SECTION 3 - DESIGN STANDARDS FOR SEWAGE PUMPING STATIONS AND FORCE MAINS

3.1. General Requirements.

3.1.01 The design of sewage pumping stations and force mains is an engineering matter and is not subject to detailed recommendations or requirements other than as required by these Standards.

3.1.02 Sewage pumping stations and force mains are to be provided solely for the conveyance of sanitary wastes. Under no circumstances shall any roof, foundation, surface or sub-surface drainage, or any other form of storm drainage be allowed to pass through the proposed facilities.

3.1.03 A detailed Preliminary Engineering (Design) Report (PER) for the proposed pumping station shall be submitted to and approved by the County prior to design of the facility. The report shall fully comply with all requirements of Section 1; shall evaluate the proposed sanitary sewer service area; shall evaluate overall effect on downstream County facilities and shall justify the proposed station peaking factor.

A. Meet with the Department to review the Sewer Facilities Plan related to sewer service area and required improvements. Discuss information from County that may be available.

B. Provide qualifications and experience resume for engineering firm(s) that are proposed for design of the pumping station. List similar projects designed by the project engineer assigned to this project.

C. Determine sewer basin boundaries for the pumping station. Determine discharge point for the force main to tie into the existing system. Determine sewer pump station location and trunk sewer routing needed to serve sewer basin. Determine approximate pipe invert elevations and station depth for proposed station location necessary to serve the defined sewer shed.

D. Using Current Comprehensive Land Use Plan and these Design Standards, determine initial and ultimate wastewater flow projections for the facility. Provide expected Average Dry Weather Flow and Peak Wet Weather Flow for a 10 yr storm and for build-out. Determine capacity phasing plan for pumping station.

E. Determine improvements required to downstream sewage conveyance facilities.

F. Provide a Technical Memorandum to include Paragraphs B, C, and D above along with associated tables, maps and calculations. Submit the Technical Memorandum for review and approval by the Department.

G. The design engineer shall tour similar type Henrico facilities with the Department. This tour is intended to establish minimum requirements for building type and materials, facility layout and operational requirements. A Memorandum of Understanding (MOU) will be prepared to define minimum standards for the facility.

H. When the Department's comments are addressed and the MOU signed by the developer and the Department, written approval of the Technical Memorandum will be provided with authorization to proceed with the Preliminary Engineering Report (PER) for the project. The Technical Memorandum and MOU shall be included in the PER.

I. The PER shall also contain the following elements. The elements listed are the basis for design for the typical pumping station constructed by the Department.

(1.) Define system operating conditions
   a. Initial, interim and design flows (firm system capacity)
   b. Future conditions (Build-out Flow)
   c. Minimum, average and peak flows for each condition
   d. Define Operating parameters to maintain flow/ velocity during initial flows

(2.) Develop a flow diagram
   a. Schematic of pumps and piping
   b. Include valves

(3.) Develop a P&ID
   a. Consult with DPU Operations for complete list of SCADA points

(4.) Develop pipeline profile
   a. Include HGL on profile
   b. Show both minimum and maximum hydraulic profile

(5.) Select pipeline materials
   a. Ductile iron pipe
      1. Size, length, route
   b. Initial and ultimate FM sizing
   c. Air release/vacuum valves

(6.) Develop hydraulic profile
   a. Include facility and pipeline
   b. Include maximum hydraulic gradient in downstream gravity sewers when all installed pumps are in operation

(7.) Estimate the total head (TDH)

(8.) Establish the system operating levels

(9.) Make a preliminary pump selection
   a. Number, type, rating point, motor size, speed
      1. For initial and ultimate capacity

b. Include pump curves (for initial and ultimate capacity)

(10.) Develop a Master Equipment List for approval by the Department

a. Describe major equipment and manufacturers

1. Flow meter
2. Comminutor /screening facilities
   (a) By-pass channel in screening structure required
   (b) Sluice gate at station entrance
      (i) Required for wet well cleaning cycle
      (ii) Motor operated
3. Emergency Generator
   (a) Install in building
   (b) Size required for operating all pumps, SCADA, lighting, and auxiliary pumping station equipment
   (c) Size and type of fuel tank – 4 day fuel storage
   (d) Provide fuel cleaning equipment
   (e) Provide plenum at intake and exhaust louvers
4. PLC / SCADA system
5. Wetwell Level Control System
6. Manufacturer of pumps and controls (acceptable to the Department)
   (a) Sewage Pumps
   (b) Switchgear
   (c) Automatic Frequency Drives (AFD)
   (d) Pump discharge valves
   (e) Pump cooling requirements (sewage cooled not acceptable)
7. HVAC System
8. Bridge crane
9. Odor Control Facilities
   (a) Carbon adsorber for wetwell
   (b) Chemical tank installed in building for protection of force main and downstream gravity sewer

(11.) Define Architectural and Structural Requirements

a. Include proposed site plan schematic
   1. Establish minimum area for pumping station site
   2. Adequate room for future expansion based on phasing plan
b. Brick and block or other approved masonry construction
   1. Architectural style compatible with neighboring development
c. Wet well / dry well configuration
   1. Trench type wet well
d. Sump and dual sump pumps in dry well

(12.) Describe scope and schedule for future capacity upgrades based on phasing plan, if applicable

(13.) Define requirements for O&M Manual

a. DEQ approval required
b. Final O&M Manuals – 2 copies with each of the items in each manual:
   1. DEQ approved document

2. Approved Shop Drawings
3. Manufacturers Operating Instructions

(14.) Provide estimate of probable cost

J. With written approval of the PER, the design engineer may proceed with station design.

3.1.04 The design must conform to the minimum standards set forth in the Virginia Department of Environmental Quality (DEQ) Sewage Collection and Treatment Regulations. County requirements for specific equipment and submittals will be detailed during engineering review.

3.1.05 An Operations and Maintenance (O & M) Manual shall be prepared in accordance with the Virginia DEQ SCAT Regulations and approved by the Department before the County will accept the station for operation and maintenance. The manual shall contain complete operating information for all equipment, a complete set of approved shop drawings and a copy of the as-built plans for the station. The as-built plans shall be updated to include all plan revisions and field changes made during bidding and construction. One complete hard (paper) copy of the O&M Manual with a reproducible set of drawings and one complete electronic copy in Tagged Image File Format (TIFF) on CD ROM of the O & M Manual and as-built/record plans shall be submitted to the County prior to Final Acceptance.

3.1.06 Prepare and submit a fuel Spill Prevention Control and Countermeasure (SPCC) plan.

3.1.07 Plats for the property occupied by the pump station and force main shall be prepared and submitted to the Department. The pump station property shall be transferred to the County and force main easements recorded prior to acceptance of the pumping station for operation.

3.1.08 All federal, state, and local permits and approvals must be obtained prior to plan approval.

A. The Engineer shall provide necessary certification to obtain DEQ Permit to Construct.

B. The Engineer shall provide necessary certification to obtain DEQ Certificate to Operate.

3.2 Technical Design.

3.2.01 System Layout

A. The sizing and configuration of the pumping station and the sizing of the force main shall be in accordance with the approved PER. The facilities to be provided

shall be based on ultimate flows unless an interim flow design shall have been incorporated in the approved PER.

B. The type of equipment to be installed in the pumping station will be influenced by the interim and ultimate capacity of the station and an evaluation of the period of time that the service of the station will be required.

C. For sewage pumping stations with an ultimate firm rated capacity of 1 mgd or less, the Department will consider design and construction of permanent pumping stations using either suction lift pumps or a wet well/ dry well configuration using dry-pit type submersible pumps in the dry well. For stations with a capacity greater than 1 mgd, only a wet well/ dry well configuration will be accepted. Wet pit or submerged pumps shall not be used for permanent installations.

D. A magnetic-type flow meter and analog wet well instrumentation shall be required.

E. A paved asphalt road and parking area shall be provided for easy access to the pumping station. Tractor trailer access for chemical and fuel deliveries shall be provided in the design.

F. The architecture of the pumping station shall be consistent with the zoning and general appearance of the surrounding area.

G. Flat roofs will not be permitted.

H. Buildings shall be of masonry construction.

I. Site grading, seeding or sod, and trees or shrubs shall be provided to present a finished appearance, as approved by the Department.

J. Approved fencing with gates shall be provided as deemed necessary to properly protect the facility in accordance with Department standards for facility security. Unless otherwise approved, an eight foot chain link fence with 1" vinyl coated (black) mesh with barbed wire top strand shall be installed around the operational area.

K. The Design Engineer shall determine the availability of electric service and coordinate the available electrical service with that required for the facility. The engineer shall also determine the need for primary service extension and advise the Department if an extension is necessary.

L. The pumping station shall be CLASS 1 Reliability in accordance with the Virginia DEQ Sewage Collection and Treatment Regulations and shall comply with the requirements thereof. Each pumping station shall have a permanently installed

emergency power generator. The generator and transfer switch shall be installed inside the building. For sewage pumping stations with a capacity greater than 1 mgd, the fuel storage tank shall be located outside the station. The fuel storage tank shall be sized to provide continuous operation of all pumps for 4 days (96 hours).

M. The Design Engineer shall consider the need for protection of the pumping station and force main against hydrogen sulfide attack and shall provide the proper equipment if such protection is found necessary. All motors, motor controls, electrical panels and other electrical equipment shall be housed in a weatherproof, above-ground masonry structure. Adequate provisions shall be incorporated for proper ventilation, drainage and flood protection in order to insure maximum reliability, and electrical and personnel safety. Pumping stations and appurtenances shall be designed to maintain the atmospheric H_2S limits at or below 1ppm, 30-day average and 2ppm, 30-minute peak.

N. Pump Control and SCADA Telemetry shall be through a Programmable Logic Controller as specified by the Department. Telemetry shall be to the DPU SCADA Control Center with equipment provided by HSQ for compatibility with existing hardware and software.

O. All pumping station wet wells shall be considered an explosion hazard. All electrical equipment installed therein shall be approved for NEMA 7, Class I, Group D, in accordance with Article 500 of the National Electric Code. The use of intrinsically safe controls in accordance with NFPA NO 493 is satisfactory, and its use is encouraged.

P. Where structurally separate wet and dry wells are provided, adequate provision for differential settlement shall be incorporated by means of flexible pipe joints consisting of a minimum of at least two standardized mechanical joint bell connections or their approved equivalent.

Q. An adequate headwork structure and wet well shall be provided. The following items shall be provided: employee access via stairs; comminutor for solids, bar rack for large solids and a davit hoist for removing screenings from headwork. A maintenance platform shall be provided in each wet well.

R. All handrails, ladders, and grating shall be aluminum. All anchors, bolts, etc. shall be stainless steel.

S All pumping stations shall be of sufficient size and contain adequate clearances to provide ample room for maintenance and equipment replacement. In wet well/dry well stations a bridge crane shall be provided for removing pumps. In suction lift stations, overhead rails with hoists for removing pumps shall be provided.

T. The facility shall be connected to a public water supply. A RPZ type backflow preventer shall be installed on the water service. Where a public water supply is not available, a water supply well shall be installed. Supply is to be adequate for facility wash down. Where public water is available, a fire hydrant shall be provided.

U. Force main locations shall generally conform to Section 2.2.01B of these Standards. Force mains shall have a positive slope from the pumping station to the point of discharge unless unusual conditions make it impractical. Extra depth of bury shall be provided in lieu of air or air/vacuum relief valves wherever feasible. Every effort shall be expended to maintain the force main below the hydraulic gradient. Where a relief valve is required, an automatic valve shall be provided and installed in an approved structure with adequate means of drainage.

V. Every effort shall be made to maintain a full force main under operating conditions.

W. Sizing of the force main shall be such that velocity shall be a minimum of 2 ft/sec for self-scouring velocity. A velocity of 8 ft/sec. should not be exceeded.

X. All force mains shall be cement lined ductile iron pipe where the force main remains full under all operating conditions. Where the force main is partially full under some operating conditions, epoxy lined ductile iron or other non-corrosive material shall be used. The epoxy coated pipe shall be used a sufficient distance upstream and downstream of the air / vacuum valve to ensure that protection against hydrogen sulfide corrosion is provided.

Y. Pipe and joints shall be equal to water main strength materials suitable for design conditions. The force main, reaction blocking, and station piping shall be designed to withstand water hammer pressures and associated cyclic reversal of stresses that are expected with the cycling of wastewater lift stations. The use of surge valves, surge tanks or other suitable means to protect the force main against severe pressure changes shall be evaluated.

Z. Isolation valves should be considered where force mains connect into a common force main and shall be full port plug type.

AA. The Design Engineer shall consider ground conditions in the case of metallic conduits and provide suitable cathodic protection where necessary.

BB. Steel casing pipe shall have minimum yield strength of 35,000 psi and a minimum internal diameter of 4 inches greater than the largest external diameter of the carrier pipe. The wall thickness of casing pipe shall be sufficient to resist

loads to which it will be subjected, but in no case less than 0.250 inches. Standard installation detail shall be as shown in VDOT Road and Bridge Standards except that the leak detector pipe shown on the VDOT details shall be eliminated. Requirements for railroads shall be as specified in a permit issued by the railroad.

CC. The size casing pipe required for each size ductile iron pipe is shown in Section 2.2.05M.

DD. The potential for sulfide and odor generation must be fully evaluated based on the characteristics and properties of odor causing compounds and the principals of control. The appropriate odor and/or sulfide control system shall be provided.

3.2.02 Capacity Design

A. Capacity design for the pumping station and force main shall be based on the current Comprehensive Land Use Plan and these Design Standards to determine initial and ultimate wastewater flow projections for the facility. Provide expected Average Dry Weather Flow and Peak Wet Weather Flow for a 10 yr storm and for build-out.

B. Proper allowance for peak flow shall be as shown on the Peak Flow Chart, Form F-2.

C. Pump selection and force main sizing shall be based on a hydraulic analysis of the required flows, pipeline velocities, and receiving gravity sewer capacities.

D. Calculations shall be prepared and a system friction chart prepared that will show static head and total dynamic head for both single and multiple pump operation. The chart shall also show the pump performance curve for both single and multiple pump operation. Where variable speed pumping is contemplated, pump performance curves shall show performance at maximum speed, minimum speed just above static head, and several intermediate speeds that will clearly indicate pump operation. The system friction curves shall illustrate the effect of wet well level on system friction. Particular attention shall be given to the available versus required net positive suction head (NPSH).

E. Consideration must be given to design that produces minimum power requirements to accomplish the functions required. If requested, supporting data shall be furnished to the County.

3.2.03 Structural Design

A. In addition to conventional design procedures, there are several specific areas that

must be considered.

(1.) The effect of hydraulic thrust must be countered by the use of thrust blocking, pipe anchorage, or other suitable means to prevent movement of pumping equipment and pipelines.

(2.) Structural requirements for force mains include the proper selection of materials and strengths of pipe and pipe accessories. This will involve a study of anticipated trench conditions and bedding methods. The minimum depth of cover shall be governed by depths of other utilities and hydraulic gradient; however, not less than 3.5 feet of cover shall be provided.

(3.) Structures shall be designed to resist uplift from anticipated buoyant forces resulting from groundwater and/or flooding conditions.

3.2.04 Geotechnical Design

A. Engineer shall submit a copy of geotechnical design report with project that includes geotechnical recommendations for design and construction. Consideration for size and depth of station and for length of access road including amount of cut and fill shall be used to determine number of test bores made.

3.2.05 Location Design

A. Electronic markers (ball type) shall be installed on all water mains, sewer gravity mains and sewer force mains in accordance with the following:

(1.) Ball type electronic markers shall be passive type as manufactured by 3M or Omni.
   a. Sewer line markers shall be rated and color coded for sewer.
   b. Water main markers shall be rated and color coded for water.

(2.) Locations for electronic markers shall be as shown on Standard Drawings entitled Electronic Marker Placement Detail for Water Mains and Sewer Force Mains (D-740).
   a. Minimum distance between markers shall be 6 feet.
   b. Markers shall be a minimum of 4 inches above the pipe.
   c. Markers shall have a maximum of 3 feet of cover.
   d. When pipe joints are deflected, place markers at the pipe joint beginning and ending the deflection and at intermediate joints for every one foot (maximum) of deflection.
   e. Locations for Markers on force mains shall be in accordance with the following:
      1. Valves
      2. Bends
      3. Deflections (begin, end, max of each one foot of deflection)
      4. Pipe vertical adjustments (beginning and end)

5. Casing ends
6. Maximum 100 feet on metallic pipe and 50 feet for non-metallic pipe
7. All points where force main or sewer crosses over or under other utilities