E

Section F. Force Main

1. Install the Force Main at least 4 feet below finished ground surface, and higher than the gravity inlet line elevation.

2. Metallic detector Tape must be laid in the same trench as the force main. The detector tape must be located above and parallel to the force main. The detector tape must bear the label "PRESSURIZED WASTEWATER" continuously repeated in at least 1.5-inch letters.

3. Provide plan and profile of the force main in plans.

4. Install an isolation gate valve on all force mains, located immediately before they turn toward the underground.

5. Minimize the number of peaks and valleys along the Force Main profile to limit the accumulation of gases. All high points shall have 2-inch minimum air and vacuum release valves rated for raw sewage. Plans must include the air release valve installation detail. See Standard Drawings.

6. Force Mains shall transition into a gravity line within a manhole via drop manhole as to minimize turbulence. The crowns of the force main and outlet gravity line shall match where possible, with bench grouting installed to direct flow into the outlet with a minimal change in the gravity flow angle to minimize turbulence.

7. Minimum force main size will be 4-inch (except for grinder pumps); however, size Force Mains so that flow velocity is between three (3.0) and three and a half (3.5) feet per second (velocities slightly above 3 feet per second are recommended) with one pump in operation. Maximum flow velocities shall be four and a half (4.8) feet per second with two pumps in operation and six (6.0) feet per second with three pumps in operation. For lift stations with more than 2 pumps, flow velocities may be as low as two (2.0) feet per second with one pump in operation, but when three or more pumps operate a flow velocity equal to, or greater than five (5.0) feet per second must be generated.

8. All pipe material shall consist of fusion-welded HDPE, and both engineering report and plans must indicate either Ductile Iron Pipe Size (DIPS) or Iron Pipe Size (IPS). Pipe shall consist of HDPE solid wall referred as to Drisco 1000, Drisco 8600, Quali Pipe, Poly Pipe, and Plexco Pipe that is in compliance with ASTM F714. All pipe and fittings shall be high density polyethylene pipe and made of virgin material, and shall have a minimum working pressure rating of 150 psi. The pipe shall be manufactured from a High Density High Molecular weight polyethylene compound which conforms to ASTM D 1248 and meets the requirements for Type III, Class C, Grade P-34, Category 5, and has a PPI rating of PE 3048. Solid wall pipe shall be produced with a plain end construction for heat-joining (butt fusion) conforming to ASTM D 2657; no flanged or slip-on joints will be accepted. See SAWS Standard Specifications for Construction, Item No. 900: "Reconstruction of Sanitary Sewer by Pipe Bursting/Crushing Replacement Process", Section 900.2.1.

9. All lift stations located over Edwards Aquifer Recharge and Contributing Zones shall be designed with double barrel force mains to provide full redundancy. Lift Stations over the Edwards Aquifer Transition Zone, and Lift Stations outside Edwards Aquifer Recharge, Contributing and Transition Zones but with either Peak Wet Weather Flows of 1,200+ gpm or force main lengths of 5,000+feet will be evaluated by SAWS to determine if double barrel force mains will be required. Double barrel force mains shall be connected (above ground) to the common header through a wye fitting, and an isolation gate valve shall be provided for each force main immediately after the wye. Double barrel force mains shall be designed to provide full redundancy.

10. Force mains pressure rating shall be at least 1.333 times greater than the pressure generated by instantaneous pump stoppage due to a power failure under maximum pumping conditions as determined by dynamic pressure analysis, but in no case shall be rated less than 150 psi. Design engineer must include an analysis showing the maximum surge pressure for such conditions in the engineering report, and provide a solution to prevent a force main break.

11. A force main average flush time analysis must be included in the engineering report. Average flush time shall not exceed 180 minutes. See section L, paragraph C.12 for example calculation.

12. Combination Air/Vacuum Release Valves must be installed in a dry vault with a minimum inner diameter of 6 feet and with a minimum 30-inch access opening. Location of force main and air release valve within dry vault must be in a manner that will provide safe working space and safe access. See Standard Drawings. Show in plans GPS coordinates of all air release valves installed along force mains.

13. Force mains must be tested by filling with water and pressurizing to 50 psi above force main nominal rated pressure. Force main must hold the test pressure for 4 hours.

14. A leak test must be also performed, and the leakage rate must not exceed 10 gallons per inch diameter per mile of pipe per day when the force main is pressure tested.

15. Per Chapter 217 requirement, install isolation plug valves at least every 2,000 feet to facilitate initial testing and subsequent maintenance and repairs. Show GPS coordinates of each plug valve on the plans. Confirm such GPS coordinates in Record Drawings or As-build drawings.

End of Section F

Section G. Electrical Equipment

1. Electrical service shall be 277/480-volt, 3-phase, and 4-wire, unless otherwise approved by SAWS. Minimum service size shall be 200 amps. General lighting and power transformer shall be at least 10KVA, and shall be housed with load center in a separate stainless steel enclosure. Request for smaller electrical service shall be reviewed by SAWS and considered for approval on a case by case basis. All enclosures shall be white enameled stainless steel 304, rated NEMA 4Xwith lever type door closures. Pump control enclosure shall be double door type 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:

480Y/277 Volts		120/240Volts 3P4W		24Vdc	
Phase A:	Purple	Phase A:	Black	Positive:	Blue
Phase B:	Brown	Phase $B_{(High)}$:	$Red_{(Orange)}$	Negative	White w/blue
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 ºC, with insulation suitable for dry and wet locations. Sizing shall be done according to NEC requirements. Power conductors shall be continuous. Field splices are not allowed.

3. Wire size for controls shall be #14 AWG copper stranded rated for 90 ºC. Wire size for SCADA controls shall be #16 AWG copper stranded rated for 90 ºC.

4. Due to the potential presence of hydrogen sulfide and other corrosive gases, greases, oils, and other constituents frequently present in sewage, all mounting hardware shall be Type 304 Stainless Steel and install seal-offs in conduit leading into the pump control panel and junction boxes. All enclosures shall be Type 304 Stainless Steel, and disconnects shall be FRP-NEMA 4X. All enclosures and disconnects shall be lockable with a padlock.

5. 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. Main electrical disconnect shall be time delay fuse or time delay circuit breaker. Provide a surge arrestor in a separate NEMA 4X, SS304 enclosure mounted in the service pole mounting rack as indicated in the Standard Drawings. Approved Manufacturers: 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 under corrosive environments. Each flexible cable shall be provided with a watertight seal and separate strain relief. High water float switch shall be normally open and non mercury type.

7. Free-standing electrical service and transfer switch shall be housed in heavy-duty electrical weatherproof, NEMA 4X, stainless steel 304 enclosures securely mounted onto the rack a minimum of 24” above the ground. Provide 120-volt, 20-amp duplex, GFI, receptacle in an “in-use” weatherproof box with clear cover. Light switches shall also be installed in a weatherproof box with an “in-use” clear weatherproof cover.

8. All electrical equipment shall be protected from the 100-year flood event and be protected from potential flooding from the wet well. If the electrical equipment is raised significantly to be above the 100-year flood event, then a platform shall be constructed with rails and adequate working clearance in front of the electrical equipment, with permanent ladder or steps for access. As a minimum, Motor Control Centers shall be mounted on a 4-inch tall concrete housekeeping pad. All electrical equipment and connections in wet wells and dry wells shall be rated for Class 1 Division 1 explosion proof.

9. Transfer switches, motor controls, dry type transformers, load centers, SCADA monitoring system and connectors for portable generators (if needed), and wiring gutters shall be mounted on a single rack under the Canopy as shown in the Standard Drawings. Mounting rack shall be constructed of type 304 stainless steel strut, 1-1/2” minimum, mounted on a minimum 4-inch diameter and ½-inch thick hot dip galvanized structural steel tube. See mounting rack layout and structural details on the Standard Drawings. Approved manufacturers: UNISTRUT, Kindorf, and B-Line. Touch up with cold galvanizing compound any scratches where coatings are applied. Close all exposed tube ends with proper size PVC plug caps. Do not use the electrical service pole for supports.

10. If a stand by generator is not required, provide quick connectors and a NEMA 4X manual transfer switch. Quick connectors shall be Crouse-Hinds, cam-lok, E1016 or 1017 Series (depending on total electric load), male type. 5 connectors – 3-phases, ground and neutral, and shall be installed within an enclosure adjoining the manual transfer switch. The manual transfer switch shall be Square D, Class 3140, 600-volt class, double throw, non-fused safety switch, NEMA 4X, Model 8234_DS, or SAWS-approved equal. Size the transfer switch to handle the entire load of the lift station. Approved Manufacturers: Square D, Siemens, General Electric, and Cutler-Hammer.

11. If a generator is required, the generator transfer switch shall be of the automatic type. Generally the generator shall be diesel fueled, but in Edwards Aquifer Recharge and Contributing Zones, if natural gas service is available, the generator shall be fueled by natural gas. Diesel fuel tanks shall be base tanks integrated into generator unit by OEM, shall include double wall containment, and shall be sized to run the generator for at least 10 hrs continuously at 100% load. The concrete base to install the generator shall be provided with a spill containment structure to capture any spillage (see Standard Drawings for details). The generator shall have a 4-foot clearance all around, and it shall be provided with noise control package. Noise Control Package Specification for Generator shall be residential rated. Sound attenuation includes enclosure and exhaust muffler package. Sound attenuation system performance shall result in measured sound levels not to exceed 78 dB @ 7 meters (23 feet), 60 Hz. Design Engineer shall perform a load analysis with the sequence of motor starting in order to know the motor starting loads and the motor running loads. Such electric load calculations must be done in kVA units to account additional loads due to low power factor.

The generator shall have a motor starting kVA capacity to limit the voltage dip to no more than 15% for any motor starting conditions. Such generator load analysis must be included in the engineering report. Approved manufacturers are Kohler, Onan, Caterpillar and Generac, or SAWS-approved equal.

12. Provide terminal blocks and panel wiring for future remote start and stop contacts.

13. If a dry well is used, consider it a confined space, and provide explosion proof dry well lighting adequate to illuminate the ladder and the floor of the dry well.

14. All underground electrical conduits shall be grey, rigid nonmetallic conduit (RNC). Field manufactured bends are not permitted. Only factory fabricated conduit bends are allowed. Buried conduit shall have a cover depth of 18 to 24 inches beneath the finished surface. Conduit shall comply with minimum NEC bend radius and not burned or kinked.

15. All exposed conduit shall be rigid aluminum. To avoid tripping hazards, conduits must be buried and/or embedded in concrete slabs.

16. Provide general illumination of 1.0 foot-candle (average) on the lift station equipment areas. Use Metal Halide fixtures for general illumination. Mount task lighting to the canopy as detailed in the Standard Drawings.

17. Provide ability to operate station with one pump removed for maintenance, by utilizing a Hand-Off-Auto switch and control logic that keeps alternating all the remaining pumps in service and no parallel switching in order to allow for proper lockout procedures. For self priming pumps, provide local non-fused disconnect with auxiliary contacts at motor per NEC.

18. Provide explosion proof local control <u>in dry well, when one is used,</u> to operate pumps for testing.

19. Install all conduit runs in initial construction sized to meet ultimate electrical and instrumentation needs.

20. The pump controller shall be provided with alternating lead-lag controls within a NEMA 4X enclosure. The pump control enclosure shall have two doors (480V equipment installed on the right side, 120V equipment installed on the left side), and shall also contain the motor disconnect circuit breakers, motor starters, level controller, and soft starters (when required).

21. Soft Starters must include by-pass mode capability, and will be required for either motor sizes of 50+ HP; force mains of 5,000+ feet long; flow velocities of 5+ feet per second (at firm pumping capacity); or static heads of 60+ feet. Soft starters must be rated for operation at 50 ºC. Soft starter shall be capable of allowing accelerating and decelerating ramps of 60 seconds without de-rating the soft starter capacity; however accelerating and decelerating ramps will be easily programmable to lower values. Approved soft starter is Benshaw, heavy duty rated (500% FLA for 30 seconds and 125% FLA continuous), open type, model RB2 with MX^2 controls and integrated bypass contactor, or SAWS approved equal. When soft

starters are required, the pump control panel must be insulated and provided with a closed-loop climate controlled unit of 2,200 BTU @ 95ºF (minimum) operating at 120 V. Climate controlled unit approved manufacturer is McLean model T20-0216-G100, or SAWS-approved equal. See Standard Drawings for details. Contact SAWS for possibility of using louvers, filters and miniature exhaust fans as a cooling alternative to A/C units. Adequate clearance must be provided to service/replace the A/C units.

22. Special considerations for submersible stations:

    a. Design electrical supply, 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 meet the requirements of the NFPA National Electrical Code to prevent the atmosphere of the wet well to enter the control center. The seal shall be so located that the motor may be electrically disconnected without disturbing the seal.
    c. Pump motor cables shall meet the requirements of the National Electrical Code for flexible cords in wastewater pumping stations. Power cord terminal fittings shall be corrosion-resistant and constructed in a manner to prevent entry of moisture into the cable, and shall be provided with strain relief appurtenances.

23. Grounding system shall have a maximum ground resistance of 5 Ohms. Design Engineer will incorporate special soils such as graphite compounds to improve the ground resistance properties. Ground moisturizing ports shall consist of 1-inch PVC Sch. 80 pipe (when directly buried in soil) or 1-inch Sch 40 galvanized pipe (when embedded in concrete), with perforated holes of 1/8-inch diameter, be buried and placed as close as possible to the grounding rods, as indicated in the Standard Drawings. The function of the moisturizing port is to inject water during dry weather to moisture the soil and maintain the quality of the ground resistance.

24. All electric conduits shall be sized in a manner that electric conductors shall not overfill the conduits. The conductor filling percentage for all conduits shall not exceed 40%. For motors with insulated jacketed power cables provided by pump manufacturer as an integral part of the pumping unit, the diameter of the electric conduit for such power cable shall have a diameter 1.58 times greater than the outer diameter of the power cable. When the calculated diameter for the conduit lies between two standard conduit sizes select the next larger size.

25. Laminated wiring schematics of Pump Control Panel and SCADA Panel shall be provided to SAWS. Also each schematic shall be placed in each respective panel.

End of Section G

Section H. Station Controls, Instrumentation and Monitoring

1. Primary level monitoring and pump control must be of the submersible level transmitter type. Accepted manufacturers are Siemens (Milltronics HydroRanger 200), Greyline Instruments, and Drexelbrook for controller. Submersible level transmitter approved manufacturer is Mercoid model PBLT2 or equivalent. An equivalent unit must be of equivalent design and weight at least 4 pounds. Submersible level sensors must include a 10 pound weight made of carbon steel, and the instrument shall be solidly fastened to the weight to prevent the instrument from being dragged into a pump intake. A stainless steel 316 stranded cable must be solidly fastened to the instrument for removal ease. A 24Vdc power supply shall be included in the pump control panel to feed the submersible level transmitter. Feed power to submersible level transmitter must be independently powered by separate 120 Vac/24 Vdc power supply mounted within pump control panel.

2. The force main discharge pressure transmitter shall have a 150 psi pressure range, but it must be calibrated to read the operating and surge pressures. It shall operate at 24 Vdc, 4-20 mA output, and it shall be located before the last valve as shown in the Standard Drawings. <u>It shall be provided with a glycerin filled diaphragm seal, an isolation ball valve and freeze protection.</u> Approved manufacturer is Rosemount model 2088G2S22A1B4E5M5 or SAWS-approved equal. Pressure transmitter will have a LCD display and will display the measured pressure in psi. Pressure transmitter will be powered from the 24Vdc power supply located within the SCADA panel.

3. Place the wet well level transmitter and high level float switch in an area of the wet well which is removed from the effects of the influent flow(s) being received (see Standard Drawings for recommended installation details). A common junction box that houses the motor power cable splice, motor sensor cable, high level float and wet well level transmitter shall be located on side of the wet well as shown in Standard Drawings.

4. Lift station shall be capable of discharging all anticipated peak wet weather flow as indicated in Table 3. The “lead” pump is turned on at the first “on control elevation” and the “lag” pump will start with a rising liquid level at the “second on control elevation.” The “lead” and “lag” pumps will continue to operate until the “pump off control elevation” is reached. The “lead” and “lag” shall automatically alternate between the two pumps at the completion of each pumping cycle. (This example is for a 2-Pump type lift station, but the same logic shall be applied for 3-Pump, 4-Pump and 5-Pump type lift stations)

5. Install a discharge pressure gauge rated for corrosive service that meets the following specifications: 4.5” Dial, Grade 1A, ASME B40.100, ±1% 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. Pressure gauge shall be provided with a glycerin filled diaphragm seal and isolation ball valve. The installation and location of the pressure gauge shall be as indicated in the Standard Drawings. Design Engineer must make sure the pressure gauge rating is 3 times greater than the operating pressure at firm pumping capacity at the location of the gauge. Install vacuum gauges on each suction pipe of self priming pumps. Vacuum gauges shall meet the same specifications of the pressure gauges.

6. Install elapsed time meters and overload reset with metal extension and plastic cap on the inner panel of the pump control enclosure. Meters shall be five digit, indicates tenths of hours and be non-resetting. Operating power shall be 120 volt. Approved manufacturers are Cramer, Hobbs, Honeywell, and Redington

7. Provide structural support of the mounting rack that houses electrical, communication, control, and instrumentation components as detailed in the Standard Drawings.

8. If specifically required by SAWS, provide flow-measuring devices with instantaneous rate indicators, totalizers and recorders designed specifically for sewage force mains on the discharge side of the pump station. Meters shall be Flowtronics or SAWS-approved equal, and shall be installed in an approved vault. Flow display to be installed at lift station electrical/controls rack. In this case the header must provide a minimum horizontal distance equivalent to 30 pipe diameters of straight pipe (20 upstream and 10 downstream) for installation of ultrasonic flowmeters.

End of Section H

Section I. Supervisory Control And Data Acquisition (SCADA)

1. Design engineer must include a radio path study report in the lift station engineering report. The radio path study must be done both physically and computer simulated. Both the report and the plans must include the NAD83 State Coordinates of the proposed lift station site. The radio path study report must show a communication solution that will ensure a clear and steady quality radio signal is achieved from the proposed lift station site to one of SAWS existing facilities with SCADA radio repeater.

2. If a clear and steady quality radio signal cannot be achieved between the proposed lift station and any existing SAWS facility with SCADA radio repeaters, the design engineer will evaluate existing SAWS facilities that are not SCADA repeaters near the proposed lift station in order to ensure a clear and steady quality radio signal is achieved as follow: from the proposed lift station to the existing SAWS non-repeater facility to an existing SAWS SCADA radio repeater facility. The design engineer must include in the lift station design and the engineering report a section that shows the required upgrades to convert the existing SAWS non-SCADA radio repeater facility into a SCADA radio repeater.

3. If a steady quality radio signal cannot be achieved through any existing SAWS facility without SCADA repeater, the design engineer must coordinate with developer to provide a new site for a radio repeater station in order to achieve a steady quality radio signal from the proposed lift station to any existing SAWS facility with SCADA radio repeater. See Standard Drawings for repeater station details and requirements. <u>New radio repeater stations will comply with all access and site requirements for lift station site as described in this guidelines.</u>

4. SCADA system shall monitor for each pump all the following, but not limited to: Pump Hand/Off/Auto Status, Pump Run, Pump Stator Leak, Motor High Temp, Motor Overload, Pump Lost Prime (if self priming Pumps). In addition the SCADA system shall monitor all the following, but not 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. See Standard Drawings for correct I/O Input wiring order.

5. 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. Radio must be located within SCADA panel, and be capable for two way communication. Approved radio is MDS Transnet 900.

7. A 4-20mA temperature transmitter must be installed within the SCADA enclosure and be wired to the PLC analog input board for internal panel temperature monitoring. Temperature transmitter must be provided with RTD sensor and transmitter. Approved manufacturer is Weed, Model 753-PB-X1-0-150, or SAWS-SAWS-approved equal.

8. SCADA enclosure minimum dimensions shall be 36-inch wide by 48-inch high by 16-inch deep. Construction shall be white enameled stainless steel 304, 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@ 95ºF minimum and operating at 120Vac. Approved manufacturer is McLean model T20-0216-G100, or SAWS-SAWS-approved equal. Design Engineer must exercise caution regarding the minimum required clearance around heater. Contact SAWS for alternative to cool panel using louvers, filter and mini exhaust fan motor in lieu of A/C unit, if permitted.

9. Tower used to mount the antenna shall be free stand type and design to withstand wind gusts of 90 MPH. The tower height will be determinate by the radio path study. Design Engineer will select the adequate tower and foundation according to the required height. Tower will be located within lift station site in a place where maintenance vehicles have straight access. See Standard Drawings. Tower structure will be away from electric overhead wires. Minimum separation between tower and electric overhead will be 40ft.

10. SCADA Panel will be provided with an uninterruptible power supply of 24Vdc. The power supply will provide reliable power for a minimum of 2 hours. Power supply will be used exclusively for the 24Vdc loads within the SCADA panel and pressure transmitter located in the header. The wet well level controller and any other 24Vdc load located within the Pump Control Panel and automatic transfer switch (if any) shall not be powered by the SCADA power supply.

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 SAWS-approved equal.

12. Tower structure shall be grounded as indicated in Standard Drawings. Ground resistance shall not exceed 5 Ohms.

End of Section I

Section J. Emergency Provisions

1. Lift Stations shall be designed to insure that no discharges of untreated wastewater will occur at the lift station or any point upstream of the collection system due to loss of power or mechanical failure within the operating time frames defined in this section. All lift stations shall be provided with service reliability based on the following paragraphs:

2. The wet well emergency storage capacity of lift stations over the Edwards Aquifer Recharge and Contributing Zones shall be provided with a wet well storage capacity equal to 60 minutes calculated with Average Daily Flow. In addition to the 60-minute wet well emergency storage capacity requirement, emergency power shall be provided by on-site stand-by generator and automatic transfer switch sized to operate 100% of lift station electric loads. See Section G, paragraph 10, and Standard Drawings for generator requirements. In addition force mains shall be double barrel, and the pumps shall be able to discharge at firm pumping capacity through a single force main.

3. The wet well emergency storage capacity of lift stations over the Edwards Aquifer Transition Zone shall be determined by SAWS at the outcome of an evaluation of the site location, water stream proximity, remoteness, and geographical features to decide if the site shall be treated as if it were located over the EARZ or outside the EARZ. SAWS will make a written determination prior to design after receiving a written request from the Engineer.

4. The wet well emergency storage capacity of lift stations not over the Edwards Aquifer Recharge, Contributing and Transition Zones shall have the wet well and incoming gravity sewer lines designed to insure that no discharges of untreated wastewater will occur at the lift station or any point upstream of the collection system for a period of time equal to 120 minutes (calculated with Average Daily Flow) of wet well emergency storage (excluding the upstream collection system) for lift stations without on-site stand-by generators. If no records are available, the designer shall use 120 minutes of Average Daily Flow (ADF) to calculate required retention capacity. SAWS may allow a minimum of a 60-minute retention time if a stand-by generator is included in the design. Power outage records shall be on the utility company letterhead, bear the signature of a utility representative, identify the location of the lift station, list the total number of outages that have occurred in the past 24 months, and indicate the duration of each power outage. For calculation purposes, the start of the outage period or mechanical failure shall begin at the Lead Pump On level elevation. See Section B, paragraph 2 for clarification.

5. The use of a spill containment structure as a means of providing service reliability is prohibited. Spill containment structures may be used in addition to one of the service reliability options detailed in this section, provided a detailed management plan for cleaning and maintaining the spill containment structure is discussed in the final engineering design report. Additionally, any spill containment structures shall be fenced with an eight-foot fence which has a minimum of 3 strands of barbed wire and which has a locked gate. Spill containment structures shall not be used to reduce other power reliability requirements in any way.

6. An audio-visual alarm system (red flashing light and horn) shall be provided for all lift stations. The audiovisual alarm shall be activated only by wet well high level alarm, by both level controller and high level float switch.

7. Emergency (quick-connection) pump by-pass system shall be provided at all lift stations. Connection shall be sized according to station and header pipe size (4, 6 or 8 inches), and shall consist of a gate valve and adapter flange with camlock “quick-disconnect” male fitting with dust cap. Provide a check valve to allow flow only in the Force Main discharge direction.

8. Lift stations equipped with soft starters must be provided with a full voltage by-pass starter to by-pass the soft starter units should they become damaged. The motor control panel must be provided with a selector switch that will allow operating the motors through soft starter or regular starter.

End of Section J

Section K. Safety Requirements

1. Overhead Wires. Do not run overhead wires over lift station site. Overhead wires include, but are not limited to, primary and secondary electric lines, electric service drop, and cable and telephone lines. If a secondary overhead electric service drop is required to feed the lift station, the service pole must be located in a place where the service drop will be at least: 10 feet away from canopy, 20 feet away from wet well, header piping and generator, and 40 feet away from SCADA tower structure.

2. Electric Conduits and Small Pipes. Eliminate tripping hazards from electric conduits and small pipes across the surface of the lift station. They must be buried in the ground or embedded in concrete slabs.

3. Arc Flash Analyses. Include an Arc Flash Analysis in engineering report. Reduce arc flash Hazard/Risk Rating to Category 2 if they originally are Category 3 or 4 by making adjustments to circuits. Electric panels must include proper warning labels.

4. Bollards. Install bollards to protect equipment located at the end of driveways, or in tight locations. If lift stations are adjacent to streets of driveways, install bollards between the equipment and the street. Removable bollards in buried sleeves are acceptable.

5. Handrails. Install removable aluminum handrails around wet well openings and dry vault openings. Portable handrails must slide into sleeves embedded in the concrete slabs. Surface-mounted brackets are not acceptable. Design shall comply with OSHA Standards, 1910.23 or 1910.27 as applicable.

6. Enclosed Dry Vaults (if approved).
    a. Install blowers and lights. Circulation of fresh air in vaults would have to be complete and deliver at least 6 air changes per hour.
    b. Locate access covers and ladders so personnel entering the vault land on flat surface, rather than on top of pipes, valves or other equipment.
    c. Provide at least 28" clearance around pipes and mechanical structures and at least 36" for all electrical equipment and panels for employee access.
    d. Ladders (if used) shall be of aluminum and shall comply with OSHA Standards, 1910.23 or 1910.27 as applicable.

7. Design shall include a freeze proof emergency eyewash and shower station located within 10-foot radius of wet well.

8. One or more lockable aluminum hatch covers with anti-slip top surface shall be installed in the wet well cover for access to the wet well, pumps, floats and level control devices. Minimum hatch dimensions shall be 3 feet by 4 feet, or as required; allowing plentiful clearance for removal of submersible pumps and access to wet well. Hatch safety grate shall be installed to provide fall protection and shall consist of aluminum material. Safety Grate shall be designed to have gaps of not more than 5 inches, and to be flush with the top of the wet well concrete slab. Black and yellow strips shall be painted around access hatch using Epoxy Enamel (Tnemec, or equal) coating system. Also a "Caution! Fall Hazard." sign shall

be painted/stenciled on all four sides of the hatch. Coating requirements and thickness shall be in accordance with Manufacturer’s recommendations.

9. No fixed ladders are permitted in the wet well; however when used elsewhere, ladders shall be aluminum with non-skid rungs and must comply with all other of OSHA 1910.27, Fixed Ladders requirements.

End of Section K

Section L. Submittal Requirements

1. An engineering design report that include construction feasibility and site analysis, a present value analysis with detailed capital and O&M cost estimate, flow development for initial and final phases of the development, wet well design, wet well detention time and force main flush time for both initial and final phases, system curves, pump curves and head calculations (Total Head including Static Head, Friction Losses, Minor Losses, NPSH, Total Suction Lift (when applicable)). Calculations and system curves at both minimum (all pumps off) and maximum (last normal operating pump on) static heads, and friction losses based on material of pipe selected, for each pump and for the combination of pumps (modified pump curves). Buoyancy calculations for the wet well in order to design a concrete slab heavy enough to keep the wet well in place. Energy consumption calculations shall be presented comparing different pumps, impellers and pipe sizes in order to select the most efficient pump. Where a suction lift is required, the report shall include a calculation of the available net positive suction head (NPSH) and a comparison of that value to the required NPSH for the pump(s) selected, as well as calculations for the total suction lift. The overall layout of the development and the development master plan shall be submitted for SAWS review.

2. The engineering design report shall be presented in the following format, although the designer is not required to use the same formulas:

A. **TITLE PAGE** - Title page should include the project name, date, developer/owner's name and engineering firm preparing plans.

B. **SEWER SYSTEM INFORMATION**
   1. Introduction
      a) Type, location and size of development
      b) Number of and range in size of lots or buildings to be serviced
   2. Existing Sewer System
      a) Location and type of gravity system the force main will discharge into.
      b) State whether the entire development will be serviced by the proposed phase or if several phases will be involved.
      c) State the number of lots this phase will encompass initially and finally if future phases are to be constructed.

C. **PUMP STATION AND FORCE MAIN DESIGN CALCULATIONS**

(The following formulas are provided as <u>guidelines</u>. The design engineer can use other formulas, of preference, to achieve the same results.)

   1. <u>Site Characteristics, and allowances, to Calculate Flows (SAWS Utility Service Regulations 11.3.1)</u>:
      a) Residential EDUs @ 240 gals/day per EDU
      b) Commercial SF @ 0.07 gals/day per SF
      c) Multi-family Units @ 0.70 EDUs per Unit
      d) Peaking Factor - 2.5 times the Average Daily Flow
      e) Inflow and Infiltration (I/I) Allowance of 300 GPD/acre.

2. Average Dry Weather Flow (ADF): This is the flow developed without the maximum flow peaking factor. This flow is used to determine the average detention time in the wet well.

   a) ADF (GPD) = Residential (single and multi-family) + Commercial GPDs
   b) ADF (GPM) = ADF (GPD) / 1440 (Min/Day)

3. Peak Dry Weather Flow (PDWF) (SAWS Utility Service Regulation 11.3.1): This flow is used to determine pipe size in the collection system.

   a) Peaking Factor = 2.5 for Proposed Residential Development, SAWS USR
   b) PDWF (GPD) = PF * ADF
   c) PDWF (GPM) = PF * ADF (GPM)

4. Peak Wet Weather Flow (PWF): This flow is used to determine the lift station design capacity. All lift stations shall be designed to handle the maximum wet weather flow for its service area.

   a) Inflow and Infiltration (I/I): Total Development Acreage * 300 GPD/acre
   b) PWF (GPD) = PDWF (GPD) + I/I (GPD)
   c) PWF (GPM) = PWF (GPD) / 1440 (Min/Day)

5. Minimum Dry Weather Flow (MDWF): This is used to determine the maximum detention time in the wet well.

   $MDWF = (0.2 * (0.0144 * ADF)^{0.198}) * ADF$

6. Minimum Pump Requirements (Peak Wet Weather Flow, PWF):
   a) For two-pump stations, size each pump to handle PWF.
   b) Calculate Total Dynamic Head (TDH):
      1) Static Head (Hs)
         Eh = Maximum force main elevation
         E1 = Wet well low water elevation
         Hs = Eh – E1
      2) Loss (Lf) due to friction in force main
         Length = Total equivalent length of force main and piping on station
         Lf = Length x Friction Factor
         (Use Hazen-Williams C of 100 and 140 for friction losses)
      3) TDH = Hs + Lf
   c) Plot System Curve on Pump Curve and determine operating point to select proper pump sizes.

7. Net Positive Suction Head: For suction lift stations, compare the net positive suction head ($NPSH_R$) required by the pump with the net positive suction head available ($NPSH_A$) in the system, at the operating range. The NPSH available shall be greater than the NPSH required by at least 3 feet.

$NPSH_A$ (suction lift) = $P_B + H_S - P_V - H_{fs}$

Where;

P_B = barometric pressure in feet absolute, use 33.4 feet
H_S = minimum static suction head, in feet
P_V = vapor pressure of liquid in feet absolute, use 1.4 feet
H_{fs} = friction loss in suction, in feet (including entrance losses and minor losses)

a) Velocity Produced in Force Main with one pump in operation shall be between 3 and 3.5 feet per second. 4.8 feet per second or less with two pumps in operation. 6 feet per second or less for three pumps in operation. May be as low as 2 fps with one pump in operation for lift stations with three or more pumps:

$$V_{fm} = 0.4087099 * (Q / d^2)$$

Where;

Q = Discharge flow for selected pump(s), in gpm.
d = Force Main interior diameter, inches

8. <u>Total Suction Lift:</u>
   a) A total suction lift calculation must be performed for self priming pumps. The total suction lift is the addition of the static suction lift plus the friction losses along the suction pipe. The static suction lift is the distance between the wet well level elevation at All Pumps Off and the elevation of the impeller eye.

   Total Suction Lift = Static Suction Lift + Friction Losses along Suction Pipe

   Static Suction Lift = Impeller eye elevation – elevation of wet well level at All Pumps Off

9. <u>Storage Requirements:</u>
   a) Required Wet Well Volume (volume between "lead pump on" and "all pumps off" elevation):

   Vr (Gals) = <u>Pump GPM * T (Minimum Cycle Time, Table 4, Section C of this document)</u>
   4

   b) Volume of Storage (Vs)
   - Not over the Edwards Aquifer recharge, transition and contributing Zone:

   Vs (Gals) = ADF (GPD) * [(1hr. minimum/2 hr. maximum storage) / 24 hours per day]

   Vs (CF) = Vs (Gals) / 7.481 CF per Gal
   - Over the Edwards Aquifer recharge, transition and contributing Zone:

   Vs (Gals) = ADF (GPD) * [(1hr.storage) / 24 hours per day]

   Vs (CF) = <u>Vs (Gals) / 7.481 CF per Gal</u>

c) Dimensions of Storage Facility

1) Wet Well diameter, minimum 72-inch diameter
2) Wet Well Depth = $\frac{4 \, x \, V_S(CF)}{\pi \, x \, D^2}$

Where:
V_S = wet well storage volume in cubic feet
D = wet well inner diameter in feet

10. Buoyancy Checks: A buoyancy check shall be performed for the pump station wet well and the retention chamber.

11. Water Hammer Calculations: Calculate surge pressures and compare to the pressure rating of the force main pipe to determine the need for a surge relief valve.

$$a = \frac{4660}{\sqrt[2]{\frac{E_W \, x \, D_i}{E_P \, x \, t_P}}}$$

Where:
a = pressure wave velocity factor
E_W = water bulk modulus (300,000 psi)
D_i = force main pipe inner diameter (inches)
E_P = force main material modulus of elasticity (130,000 psi for HDPE)
T_P = force main pipe wall thickness (inches)

$$P = \frac{a \, x \, V}{2.31 \, x \, g} + \text{operating pressure}$$

Where:
P = water hammer pressure (psi)
a = pressure wave velocity factor
V = flow velocity in force main at firm pumping capacity (ft/s)
g = acceleration of gravity (32.2 ft/sec^2)
2.31 = conversion factor

12. Force Main Flush Time Calculations: Calculate force main average flush time.

Instructions:

1. Basic Information Required.
   1.1. Wet Well Diameter (D)
   1.2. Distance between All Pumps Off and Lead Pump On ($\Delta h_{On\text{-}Off}$)
   1.3. Wet Well Inflow (Q_i)
   1.4. Pumped Flow (Q_o)
   1.5. Force Main Length (L)

2. Basic Calculations Required
   2.1. Wet Well Filling Time (WWFT)

The wet well filling time is the time that takes to raise the wet well level from All Pumps Off to Lead Pump On.

2.2. Pump Running Time (PRT)

The pump running time is the time that takes to drop the wet well level from Lead Pump On to All Pumps Off.

2.3. Wet Well Detention Time (WWDT)

The wet well detention time is the addition of the wet well filling time plus the pump running time.

2.4. Flushing Cycles (FC)

The flushing cycles are the number of cycles required to flush the force main.

2.5. Flush Time (FT)

The flush time is the time that takes to flush the force main completely.

3. Formulas

3.1. Equation 1: Wet Well Filling Time (WWFT)

$$WWFT = \frac{7.481\pi D^2(\Delta h_{On-Off})}{4Q_i}$$

Where:
D is the Wet Well Diameter in feet.
Δh_{On-Off} is the distance in feet between Lead Pump On and All Pumps Off.
Q_i is the wet well inflow in gal/min.

WARNING!
Use Average Daily Flow to calculate Average Wet Well Filling Time.

3.2. Equation 2: Pump Running Time (PRT)

$$PRT = \frac{7.481\pi D^2(\Delta h_{On-Off})}{4(Q_o - Q_i)}$$

Where:
D is the Wet Well Diameter in feet.
Δh_{On-Off} is the distance in feet between Lead Pump On and All Pumps Off.
Q_i is the wet well inflow in gal/min.
Q_o is the pumped flow in gal/min.

WARNING!
Average Daily Flow to calculate Average Pump Running Time.

3.3. Equation 3: Wet Well Detention Time (WWDT)

$$WWDT = WWFT + PRT$$

Where:
WWFT is the wet well filling time in minutes.
PRT is the pump running time in minutes.

WARNING!
Use average wet well filling time and average pump running time to calculate average wet well detention time.

3.4. Equation 4: Flushing Cycles (FC)

$$FC = \frac{L}{60v(PRT)}$$

Where:
L is the force main total length in feet.
V is the flow velocity within the force main in ft/s.
PRT is pump running time in minutes.

WARNING!
Use average pump running time to calculate average flushing cycles.

IMPORTANT!
Normally the flushing cycles are composed by whole and decimal numbers. It is required to separate the whole part from the decimal part in order to be used in the following equation.

3.5. Equation 5: Flushing Time (FT)

$$FT = (FC_W)(WWDT) + (FC_D)(PRT)$$

Where:
FC_W is the whole part of the flushing cycles.
WWDT is the wet well filling time in minutes.
FC_D is the decimal part of the flushing cycles.
PRT is the pump running time.

WARNING!
Use average flushing cycles, average wet well detention time and average pump running time to calculate average force main flushing time.

4. Example:

A lift station with a 12-foot diameter wet well has a 3000-foot force main. The average daily flow is 150 gal/min. The distance between Lead Pump On and All Pumps Off is 2 feet. The pumps discharge 600 gal/min, and the flow velocity within the force main is 3.25 ft/s. Calculate the average force main flush time.

Procedure

Step 1: Calculate average wet well filling time with equation 1 as follows:

$$WWFT = \frac{7.481\pi(D)^2(\Delta h_{On-Off})}{4Q_i} \Rightarrow \frac{7.481\pi(12)^2(2)}{4(150)}$$

The <u>Average Wet Well Filling Time is 11.28 minutes</u>.

Step 2: Calculate average pump running time with equation 2 as follow:

$$PRT = \frac{7.481\pi D^2(\Delta h_{On-Off})}{4(Q_o - Q_i)} \Rightarrow \frac{7.481\pi(12)^2(2)}{4(600-150)}$$

The <u>Average Pump Running Time is 3.76 minutes</u>.

Step 3: Calculate average wet well detention time with equation 3 as follow:

$$WWDT = WWFT + PRT \Rightarrow 11.28 + 3.76$$

The Wet Well Average Detention Time is 15.04 minutes.

Step 4: Calculate average flushing cycles with equation 4 as follow:

$$FC = \frac{L}{60v(PRT)} \Rightarrow \frac{3000}{60(3.25)(3.76)}$$

The Average Flushing Cycles are 4.09 cycles.

Step 5: Calculate average force main flush time with equation 5 as follow:

$$FT = (FC_W)(WWDT) + (FC_D)(PRT) \Rightarrow (4)(15.04) + (0.09)(3.76)$$

The Average Force Main Flush Time is 60.49 minutes.

Step 6: Summary Table. Make a table showing all the results of the calculations as follow:

Table1: Average Flush Time Results

Wet Well Diameter	12.00	Average Wet Well Filling Time	11.28
Distance between Lead Pump On and All Pumps Off	2.00	Average Pump Running Time	3.76
Average Daily Flow	150.00	Average Wet Well Detention Time	15.04
Pumped Flow	600.00	Average Flushing Cycles	4.09
Force Main Length	3000.00	**Average Force Main Flush Time**	**60.49**
Flow Velocity Within Force Main	3.25		

D. **CYCLE TIMES.** Calculate detention times (Td) for Average Daily Flow, Peak Wet Weather Flow, and Minimum Dry Weather Flow.

Td = Tf + Te

Where;

Tf = time to fill wet well in minutes = Vr / i
Te = time to empty wet well in minutes = Vr / (Q – i)
Vr = Required Wet Well Volume, 8.a
i = Flow into the station for given condition
Q = Pump capacity in gpm

1. Average Detention Time (based on Average Dry Weather Daily Flow):

a) Tf = Vr /ADF (GPM)
b) Te = Vr / (Q – ADF)
c) Td (ADF) = Tf + Te

2. Maximum Detention Time (based on Minimum Dry Weather Flow):

a) Tf = Vr /MDWF (GPM)
b) Te = Vr / (Q – MDWF)
c) Td (MDWF) = Tf + Te

If detention times exceed 180 minutes, SAWS may require the design and installation of a chemical drum scrubber with top mounted blower for odor control. See Section B(3) for details.

3. Total Cycle Times:
   Pump ON for Te
   Pump OFF for (2) Tf + Te

The pump is on for one pumping cycle of Te and off for 2 storage cycles of Tf plus one pumping cycle of Te because pumps alternate

E. **LISTING OF RESULTS FROM THE DESIGN CALCULATIONS TO BE PRESENTED IN THE FOLLOWING ORDER:**

1. Number of Lots or Buildings
2. Acreage of lift station subcatchment
3. Average Daily Flow in GPM
4. Peak Dry Weather Flow in GPM
5. Peak Wet Weather Flow in GPM
6. The Volume of the Retention Chamber
7. Static Head
8. Total Dynamic Head
9. Net Positive Suction Head Available ($NPSH_A$) from system
10. Static and Total Suction Lift (for self priming pumps only)
11. The Pump Selected including the following:
    a) Manufacturer
    b) Model
    c) Impeller Diameter
    d) Flow
    e) Head
    f) $NPSH_R$
    g) Break Horse Power
    h) Efficiency
12. Pump Motor Data
    a) Rated Power
    b) Efficiency
    c) Power Factor
    d) NEMA Code Letter
    e) Voltage
13. Net Positive Suction Head Required ($NPSH_R$) form pump

14. Total Detention Times for, Maximum Dry Weather Flow, and Average Dry Weather Flow
15. Total Cycle Times for, Maximum Dry Weather Flow, and Average Dry Weather Flow
    a) Number of Minutes ON (Pumping Time)
    b) Number of Minutes OFF (Fill Time)
16. Material, Class, Size, Inner Diameter, Rated Pressure and Length of Force Main
17. Flow Velocity in Force Main
18. Force Main Average Flush Time
19. Water Hammer Analysis
20. Wet well buoyancy calculations
21. Generator analysis (if a generator is included in the design)

F. **COST EFFECTIVENESS ANALYSIS**

As required by the San Antonio Water System Utility Services Regulations.

End of Section L

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