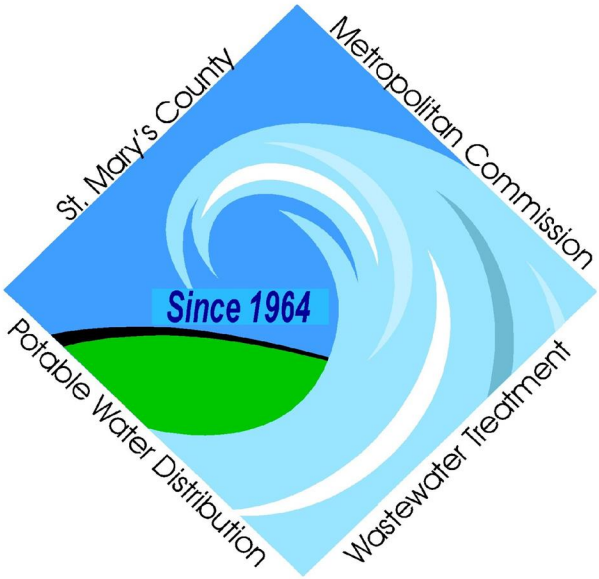
CHAPTER 5

WASTEWATER PUMPING STATION DESIGN



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5.1 Introduction

This Chapter includes the criteria and guidelines for designing wastewater pumping stations in St. Mary's County. All new wastewater pumping stations shall incorporate GREEN technology when possible.

To the extent practical, designs shall conform to the design standards given herein as well as the latest publication of the "Recommended Standards for Wastewater Facilities" (Ten-State Standards). The design standards shall be applied to design conditions in a careful and thoughtful fashion. Deviations from the design standards must be brought to the attention of the Chief Engineer. Requests for waivers of either the design manual or Ten-State Standards must be justified to the Chief Engineer, in writing, from an engineering evaluation standpoint and include consideration of life cycle costs and ease of maintenance. Approval or denial of the waiver request will be by return letter signed by the Chief Engineer.

5.2 Regulations

Wastewater pumping stations must satisfy the regulations of agencies having jurisdiction.

Wastewater pumping stations shall conform to the latest addition of the "Recommended Standards for Wastewater Facilities" (aka. 10-State Standards) as well as the latest addition of MDE's "Design Guidelines for Sewerage Facilities." Buildings shall comply with applicable IBOCA and St. Mary's County building code requirements as well as any permitting requirements of the St. Mary's County Department of Land Use and Growth Management. Other regulations governing facilities and construction shall be adhered to, including regulations published by the Occupational Safety and Health Administration (OSHA), the National Fire Protection Association (NFPA), National Electric Code (NEC), State of Maryland Plumbing Code and others as applicable.

5.3 Permits and Approvals

Refer to Chapter 1 in this manual for applicable permit requirements. In addition, for any above ground structure, the Designer shall make all applications for and obtain the required building and grading permits prior to bidding of the project.

5.4 Design Phases

A. Engineering Report

The engineering report shall include the description of design criteria to be utilized, preliminary flow computations, design calculations, calculated system curves, surge protection analysis/recommendation, identification of land acquisition and easement requirements, number of property owners involved, listing of permit requirements and cost estimate based on unit costs for major elements of work. In addition, the following design criteria shall be developed:

1. Site Development
2. Structural Design
3. Architectural Design
4. Hydraulic Analysis
5. Mechanical Design
6. Electrical Design
7. Process and Instrumentation Control
8. Corrosion Control
9. Odor Control
10. Noise Control
11. Secondary Power Supply
12. Skid-mounted standby pump.

Once the engineering report has been approved by the Chief Engineer, design of the facilities may proceed. Milestone submittals of design plans and specifications shall be made at 30%, 60%, 95% and Final Design.

B. Design Plans & Specifications

At a minimum, the following information shall be supplied at the milestone submittals:

30% Submittal: Site Plan, Design Schematics (showing station layout and major equipment), Specification Table of Contents.

60% Submittal: Complete civil, mechanical and structural design plans and preliminary technical specifications.

95% Submittal: Complete design for all disciplines including electrical and architectural plans and details. Complete specifications including front end documentation. This phase should

represent complete, bid-ready contract documents from the Designer.

Final Design: The 95% Submittal with the Chief Engineer's final comments incorporated.

C. Cost Estimate

At each formal submittal and at the conclusion of the design process, the Designer shall prepare a detailed cost estimate for the pumping station. This estimate shall be developed for each major category of work including civil, mechanical, electrical, structural, architectural work and contingent cost.

5.5 Types of Wastewater Pumping Stations and Selection

St. Mary's County wastewater pumping stations are divided into two categories, small (less than 250 gpm) and large (greater than 250 gpm). The types of stations allowed and in order of preference are described below along with acceptable selection criteria. All pump stations shall be equipped with a channel mounted macerator.

Suction Lift: Suction Lift stations are defined as stations where the pumps are located above the water level of the wet well and hence must employ some means of lifting the wastewater to the pumps in order for the pumps to be primed.

Suction lift stations shall not be used for suction lifts (water level in wet well to centerline of pump volute) greater than 18 feet or motor sizes greater than 20 Hp.

Submersible: Submersible stations are defined as stations where the pumps are "submerged" in the wet well. Because the pumps operate under water in the wet well, there is no need for a separate pump room. Guide rails enable the pump to be raised and lowered into place without requiring entry by personnel under normal circumstances. Submersible stations shall not be used for wet well depths greater than 25 feet or motor sizes greater than 10 Hp except for special low flow conditions.

Package: Package pumping stations are defined as wet well/dry well pumping stations in which the pumps, suction and discharge piping, pump dry well, electrical equipment and connections are pre-assembled by a single manufacturer and then erected on-site by the Contractor.

Package pumping stations with metal, dry well chambers are not acceptable.

Pre-cast concrete or fiberglass dry well chambers will be permitted. The pumping station wet well may or may not be supplied by the package manufacturer.

Package pumping stations shall not be used for wet well depths greater than 25 feet.

Conventional: Conventional pumping stations are defined here as pumping stations in which the wet well and dry well structures are assembled or constructed on site and are typically used for flows greater than 250 gpm. The preferred method of construction is for the Contractor to use pre-cast concrete sections. However, if the configuration or sizes would make this unfeasible then cast-in-place concrete sections will be permitted with the approval of MetCom. All of the piping, valves, wiring and controls are assembled on-site by the Contractor.

5.6 Hydraulic Computations

A. Design Flow Rate

Wastewater pumping stations must satisfy the design flow rate. The design flow rate is the peak flow rate for the service area plus the I/I allowance. The design of wastewater pumping stations shall consider existing and projected peak flow rates and wastewater composition. Wastewater pumping stations shall be designed to pump the peak flow for existing and future users plus the I/I allowance. In developed areas, population shall be determined by house count and non-domestic user inventory with allowances made for remaining undeveloped tributary areas. Population densities and per capita flows shall be as established by Facility Plans or in their absence, in agreement with the Comprehensive Water and Sewerage Plan or as instructed by the Chief Engineer. Institutional, commercial and industrial flows shall be determined by a study of similar types of establishments.

The Chief Engineer shall be consulted for future domestic and non-domestic land use and population densities. A drainage area map and tabulation of the design flow shall appear on the plans. The map and tabulations shall show initial and ultimate drainage areas and wastewater flows.

B. Wastewater Composition

Wastewater composition can vary widely depending upon the proportion of design flow generated by non-domestic users. Non-domestic user wastewater composition shall be investigated and the results included in the Engineering Report provided to the Chief Engineer. Adequate consideration and all necessary provisions shall be taken to ensure that wastewater pumping station equipment and materials are suitable for the anticipated composition of the wastewater.

Consultation with the Chief Engineer is required in the event that the wastewater composition affects standard material and equipment requirements.

C. Number of Pumps

Wastewater pumping stations shall be capable of pumping the design flow rate with the largest single pump out of service.

D. Wetwell Sizing

Wetwells shall be sized in accordance with MDE requirements.

E. Hydraulic Analysis

Wastewater pumping stations must satisfy the hydraulic conditions of the system. The Designer shall perform a complete hydraulic analysis of each wastewater pumping station. The hydraulic analysis shall consider potential impacts on existing force mains, gravity sewers and pumping stations when the new pumping station is added to the system. See Chapter 4, “Sewer Main Design,” for force main design requirements and analyses that must be performed in conjunction with the pumping station design.

Wastewater pumping stations shall be designed to operate at the appropriate discharge head and flow rate.

F. Pump and System Curves

System curve (Head vs. Flow) characteristics shall be determined by the Hazen-Williams formula for piping head loss. The pump/system curve shall be shown on the plans to scale. The pump/system curve shall show the following information at a minimum:

- Static Head
- Pipe Friction Losses
- Pump Curve
- Pump Horsepower, Efficiency and RPM

Pump / system curves shall be shown for single pump operation, as well as for multiple pump operation in stations having three or more pumps. Hazen-Williams "C" factors used in evaluating pump and system curves shall be in accordance with the guidelines given in Chapter 4, “Hydraulic Calculations,” of this manual for various pipe materials.

G. Water Hammer

The potential impact of water hammer shall be evaluated. If the combined effects of static head and water hammer do not exceed the weakest piping system component working pressure by a safety factor of 1.1, no special provisions need to be included to control water hammer. Where the maximum water hammer pressure exceeds the weakest piping system component working pressure by a safety factor of 1.1, strengthen those elements affected, reevaluate pipe size and velocities or select an appropriate device to control water hammer. No pressure vessel/surge tank type devices will be acceptable. The decision to strengthen piping system components instead of utilizing a water hammer control device or different pipe size shall be based upon a life cycle cost economic comparison.

H. Pump Selection Criteria

Provide proper wet well design and suction line design per Hydraulic Institute Standards to avoid cavitation. The Designer shall perform a net positive suction head available (NPSHA) analysis and include this information in the pump specification.

The NPSHA shall be calculated for the expected design flows and shall exceed the pump manufacturer's requirements by an added margin of safety of not less than five (5) feet. Pumps shall be selected to have their maximum efficiency at the operating point. Under no circumstances shall a pump be specified to operate outside of its published recommended range. Examples would be pumps operating at very low flows and high heads, near shutoff heads, or "runout" conditions (maximum possible flow rate of the pump). These conditions can result in excessive hydraulic loading or cavitation damage to impellers, casings and shafts, rapid bearing and mechanical seal wear, and high vibration. The Designer shall avoid the selection of pumps whose curves are flat (i.e. small changes in head resulting in large changes in flow rate).

5.7 Large Wastewater Pumping Stations

Conventional wastewater pumping stations shall be engineered to meet the requirements of these guidelines, as well as any supplemental guidelines imposed by the Chief Engineer on a case-by-case basis. These stations will have a wet well/dry well configuration and be of pre-cast or cast-in-place concrete construction. Conventional pumping stations shall be designed as long-term (greater than 20 years) facilities. The design of conventional stations shall include room for anticipated expansion. The following guidelines and features shall be incorporated in the design of these stations:

A. Site Design

1. Location: Wastewater pumping stations shall be located as far as possible from populated areas. Natural screening and remoteness of the site shall be primary elements of site selection wherever possible. Where pumping stations are sited in proximity to developed areas, the architecture of the station shall be compatible with the surrounding area. Predominant wind direction for potential odor dispersion and building aspects such as generator exhaust and ventilation fan noises shall be considered. Similarly, building setbacks shall be considered to provide minimal impact to neighboring properties.

2. Land Acquisition: Land required for pumping stations, including necessary vehicular access routes to an existing or proposed public roadway shall be owned in fee simple by the Commission. As part of this process, a boundary survey of the property is required together with a record plat and a metes and bounds description of the parcel. In determining the space requirements for the facility, particular attention shall be given to the width provided for the access road to ensure adequate space for grading and drainage within the access road right-of-way and easy access for maintenance and delivery trucks.

3. Topography: Sewers tributary to wastewater pumping stations commonly dominate site selection. Adjacent drainage areas potentially served by the wastewater pumping station must also be considered. Wastewater pumping station site selection shall also be compatible with suitable site access, and soil capability with respect to land grading in conjunction with site development. Existing contours and other topography shall be shown for the entire site including a 100-foot minimum width outside of the proposed property boundary.

   Contour interval shall be two-foot, unless otherwise approved by the Chief Engineer.

4. Floodplain: Wastewater pumping stations shall be sited to remain operational and permit access during a 100-year return frequency flood. The pumping station top slab elevation shall be set a minimum of three-feet above the 100-year floodplain elevation. The access road shall be above the 10-year return flood level elevation.

5. Wetlands: Avoid direct impacts wherever possible and minimize impacts to wetland buffer areas. Buffer areas include the first 25 feet beyond non-tidal wetlands.

6. Grading: Wastewater pumping station grades shall prevent local ponding, provide positive drainage away from structures and generally be limited to no greater than 4 percent slopes. Stone surfaces around paved areas shall provide proper site drainage at slopes 10 percent or less. Land grading outside of the wastewater pump station perimeter fence shall not exceed 3 to 1 slopes; 4 to 1 slope maximums are desirable. Lesser slopes wherever possible are preferred.

   Site grading design shall be compatible with slope stability for the soils encountered. Slope stabilization shall be appropriate for the degree of slope and soil conditions. The use of retaining walls on or immediately adjacent to the wastewater pumping station site is not permitted. Access drive slopes shall be a maximum of 7 percent at any point along the centerline of the drive.

7. Sediment Control: A sediment control plan shall be provided and approval obtained from the Soil Conservation Service (SCS).

8. At least two test borings shall be taken, one at the proposed wetwell location and one at the proposed building to determine soil types, rock, water table elevations, soil bearing values, etc. Standard penetration tests shall be taken at intervals not to exceed five (5) feet. Borings shall be taken to a depth of not less than fifteen (15) feet below the bottom of the proposed structure. Borings shall be taken deeper as necessary, depending on soil conditions.

9. Landscaping: Landscaping shall meet County requirements for buffers and shall consist of low maintenance shrubs and trees for screening.

10. Site Security: Pumping station sites shall be fenced with black vinyl coated chainlink fencing, black vinyl coated post and black hardware, and a 12-foot wide double leaf locking gate for vehicle access. Three strands of barbed wire on angled barb arms, shall be included for a total height of seven feet (six feet of fabric with one foot of barbed wire) or shall be eight feet high fabric without barbed wire. Additional property line fencing may be required as determined by the Chief Engineer. The pumping station building shall have exterior lighting controlled by motion detectors. The pumping station doors shall be 16-gauge steel with locks keyed as specified by the Chief Engineer. The building shall be provided with an entry alarm connected to the station SCADA.

11. Paving: Pumping station sites shall have a paved access road and a minimum of two parking spaces. The access road shall have sufficient room and turn-around area so as to allow access to the wet well by maintenance boom and vacuum trucks.

The turning area in a pumping station site shall have a minimum turning radius of 50 feet. Pumping station access roads shall be used exclusively for pumping station maintenance and access.

12. Station Sign: A permanent sign shall be provided at each pumping station stating the station name, street address and emergency telephone number. The sign must meet St. Mary's County 911 addressing system.

13. Pumping stations shall not be located directly downstream of any stormwater management facility discharge. Site grading shall direct surface water away from the structure.

14. DIP shall be used inside the pump station vaults and PVC can be used outside of the vault.

B. Structures

1. Wet Well Design: Wet wells shall be considered a hazardous environment, classified as NEC Class I, Division I for explosive gases. Wet wells shall be designed and constructed to be as hazard free as possible, and corrosion-resistant materials shall be used throughout. All materials and equipment used in wet wells shall meet NEC Class I, Division I standards, with the exception of control floats.

   Conduits between the junction box and control building shall be sealed at the junction box with explosion-proof seals. Conduits carrying float cables between the junction box and the wet well shall be sealed with explosion-proof seals. Junction box is to be placed outside of the wet well.

   a. Structure: Wastewater pumping station wet wells shall be constructed of reinforced concrete. Wastewater pumping station wet wells shall consist of reinforced concrete base slabs, riser sections/walls and top slabs. Wet wells shall have an interior epoxy paint finish and exterior elastomeric membrane waterproofing. The bottom of the wet well shall be grouted to a minimum slope of 45 degrees toward the pump suction inlet.

      Wet wells shall be adequately designed to prevent flotation. The wet well size and depth shall be as required to accommodate the influent sewer, as well as pump suction submergence as recommended by Hydraulic Institute Standards. The required working volume and preferred intervals between influent sewer and control elevations shall be determined as follows:

      Wet wells shall be designed for a minimum pump cycle time of 15 minutes as defined by the following formula:

$T = 4V/Q$

where:

T = Pump Cycle Time (time between pump starts) in Minutes

V = Volume of wet well between the lead pump start and pump stop elevations, in gallons

Q = Pump rate of the lead pump, in gallons per minute

The detention period for wastewater in the wet well shall not exceed 30 minutes at the average flow rate for the initial, intermediate and ultimate design years. When initial average flows are insufficient to actuate the pumps within a 30-minute period, temporary removable appurtenances shall be placed in the wet well or the adjustable floats for pump start shall be lowered. Wet wells shall be deep enough to accommodate the control elevation points.

b. Access: Wet well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch shall be 36-inch by 36-inch minimum size and as large as necessary to allow removal of equipment from the wet well.

c. Ventilation: Wet wells shall be provided with a separate ventilation system and shall be sized to provide a minimum of 30 complete air changes per hour. In addition to manual control, time clock operation of fans shall be provided to allow a minimum of two (2) complete air changes per hour.

   Ventilation shall be accomplished by the introduction of fresh air into the wet well under positive pressure. The fan shall be installed outdoors. The fan assembly and housing shall be corrosion-resistant and weatherproofed. The entrance hatch to the wet well shall be provided with a limit switch to energize the fan whenever the hatch is open. The fan shall be direct drive.

d. Access: Access to the wet wells shall be located a minimum of 12-inches above finished grade.

2. Dry Well Design: Dry wells shall consist of reinforced concrete construction. Dry wells shall have exterior elastomeric membrane waterproofing.

   The dry well floor shall be sloped to a sump. A sump pump with piping to the wet well shall be provided and sump pump alarms are required. Sump pump piping shall contain a check valve to prevent siphoning from the wet well. The pump suction isolation valve shall have a hand wheel with an operating

stem extending up to the control room. The hand wheels shall be marked with an open arrow. A surge relief valve, if required, shall be placed on the discharge header before the pipe leaves the station. Surge relief piping shall be piped to the wet well.

a. Access: Dry well access shall be via a staircase with all necessary landings and handrails per OSHA requirements. Equipment hatches for the pumps shall be located in the top slab and directly above the pumps. Traversing monorails with cranes of adequate capacity shall be provided above the dry well to facilitate removal of the pumps, motors, valves and all other related equipment. Grating (catwalks) shall be provided in the dry well to facilitate access to all piping without climbing over pipes, equipment, etc.

b. Ventilation: Dry wells shall be provided with a separate ventilating system and shall be sized to provide a minimum of 10 complete air changes per hour. In addition to manual control, time clock operation of fans shall be provided to allow a minimum of four (4) complete air changes per hour.

   Ventilation shall be accomplished by the introduction of fresh air into the dry well under positive pressure. The dry well ventilation system shall under no circumstances be connected to the wet well ventilation system and shall be away from any source of contamination.

   Ventilation shall be automatically activated whenever the dry well lighting is energized and/or the access door is opened and the station is occupied by personnel.

3. Influent Manhole: An influent manhole collecting all of the gravity sewers that flow to the pumping station shall be provided. The influent manhole shall be located on the pumping station site. A gravity sewer shall carry wastewater from the influent manhole to the wet well. The influent manhole shall be capable of being isolated from the pumping station wet well.

4. Influent Grinder/Macerator: An influent wastewater channel mounted grinder/macerator (grinder) shall be provided. The influent grinder shall be of the vertical twin rotor type and be located in either the influent manhole or in the wet well. The influent grinder shall be capable of being lifted out of the wet well or manhole by means of stainless steel guide rails without entering. The influent grinder motor shall be explosion proof and rated NEMA 4X. The grinder shall be timer operated with an upstream high water level override.

5. Pumping Station Design/Architectural Standards: Pumping stations shall be architecturally compatible with surrounding structures and shall not have slate roofs. Pumping stations shall be of pre-cast concrete walls and concrete roof or shall be pre-cast concrete and shall be designed to be vandal-proof. Wood

or asphalt shingles are not permitted. There shall be no exposed woodwork on the outside of the building. All exterior woodwork shall have a vinyl or aluminum coating. The pumping station shall have a lightning protection system. Provisions shall be made in the structure for traversing bridge cranes of adequate capacity to facilitate the removal of pumps, motors, valves and all other related heavy equipment. Doors shall be constructed of heavy duty metal with deadbolts and locks keyed to the Commission standard.

The building shall be a minimum of 10 feet by 12 feet and shall include a work bench and wall cabinets for storage.

The finished floor and all electrical equipment shall be located at least three feet above the 100-year flood elevation. Ventilation openings shall be protected with aluminum louvers with bird screens. Floors shall be sloped to floor drains piped to the influent manhole or wet well. The building shall be furnished with a service sink with both hot and cold water, on-demand hot water heater, outside non-freeze hose bibb, small desk with chair, and telephone line. The Chief Engineer may require in some instances that a toilet room with waste piped to the influent manhole or wet well also be provided. The building shall conform to all St. Mary's County building codes and zoning regulations.

a. Control Room

   Electrical equipment shall be located above grade in a control room above the dry well. The control room shall be designed with adequate space to accommodate future upgrades.

b. Toilet Room

   In some instances, a toilet room shall be provided with toilet, lavatory, on-demand hot water heater, towel dispenser, soap dispenser and mirror.

c. Generator Area

   If a permanently mounted pump-around is not appropriate for the type of system proposed, a separate generator area shall be provided for the emergency generator and fuel tank. The generator area shall be located a minimum of three (3) feet above the 100-year flood elevation.

6. Pumping Station Building Heating and Ventilation: The building shall be heated by electric unit heaters with integral thermostats sized to maintain a minimum inside temperature of 55 degrees Fahrenheit. Ventilation shall be by means of wall mounted exhaust fans with backdraft dampers operated by thermostats and freezestats and intake louvers with motor operated dampers.

Ventilation shall be designed for a minimum of six (6) air changes per hour. Provisions shall also be made, if applicable, to ensure against condensation forming on controls and other major items of equipment.

C. Equipment

1. Yard Valves: Yard valves shall be buried plug valves complying with the Commission's Standard Specifications and Details for Construction with operating nut and roadway valve box at grade.

2. Station Bypass: If a permanently mounted pump around is not provided, the wastewater pumping station shall be provided with an auxiliary force main connection downstream of the station in addition to the influent manhole described above to enable the station wet well to be taken off-line for periodic maintenance or repairs. The connection shall use a plug valve or resilient seat gate valve for isolation. The point of connection shall be conveniently located with respect to the wet well.

3. Interior Piping: All interior wastewater piping shall be DIP, Class 53, with flanged fittings. Flanges shall be integrally cast on pipe or factory assembled screwed-on with proper bonding compound. Manifolds shall include flexible couplings for make-up and for expansion and contraction of the piping system.

   Flexible couplings shall be provided on the suction and discharge of each pump.

   Arrangement of piping and equipment within the station shall be made with adequate space for maintenance, repair, removal or replacement of equipment, as well as to safeguard personnel working in the station. Piping shall be adequately supported. Control and instrumentation piping shall be copper or stainless steel.

4. Valves: Each wastewater pump shall have isolation valves on the suction and discharge to permit the removal or maintenance of the pumps without affecting the operation of the remaining pumps. Interior isolation valves shall be plug valves. The pumping station isolation valve shall be provided with a handwheel, extension stem and operating nut to allow access from the Control Room floor. The handwheel shall be marked with an open arrow. Each pump shall have a hydraulically operated, time adjustable pump check service valve or a swing check valve to prevent backflow through inoperative pumps. In accordance with the criteria for water hammer control, pump check service valves shall be of the type and strength required to eliminate water hammer damage. Isolation and check valves may be located either inside the pumping station building or in a separate valve vault. Pump isolation or check valves

shall not be located in the wet well. Spring type, oil cushioned elbow surge relief valves, when required, shall be provided on the discharge header of the station and be piped to the wet well.

5. Pressure Gauges: Pressure gauges for direct reading of line conditions shall be placed on both the suction and discharge of each pump and on the main discharge header piping after the last pump. Pressure gauges shall be oil-filled type, have a minimum 3 ½-inch diameter face and be equipped with snubbers and diaphragms.

   Accuracy shall be to within 0.5% of pressure. Pressure gauges shall have a range such that the normal operating pressure is near the middle of the gauge.

6. Flow Metering: All wastewater pumping stations shall have polyurethane lined magnetic type flow meters with a replacement spool piece or bypass line provided to enable the pumping station to operate when the meter is being serviced.

   Magnetic flow meters shall be provided with grounding rings and isolation valves. Accuracy shall be to within 1% of flow. All flow meters shall have an adequate straight run of pipe both upstream and downstream of the meter in accordance with the manufacturer's recommendations. A seven (7) day circular chart recorder with totalizer and indicator recorder in units of gpm shall also be provided.

7. Pumping Units: Wastewater pump suction and discharge shall be 4-inch minimum diameter. All wastewater pumps shall rotate clockwise as viewed from the motor end. Wastewater pumps shall be centrifugal non-clog solids handling pumps capable of passing a 3-inch sphere and meet all requirements of MDE.

   The pump bearings shall have a minimum 100,000 hours ABMA-10 bearing life. The pump motors shall operate on 460 volt, 3 phase, 60 cycle electrical service and at a speed no higher than 1780 rpm. The pump motor horsepower shall be sufficient to prevent motor overload under all possible conditions. The pumps shall meet the vibration performance specifications of the Hydraulic Institute (HI). All wastewater pumps shall be factory witness tested and approved prior to shipment. All wastewater pumps must pass an on-site vibration test performed by an independent vibration testing company prior to acceptance. Wastewater pumps and motors shall be suitable for continuous duty. Pumps shall be of the types listed below.

   a. Dry Well Wastewater Pumps (conventional and package stations only):

Pumps shall be of the dry pit submersible design. The pump casing/volute, impeller, support base, suction elbow, seal housing/motor adapter and motor housing shall be of cast iron construction. The pump's casing and impeller shall be fitted with replaceable hardened stainless steel wear rings to maintain sealing efficiency between the volute and the impeller. At the option of the Chief Engineer, other pump materials may be required to suit a particular application. Each pump discharge volute casing and suction elbow shall be provided with an inspection and clean out opening.

b. Dry pit submersible wastewater pumps shall have the following additional features:

1) One piece backhead and motor adapter with impeller adjustment cap screws.

2) Solid full diameter stainless steel shaft with no shaft sleeve or solid large diameter high strength alloy steel shaft with stainless steel shaft sleeve having a tapered end with a keyway to receive the impeller.

3) Double mechanical shaft seals cooled and lubricated by potable water through a cleanable seal filter assembly and provided with a mechanical seal vent with petcock. Oil cooled may be provided with the approval of the Chief Engineer.

4) Premium Efficiency motors shall be specified (where commercially available) for all three-phase pump motors. Dry Pit submersible wastewater pumps shall be designed for continuous operation in air for application in a dry well. The motors for dry pit applications shall be capable of a minimum of eight (8) starts per hour in air.

The pumps/motors shall also be designed to function continuously in a submerged condition should the dry well become flooded. Motor cooling shall be via cooling water jacket, submersible-rated air-over motor cooling fan or positively forced oil cooling. Variable drive units shall be provided when feasible.

D. Electrical and Controls

1. Electrical Design: All electrical designs and components shall be in strict accordance with all applicable National and County Code requirements. Electrical design shall be such that phase out protection shall be provided so that the power will automatically switch off in the event of a loss of any one phase. Incoming electrical service shall be underground with electric meters installed outside the pumping station building. The electrical plans shall include, but not be limited to, the following:

a. Complete plan layout indicating all conduit, wire sizes and equipment locations including lighting and other appurtenances. Incoming electrical service on the pumping station site shall be underground and within concrete encased conduits.

b. Installation details of equipment that are wall mounted, or suspended from the ceiling or otherwise required for clarity.

c. Single line diagrams incorporating all electrical components required for operation of the facility.

d. Complete lighting schedule noting model, size, location and installation data as well as appurtenances. Vandal proof exterior lighting shall be provided.

e. Complete control and SCADA diagrams.

f. Elevation of control panels with equipment and mounting dimensions and notes identifying each component.

g. Complete circuit breaker schedule indicating size and identifying each circuit.

h. Ventilation schedule noting fan size, operating conditions, location, model, installation data, etc. The ventilation schedule shall also outline louver data including size, material, fixed or motorized.

i. Secondary power facilities and alarm equipment shall be designed so that they may be manually activated for periodic maintenance checks to ensure proper operation.

j. Provide a legend of all symbols used for the above.

2. Lightning and Surge Protection: The Designer shall provide lightning and surge protection at the wastewater pumping station. The lightning and surge protection shall comply with the latest editions of all applicable codes and standards.

3. Backup Power (when permanently mounted pump around is not provided): All wastewater pumping stations shall be provided with either emergency generators or a secondary power feed with automatic transfer switches as described in MDE guidelines. Emergency generators shall be sized to maintain full station operation. Emergency generators shall be diesel driven with fuel storage on the underside of the generator in a belly tank or outside

the building in an above ground storage tank. Fuel spillage protection shall be provided. Tank size shall be suitable for a minimum of 24 hours of generator operation at full load. When emergency generators are located inside the pumping station building, they shall be mounted on vibration isolators, with a fuel tank fill connection to the outside. Generator engine exhaust shall be provided with a critical grade silencer and piped to the outside of the control building. Generator exhaust shall face away from nearby neighbors. If this is not possible, a baffle wall shall be constructed in front of the generator exhaust to deflect the noise.

Generators shall be fueled by natural gas. If natural gas is unavailable and a new service cannot be obtained, propane may be used. If either natural gas or propane is not feasible, a diesel fuel powered generator shall be provided.

4. Controls and Alarms: The pumps shall be controlled by means of either an ultrasonic or submersible level transmitter. The transmitter shall be programmed to turn the pumps on or off at various levels in the wet well as described below.

   The lead and lag pumps shall alternate automatically with every pumping cycle. Ultrasonic level transmitter sensors shall be mounted near the top of the wet well and be removable without entering the wet well. The transmitter shall also report the level in the wet well on an indicator located inside of the station. The pumping station shall also have a back-up mercury float switch control system with floats for turning the individual pumps on and off if the ultrasonic level transmitter malfunctions. Pumps shall have back-up floats to maintain the "safe pumping capacity" (i.e. largest pump out of service) of the station. The back-up floats shall be wired directly into the TCU. The controls shall be designed so that upon a malfunction of the ultrasonic level transmitter control system, control shall be transferred to the back-up float control system and an alarm transmitted to the Commission. Pump control shall then continue to operate on the float control system until manually reset back to the primary ultrasonic level system.

   A separate manual control shall also be provided so that the pumps may be manually activated or shut down, thereby overriding the automatic controls. An exception to this override shall occur when the station shuts down due to a loss of phase from the primary or secondary power sources. Each control system shall have an individual circuit breaker.

   All equipment shall be provided with pilot lighting indicating "on" and "off" operating status and lights shall be green and red, respectively, and be located at a central control panel. Indicator lights for the pumps shall be located on the outside of each starter cabinet.

5. SCADA: At a minimum, the following SCADA shall be provided at each pumping station:

    a. Pump On (each pump)
    b. Pump Failure Alarm (each pump)
    c. Control Valve Failure Alarm (each control valve)
    d. High Wet Well Water Level Alarm
    e. Low Wet Well Water Level Alarm
    f. Loss of Primary Power Alarm
    g. Generator/Secondary Power On
    h. Telemetry Failure Alarm
    i. Antenna Tower

    A minimum of five (5) spare inputs and five (5) spare outputs shall be provided with the SCADA system. The Chief Engineer may require additional telemetry and SCADA communications at a particular station.

    The Designer shall obtain from the Chief Engineer any information necessary for proper system communication, which may be applicable.

E. Painting and Coating

All exposed piping, pump equipment and appurtenances shall be painted with epoxy coating. All pumping station control rooms shall be painted. Pumping station dry wells shall not be painted. Wet wells shall be coated as described in previous sections of this chapter. Painting system and colors shall be submitted to the Chief Engineer for approval. All pumping station floors shall have floor hardeners.

F. Miscellaneous

1. Odor Control: An odor control system shall be provided when required by the Chief Engineer. The type of odor control system to be used at a particular station must be approved by the Chief Engineer prior to design. Odor control systems shall be designed to mitigate odors from the wet well and influent manhole.

Acceptable methods include, but are not limited to: carbon adsorption (air scrubbing), chemical addition at the wet well or influent manhole, and soil odor filters.

Wastewater pumping stations should be designed to minimize the possible formation of odors by limiting wet well detention times and avoiding turbulence in manholes and wet wells which cause odors to be released.

2. Operations and Maintenance Manual: Three (3) complete operations and maintenance manuals shall be provided for each pumping station. Manuals should contain approved shop drawings, catalog cut sheets, description of operation including various control sequences or any other special operational details incorporated in the pumping station design, equipment model and serial numbers, installation instructions, maintenance schedules, list of recommended spare parts, warranties, names and telephone numbers for local equipment representatives, for each item of equipment.

5.8 Small Wastewater Pumping Stations

A. General

Design criteria for small wastewater pumping stations shall be the same as for conventional stations described above except where specifically stated otherwise.

B. Suction Lift Stations

1. Pumping Station Configuration: Suction Lift pumping stations shall be designed with the pumps mounted directly above the wet well and shall have suction pipes that are straight. Suction Lift stations shall satisfy pump NPSH requirements.

   Suction Lift stations shall have suction lift no greater than 18 feet. Two-stage pumping is not acceptable. The pumping station building shall contain all electrical and control equipment as described in the preceding sections of this chapter. The wet well and pumps shall be located adjacent to the pumping station building. The wet well and pumps shall be covered by a canopy roof structure that is attached to the pumping station building and is of the same construction as the pumping station building roof. The emergency generator shall be located outside of the pumping station building in a weatherproof, sound insulated enclosure.

2. Wet Well Design: Suction Lift pumping station wet wells shall be designed for pre-cast concrete construction. Wet well coating and design features shall

be the same as described for conventional pumping stations except as described below.

a. Access: Wet well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch shall be 36-inch by 36-inch minimum unobstructed size and as large as necessary to allow removal of equipment from the wet well.

b. Ventilation: Wet well ventilation for suction lift pumping stations shall be the same as for conventional pumping stations.

3. Suction Lift Wastewater Pumps: Pump volute, impeller and motor housing shall be of cast iron construction. The pump volute casing and impeller shall be fitted with replaceable stainless steel wear rings to maintain sealing efficiency between the pump volute and impeller. At the Chief Engineer's option, other special pump materials may be required for a particular application. All nuts, bolts and screws shall be stainless steel. Both vacuum prime and self-priming suction lift pump styles are acceptable.

4. Flow Meter Vault: A flow meter meeting all the same requirements as for conventional pumping stations shall be located in a pre-cast concrete vault located on the pumping station site with an adequate straight run of pipe both before and after the vault as required by the flow meter manufacturer. The flow meter vault shall be coated on the outside with elastomeric membrane waterproofing. The flow meter vault shall be equipped with an aluminum access hatch. Ventilation shall be by means of two gooseneck openings at the top of the vault. The floor of the flow meter vault shall be sloped to a sump with a drain open to gravel when required.

C. Submersible Stations

1. Pumping Station Configuration: Submersible pumping stations shall be designed with an equipment hatch in the top slab for pump removal, non-sparking, stainless steel, guide rails and manway hatch. Pumps shall be of the wet pit submersible type. The pumping station building shall contain all electrical and control equipment and a toilet room as described in the preceding sections of this chapter. The wet well and pumps shall be located adjacent to the pumping station building. If applicable, the emergency generator shall be located outside of the pumping station building in a weatherproof, sound insulated enclosure.

2. Wet Well Design: Submersible pumping station wet wells shall be designed for pre-cast concrete construction. Wet well coating and design features shall be the same as described for conventional pumping stations except as described below.

a. Access: Wet well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch shall be 36-inch by 36-inch minimum unobstructed size and as large as necessary to allow removal of pumps from the wet well.

b. Ventilation: Wet well ventilation for submersible pumping stations shall be the same as for conventional pumping stations.

c. Size: The wet well size and depth shall be as required to accommodate the influent sewer, as well as for complete pump submergence.

3. Wet Pit Submersible Wastewater Pumps: Pump volute, impeller and motor housing shall be of cast iron construction. The pump volute casing and impeller shall be fitted with replaceable stainless steel wear rings to maintain sealing efficiency between the pump volute and impeller. At the Chief Engineer's option, other special pump materials may be required for a particular application. The motor shaft shall be a single piece heat-treated high strength alloy steel or high strength stainless steel having a tapered end with keyway to receive the impeller. All nuts, bolts and screws shall be stainless steel. The motor shall be Class F insulated (minimum) and sealed from the pump by independent double mechanical seals.

   The upper and lower mechanical seal shall run in an oil chamber. The upper seal shall be a stationary tungsten-carbide seal with rotating carbon ring. The lower seal shall be one stationary and one positively driven rotating tungsten-carbide ring. All mating surfaces where watertight sealing is required shall be machined and fitted with a rubber O-ring. The machining of mating surfaces shall provide metal to metal bearing on sealing surfaces without crushing the O-ring.

4. Valve Vault: Pump check and isolation valves meeting all the same requirements as for conventional pumping stations shall be located in a pre-cast concrete vault adjacent to the wet well. The valve vault shall be coated on the outside with elastomeric membrane waterproofing. The valve vault shall be equipped with an aluminum access hatch. Ventilation shall be by means of two gooseneck openings at the top of the vault. The floor of the valve vault shall be sloped to a sump with a drain open to gravel.

5. Flow Meter Vault: A flow meter meeting all the same requirements as for conventional pumping stations shall be located in a pre-cast concrete vault located on the pumping station site with adequate straight run of pipe both before and after the vault as required by the flow meter manufacturer. The flow meter vault shall be coated on the outside with elastomeric membrane waterproofing. The flow meter vault shall be equipped with an aluminum

access hatch and an access ladder to the bottom. The access ladder shall have safety extension poles at the top. Ventilation shall be by means of two gooseneck openings at the top of the vault. The floor of the flow meter vault shall be sloped to a sump with a drain open to gravel.

5.9 Package Stations

1. Pumping Station Configuration: Package pumping stations shall be of a wet well/dry well configuration. Electrical equipment shall be located at grade in a pumping station building erected above the pump chamber. Access hatches for the pumps shall be located in the floor slab of the pumping station building. Pumps shall be of the dry-pit submersible type. The pumping station building shall contain all electrical and control equipment and a toilet room as described in the preceding sections of this chapter. If applicable, an emergency generator shall be located outside of the pumping station building in a weatherproof, sound insulated enclosure.

2. Wet Well Design: Package pumping station wet wells shall be designed for pre-cast concrete construction or equal. Wet well coating and design features shall be the same as described for conventional pumping stations except as described below.

    a. Access: Wet well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch shall be 36-inch by 36-inch minimum unobstructed size and as large as necessary to allow removal of equipment from the wet well.

    b. Ventilation: Wet well ventilation for package pumping stations shall be the same as for conventional pumping stations.

3. Dry Well Design: Dry wells shall be of pre-cast reinforced concrete construction.

    Dry wells shall have exterior elastomeric membrane waterproofing. The dry well floor shall be sloped to a sump. A sump pump with piping to the wet well shall be provided. Sump pump piping shall contain a check valve to prevent siphoning from the wet well. A surge relief valve, if required, shall be placed on the discharge header before the pipe leaves the station. Surge relief piping shall be piped to the wet well.

    a. Access: Dry well access shall be via a staircase with all necessary landings and handrails per OSHA requirements. Equipment hatches for the pumps shall be located in the top slab and directly above the pumps. Grating (catwalks) shall be provided in the dry well to facilitate access to all piping without climbing over pipes, equipment, etc.

b. Ventilation: Dry well ventilation for package pumping stations shall be the same as for conventional pumping stations.

End of Chapter 5