25. Grinder Pump, Pressure Sewer System.

a. General.

1) Refer to WSSC Standard Operating Procedure governing authorization of grinder pump/pressure sewer systems. A grinder pump and pressure sewer system is to be considered as an alternative for providing sewer service for a site, only if the site cannot be serviced by conventional gravity systems (including pumping stations).

2) Pressure sewer system is defined in this section as an area to be serviced by more than a single grinder pump.

b. Design Requirements.

1) Grinder pumps used in pressure sewer systems for residential areas can only be the ones that have been previously approved or ones that may be subject to approval by the WSSC for systems applications. Determine the type and model of the pump suitable for the system.

2) All pump types and models are to be the same in a single pressure sewer system unless otherwise approved by the WSSC.

3) Primary design parameters to be considered are the number of pumps under simultaneous operation, flow velocities in pressure sewer piping, and limiting the operating head at a pump. Consider the following guidelines in defining these parameters:

a) Number of pumps under simultaneous operation.

(1) Semi-positive displacement pump systems, using Environment One (E/1) pumps, the maximum number of simultaneously operating pumps has been statistically defined and referenced in the Environment One Pressure Sewer Design Handbook. Use this information for the design of such systems.

(2) Centrifugal pump systems.

(a) The maximum number of pumps that may be expected to operate simultaneously has not been consistently developed for centrifugal pump systems. Such systems shall be sized so that the pumps under simultaneous operation shall be able to discharge the peak flow generated by the dwelling units located upstream of any point in the pressure sewer system under consideration.

(b) For centrifugal pumps having a nominal discharge rate relatively close to that of an E/1 pump, the maximum number of simultaneously operating pumps developed for E/1 pump systems may be used.

b) Flow velocities.

(1) Size a system for the maximum number of pumps that may be expected to operate under the full development stage, thereby generating the highest flow velocities and pumping head. Also consider in the design system hydraulics during the initial stage when a fewer number of pumps are expected to operate and lower velocities may be expected.

(2) The minimum flow velocity should be approximately three (3) fps under simultaneous pump operating conditions, except for piping servicing one to two dwelling units where a two (2) fps minimum velocity shall be used. A three (3) fps minimum velocity criteria is required for pressure sewer profiles which have multiple high points and low points.

(3) The maximum velocity shall be approximately seven (7) fps under simultaneous pump operating conditions.

c) Operating head at a pump.

(1) Design an E/1 semi-positive displacement pump at one hundred twenty-five (125) ± feet (maximum) of pumping head, although the manufacturer's pump performance curve may show a maximum operating head of one hundred thirty-eight (138) feet. WSSC recommends maximum pumping head for system design to be ninety (90%) percent of the manufacturer's pump performance curve.

(2) Design a centrifugal pump not to operate at above ninety (90%) percent of its shut off head and at or below its cut off point. The shut off head is the head at zero pump discharge; the cut off point is a point on the pump curve where discharge head decreases abruptly with a small incremental flow.

(3) Size a pressure sewer system and develop alternative designs such that the above criteria can be met during the full development stage and the initial stage as well.

4) Piping system design. With the selected maximum number of grinder pumps in simultaneous operation, design the piping system and submit all calculations, using the following design methods:

a) For semi-positive displacement pump systems using E/1 pumps, the design methodology is described in detail in the E/1 Design Handbook for Pressure Sewer Systems. Computerized design may be used for complex systems to give better accuracy in hydraulic calculations.

b) For centrifugal pump systems, a number of branches should be used to represent the piping layout similar to the design of semi-positive displacement pump systems. The peak flow generated by all dwelling units in a branch shall be estimated. Locations of the pumps shall be designated and computer designs shall be used for analyzing system hydraulics during simultaneous pump operation.

c) Pumps located at the most remotest part of a system, farthest from the point of discharge to gravity system, and pumps located at the lowest elevations in a system must be considered in pump selection for simultaneous operation.

d) Size of pressure sewers, maximum 4-inch pipe diameter and minimum 1-1/4-inch pipe diameter.

e) Allowable pipe material, SDR-21 PVC pipe and/or SDR-11 HDPE pipe, see Specifications. PVC pipe is generally installed in open-cut trench and HDPE pipe can be installed in open-cut trench or by horizontal directional drilling.

f) Use Hazen-Williams (HW) friction coefficient of one hundred forty (140) for calculating headlosses through piping. Consider headlosses through fittings and bends and other minor losses when calculating the total dynamic head.

g) In computing the static head, base the pump elevation on the developer's proposed elevation at which the grinder pump will be installed.

h) Centrifugal grinder pumps should not be designed to operate at or below the pump's cut off point. This situation can occur at centrifugal pumps located relatively close to the transition manhole and at pump elevations close to that of the transition manhole, when fewer than the maximum number of pumps are operating simultaneously. These operating scenarios should be analyzed during system design, so as to ensure that the pumps will perform satisfactorily under various operating conditions.

i) Use sound engineering and hydraulic principles in design and analysis. Consider various scenarios of pipe sizes, system layout, and pump operation to arrive at an optimum design. Use of computer analysis enables checking for minimum and maximum flow velocities and pump discharge head under various operating scenarios.

(1) Uphill pumping is preferred in a pressure sewer system where the point of discharge to gravity system is at a higher elevation than the rest of the system, so as to maintain positive pressure throughout the system.

(2) Eliminate vertical piping alignment that may be conducive to siphoning at high points or gravity drain/air binding in downhill pumping conditions.

(3) Ideally, high points and low points are to be avoided and a continuously rising pressure sewer profile toward the point of gravity discharge is to be designed. Place pressure sewer air vacuum and air release valves at all high points in a system, if the high point cannot be eliminated.

(4) PVC and HDPE pipe having the same nominal diameter have different inner diameters. Hydraulic calculations used for sizing the pipe diameters of the system should reflect this. If the option of using PVC and/or HDPE piping is allowed, the nominal pipe diameters called for on the drawings may be different depending on the material. For example, calculations might indicate 1-1/2-inch PVC is hydraulically satisfactory in a particular situation. Calculations may indicate, however, that 1-1/2-inch HDPE, due to its smaller ID, is not hydraulically compatible for the same situation. The use of HDPE as an alternative may therefore require 2-inch HDPE. If the Contractor has the option of using either PVC or HDPE under these circumstances, a note must placed on the drawings indicating that where the drawings show 1-1/2-inch PVC, 2-inch HDPE installed by horizontal directional drilling may be used as an alternative.

j) Verify calculations used in sizing the grinder pump system with basement elevations shown on the drawings.

k) Joints and thrust restraint.

(1) Lengths of PVC pressure sewer pipe greater than 1-1/4-inch diameter are joined together using push-on gasketed integral bell and spigot joints or bell by bell gasketed couplings. 1-1/4-inch PVC pipe is joined together using solvent weld couplings or integral solvent weld bell and spigot joints. In limited cases, for instance at connections to valves in flushing connection manholes, flanged or threaded joints are necessary, see Standard Details PS/1.2 and PS/1.3. Material and installation requirements for all joints are provided in the Specifications. Thrust restraint for PVC pressure sewer pipe is provided by concrete thrust blocking, see Standard Details PS/1.4, PS/1.41 and PS/1.42.

(2) HDPE pipe is generally a continuous pipe from a long coil or lengths of pipe and fittings joined by thermal butt-fusion, electrofusion, or by special mechanical couplings. Joints for all HDPE pipe that is to be installed by horizontal directional drilling will be butt-fused. Butt-fusion and electrofusion joints are restrained joints and this should be considered in cases where sufficient lengths of pipe can be harnessed for use in thrust restraint in lieu of using concrete thrust blocking. For information on thrust restraint design using restrained joint pipe, see Part Three, Section 27 (Thrust Restraint Design for Buried Piping). Where sufficient length of restrained joint pipe is not available to restrain a fitting, provide thrust blocking, see Standard Details PS/3.0. Special mechanical couplings and transition fittings are used for connecting HDPE pipe to HDPE pipe or to different pipe materials such as PVC in open-cut installation. Material and installation requirements for these special mechanical couplings and transition fittings are included in the Specifications. Some of the mechanical couplings provide joint restraint. HDPE has a very high coefficient of thermal expansion/contraction. To prevent pullout of the HDPE pipe from an unrestrained joint because of contraction due to change in temperature, a small thrust collar is installed on the HDPE pipe adjacent to the unrestrained joint, see Standard Detail PS/3.1. Where an HDPE pipe end is to be inserted into a mechanical type coupling or joint, a metal insert must be installed inside the end of the HDPE pipe that goes into the joint, see Specifications.

l) Locator Stations. It may become necessary in the future to locate the HDPE pipe installed by horizontal directional drilling. The Specifications therefore require the Contractor to pull a copper wire along with the pipe. The wire is terminated at each end of the HDPE in a locator station. Two types of locator stations are specified in the Specifications and shown in the Standard Details. One type is used when the wire is terminated in a manhole, such as used for a flushing connection or transition manhole, see Standard Detail PS/8.0. The other is a flush-mounted underground station used when a manhole is not available or convenient, see Standard Detail PS/8.1. Refer to and indicate on the drawings, the location(s) and type of the locator stations.

c. Appurtenances and Structures.

1) Flushing connections. Install approximately every four hundred (400) feet in the system, at dead ends and along downhill sloping piping. There are two (2) types of flushing connections, in-line and terminal.

a) For terminal and in-line flushing connections for pressure sewers less than 2-1/2-inch diameter, see Standard Detail PS/1.2.

b) For in-line flushing connections for pressure sewers 2-1/2-inch to 4-inch diameter, see Standard Detail PS/1.3.

2) Air valves. For the design see requirements under Part Two, Section 27 (Air Valves). For Standard Details, see PS/1.5 and PS/1.5a.

3) Transition manhole.

a) Design the connection between the pressure sewer and the gravity sewer with a transition manhole. Set the top of weir elevation in the transition manhole 1-inch higher than the crown of the pressure sewer. Pressure sewers 4-inch and smaller in diameter, see the Standard Details PS/4.0, PS/4.1 and PS/4.2.

b) Design the invert elevations of both the pressure sewer and the gravity sewer at the same elevation.

c) Hydrogen Sulfide (H_2S) corrosion mitigation.

(1) Coat the interior of the transition manhole, see Specifications and provide a note on the drawings.

(2) Coat the interior of the gravity sewer pipeline if it is other than PVC pipe. Note the distance of the gravity sewer piping requiring interior coating on the drawings. The minimum distance for interior pipe coating is to the next manhole, but the design may require several downstream manholes and pipeline sections to have interior coatings, see Specifications.

4) Pressure sewer house connections (PSHC).

a) For trench details for PSHC, see Standard Detail PS/1.0. Provide a service valve assembly at the end of the PSHC, see Standard Detail PS/1.1.

b) Do not design PSHC in a common trench with a water house connection (WHC), see Part Three, Section 3 (Pipeline Crossings and Clearances).

d. Horizontal and Vertical Alignment.

1) Horizontal alignment, see requirements under Part Two, Section 24 (Force Main Design), except for the following:

a) For minimum radius of curvature for PVC pressure sewer pipe, see Table "18". Minimum radius of curvature for HDPE pipe installed in open-cut trench is forty (40) times the outside pipe diameter. Minimum radius of curvature for directionally drilled HDPE is dependent on allowable radius of curvature of Contractors' drilling rods. For design purposes, this can be assumed to be forty (40) feet. Radius of curvature at low points should be maximized.

TABLE "18"

Minimum Curve Radius for PVC Pressure Sewers

Pipe Size	Minimum Radius
1-1/4-inch to 1-1/2-inch	60 feet
2-inch	70 feet
2-1/2-inch	90 feet
3-inch	100 feet
4-inch	130 feet

b) Do not design ninety (90°) degree bends in the pipeline alignment.

c) Design the piping layout to minimize the total piping length.

2) Vertical alignment, see requirements under Part Two, Section 24 (Force Main Design).

3) To install HDPE pipe by horizontal directional drilling construction areas will be required at one end of the operation for layout and fusing pipe lengths to be pulled unless coils are used, and at the other end to set up and operate the drilling/pulling machine and drilling fluid storage tank and waste fluid storage. The amount of area required depends on the specific equipment used. Generally, sufficient area will be available in the normal right-of-way and construction strip used

in the pipeline design. Verify that adequate space is available in the right-of-way and construction strip limits.

e. Required Analysis for Hydrogen Sulfide (H_2S) Generation and Release.

1) Generation.

a) Design submittal requirements. Perform the analysis for the proposed design as indicated in Part Two, Section 29 (Hydrogen Sulfide (H_2S) Control) to determine the potential for hydrogen sulfide generation.

b) System design. Design the piping layout to minimize the total piping lengths and pipe sizes within the constraints of the hydraulic design criteria, so as to minimize sewage detention time in the system. Avoid downhill pumping conditions with a high point above the transition manholes, which will potentially cause the release and accumulation of hydrogen sulfide gas at the high points.

2) Release. The discharge of sewage from a pressure sewer into a gravity sewer can potentially generate odor and the release of hydrogen sulfide at the transition manhole and in the downstream gravity sewer. Turbulence in the transition manhole should be minimized. Consider the corrosive effects of hydrogen sulfide in the design and selection of gravity sewer pipe material downstream of transition manholes, see the requirements in Transition Manhole, in this section, and under Part Two, Section 28 (Hydrogen Sulfide (H_2S) Control) and Section 3 (Selection of Pipe Material – Gravity Sewers).

f. Industrial or Commercial Developments.

1) Except for on-site systems, where each system is designed to service one property, the use of grinder pumps systems for non-residential development is not permitted. For on-site grinder pump systems, it is important to recognize the uncertainties in estimating total system flows, daily flow pattern, and the number and capacity of grinder pumps that may be expected to operate simultaneously.

g. Abandonment of Existing Pressure Sewer.

1) For PVC PSHC, remove minimum one (1) foot section of PSHC, cap existing PSHC at mainline tee and at end of abandoned PSHC. See Standard Detail PS/6.0.

2) For HDPE PSHC, remove minimum two (2) foot section of PSHC, provide coupling, PVC nipple and cap on mainline side of abandoned PSHC. Provide cap on end of abandoned PSHC. See Standard Detail PS/6.0.

h. Connecting to Existing Pressure Sewer.

1) Connect new mainline pressure sewer or PSHC to existing pressure sewer using socket tee, nipples and coupling. See Standard Detail PS/5.0.

i. Connecting Pressure Sewer House Connection (PSHC) into a Gravity Sewer.

1) Connect PSHC to a clean-out and gravity sewer house connection, see Standard Detail PS/1.6.

j. Shutdown of Existing Pressure Sewer System.

1) Shutdown requirements are in the Specifications.