

Sanitary Sewer Design Manual

Office of the City Engineer



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PART 1 GENERAL

1.1 Purpose and Scope

The purpose of this manual is to provide minimum requirements for the design of gravity sewers, low pressure sewers, lift stations, and force mains that connect to the City of Tuscaloosa (City) sanitary sewer system and are intended to be maintained by the City.

- 1.1.1 The basic methodology presented in this manual is to establish minimum requirements and should not be accepted as a comprehensive design document. Acceptance of plans by the Office of the City Engineer (OCE) shall not relieve the Owner/Developer of any errors or omissions that may result due to a lack of adherence to this manual or due to engineering judgement used for those matters not exclusively addressed by the manual. Furthermore, acceptance by the OCE will not restrict OCE from requiring additional information deemed necessary for a thorough and proper review.
- 1.1.2 Where practical and technically feasible, sanitary sewer service to a development should be provided by gravity sewer without the use of lift stations.

Gravity service may be considered impractical under the following conditions:

- Depth: Installation would require pipe depths greater than 20 feet at any point.
- Distance: The nearest gravity connection point is more than 1,000 feet away and achieving required slopes would result in depths exceeding 20 feet.
- Topography: The site lacks sufficient grade to maintain minimum gravity slopes (e.g., 0.40% for 8-inch pipe) .
- Environmental/Geologic Constraints: Installation would require crossing wetlands, blasting through rock, or dewatering in high groundwater conditions.
- Property Access: Routing gravity sewer through adjacent properties would require obtaining off-site easements that are impractical or unattainable.
- Other considerations as presented by the Owner / Developer.

If gravity service appears infeasible, the Owner/Developer should provide documentation—such as sewer profiles, site plans, and geotechnical reports—demonstrating these conditions. The City will review this information and work collaboratively with the developer to determine the most practical solution.

- 1.1.3 Private sewer lines that connect either directly or indirectly to the City's collection system shall be subject to the requirements stated in this design manual, the Sanitary Sewer Construction Specifications, and the Standard Details for Sewer Construction. Direct or indirect connections to said system by roof drains, yard drains, foundation drains, or other sources of inflow shall be strictly prohibited.



1.2 References

Unless otherwise stated herein or preapproved by the Office of the City Engineer for the City of Tuscaloosa, sanitary sewers shall be designed in accordance with the following references:

- 1.2.1 Sanitary Sewer Design Manual (Latest Edition), City of Tuscaloosa
 - A. Lift Station Design Standards (Part 8)
 - B. Sanitary Sewer Standard Construction Specifications (Part 9)
 - C. Sanitary Sewer Standard Details (Part 10)
- 1.2.2 Land Development Manual (Latest Edition), City of Tuscaloosa
- 1.2.3 Recommended Standards for Wastewater Facilities (2014 Edition), Great Lakes – Upper Mississippi River Board of Stat and Provincial Public Health and Environmental Managers, also widely known and referred to as ***Ten States Standards (TSS)***.

1.3 Registration and Licensing

A Professional Engineer licensed in the State of Alabama shall perform all sanitary sewer design and construction inspection. Any required surveying shall be by a Professional Land Surveyor licensed in the State of Alabama. Construction of City sanitary sewer shall be performed by a licensed contractor as defined in this manual and approved by the City and in strict accordance with the Ordinances of the City.

1.4 Definitions and Abbreviations

- 1.4.1 A – Amp
- 1.4.2 ADEM – Alabama Department of Environmental Management
- 1.4.3 ADF – Average Daily Flow
- 1.4.4 Aggressive Soil – A soil deemed corrosive or potentially corrosive to ductile iron pipe according to Appendix A of ANSI/AWWA C105/A21.5. The test methods to determine soil corrosivity outlined in Appendix A evaluate five soil parameters: resistivity, pH, redox potential, sulfide content, and moisture content. A points system is provided for each parameter based on the results of the tests. If the points total 10 or more, the soil is corrosive to ductile iron pipe, and protection against exterior corrosion should be provided. Other parameters listed in the appendix, which require consideration, include soil description, potential stray direct currents, and experience with existing installations.
- 1.4.5 ANSI –American National Standards Institute
- 1.4.6 ASTM – American Society for Testing and Materials

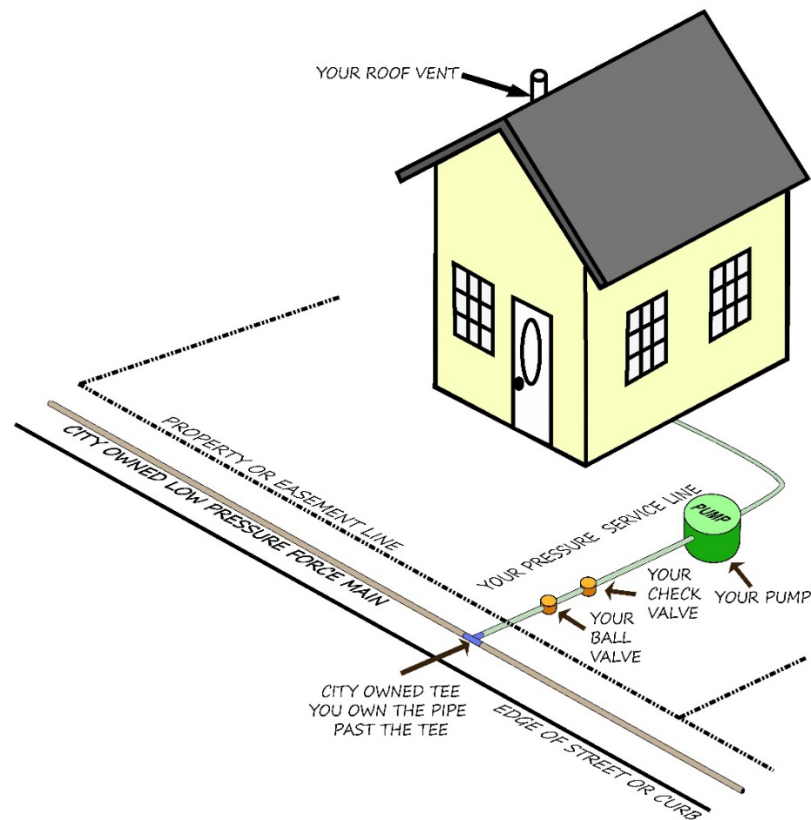


- 1.4.7 AWWA –American Water Works Association
- 1.4.8 CFR – Code of Federal Regulations
- 1.4.9 City – The City of Tuscaloosa; as defined in Section 1-2 of the Code of Tuscaloosa, including its duly authorized deputy, agent, or representative.
- 1.4.10 Contractor – The individual, firm, partnership, or corporation licensed by the Alabama Licensing Board for General Contractors who, for a fixed price, commission, fee, or wage undertakes to construct or superintend or engage in the construction, alteration, maintenance, repair, rehabilitation, remediation, reclamation, or demolition of any building, highway, sewer, structure, site work, grading, paving or project or any improvement in the State of Alabama where the cost of the undertaking is equal to or more than the minimum as required by the Alabama Public Works Bid Law. Any Contractor performing work on the City of Tuscaloosa sanitary sewer system shall have a current Alabama License classification for Municipal & Utility (MU).
- 1.4.11 DI – Ductile Iron
- 1.4.12 DR – Dimension Ratio. Ratio of average outside diameter to minimum wall thickness of pipe.
- 1.4.13 Engineer – A Professional Engineer licensed by the Alabama State Board of Engineers and Land Surveyors and employed by the Owner/Developer to perform detailed design of the sanitary sewer system. The Engineer shall prepare and stamp plans and specifications for review by the City, and any other relevant government agency.
- 1.4.14 Easement –A right to make use of or control the property of another for a limited purpose.
- 1.4.15 FEMA – Federal Emergency Management Agency
- 1.4.16 Force Main – A pressurized sewer line, with a pipe diameter of four (4) inches or greater, by which wastewater is transported from a sewage pumping station to a point of higher elevation in the collection system from which the wastewater can gravity flow.
- 1.4.17 GPD – Gallons per Day
- 1.4.18 GPM – Gallons per Minute
- 1.4.19 HP - Horsepower
- 1.4.20 Land Surveyor – The licensed Professional Land Surveyor and/or Firm



- 1.4.21 Lateral – A private sewer generally serving a single user or establishment that generally should have no tributaries to it, and which is capable of contributing wastewater into the System by accessing a sanitary sewer or sewer main, line, or inceptor. Laterals do not form part of the City's sanitary sewer system and are not maintained by the City. A representation of a sewer lateral / private sewer is shown in blue in the schematic below and labeled as “Your Sewer Service Pipe”.
- 1.4.22 Low Pressure Sewer – A pressurized sewer line, with a pipe diameter of less than four inches, by which wastewater is transported from a sewage pumping station to a point of higher elevation in the collection system from which the wastewater can gravity flow. Low pressure sewers generally service grinder pumps and septic tank effluent pumps. A representation of a low pressure sewer system is shown in blue in the schematic below.

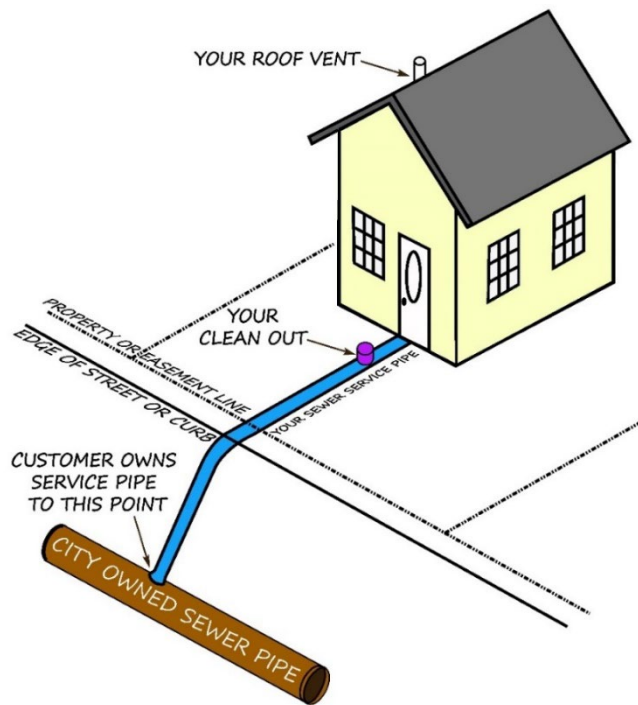
YOUR LOW PRESSURE SYSTEM



1.4.23 NFIP – National Flood Insurance Program

1.4.24 OCE – Office of the City Engineer; this shall include City Engineer or representative thereof.

- 1.4.25 Owner/Developer – Any person, firm, partnership, corporation or other legal entity or their representative seeking a Land Development Permit for the purpose of constructing a developer sanitary sewer or any person, firm partnership, corporation, or legal entity that has been issued a Land Development Permit. The terms owner and developer shall be used interchangeably.
- 1.4.26 PHF – Peak Hourly Flow
- 1.4.27 Pressure Sewer – Low pressure sewers and force mains.
- 1.4.28 Private Sewer – A sanitary sewer that is not a sanitary sewer or sewer main, line, or interceptor of the system as herein defined and is or was constructed and/or owned by an entity other than the City, not maintained, and/or accepted for maintenance by the City and/or not located within public rights-of-way, easements, or interest in land sufficient for that purpose and /or which the City has no pecuniary interest. A representation of a sewer lateral / private sewer is shown in blue in the schematic below and labeled as “Your Sewer Service Pipe”.



- 1.4.29 PSI – Pounds per Square Inch
- 1.4.30 PVC – Polyvinyl Chloride
- 1.4.31 RTU – Remote Terminal Unit

- 1.4.32 Sanitary Sewer – A pipe or conduit used for the transport of wastewater and to which storm, surface, and groundwater are excluded. These shall include gravity sewers, low pressure sewers, or force mains
- 1.4.33 Sanitary Sewer System – The Publicly Owned Treatment Works (POTW) and all City sanitary sewers or sanitary sewer mains, lines, collectors, interceptors, lift stations and related facilities of the City for the collection, transportation, and treatment of wastewater, not including laterals or private sewers.
- 1.4.34 SCADA – Supervisory Control and Data Acquisition
- 1.4.35 SDR – Standard Dimension Ratio; the ratio of average outside diameter to minimum wall thickness of pipe.
- 1.4.36 SN – Structural Number
- 1.4.37 SS – Stainless Steel
- 1.4.38 SSD Manual – Sanitary Sewer Design Manual of the City of Tuscaloosa
- 1.4.39 TDH – Total Dynamic Head
- 1.4.40 V - Volt



PART 2 SUBMITTALS

The submittal procedure for approval of proposed sanitary sewer infrastructure shall be as set forth in this Sanitary Sewer Design Manual. The procedure may be amended, and additional items may be required at the discretion of the City.

2.1 Preliminary Engineering Submittals

It is in the best interest of developers, as well as the City of Tuscaloosa, to understand the impact of a proposed development on the sanitary sewer collection system in the preliminary design phase. Capacity issues identified in the sanitary sewer collection system serving a proposed development can require significant investments for developers. Identifying these issues early in the design process will allow developers to understand the scope of the potential upgrades required to the sanitary sewer collection system prior to significant investments in design fees.

2.1.1 Request for Sanitary Sewer Availability

- A. Pre-design meetings are held as an initial step in the City of Tuscaloosa process for approval of new developments. The Owner/Developer's Engineer shall provide the projected wastewater flow prior to the pre-design meeting through a written request to connect to the City's sanitary sewer.
- B. The projected wastewater flow shall be estimated for the proposed development or improvement as per criteria set forth in subsequent sections of this Sanitary Sewer Design Manual. The Owner/Developer's Engineer shall submit calculations to the OCE, which include assumptions regarding total number of housing units and housing density design flowrates and peak factors.
- C. If the development cannot connect to the existing sewer system by gravity, then the Owner/Developer's Engineer shall also submit design calculations to the OCE for the proposed pump station including, but not limited to, pump capacity, force main sizing, wet well sizing including cycle time and runtime, and flotation calculations when applicable.

2.1.2 OCE Capacity Review

Once the projected wastewater flows are received through a written request to connect to the City's sanitary sewer, OCE will review and consult internally for a period of up to 10 working days. Time is needed to review the sanitary sewer collection system and lift station capacity downstream of the proposed development. OCE will issue a response advising the Owner/Developer how to proceed. The responses to the request will generally be as follows:

- A. An OCE letter response indicating the downstream collection system has sufficient capacity.



- B. An OCE letter response indicating further study is required downstream. In this case, a Sanitary Sewer Impact Report prepared by a Professional Engineer will be required to accompany a preliminary plat or LDP submittal. This will allow time for OCE to review the report prior to the planning commission hearing, if applicable. The Sanitary Sewer Impact Report shall be based on an engineering analysis and summarize the downstream capacity of the sanitary sewer system. The report should also include upgrades required to accommodate the proposed development or a statement indicating there is sufficient downstream capacity and no upgrades are needed. In addition, an Executive Summary shall be included at the beginning of the Sanitary Sewer Impact Report which provides a concise summary of the report's findings. Upon request, pump station SCADA information can be provided by the City of Tuscaloosa. If additional information is needed for productive analysis, such as flow monitoring or pump performance testing, the Owner/Developer will be responsible for providing this information and will be responsible for all associated costs, such as traffic control, to accommodate flow monitoring. The Sanitary Sewer Impact Report shall be taken to the extent determined by OCE.

2.1.3 Sanitary Sewer Impact Report Considerations (if required)

If a sanitary sewer Impact report is required, the report shall include the following considerations:

- A. To determine the capacity for a sanitary sewer, population and land use projections for the sewer's service area shall be made for a 20-year planning period, and also the saturation condition, on information obtained from the City of Tuscaloosa Urban Development – Planning Division. Mapping showing basin delineation and zoning shall be included in the report to support projections.
- B. Flow monitoring and analysis shall take into consideration seasonal, or event based peak flows (i.e. schools in session, University of Alabama home football games, etc.)
- C. Flow monitoring shall typically be for a two-week period to establish typical daily flows and mitigate the impact to the average of any outliers. Extended flow monitoring may be required if directed by OCE.
- D. History of Sanitary Sewer Overflows (SSOs) in the vicinity.
- E. Existing downstream lift station starts / stops per hour. Lift station redundancy, meaning that one pump handles the ADF such that the second pump provides redundancy.
- F. Ability to tie into existing sewer system based on elevations.



- G. If the development cannot gravity flow into the existing sewer system, the Owner/Developer's Engineer shall submit calculations to the OCE for pump station design including, but not limited to, force main sizing, wet well sizing including cycle time and runtime, and flotation calculations when applicable.

2.2 Final Engineering Design Submittals

After approval of preliminary engineering submittals, the Owner/Developer's Engineer shall submit final design plans and specifications through the Land Development Permit (LDP) process. The following shall be provided as a minimum when there is sanitary sewer infrastructure to be constructed for maintenance by the City of Tuscaloosa.

- 2.2.1 Detailed Plans for the proposed project stamped by a Professional Engineer licensed in the State of Alabama.
- 2.2.2 Reference for construction to be performed in accordance with the most recent City of Tuscaloosa Sanitary Sewer Design Manual and Specifications.
- 2.2.3 Plan and Profile sheets. All public sewer mains shall include a profile.
 - A. Plan view shall include a north arrow and be shown over profile on the same sheet. Profiles that are on a separate sheet from the matching plan view will not be accepted.
 - B. Location and size of any potable water lines should be included on the plan and profile sheets.
 - C. Profile shall show *Existing Ground* (dashed line) and *Proposed Grade* (solid line) surface lines.
 - D. Profile shall be stationed to determine length between manholes.
 - E. 100-year Floodplain per FEMA mapping shall be shown in the plan view, if applicable.
 - F. 100-year Base Flood Elevation shall be shown in profile view, if applicable.
 - G. Existing City of Tuscaloosa manhole numbers should be called out in the plan and profile views, if applicable. Existing City of Tuscaloosa manhole numbers can be found online through the City of Tuscaloosa Sanitary Sewer GIS application.
 - H. Proposed Sanitary Sewer manholes should be labeled downstream to upstream for consistency and clarity. Manhole numbers will be assigned to proposed manholes by the City of Tuscaloosa Asset Management Team after submission of the LDP.
 - I. Rim and pipe invert elevations shall be called out for each manhole in the profile view. Existing ground elevations shall be called out where the rim elevation is above the ground elevation by design.



- J. Manhole Diameters shall be called out in the profile view (i.e. 48", 60", 72").
- K. Special accommodations to manholes, frames, or covers shall be called out in the profile view. This would include, but is not limited to, hinged lids and watertight manholes.
- L. Utility crossings shall be called out in the profile view.
- M. Pipe size, material, slope (in %), flow arrow shall be called out in the profile view.
- N. Special features such as concrete encasements, aerial piers, etc.
- O. City of Tuscaloosa Standard Details on standard City border. This allows reviewers and contractors to quickly understand the most recent standard detail that is being used. Any revisions to the standard detail should be noted in the revision block of the standard detail border.

2.3 Revisions to Engineering Submittals

If required, following review and comment by the OCE, the Engineer shall resubmit revised calculations and/or plans.

2.4 Construction Submittals

- A. The Owner/Developer or Owner/Developer's Representative shall provide material submittals, including manufacturer's pump performance test, to the OCE for review and approval prior to ordering of material. The OCE will review to verify conformance with approved plan and standard specifications per these City Sanitary Sewer Standards.
- B. Materials arriving on-site shall be inspected and approved by the City prior to installation. The Owner/Developer's Contractor shall be responsible for supplying the delivery ticket that the Contractor receives for the materials delivered onsite.
- C. The Owner/Developer shall provide daily observation reports and any testing and start-up data reports to the City.
- D. The Owner/Developer shall prepare Record Drawings, including inverts, and provide the City with digital copies in both a PDF format and a CAD format that can be uploaded to the City GIS system.
- E. If a lift station is required, the Developer shall provide the City with three (3) copies of the Operation and Maintenance Manual on the pumps, generator, and any other equipment installed at the lift station site.
- F. No lift station will be accepted for service until all easements have been prepared and granted to the City.



- G. The Owner/Developer shall provide a Lift Station Information Sheet including information as listed on the following page:



LIFT STATION INFORMATION SHEET
STATION NO:

Name _____	
Address _____	
Date Installed: _____	Date Accepted: _____
Station Type: <u>Duplex Submersible</u>	DPI File No: _____
Design GPM: _____	Wet Well Diameter: _____
Design TDH: _____	Wet Well Depth: _____
PUMPS	
Manufacturer: _____	Impeller: _____
Pump 1 Model No: _____	Pump 2 Model No: _____
Pump 1 Serial No: _____	Pump 2 Serial No: _____
COMMUNICATION	
Type: _____	Antennae Height: _____
POWER	
Voltage: _____	ALPCO Account No.: _____
Phase: _____	Meter No.: _____
	Main Breaker Fuse Size: _____
Generator Make: _____	Generator Size: _____
Generator Serial No: _____	Generator Fuel Type: _____
MOTORS	
Motor 1 Model No. _____	
Motor 1 Serial No. _____	
Motor FLA: _____	HP: _____ Service Factor: _____
Amp Readings - L1: _____	L2: _____ L3: _____
Motor Speed: _____	Motor 1 Frame: _____
Starter Make: _____	Starter Size: _____
Starter Model No.: _____	Coil No.: _____
Motor 2 Model No. _____	
Motor 2 Serial No. _____	
Motor FLA: _____	HP: _____ Service Factor: _____
Amp Readings - L1: _____	L2: _____ L3: _____
Motor Speed: _____	Motor 2 Frame: _____
Starter Make: _____	Starter Size: _____
Starter Model No.: _____	Coil No.: _____



2.5 Construction Inspection

- A. The Owner/Developer's Engineer shall provide Resident Project Observation.
- B. It shall be the responsibility of the Owner/Developer to provide advance notice to the City Engineer (Office of City Engineer) and the Director of Capital Projects (Water and Sewer Department) of the start of construction, any variances from approved plans or submittals, and field testing as required for approval.
- C. The Owner/Developer's Engineer will provide all construction staking for the location of manholes, mains, bores, lift stations, and appurtenances to be constructed.
- D. The project shall always be accessible to the City for inspection by the City.

2.6 Guarantees and Warranties

- A. The Owner/Developer shall guarantee for one year from the date of acceptance of the sanitary sewer and lift station (if required) by the City that the infrastructure and all the equipment, pumps, motors, and appurtenances therein shall be free from defects and design, materials and workmanship.
- B. For sanitary sewer lift stations, the manufacturer shall furnish replacement parts for any component proven defective, whether of his or other manufacturer during the guarantee period, accepting only those items which are normally consumed in service, such as light bulbs, oil, grease, packing, etc. These guaranteed components (not parts) shall include pumps, pump motors, electrical control panels (not parts) structural components and items that require the removal of specified components. The manufacturer shall provide all labor necessary to replace and repair major components which fail during the guarantee period.

2.7 Final Acceptance

- A. *Application.* The Owner/Developer or Owner/Developer's Contractor must make written applications to the Water and Sewer Department and the Office of the City Engineer for final approval and acceptance. The City will notify the Owner/Developer within thirty (30) days of the date of request, approving the installation in writing or setting forth corrective measures necessary for approval. When any corrective action or improvements are necessary for approval, the Owner/Developer or Contractor must give the City written notice of completion dates. After corrective measures have been completed by the Owner/Developer, a written request for approval must be submitted to the Office of the City Engineer and Water and Sewer Department who shall have thirty (30) days to either approve or recommend further corrective measures.
- B. *Deeds.* When required for lift stations, the Owner/Developer shall present a warranty deed, on City form, duly executed by the property owner, conveying in fee simple to the City, the property upon which the lift station is located, including adequate access and sufficient area to maintain and operate the station. The Owner/Developer shall provide a property description and plat of the same by a licensed Land Surveyor, unless said property is a lot of a recorded subdivision.



- C. *Easements.* Sewer improvements will not be accepted for service until all easements have been prepared and granted to the City.
- D. *Power Costs.* Upon final acceptance of lift stations, the City will assume payment of power costs.
- E. *Plans.* At the time of final acceptance, the City shall be provided with "as-built" drawings, in CAD and PDF formats, for lift stations, and at least two (2) copies of the operation and maintenance documents which shall include all design criteria, pump curves, dimensions and all pertinent data pertaining to the lift station in hard copy and electronic formats.



PART 3 LOCATION CRITERIA

3.1 Factors to Consider

Gravity sewers, low pressure sewers, and force mains shall be located using sound engineering practices to determine a cost-effective route that best serves the entire tributary area. The best route will provide service to the greatest number of people within a service area and be acceptable to OCE. To determine the "best" route that meets the City's specifications, consideration must be given to several factors in addition to cost. Some of these factors include:

- 3.1.1 Rim and invert elevations of existing sewers, pump stations, and/or treatment plant.
- 3.1.2 Sewer depths required to service users (particularly those with basements).
- 3.1.3 Impacts to environmentally sensitive areas such as streams, wetlands, protected habitats.
- 3.1.4 Impact on areas of archeological significance.
- 3.1.5 Existing utilities (overhead and underground), railroads, and highways.
- 3.1.6 Existing or proposed high water elevation and/or floodplain.
- 3.1.7 Property values, easement requirements, and aesthetic concerns of affected properties.
- 3.1.8 Potential development and street extensions within the basin.
- 3.1.9 Topographic features such as creek crossings and rock excavation.
- 3.1.10 Accessibility by sewer maintenance equipment.
- 3.1.11 Adjoining property within the drainage area.

3.2 Minimum Water and Sewer Line Separation

In accordance with Section 33-7-7-.03(a).4. of Division 335-7 of the ADEM Water Supply Program, the following water and sewer line separation is required:

- 3.2.1 A minimum horizontal separation of five (5) feet shall be maintained between water mains and sanitary sewers mains.
- 3.2.2 Where possible, install the water main such that the top elevation of the sewer main is a minimum of 18 inches below the bottom elevation of the water main.
- 3.2.3 When water and sewer main crossings are necessary and required separations cannot be accommodated, place a continuous casing around one of the mains to allow a minimum five-foot separation between each end of the cased and uncased main. Refer to Standard Details for casing installation.

3.3 Adjacent to Concrete Curbs, Gutters, or Sidewalks

Sewers shall not run parallel under concrete curbs or gutters or sidewalks. To allow for maintenance, the minimum distance between the edge of the curb and the centerline of a parallel sanitary sewer shall be five feet. Sanitary gravity sewers shall generally be located as close as practical to the street centerlines and outside of the wheel path.

3.4 Adjacent to Buildings

Sewer mains shall not be installed closer than fifteen (15) feet when running parallel to a building.



3.5 Easements

Because of the significant costs that can be associated with easement acquisition, sanitary sewers should be located within existing easements and rights-of-way.

3.5.1 The Owner/Developer shall provide plats and descriptions, meeting minimum technical standards, prepared by, and signed by a Professional Land Surveyor licensed by the State of Alabama, for all sites and easements related to the project.

3.5.2 The Project plans will show all sites and easements to be obtained for the project.

3.5.3 Deeds and Easements

- A. The Design Engineer, as consultant to the Owner/Developer, shall provide plats and legal descriptions to the City. The Design Engineer will coordinate with OCE for preparation of Deeds and Easements in accordance with City policy.
- B. Easements within subdivisions may be provided following the completion of construction. The Design Engineer must show the proposed easements as part of the subdivision plan and make changes on final plats to show as constructed easements prior to recording, if necessary.
- C. Easements NOT within subdivisions shall be provided prior to the scheduling of a preconstruction conference with OCE.

3.5.4 Easement Widths

For the City of Tuscaloosa, gravity sewers, low pressure sewers, and force mains shall generally be located in the street rights-of-way. If necessary, sections may require locating in dedicated sewer easements. Temporary construction easements shall be provided, as required.

- A. Easement widths shall not vary between manholes. If the easement width needs to change, the wider width shall extend a distance of half (1/2) the larger easement width past the centerline of the manhole.
- B. Sanitary sewer piping shall lay in the centerline of the easement.
- C. The minimum easement width shall be 20 feet, or as listed in Table 3.5.4, or that is necessary due to sewer depth to allow for construction and maintenance or that is necessary for construction adjacent to slope, buildings, or retaining walls, whichever is greater. For easement widths less than those recommended, or for excavation depths greater than 20 feet, written approval from the OCE will be required. Table 3.5.4 includes the minimum easement widths required for varying excavation depths.



Table 3.5.4 Minimum Easement Widths

EXCAVATION DEPTH (FEET FROM FLOWLINE OF PIPE)	MINIMUM WIDTH OF PERMANENT EASEMENT (FEET)
< 8	20
≥ 8 and < 12	30
≥ 12 and < 16	40
≥ 16 and ≤ 20	50

- D. Access shall be provided to all City sewer infrastructure. If, due to site limitations, the utility easement does not provide access, an additional access easement is required for ingress and egress. At the discretion of the OCE, an access easement parallel to the utility for operation and maintenance may be required if warranted by spatial constraints.
- E. When more than one city utility line is to be installed within the same easement, a minimum of ten (10) feet of additional width is required for each additional utility.
- F. Any sewer easement adjacent to slopes, buildings, or retaining walls shall require special design and calculations by a Registered Professional Engineer to show that there will be no adverse loading on the sewer and that the limits of the trenching operations for sewer repair or replacement will be outside the area of influence of the slopes, buildings, or retaining walls.



PART 4 DESIGN GUIDELINES FOR SEWER CAPACITY

4.1 General Design Capacity

In general, sewer capacities should be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity (Section 32 of Ten States Standards). Determining the required sewer capacity requires consideration of not only the current commercial and/or residential development but potential future growth within the upper reaches of the sewer service area as part of the process to develop a long-range plan for sizing and installation of main sewers. The plan must consider the entire drainage area beyond the limits of the subdivision. These population estimates require land use projections, good engineering judgment, and consultation with the City's Planning Department. During the City's preliminary capacity review of information submitted by the Owner/Developer, the City will notify the Owner/Developer of any additional planned development or population projections that need to be included in the sewer design.

4.2 Wastewater Flow Definitions and Identifications

The following flows for the design of sewers shall be identified as defined in Section 11.241 of Ten States Standards.

4.2.1 Design Average Flow

The design average flow is the average of the daily volumes to be received for a continuous 12-month period expressed as a volume per unit time. However, the design average flow for facilities having critical seasonal high hydraulic loading periods shall be based on the daily average flow during the seasonal period.

4.2.2 Design Peak Hourly Flow

The design peak hourly flow is the largest volume of flow to be received during a one-hour period expressed as a volume per unit time.

4.3 Wastewater Flow Projections

Wastewater flows are generally divided into two categories: residential and non-residential. To determine the sewer design flow from a service area, the design average flow and design peak hourly flow must be estimated for existing and proposed residential and non-residential sewer customers.

4.3.1 Flow Monitoring

Estimated sewer flow from existing customers shall be made from actual flow data to the extent possible. The probable degree of accuracy of data and estimations as well as critical data and methodology used shall be included.



4.3.2 Single Family Residential Wastewater Flows

In accordance with Section 11.243 of Ten States Standards, the sizing of sewer systems receiving flows from new sewer collection systems shall be based on an average daily flow of 100 gallons per capita unless water use data or other justification upon which to better estimate flow is provided. When used with a peaking factor, this flowrate includes normal infiltration for systems built with modern construction techniques. Although the number of persons occupying a single residence varies, an average of 3.5 persons per residence has been generally accepted for use in these calculations. The average daily flow for single family residential areas shall be calculated using the following criteria:

$$\text{Single Family Residential } Q_{AVG} = \frac{100 \text{ gals}}{\text{capita-day}}, \text{ and } 3.5 \text{ persons/lot}$$

4.3.3 Multi-Family Residential Wastewater Flows

Ten States Standards does not have recommended average wastewater usage for multi-family dwellings. However, based on various other sources, unless otherwise approved, an average daily usage shall be 80 gallons per capita. Allowing for some normal infiltration, the average daily flow for multi-family residential areas shall be calculated using the following criteria:

$$\text{Multi-Family Residential } Q_{AVG} = \frac{80 \text{ gals}}{\text{capita-day}}, \text{ and}$$

2 persons/dwelling unit or 1 person/bedroom, whichever is greater

4.3.4 Residential Wastewater Flow Peaking Factor

Figure 1 in Chapter 10 of the Ten State Standards is a graph of the ratio of peak hourly flow to design average flow. These ratios are calculated from the following relationship in which P is the ultimate design population *in thousands*:

$$\frac{Q_{PEAK}}{Q_{AVG}} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

Using a maximum peaking factor of 4.0 and extrapolating the data from the Ten States Standards Figure 1, the residential wastewater flowrate peaking factor shall be selected from Table 3.3.4, or as estimated based on the previous formula, or as otherwise approved by the OCE. The calculation for the design peak hourly flow is as follows:

$$\text{Residential } Q_{DESIGN} = (\text{Single Family } Q_{AVG} + \text{Multi-Family } Q_{AVG}) \times (PF)$$



Table 4.3.4 Peaking Factors for Residential Flows

POPULATION	PEAKING FACTOR (PF)
100	4.0
500	4.0
1,000	3.8
2,500	3.5
5,000	3.3
10,000	3.0
100,000	2.0

4.3.5 Sample Calculation - Residential Wastewater Flow Projection

Determine the design flow (i.e. maximum hourly flow) for a single-family residential development with an anticipated population of 500 persons.

Step 1 - Determine average daily flow and convert to cubic feet per second.

$$Q_{AVG} = (500 \text{ person}) \times \left[\left(100 \frac{\text{gal}}{\text{capita} - \text{day}} \right) \times \left(\frac{1 \text{ ft}^3}{7.48 \text{ gallons}} \right) \times \left(\frac{1 \text{ day}}{24 \text{ hr}} \right) \times \left(\frac{1 \text{ hr}}{3600 \text{ sec}} \right) \right]$$

$$Q_{AVG} = 0.0774 \text{ cfs}$$

Step 2 - Determine design flow by applying a peaking factor to average daily flow.

$$Q_{Design} = (0.0774 \text{ cfs}) \times (4.0)$$

$$Q_{Design} = 0.3096 \text{ cfs}$$

4.3.6 Non-Residential Wastewater Flows

Non-Residential Wastewater Flows are derived from industrial, commercial, institutional, and recreational land uses. Because wastewater flow rates may vary widely, even within similar non-residential developments, extensive effort should be made to obtain an accurate flow estimate. Calculations for estimated non-residential flows along with documented sources shall be provided. A peaking factor of 2.0 shall be applied to all non-residential average flowrates to obtain maximum hourly flows. The calculation for the design peak hourly flow is as follows:

$$\text{Non-Residential } Q_{DESIGN} = Q_{AVG} \times (PF)$$



4.3.7 Design Peak Hourly Flow

The design flow from which hydraulic design of the system may begin consists of the maximum hourly flows from residential and non-residential developments:

$$Q_{DESIGN} = Residential\ Q_{DESIGN} + Non - Residential\ Q_{DESIGN}$$



PART 5 DESIGN GUIDELINES FOR GRAVITY SEWER

5.1 Manhole Design Criteria

The primary purpose of a manhole is to allow above ground access to the sewer for inspection and maintenance purposes. The design of the sanitary sewer system shall comply with the requirements listed in this section. All manholes shall be precast concrete. Pour-in-place manholes or precast manholes deeper than 20 feet require that special design be submitted to the OCE for approval.

5.1.1 Doghouse Manholes

The City of Tuscaloosa will not approve or accept the use and construction of doghouse manholes when connecting to the City's sanitary sewer system. However, for special circumstances when all other possible alternatives have been exhausted, the OCE reserves the right to approve doghouse manholes.

5.1.2 Manhole Placement, Spacing, and Sizing

- A. Manholes shall be placed at the following locations:
 - * the upper reach of each line
 - * grade, pipe size, or alignment changes
 - * sewer main junctions
 - * within maximum spacing requirements.
- B. The maximum manhole spacing shall be limited to 500 feet. Greater spacing may be allowed for large sewers or where site-specific conditions require such. Spacing greater than 500 feet requires approval from the OCE.
- C. Where the difference in invert elevation of two or more sewers, 18 inches in diameter or smaller, intersecting one manhole is two (2) feet or more, a drop manhole shall be constructed. *Drop manholes should be avoided, if possible. The practice of using a 1.9-foot invert drop across a manhole to lessen excavation depths shall not be acceptable. Pipes shall be laid up to the maximum allowable slopes to avoid drop manholes.* Refer to Standard Details. NOTE: A drop inside the manhole is only allowed for special circumstances and when OCE has provided specific approval. Manholes with an inside drop must have a diameter of 60-inches or more.
- D. The maximum deflection angle of sewer alignment at manholes shall be 90 degrees. Refer to manufacturer's recommendation for deflection angles at manhole greater than 45°.
- E. Unless otherwise recommended by the manufacturer or the OCE, minimum manhole diameters shall be as indicated in Table 5.1.2 below:



Table 5.1.2 Minimum Manhole Diameter

PIPE SIZE (INCHES)	MINIMUM DIAMETER (INCHES)
8 - 24	48
30	60
≥36	As Directed by the City

5.1.3 Location of Manholes

- A. Manholes located in streets shall be placed a minimum of five feet from the edge of curb or pavement (within pavement limits); manholes shall be positioned outside the normal tire path of vehicles.
- B. When possible, manholes shall be located outside areas subject to flooding or runoff.
- C. Manholes located along drainage channels or structures, in low-lying areas, in swampy areas within the 100-year flood zone, or in fill areas shall be designed as follows:
 - 1) The rim elevation shall be a minimum of two (2) feet above grade elevation to lessen the possibility of storm water entering the sanitary sewer and shall have a watertight rotating hinged manhole cover as per the standard details.
 - 2) Generally, adjustment rings are not allowed for height adjustment. In certain instances, use of metal adjustment rings will be allowed for existing conditions where inflow / infiltration is not a concern and approval is given by OCE.
 - 3) Where possible, the surrounding ground shall be built up around the manhole so that the rim elevation is no higher than two feet above the ground elevation. The surrounding ground in these cases shall be constructed to provide a minimum three-foot horizontal area around each manhole. The horizontal area shall be sloped away from each manhole at a 1/4 inch per linear foot slope for a minimum of three (3) feet, then sloped at a 3:1 slope to tie to the existing ground.
 - 4) For areas where buildup is not possible, and the rim elevation is higher than two (2) feet above the ground elevation, OCE approval is required.
 - 5) Where raised manholes are not allowed, manholes shall be equipped with standard (non-hinged) watertight frames and covers as per the standard details.
 - 6) Manholes to be located within the 100-year flood elevation shall be equipped



with manhole section anchor assemblies.

- 7) Where required by the OCE, an access road shall be constructed to allow access to all manholes.
- 8) For manhole installation within a 100-year flood zone, refer to Standard Details.
- 9) For manholes located in swampy areas within the 100-year flood zone or in fill areas, a reinforced concrete spread footing shall be required. Calculations for each manhole spread footing shall be submitted to the OCE for review and include the following:
 - a) Within the 100-year flood zone, the size of each spread footing shall be designed to prevent manhole flotation. The spread footing shall be designed for the most conservative condition, which includes an empty manhole just prior to being placed in service with a groundwater table at the top of the manhole.
 - b) For manholes located in fill areas, the spread footing shall be designed for the total weight of the precast manhole structure, plus the calculated weight of water to within one foot of the top of the manhole. The size of each spread footing shall be designed to equally distribute this total load to the soil without exceeding the allowable soil bearing pressure.

5.1.4 Headloss Through Manholes

- A. Unless otherwise approved by OCE, the following practices listed in Table 5.1.4 shall be adopted to account for entrance and exit losses from flow through the manholes.

Table 5.1.4 Headloss Through Standard Manholes

FLOW CONDITION THROUGH MANHOLE	INVERT DROP ACROSS MANHOLE
No change in pipe size.	0.1 ft elevation drop in invert of existing pipe, not to exceed 0.75 ft.
No change in pipe size or increase by only one pipe size and alignment changes by 90°.	0.2 ft elevation drop in invert of existing pipe, not to exceed 0.75 ft.
Increase in pipe size by 4 inches or more.	Match crown elevations at centerline of manhole.



- B. These standard headloss requirements are applicable to subcritical flow conditions which are characterized by slow, tranquil flow often seen in gravity systems. The flow channel straight through the manhole shall be made to conform as closely as possible in shape and slope to that of the connection sewers. The channel walls should be formed or shaped to the full height of the crown of the outlet sewer in such a manner as to not obstruct maintenance, inspection, or flow in the sewer.
- C. When curved flow channels are specified in manholes, including branch inlets, the minimum slopes should be increased to maintain acceptable velocities.

5.1.5 Manhole Linings

- A. When required by the OCE, manholes shall be protected from corrosion by the use of factory applied linings. The internal liner system shall be **an approved** geopolymer, multilayered polyurethane/polymeric stress skin panel system, a 100 percent solids epoxy or polyurethane coating, or a composite system consisting of an epoxy or polyurethane topcoat over a cementitious base coat.
- B. At a minimum, manholes located in the following locations shall be lined:
 - 1) Within 500 feet upstream and downstream of a pumping station.
 - 2) Manholes directly receiving flow from a force main 10 inches or greater in diameter.
 - 3) If conditions dictate, at the discretion of the OCE.

5.2 Hydraulic Design of Gravity Sewer System

The hydraulic design of a gravity sewer system shall be based on the Manning Equation which is stated in the form:

$$V = (1.486/n) R^{2/3} S^{1/2} \quad (\text{Equation \#1})$$

where V = velocity (feet per second),
 N = roughness coefficient,
 R = hydraulic radius (feet)
 = cross-sectional area of flow / wetted perimeter,
 S = slope of energy grade line (ft/ft) or, for uniform flow
 = slope of pipe (ft/ft).

Assuming full pipe flow ($R = D/4$) and substituting $Q = VA$,

$$V = (0.590/n) D^{2/3} S^{1/2} \quad (\text{Equation \#2})$$

$$Q = (0.463/n) D^{8/3} S^{1/2} \quad (\text{Equation \#3})$$

where Q = flow (cfs)
 D = pipe diameter (feet)



The roughness coefficient ("n") for ductile iron, polyvinyl chloride, and concrete shall be 0.013. The basis of the gravity sanitary sewer design requires that a minimum self-cleansing flow velocity of two (2) feet per second be maintained at the design flow. Where velocities exceed 10 feet per second at design flow, special design provisions shall be considered to avoid scour and protect against displacement caused by erosion or impact.

5.2.1 Sizing of Pipe

- A. The minimum pipe size allowed for the City of Tuscaloosa is eight (8) inches.
- B. Criteria, as listed in the following Table 5.2.1, shall be used when selecting pipe size.

Table 5.2.1 Pipe Sizing Criteria

PIPE SIZE (INCHES)	SIZING CRITERIA	MINIMUM VELOCITY AT DESIRED DEPTH OF
8 – 15	1/2 full flow depth at design flow	2.0
> 15	3/4 full flow depth at design flow	2.5

Reference: "Gravity Sanitary Sewer Design and Construction", ASCE Manuals and Reports on Engineering Practice No. 60, WPCF Manual of Practice No. FD-5.

- C. Due to the hydraulic properties of circular pipe, the flow velocities at half pipe flow and full pipe flow are equal. The maximum flow velocity in circular pipe occurs at a flow depth in the range of 80 – 85% of the full flow depth. Because of this occurrence, it is good engineering practice to establish a minimum velocity of 2.5 feet per second when sizing a pipe for 3/4 full flow depth. This allows the minimum velocity to remain at or above two (2) feet per second at half pipe flow and full pipe flow.

5.2.2 Slopes

- A. Sewers, 42 inches or less, shall be designed and constructed to give mean velocities, when flowing full, of not less than two (2) feet per second, based on Manning's formula using "n" value of 0.013. The following Table 5.2.2.A includes minimum allowable slopes for sewers 42 inches or less.



Table 5.2.2. A Minimum Allowable Slopes

NOMINAL SEWER SIZE (INCHES)	MINIMUM SLOPE (FEET/100 FEET)
8	0.40
10	0.28
12	0.22
15	0.15
16	0.15
18	0.12
≥ 24	0.08*

* Minimum practical slope for gravity sewer line construction is 0.08 ft./100 ft.

- B. To control sewer gases and maintain self-cleansing velocities, sewers 48 inches or larger should be designed and constructed at slopes that produce mean velocities, when flowing full, of not less than three (3) feet per second, based on Manning's formula using "n" value of 0.013.
- C. Unless special provisions are made to protect against scouring and erosion for impact, sewers shall be designed with maximum velocity of 10 feet per second derived from Manning's equation at full flow conditions. The following Table 5.2.2.C includes maximum allowable slopes for sewers 42 inches or less.

Table 5.2.2.C Maximum Allowable Slopes

NOMINAL SEWER SIZE (INCHES)	MAXIMUM SLOPE (FEET/100 FEET)
8	8.34
10	6.19
12	4.86
15	3.61
16	3.31
18	2.83
24	1.92
30	1.43
36	1.12
42	0.91



- D. Where site conditions (i.e., steep slopes) require velocities in excess of 10 feet per second, proper design consideration must be given to pipe material, **joint restraint**, special manholes with energy dissipators, abrasive characteristics of wastewater, turbulence, thrust at changes in direction, and surface erosion. It may also be necessary to provide anchorage or cut-off dams to prevent sewer pipe from creeping downhill or prevent water from flowing along the pipe resulting in trench washout. Such conditions will require that special design be submitted to the OCE for approval.
- E. As recommended by Section 33.46 of Ten State Standards, sewers on 20 percent slopes or greater shall be anchored securely with concrete, or equal, anchors spaced as follows:
 - 1) Slopes 30% - 35%: Not over 36 feet, center to center
 - 2) Slopes 35% - 50%: Not over 24 feet, center to center
 - 3) Slopes 50% or more: Not over 16 feet, center to center

5.2.3 Depth of Cover

- A. Typically, gravity sewer mains shall be installed below finished grade with a depth of cover between three (3) feet and 12 feet.
- B. Minimum Depth
 - 1) All gravity sanitary sewer lines in the City of Tuscaloosa shall have a minimum cover of 36 inches. Special cases where a minimum cover of 36 inches cannot be maintained will require approval from the OCE.
 - 2) Collector gravity sewers shall be located at sufficient depth to allow for service to adjoining lots and shall extend into the upper reach of the service area such that lateral lengths are kept to a minimum.
 - 3) At ditches and swales where a minimum cover of 36 inches cannot be achieved and at actively flowing streams, an encasement pipe will be required. For aerial sewers, concrete piers to support the pipe will be required in accordance with the Standard Details.
- C. Maximum Depth
 - 1) The maximum depth of cover allowed for gravity sewer mains is 20 feet.
 - 2) Special cases deeper than 20 feet require design calculations to be submitted to the OCE for approval. Calculations should consider bury depth, pipe diameter, pipe material, and backfill conditions and estimate a deflection less than the 5% maximum.

5.3 Evaluation of the Impact on Existing Sewers

Before design of a proposed upstream sewer system begins, future wastewater quantities (i.e., design flows) shall be calculated to determine if available capacity exists within the existing downstream structures. A similar analysis using the methods outlined above should be performed and applied to an existing system to determine available capacity to the extent determined by the OCE. This issue of existing system capacity shall be addressed in the Preliminary Engineering Design discussed in Section 2.1.1.



5.4 Pipe Materials Selection and Design Criteria for Gravity Sewers

The accepted gravity sewer pipe materials for the City of Tuscaloosa are polyvinyl chloride (PVC) and ductile iron (DI). PVC shall be used for all gravity sewers, unless conditions dictate the use of DI. All gravity piping shall meet the minimum requirements of the City of Tuscaloosa Sanitary Sewer Construction Specifications and be bedded and backfilled according to the City of Tuscaloosa Standard Trench Details. The same pipe material shall extend from manhole to manhole. This section includes the minimum design criteria for each pipe material. A summary of required pipe material for various laying conditions is summarized in Table 5.4. below:

Table 5.4 Pipe Material Selection Chart

Criteria	Laying Condition(s)	Required Pipe Material
1	Slopes < 15%	DI Pipe or PVC
2	Slopes ≥ 15%	DI Pipe with restrained joints or PVC with bells anchored into trench
3	Slope from 20.00%-34.99%	DI Pipe with anchors spaced at 36-ft centers
4	Slope from 35.00%-49.99%	DI Pipe with anchors spaced at 24-ft centers
5	Slopes ≥ 50%	DI Pipe with anchors spaced at 16-ft centers
6	Shallow crossing (< 3 feet)	DI Pipe with steel casing or concrete pier support
7	Deep installations where deflection exceeds 5% for PVC	DI Pipe
8	Carrier pipes installed in a bore or tunnel	DI Pipe with "Fast-Grip" gaskets
9	Ditch or Stream Crossing	DI Pipe with steel casing or concrete pier support
10	Condition requiring concrete bedding or encasement	DI Pipe
11	Aerial locations	DI Pipe with concrete pier support at each joint

5.4.1 Polyvinyl Chloride (PVC)

- A. PVC gravity sewer pipe and fittings, 8 to 12 inches in diameter, shall conform to and be tested under ASTM D3034 and shall have a wall thickness equal to or greater than SDR 26.
- B. PVC Gravity Sewer pipe and fittings, 15 inches through 60 inches in diameter, shall conform to ASTM F679. Pipe may be either PS46 (Type 1 Wall Construction) or PS115 (Type 2 Wall Construction). Joints shall conform to ASTM D3212 and gaskets shall conform to ASTM F477.
- C. Pipeline deflection, as determined by field mandrel testing after installation, shall have a deflection not exceeding 5% of the base inside pipe diameter as established by ASTM Standards D3034 and F679.



- D. Table 5.4.1.D below summarizes the allowable PVC pipe materials for gravity and pressure sewer applications.

Table 5.4.1.D. Summary of Allowable PVC Materials

Sewer Type	Material Specification	Pipe Size
Gravity Sewer	ASTM D3034 SDR26	8 - 12 inches
Gravity Sewer	ASTM F679 PS46 or PS 115 (for depths where deflection <5%)	15-60 inches
Service Lateral	ASTM D3034 SDR26	≥ 4 inches
Service Lateral	AWWA C900 SDR26	≥ 4 inches
Low Pressure Sewer	ASTM D2241 SDR21	≤ 4 inches
Low Pressure Sewer	ASTM D1785 SCH 40	≤ 4 inches
Force Main	ASTM D2241 SDR21 w/ DIMJ Fittings	4- 12 inches

5.4.2 Ductile Iron Pipe

- A. All ductile iron pipe shall conform to ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51, latest revision.
- B. Pipe pressure classes and wall thicknesses shall be in accordance with bury depths and laying conditions, as specified in the above Standards.
- C. Minimum pressure classes for buried pipe shall be 350 psi for pipes ≤ 12 inches, 250 psi for pipes ≤ 24 inches, and 150 psi for pipes ≤ 30 inches. For depth of cuts greater than eight (8) feet, pipe wall thickness greater than the minimum specified above may be required. The design parameters specified in ANSI/AWWA C151/A21.51, latest revision, shall be followed to determine the minimum pipe wall thickness under these conditions. Thickness design of gravity sanitary sewers shall be based on an internal pressure of 0.00 psi gage or atmospheric pressure.
- D. Ductile Iron Pipe Coatings, Linings, and Encasements
- 1) All ductile iron pipe and fittings shall be cement mortar lined conforming to AWWA C104 and C151. Cement mortar lining shall be standard thickness with a bituminous seal coat.
 - 2) All ductile iron pipe for underground installation shall be provided with an exterior bituminous coating of 1-mil minimum thickness.
 - 3) For protection against hydrogen sulfide corrosion, all ductile iron pipe sewer pipe and fittings for the City of Tuscaloosa shall be lined with a 40-mil thickness coating of Permax CTF amine cured novolac epoxy, or approved equal. The coating shall be red in color.



- 4) Polyethylene tube or sheet encasement shall be used with ductile iron pipe in project areas where aggressive soils (as defined in Appendix A of ANSI/AWWA C 105/A2 I.5) are encountered, or in project areas where other metal pipes exist, to protect against corrosion caused by stray currents.
 - a. For any project areas suspected of having aggressive soils, or at the discretion of the OCE, a soils test shall be conducted by qualified personnel experienced in soil analysis and evaluation of conditions potentially corrosive to ductile iron pipe. Certain soil environments, however, can be identified as potentially corrosive to ductile iron pipe, and thus do not require testing to determine the need for corrosion protection. Such environments include, but are not limited to, coal, cinders, muck, peat, mine wastes, and landfill areas high in foreign material.
 - b. For steel gas crossings, ductile iron pipe shall be polyethylene encased a minimum of fifty (50) feet to either side of the crossing.
 - c. Polyethylene encasement for use with ductile iron pipe systems shall consist of three layers of co-extruded linear low-density polyethylene (LLDPE), fused into a single thickness of not less than eight (8) mils. The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of antimicrobial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion (V-Bio).

5.5 Abandoned Manholes and Sewer Mains

5.5.1 Abandonment of Sewer Mains

All sewer mains having a diameter greater than 4-inches shall be plugged with grout fill or flowable fill for the entirety of the line.

5.5.2 Abandonment of Manholes

All piping connected to abandoned manholes shall be plugged with grout fill or flowable fill at each end. The manhole ring & cover and top section of pre-cast manholes shall be removed or the top 4 ft of non-precast manholes shall be removed. The remaining manhole below the top section (precast) or top 4-ft (non-precast) can remain in-place and shall be filled with grout fill or flowable fill. The void above the remaining in-place manhole shall be backfilled as applicable to the location and in accordance with the trench details located in the Standard Details.

5.6 Testing of Gravity Sewers and Manholes

5.6.1 General



- A. The OCE requires testing of all new public and private sanitary sewer lines and manholes. Minimum testing requirements are as required in the Construction Specifications included as Part 9 of this manual. Approval and acceptance of gravity sewer lines and manholes shall be based on final testing. The Contractor must provide a 72-hour notice prior to final testing. A representative from the OCE or the City's representative must be present to witness final testing procedures. Tests performed in the absence of the OCE, or its representative shall be considered invalid and shall be repeated by the Contractor.
- B. Final testing of gravity lines shall only be performed after all work adjacent to and over the pipeline has been completed. Trench backfilling, grading, compacted roadway subgrade, concrete work, other utility installation, and any other superimposed loads shall be completed and in place prior to final testing.
- C. All apparatus and equipment required for testing shall be furnished by the Contractor.
- D. The Contractor shall provide the Engineer and Owner with copies of all field notes and documentation obtained during final testing.

5.6.2 Testing Scope

- A. At a minimum, all gravity sewers shall be tested by the following methods:
 - 1. Exfiltration of Air Under Pressure (low pressure air testing by the Contractor).
 - 2. Video Inspection (to be Performed by the City).
- B. In addition to the above testing requirements, all PVC gravity sewers shall pass mandrel testing to verify roundness and proper installation.
- C. All manholes shall be vacuum tested.



PART 6 DESIGN GUIDELINES FOR SERVICE LATERALS

6.1 Service Lateral Materials

- 6.1.1 Residential service laterals shall not be less than four (4) inches in diameter.
- 6.1.2 For new construction, sewer main fittings for service lateral connections shall be factory made inline wye fittings. For connection to existing sewers and at the discretion of the OCE, saddles may be allowed for special circumstances; but only when preapproved for a specific location. For review prior to preapproval, a material submittal for the saddle and a connection detail must be submitted to the OCE.
- 6.1.3 Connections to force main sewer are not allowed.
- 6.1.4 The accepted sewer service lateral materials for the City of Tuscaloosa are polyvinyl chloride (PVC) and ductile iron (DI) when required by laying conditions across creeks, aerial, or other as preapproved by OCE. Refer to previous Table 5.4, Pipe Material Selection Chart.
 - A. Polyvinyl Chloride (PVC)
 - 1) PVC service laterals for PVC sewer mains shall conform to ASTM D3034 and shall have a wall thickness equal to or greater than SDR 26.
 - 2) PVC service laterals for ductile iron gravity sewer mains shall conform to AWWA C900 and shall have wall thickness equal to or greater than SDR 25.
 - B. Ductile Iron (DI)
 - 1) Ductile iron shall only be used for sewer lateral when required by laying conditions across creeks, aerial, or other and shall be preapproved by OCE.
 - 2) Ductile iron service laterals shall conform to ANSI/AWWA C150/A2I.50 and ANSI/AWWA C151/A2I.51, latest revision.
 - 3) Minimum pressure class shall be 350 psi.
 - 4) Coatings, linings, and polyethylene encasement shall be as previously stated in Section 5.4.2.D of this manual.

6.2 Service Lateral Installation

- 6.2.1 Laterals shall be installed by a licensed plumber when on private property, or when inside public right-of-way installed by a properly licensed utility contractor.



- 6.2.2 A plumbing permit is required for sanitary sewer lateral installations performed outside of public right-of-way and shall be inspected as per the permit. The connection between the service lateral and sewer main shall be watertight and shall not protrude into the sewer main.
- 6.2.3 Service laterals shall be installed for each lot and extend from the sewer main to the user's property line.
- 6.2.4 A PVC-coated electronic service marker shall be located six inches above the lateral.
- 6.2.5 The service lateral shall have a minimum slope of 1/8" per 12" (1%) as per Chapter 7 of the International Plumbing Code.
- 6.2.6 The minimum depth of cover for service laterals from the top of curb shall be three (3) feet.
- 6.2.7 Service laterals shall be installed in accordance with the Standard Details and Construction Specifications, or as otherwise approved by the OCE.
- 6.2.8 A lateral drop inside the manhole is not allowed.



PART 7 DESIGN GUIDELINES FOR LOW PRESSURE SEWERS

7.1 General Purpose

7.1.1 Disclaimer

The City of Tuscaloosa encourages gravity sewer systems as the preferred method for sanitary sewer service because they provide the most reliable and cost-effective long-term solution.

Low-pressure sewer systems, which utilize privately owned grinder pumps and connect to publicly owned Low-Pressure force mains, will be considered when gravity service is impractical based on site conditions such as:

- Depth: Installation would require pipe depths greater than 20 feet at any point.
- Distance: The nearest gravity connection point is more than 1,000 feet away and achieving required slopes would result in depths exceeding 20 feet.
- Topography: The site lacks sufficient grade to maintain minimum gravity slopes (e.g., 0.40% for 8-inch pipe) .
- Environmental/Geologic Constraints: Installation would require crossing wetlands, blasting through rock, or dewatering in high groundwater conditions.
- Property Access: Routing gravity sewer through adjacent properties would require obtaining off-site easements that are impractical or unattainable.
- Other considerations as presented by the Owner / Developer.

If a low-pressure system is proposed, the Owner/Developer should provide documentation demonstrating these conditions (such as sewer profiles, site plans, geotechnical reports, and easement feasibility). The City will review this information and work collaboratively with the developer to determine the most appropriate solution. Any approved low-pressure system must comply with all City standards for design, installation, and maintenance responsibilities.

7.1.2 Scope

Pressure sewers transport wastewater from pumping stations to points of higher elevation in the collection system. There are two categories of pressure sewers: low pressure sewers and force mains. Low pressure sewers are generally defined as having a diameter of less than four (4) inches and servicing grinder pump installations and septic tank effluent pump installations. Conversely, pumping station force mains have pipe diameters of four (4) inches and larger. When approved by OCE due to special circumstances, Part 7 of this manual provides design guidelines for low pressure sewers. For force main design requirements, refer to subsequent Section 8.8.

7.2 Design Approach

The design approach for low pressure sewer piping requires consideration of three parameters, which should be reviewed to verify that the minimum pipe requirements specified in this manual are satisfied. Parameters to be considered include:



- 7.2.1 The required long-term pressure rating of the PVC pipe (with a factor of safety of 2.0) based on the operating pressures of the pump system.
- 7.2.2 The required short-term pressure rating of the PVC pipe (with a factor of safety of 2.0) based on the worst-case surge pressure of the pump system.
- 7.2.3 The required DR rating of the PVC pipe is based on the pump system's peak pressure due to cyclic pressure surge created at pump start-up and shut-down for a 50-year service life.

7.3 Pressure Sewer Velocity

The size of a low pressure sewer is dependent upon the required flow and allowable headloss of the pumping system. Accordingly, the size of the force main is determined during design of the pumping station. However, the size of the main shall be selected such that a minimum scouring velocity of 2.0 feet per second is maintained.

7.4 Low Pressure Sewer Layout

In addition to the location criteria specified in previous Part 2, low pressure sewer main layout shall conform to the following guidelines:

7.4.1 Alignment

- A. Low pressure sewer mains shall be designed in profile on straight grades to generally parallel the ground surface and minimize high or low points. Alignment and grade shall generally be straight reaches using manufactured fittings to change direction.
- B. The maximum bend angles shall be 45° (no 90° bends allowed). Deflecting joints to accomplish changes in direction will be allowed, but only within the allowable joint deflections as recommended by the manufacturer. Changes in grade or alignment without fittings shall be performed uniformly with several joints rather than one abrupt change in a single joint.
- C. The minimum cover shall be three (3) feet, or as required by the agencies governing rights-of-way for which permits must be obtained.
- D. At roadway crossings, ditches, swales, or actively running streams, steel casing pipe with casing spacers and casing end seals or concrete piers to support the pipe shall be required. The conditions required to protect the pipe in these instances shall be at the discretion of the OCE.

7.4.2 Pressure Sewer Air and Vacuum Release

- A. At a minimum, sewage combination air valves (CAV) shall be installed at all high points



along the pressure sewer to prevent air entrapment.

- B. Valve types shall be sized per venting capacity requirements for the system operating pressure and manufacturer's recommendation.
- C. Additional air release valves (ARV), air/vacuum valves (AVV), and/or combination air valves (CAV) shall be required as directed by the OCE.
- D. All air and vacuum release valves shall be located in standard 48" diameter precast concrete doghouse manholes, or as approved by the OCE.

7.4.3 Flushing Connections

- A. Flushing connections shall be required at the end of all lines, at junctions with other lines, and along straight sections every 600 feet.
- B. All flushing connections shall be valved off using Schedule 80 Union Ball Valves. Flushing connections shall be located in a standard 48" diameter precast concrete manhole, or as approved by the OCE.

7.5 Low Pressure Sewer Pipe Material

7.5.1 Polyvinyl Chloride (PVC) for Low Pressure Sewers

- A. The accepted low pressure sewer material for the City of Tuscaloosa is polyvinyl chloride pipe.
- B. Low pressure sewer piping shall meet the minimum requirements of the City of Tuscaloosa Sanitary Sewer Construction Specifications, and be bedded and backfilled according to the City of Tuscaloosa Standard Trench Details.
- C. All low pressure PVC pipe shall be green in color.
- D. City-owned PVC low pressure sewer pipe and fittings, less than four (4) inches in diameter, shall conform to and be tested under all requirements of ASTM D2241. PVC low pressure sewer pipe and fittings shall have a wall thickness equal to or greater than SDR 21 and shall have a minimum pressure rating of 200 psi.
- E. Option: Customer-owned PVC low pressure sewer pipe and fittings, less than four (4) inches in diameter, may conform to Schedule 40 made in accordance with ASTM DI 785 and ASTM D2665 from a PVC compound conforming to a cell classification of 12454 as defined by ASTM DI 784 and have a minimum pressure rating of 260 psi. Pipe shall be solvent welded.

7.6 Testing for Low Pressure Sewer

- 7.6.1 The OCE requires testing of all new public and private sanitary sewer lines and manholes.



Minimum testing requirements are as required in the Construction Specifications included as Part 9 of this manual. Approval and acceptance of low pressure sewer shall be based on final testing. The Contractor must provide a 72-hour notice prior to final testing. A representative from the OCE or the City's representative must be present to witness final testing procedures. Tests performed in the absence of the OCE or its representative, shall be considered invalid and shall be repeated by the Contractor.

- 7.6.2 Testing of low pressure sewer mains shall be in accordance with these requirements for all portions of the system.
- A. All apparatus and equipment required for testing shall be furnished by the Contractor.
 - B. The Contractor shall provide the Engineer and Owner with copies of all field notes and documentation obtained during final testing.
 - C. At a minimum, testing of low pressure sewer mains shall include the following:
 - 1) Flushing with a velocity of at least two and one-half feet per second (2 1/2 fps).
 - 2) Hydrostatic pressure testing, as described in the Specifications.
 - 3) Leakage testing, as described in the Specifications.



PART 8 LIFT STATION DESIGN STANDARDS

8.1 General Design and Licensing

- 8.1.1 Where practical and technically feasible, sanitary sewer service to a development should be provided by gravity sewer without the use of lift stations.

Gravity service may be considered impractical under the following conditions:

- Depth: Installation would require pipe depths greater than 20 feet at any point.
- Distance: The nearest gravity connection point is more than 1,000 feet away and achieving required slopes would result in depths exceeding 20 feet.
- Topography: The site lacks sufficient grade to maintain minimum gravity slopes (e.g., 0.40% for 8-inch pipe) .
- Environmental/Geologic Constraints: Installation would require crossing wetlands, blasting through rock, or dewatering in high groundwater conditions.
- Property Access: Routing gravity sewer through adjacent properties would require obtaining off-site easements that are impractical or unattainable.
- Other considerations as presented by the Owner / Developer.

If gravity service appears infeasible, the Owner/Developer should provide documentation—such as sewer profiles, site plans, and geotechnical reports—demonstrating these conditions. The City will review this information and work collaboratively with the developer to determine the most practical solution.

- 8.1.2 This document is to formally outline the requirements for developer-built sanitary sewer lift stations that connect to the City's sanitary sewer system and are intended to be maintained by the City. These are not inclusive of all requirements for components of such lift stations. Other engineering and construction requirements may be applicable. This document is provided as a guide to the design and construction of lift stations to the sanitary sewer system of the City and is not intended to supersede any ordinances, laws, or regulations. Sewer lift stations are to be provided solely for the conveyance of sanitary wastes. Under no circumstances shall any form of storm water be allowed to pass through the proposed facility.

- 8.1.3 A Professional Engineer licensed in the State of Alabama shall perform all designs of city sewer lift stations. Construction of city sewer lift stations shall be performed by licensed municipal utility contractors approved by the City, and in strict accordance with the Ordinances of the City. Specific to Lift Stations, the following process outlines the steps for a licensed contractor to apply to be placed on the approved contractors list to work on City sanitary sewer Lift Stations.

- A. The Contractor must be licensed in the state of Alabama with a Municipal & Utility (MU) major classification.
- B. Contractor must contact the City of Tuscaloosa, Water & Sewer, Director of Capital Projects, to request application to be added to the *Approved Lift Station Contractor's List*.



- C. The application will be reviewed by the City of Tuscaloosa, Water & Sewer, Director of Capital Project.
- D. The City of Tuscaloosa will issue a response to application stating that the Contractor is on the approved list, or that the application is denied.

8.1.4 Limitations

The requirements outlined in this manual are intended for small wastewater lift stations serving a proposed development. Small wastewater lift stations shall be classified as those with a peak capacity of 400 GPM or less.

- A. Where the peak capacity of the lift station is over 400 gallons per minute (GPM), a review meeting shall be set up with the OCE to review the overall project and concepts prior to the start of design. These will only be approved on a case-by-case basis by the OCE and approval to proceed with the development should be obtained prior to the start of work. The City shall reserve the right to contract the design and inspection of any pump station proposed for a single development with a firm design capacity larger than 400 GPM at the full cost of the Owner/Developer.
- B. This manual does not apply to required existing sewer lift station modifications. If required, the City shall contract the design and inspection of any existing lift station modifications at the full cost of the Owner/Developer.

8.1.5 Pump Design and Operating Conditions

A. Wastewater Characteristics

Due to the nature of the solid material that can be expected in the wastewater, all pumps shall be non-clog type sewage pumps suited for continuous duty, designed and manufactured for use in conveying raw, unscreened sewage, and shall be capable of passing solids a minimum of three (3) inches in diameter, regardless of mechanical means for solids reduction.

B. Lift Station Equipment Type

- 1) All sewer lift stations shall consist of duplex pumping systems utilizing submersible pumps installed within a pre-cast concrete wet well having a separate below grade valve vault. Submersible pumps shall, at a minimum, be vertical, double-mechanical-sealed, non-clog, solids handling pumps capable of passing a three-inch (3") diameter sphere. Submersible grinder pumps are not acceptable.
- 2) No other pumping station configurations shall be allowed by the City, unless approved in writing by the OCE.
- 3) Only lift stations with electric motors will be permitted. Pumps with diesel, natural gas, petroleum, or other types of motors are prohibited.



8.1.6 Design Flow Criteria

- A. The rating of each pump (gallons per minute and total dynamic head) shall be specified by the Owner/Developer. The design capacity shall be equal to the estimated peak hourly flow (PHF).
- B. A summary of the calculations used to establish the present, and any anticipated future capacity requirements, shall be provided. Wastewater flow projection calculations shall conform to requirements set forth in the Sanitary Sewer Design Manual.
- C. The lift station layout shall include a duplex pump arrangement with the design capacity being met with the largest pump out of service. The pumps shall be set up in a lead-lag arrangement, alternating the lead pump with each cycle. A maximum of five starts per hour is allowed for each pump.
 - 1) Unless otherwise stated herein, or preapproved by the OCE, as related to flow and capacity, lift stations shall be designed in accordance with recommendations as provided in the Ten State Standards.
 - 2) In accordance with Ten State Standards, Section 48.61, friction losses shall be based on the Hazen and Williams formula and the value of the coefficient "C" for smooth pipe shall not exceed 120.

8.2 Lift Station Site Layout

8.2.1 Property Ownership

The Owner/Developer shall provide the City with sufficient (as determined by the OCE) real property necessary for the installation, operation, and maintenance of the lift station.

- A. Minimum site dimensions shall be 50 feet by 50 feet.
- B. The lift station shall be installed on a separately deeded parcel of land, and a Fee Simple Title of the parcel shall be assigned to the City. Fee Simple Title of the lift station parcel shall be duly recorded with the Tuscaloosa County Probate Court. The Design Engineer, as Consultant to the Owner/Developer, shall provide plats and legal descriptions to the City. The Design Engineer will coordinate with OCE for preparation of deeds and easements in accordance with City policy.

8.2.2 Site Development

Lift stations should not create nuisance conditions (noise, odor, light, visual, drainage, traffic, etc.) for adjacent properties, and site improvements shall be provided for all-weather access, security, and maintenance.

- A. Site Compaction - Compacted backfill around the lift station and wet well shall meet 95%



compaction test at plus/minus 4% moisture (AASHTO A-4 Soils or Better).

- B. Floodplain - Lift station structures, as well as all mechanical and electrical equipment and appurtenances, shall not be located in a 100-year floodplain. The 100-year flood plain elevation shall be noted on the Owner/Developer's drawings. All above ground equipment, electrical controls, and access hatches shall be located at least two feet above the 100-year flood plain elevation, as defined by the latest FEMA NFIP Flood Map.
- C. Access Road
 - 1) The Owner/Developer will be required to build a service road (fourteen (14) feet wide and paved with two (2) foot shoulders on each side) to the pumping station property.
 - 2) Access road shall have a minimum twenty-five (25) foot right-of-way.
 - 3) Access road shall not have a grade of more than ten (10) percent.
 - 4) If the access road exceeds 50 feet in length, then a 'hammerhead' turnout apron shall be provided.
- D. Layout - The lift station layout shall consider access to infrastructure for future maintenance and repairs including, but not limited to, the following:
 - 1) Wet well access to lift and remove the pumps using a boom truck or similar equipment.
 - 2) Vacuum truck access to wet well for routine cleaning and maintenance.
 - 3) Access to bypass piping by an emergency trailer mounted dri-prime pump, if needed.
- E. Surface Loading - Surface shall be designed to accommodate heavy truck traffic and support crane/hoists, as required for the installation and/or removal of equipment from the site. A minimum SN of 3.0 shall be utilized for the design of asphalt surfaces.
- F. Interior Surfacing - All interior, non-paved areas inside the fenced lift station shall consist of four-inch (4") depth of #57 stone over filter fabric.
- G. Stormwater Management - The site shall be graded to provide positive drainage away from the wet well, mechanical and electrical equipment, and appurtenances.
- H. Water Service
 - 1) The applicant shall provide a source of potable quality water for the lift station. The potable quality water shall be used for area washdown and equipment maintenance activities. At a minimum, the connection to the public water supply system shall include a one-inch (1") service connection to the public water main, water meter, backflow preventer, and freeze-proof yard hydrant.
 - 2) The water service line shall be Type "K" Copper, minimum one inch (1") diameter.



- 3) The applicant shall obtain all easements required to install the water supply system for the lift station.
- J. Fencing - A six-foot-high chain link fence with a minimum twelve-foot-wide drive gate shall be installed around the lift station site. No wooden privacy fences will be accepted by the City.
- K. Lighting
 - 1) Exterior lights shall be provided to adequately light the equipment area. The lights shall be appropriately shielded to prevent “spillage” on to neighboring properties.
 - 2) Exterior lift station lighting shall be fitted with photocell sensors for automatic on-off operation and shall also be fitted with manual on-off switches.
 - 3) Exterior lift station lighting shall be mounted on a separate aluminum pole. Lighting will not be allowed on power service poles.

8.3 Submersible Pumps

8.3.1 General

- A. Submersible pumps shall be fitted with a Type 316 stainless-steel pump chain sized to meet the manufacturer’s requirements, and a stainless-steel grip eye lifting system.
- B. The design shall be such that the pumping units will have a quick-disconnect sealing flange that automatically connects to the discharge piping by positively locking the volute into position to prevent any movement when lowered into place. Guiderail systems shall be compatible with approved pumps. Intermediate rail supports shall be provided at 10 feet on center.
- C. The pump discharge connection shall be permanently mounted with Type 316 stainless steel anchors doweled and epoxied into the wet well floor.
- D. The pumps, with motor cable, appurtenances and lifting cable, shall be designed for continuous operation under submergence, without leakage, in water to a depth of sixty-five (65) feet.

8.3.2 Motors

- A. Motor shall be designed for continuous operation in a non-submerged or partially submerged condition without damage.
- B. Motor shall be non-overloading for the entire pump operating curve.
- C. Motors shall be provided with a service factor of 1.15.



- D. Air-filled or oil-filled motors will be accepted. The motors may be fitted with an internal closed loop fluid cooling system. The cooling system fluid shall not come in contact with the pumped media. Pumps with motor cooling jackets, whether using recirculated pumped product or any outside cooling source, will not be considered.

8.4 Wet Well

8.4.1 General

- A. All penetrations are to be cast with watertight flexible boots meeting ASTM C-923 requirements.
- B. An upstream manhole, a maximum of 100 feet away from the wet well influent, shall be provided to allow the wet well to be completely isolated for bypass during maintenance events.
- C. The interior components of the wet well, such as nuts, bolts, mounting brackets, conduit, etc., shall all be Type 316L stainless steel.
- D. All instrumentation mounted in the wet well shall be accessible from the wet well hatch at the top of the wet well so that maintenance and instrument retrieval can be accomplished without entering the wet well.
 - 1) No lift stations shall be constructed with an overflow mechanism.
 - 2) The wet well shall be placed on a six inch (6") minimum #57 crushed limestone base.
 - 3) An aluminum access frame and cover shall be provided having a minimum concrete opening, as required by the pump manufacturer for access, a minimum 300 lbs./S.F. rating, have a keyed recessed locking mechanism, and include an OSHA approved safety grate. The safety grate shall be designed to combine covering of the hole per OSHA standard 1910.23 and shall include fall through protection and controlled confine space entry. All access frame and cover hardware shall be of Type 316L stainless steel material.
 - 4) Provisions against floatation shall be evaluated and provided when necessary.

8.4.2 Wet Well Sizing

- A. The wet well shall be designed such that the minimum wet well operating level can be maintained below the bottom of the inlet pipe. The Owner/Developer's Engineer shall provide calculations. The wet well active volume calculations may not consider influent gravity sewer volume. The influent sewer may not be designed to surcharge.



- B. The effective capacity of the wet well shall be such that one pump will run continuously, at least five (5) minutes during a thirty (30) minute period of minimum flow at design flow conditions, and there will be no more than five (5) pump starts per pump in one hour.
- C. Wet wells shall be designed in conjunction with pump manufacturers to ensure proper spacing of piping and pumps for installation and maintenance.
- D. Lift station wet wells shall be sized and configured to allow for maintenance and cleaning and eliminate the need for personnel to enter the wet well.

8.4.3 Wet Well Shape

- A. All wet wells shall be circular pre-cast concrete structures, unless otherwise approved by the OCE. The minimum diameter shall be six feet.
- B. Lift station wet wells shall have conical bottoms that surround the submersible pump to promote the settling and depositions of debris to the bottom of the wet well near the inlet, allowing the accumulated debris to be removed more readily with each complete pump cycle.

8.4.4 Lining

All interior surfaces of wet wells shall be lined with 14-20 mils minimum of coal tar, or other approved corrosion resistant adhesive coating material, to prevent decay of the concrete walls.

8.5 Valve Pit, Bypass, and Discharge Piping

8.5.1 General

All fasteners shall be Type 316 stainless steel, unless otherwise stated.

8.5.2 Pump Discharge Piping (also referred to as the Force Main)

- A. Each pump shall be provided with separate discharge piping systems.
- B. Discharge piping shall be a minimum of four (4) inches in diameter, unless otherwise approved by the OCE.
- C. Discharge piping shall be sized to maintain velocities between two and eight feet per second.
- D. All exposed fittings, whether inside or outside the lift station, shall be flanged joint ductile iron fittings.



- E. The ductile iron pipe and fittings shall be asphaltic coated on the exterior and lined in the interior with factory applied 40-mil thickness coating of Permax CTF amine cured novolac epoxy, or approved equal.

8.5.3 Valves

- A. All lift stations shall be provided with sufficient valves to allow for proper operation and maintenance of the lift station during normal, peak, and emergency bypass conditions.
- B. Valves shall be suitable for use with raw wastewater and shall be of a design suitable for its function, its installation location, as well as the normal and maximum operating pressures expected at the lift station.
- C. A full-port plug shut-off valve shall be provided on the discharge piping of each pump. Plug valves shall be installed with the plug on top of the pipe when open. Bevel gear will be required.
- D. An outside weighted lever, swing check valve shall be provided on the discharge piping of each pump, between the pump and the plug valve. Check valves shall be installed in the horizontal position.
- E. A pressure gauge and pressure transducer with diaphragm mounted seals shall be located on the sides of each pipe in the valve vault, downstream of the check valve and upstream of the plug valve.
- F. No valves shall be placed inside the wet well.

8.5.4 Valve Vault

- A. All valves, piping sensors/gauges, air injection points, or other special piping assemblies shall be accessibly located within a valve vault.
- B. No valves shall be located in the wet well or buried. The vault shall be located to provide a maintenance vehicle with complete access.
- C. The minimum clearance between piping and the floor of the valve vault shall be one foot.
- D. The vault shall be a pre-cast reinforced concrete structure designed for H-20 traffic loading. The structure shall be watertight and have a gas-tight separation from the wet well. Provisions against floatation shall be evaluated and provided when necessary.
- E. Valve vaults shall be provided with a minimum 4' x 4' double leaf aluminum access hatch.
- F. Vault access hatch(s) shall be sized to allow direct overhead access to all removable parts.



- G. The valve vault shall be placed on a six inch (6") minimum #57 crushed limestone base.
- H. Dewatering of the vault shall be provided by a gravity drain back to the wet well. The vault floor shall be adequately sloped to the point of drainage. Gravity drains shall be provided with a cast iron floor drain with a backflow prevention insert in the valve vault and check valve located inside the wet well. The drain cover and backflow insert shall be easily removed for clean-out or replacement. The drainpipe shall be four (4) inches at minimum with a U-trap to prevent gas release from the wet well to the valve vault.
- I. Access to the vault shall be provided by manhole steps. Manhole steps or ladder shall be stainless steel, have a maximum spacing of 16-inches, and include at least three steps.
- J. All piping and conduit penetrations through valve vault walls shall be watertight. Penetration holes shall be pre-formed or cored out smoothly without damaging the structure and a mechanical seal shall be installed. Mechanical seals shall be suitable for use in a potentially corrosive environment.
- K. The minimum allowable interior size for valve vaults shall be six feet by six feet (6' x 6') for lift stations with four-inch (4") through six-inch (6") force mains and eight feet by eight feet (8' x 8') for larger force mains.

8.5.5 Bypass Piping

- A. All lift station sites shall be provided with the necessary piping, fittings, and valves to allow for bypassing of the lift station and wet well.
- B. A bypass connection assembly shall consist of a tee, a plug valve matching the sizing of the force main piping, a riser extending above grade, and a 90-degree flanged ductile iron bend with a blind flange to cover the opening.
- C. Bypass location must not impede access to the wet well.

8.6 Pump Performance Tests

Prior to acceptance by the City of Tuscaloosa, inspection and/or documentation of pump performance tests shall be provided as follows:

8.6.1 Pump Performance Tests by Manufacturer at Factory

- A. Each pump shall be provided with a Certified Performance Test as described herein. Testing shall be performed in strict accordance with the current ANSI/HI (Hydraulic Institute) 1U Testing Standards, which allows for 0 to +10% of flow and 0 to +6% for total



head. Multiple evenly spaced test points for pressure and flow shall be taken using calibrated instrumentation in the manufacturer's dedicated testing facility, including the condition at shut-off (zero flow) and at the design point that is specified herein. Test results shall establish the actual pump performance curve. Input kilowatt (kW) readings shall also be observed, noted, and reflected on the final test data, which shall be submitted to the Engineer for review and approval prior to shipment of the equipment.

- B. The Engineer and/or representative(s) of the City shall be given sufficient notice of the testing date and shall have the opportunity to witness the test if they choose. All costs for attending the pump performance testing shall be borne by the witnesses, and not the pump manufacturer.

8.6.2 Pump Performance Tests by Manufacturer at Start-up

- A. The Engineer or Engineer's representative must be present at start-up.
- B. The pump shall be tested at start-up and voltage, current, flow, total dynamic head, and other significant parameters recorded. The manufacturer shall provide a formal test procedure and forms for recording data. Only factory certified service personnel shall perform start-up service. Proof of certification shall be required prior to equipment approval.
- C. The pump controls (provided by others) should be checked at start-up. The Owner/Developer's Contractor must simulate a complete on/off cycle for each pump, the additional pump on switch, and the alarm switch to ensure that the level controls are adequate.
- D. Documentation of all start-up procedures, tests, and checks shall be noted and a copy of all notes provided to the OCE.

8.7 Pump Spare Parts

- 8.7.1 After successful startup of all equipment, the pump manufacturer shall provide the following list of spare parts to the City for use during normal operation as well as maintenance of the new pumps:
 - A. One (1) of each type of mechanical seal used in the pumps.
 - B. One (1) complete set of all O-rings used in the pumps.
 - C. Two (2) guide rail rubber bushings per pump (four (4) total per lift station).
 - D. One (1) gasket for pump discharge to pedestal connection, if required by pump manufacturer (two (2) total per lift station).



- 8.7.2 All spare parts shall be provided packed in suitable containers for extended storage by the Owner. Any spare parts consumed during equipment startup shall be replaced by the manufacturer without cost to the City.

8.8 Force Main

8.8.1 General

- A. All force main piping shall meet the minimum requirements of the City of Tuscaloosa Sanitary Sewer Construction Specifications and be bedded and backfilled according to the City of Tuscaloosa Standard Trench Details.
- B. Force main piping beyond the lift station valve vault and bypass connection shall be slip joint PVC, unless otherwise approved by the OCE.
- C. All wet well piping and force main piping prior to the lift station valve vault and bypass connection shall be ductile iron.
- D. Fittings shall conform to AWWA C100 or C153 and have mechanical joints. Fittings shall be made of ductile iron. The interior of fittings shall be lined with a 40-mil thickness coating of amine cured novolac epoxy.

8.8.2 Pipe Materials

A. Ductile Iron

- 1) Ductile iron force main piping shall be in accordance with ANSI/AWWA C151/A21.51. The minimum pressure class shall be 350 for diameters four (4) inches through 12 inches and 250 for diameters 14 inches and larger.
- 2) Internal Lining Requirements. All ductile iron force mains shall be installed with a corrosion resistant internal lining. Lining shall be a 40-mil thickness coating of amine cured novolac epoxy.
- 3) External Coating Requirements:
 - a. At a minimum, buried ductile iron force mains shall be bituminous coated in accordance with AWWA C151.
 - b. All ductile iron force main piping within the lift station wet well shall be coated with coal tar epoxy.
 - c. All non-submerged ductile iron force main piping inside vaults shall have an approved exterior coating system that is highly resistant to abrasion, wet conditions, corrosive fumes, and exterior weathering.



B. PVC

- 1) PVC force mains 4"-12" shall conform to ASTM D 2241. Pipe shall be a minimum of pressure class 200 with a standard dimension ratio of SDR 21.
- 2) PVC force mains 14"-24" shall conform to AWWA C900 / C905. Pipe shall be a minimum pressure class 200 with a dimension ratio of DR14.

8.8.3 Diameter

- A. Force mains shall be a minimum of four (4) inches in diameter.
- B. The force main diameter shall be the largest standard available pipe diameter that permits a scour velocity of two feet per second (2 fps) under normal operating conditions.
- C. The maximum velocity in any portion of the force main shall be seven (7) fps under any condition.

8.8.4 Combination Air and Vacuum Valves

Intermediate high points and points of slope change shall be eliminated to the greatest extent possible. Where high points cannot be eliminated, they shall be vented with proper and adequate combination air and vacuum valves. Combination air and vacuum valves shall be constructed per Standard Details and the Owner/Developer shall provide sizing methods and calculations.

8.8.5 Right-of-Way Requirements

- A. The force main shall be located in the center of a dedicated 20-foot-wide utility easement or within the public road right-of-way (ROW). When located in the public road ROW, a minimum distance of ten (10) feet is required between the ROW boundary to the center of the force main to allow access for future maintenance and repairs. If sufficient ROW is not available, then a dedicated utility easement just outside of the ROW is required at the width needed to provide a minimum 10-foot width.
- B. The Owner/Developer shall provide plats and descriptions, prepared by and signed by a Registered Professional Land Surveyor licensed by the State of Alabama.
- C. The project plans will show all easements to be obtained.
- D. The Design Engineer, as Consultant to the Owner/Developer, shall provide legal descriptions to the City and coordinate with the OCE for preparation of easements in accordance with City policy.



- E. Easements within subdivisions may be provided following the completion of construction. The Design Engineer must show the proposed easements as part of the Subdivision Plan, and make changes to final plats to show as-constructed easements prior to recording, if necessary.
- F. Easements not within subdivisions shall be provided prior to the acceptance of the lift station.
- G. Easements shall be provided such that force mains shall not be installed closer than fifteen (15) feet when run parallel to a building.

8.8.6 Testing of Force Mains

- A. The OCE requires testing of all new public and private sanitary sewer lines and manholes. Minimum testing requirements are as required in the Construction Specifications included as Part 9 of this manual. Approval and acceptance of force mains shall be based on final testing. The Contractor must provide a 72-hour notice prior to final testing. A representative from the OCE or the City's representative must be present to witness final testing procedures. Tests performed in the absence of the OCE, or its representative shall be considered invalid and shall be repeated by the Contractor.
- B. Testing of sanitary sewer force mains shall be for pipe sizes of four inches (4") in diameter and larger, be for both Ductile Iron and Polyvinyl Chloride (PVC) pipe, and be in accordance with these requirements for all portions of the system.
- C. All apparatus and equipment required for testing shall be furnished by the Contractor.
- D. The Contractor shall provide the Engineer and Owner with copies of all field notes and documentation obtained during final testing.
- E. At a minimum, testing of force mains shall include the following:
 - 1) Flushing with a velocity of at least two and one-half feet per second (2 1/2 fps).
 - 2) Hydrostatic pressure testing, as described in the Specifications.
 - 3) Leakage testing, as described in the Specifications.



8.9 Electrical, Instrumentation, and Controls

8.9.1 General

The electrical design for all sewer pump stations shall be prepared by an Electrical Engineer registered in the State of Alabama. The design shall comply with National Fire Protection Association (NFPA) Article 820, the Institute of Electrical and Electronics Engineers (IEEE), and the National Electrical Code (NEC), as well as all local electrical codes. The standards included in this section shall be considered minimum requirements for the electrical design of a sanitary sewer pump station.

- A. All electrical enclosures shall be located on an equipment support rack under a canopy as described herein. The Developer shall provide details to the City for approval.
- B. All electrical enclosures shall be NEMA-4X stainless-steel standard lockable control panel on a stainless-steel frame with an external operating handle to padlock the breaker in the "ON" or "OFF" position. The enclosure shall be sized sufficiently to contain the required components.
- C. All pump starters, Variable Frequency Drives (VFDs), and other high voltage equipment shall be housed in a separate enclosure, outside of the RTU / control panel.
- D. For all pumps requiring a motor 30 horsepower (HP) and above:
 - 1) VFDs shall be required.
 - 2) If there is a long lead time for the VFD, the Owner/Developer may request approval from the City to use a Soft Starter in lieu of a VFD.

8.9.2 Equipment Support Rack

All electrical equipment, including but not limited to, fused disconnect switch, automatic transfer switches, transformer (where approved), mini power zones, breaker panels, pump control and SCADA panel, and VFD or starter panels shall be mounted to an equipment support rack meeting or exceeding the following minimum requirements:

- A. The equipment rack shall be sized with an adequate width and height (minimum 8'-4" from ground level to top), as required to accommodate all necessary equipment.
- B. A 1/4-inch aluminum backplate with rounded edges (where required) shall span the entire width of the equipment rack. The backplate shall be welded directly to the "front" of the aluminum frame.



- C. The aluminum backplate shall be supported by four-inch square, Schedule 40 aluminum framing posts, spaced symmetrically at a maximum of 4'-0" on center.
- D. The framing posts shall extend a minimum of 3'-0" into the footings. Footings shall be designed to withstand 140 mph wind load.
- E. All electrical equipment shall be mounted so that, where practical, the tops of the panels are generally aligned at the same heights.
- F. A concrete pad, with a minimum 6-inch thickness, at a minimum 6'-0" depth beyond the front of the panel, minimum width of 12-inches beyond each side of the proposed equipment rack, and fiber reinforcement, shall be provided underneath the equipment rack and on top of a minimum 6-inch-thick layer of ALDOT No. 57 crushed limestone.
- G. All equipment shall be secure to the aluminum backing using stainless steel hardware and in accordance with manufacturer's recommendations.
- H. A canopy-style roof shall be constructed above the equipment rack. The roof shall be:
 - 1) Constructed to extend a minimum 5'-6" in front of the equipment rack.
 - 2) Be provided with adequate lighting fixtures for maintenance.

8.9.3 Power Supply

Lift stations shall be equipped with a constant utility power source as well as a backup generator power source for when interruptions in utility power source occur.

- A. All lift stations shall be provided with 480V three-phase power. For lift stations utilizing 20 HP pumps and smaller, where three-phase power is not available, and it has been demonstrated to the City that extending three-phase power to the site is cost-prohibitive, a variable frequency drive may be used to provide three-phase power.
- B. The main power feed shall be equipped with an above grade, fused disconnect switch.
- C. An Underwriters Laboratories, Inc. (UL) recognized three-phase power monitor shall be installed in the pump control panel. The power monitor shall interrupt the control power in the event of phase loss, phase reversal, low voltage, and phase unbalance. The power monitor shall have primary fuse protection. The contacts shall be rated for 15A resistance at 120 volts alternating current (VAC).
- D. The power source service shall be inspected by the City Building Inspection Department. It shall be the Owner/Developer's responsibility to provide notification to the Building Inspection Department and to coordinate this inspection.



8.9.4 Standby Power System

- A. The standby generator shall be of sufficient size to supply power to all loads in the pump station and meet peak pumping capacity. The generator set shall be equipped with an electric start kit, battery tender, trickle charging system, automatic transfer switch, cooling system, exhaust system, and other accessories required for a fully automatic system.
- B. The standby generator shall be installed in a weather-protective, sound-attenuated enclosure. An outdoor, weather-protective housing with critical grade exhaust muffler shall be installed. The housing shall have hinged, side access doors and a rear control door. All doors shall be lockable. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color. Vibration isolators, as recommended by the generator set manufacturer, shall be provided. The generator must be mounted far enough away from obstructions to allow all doors to be opened 90 degrees.
- C. Generator sets shall be natural gas powered unless natural gas is not available at the site. If it is necessary for the unit to be diesel powered, it shall be provided with a 100 gallons minimum fuel storage capacity or 72-hour operating time, whichever is greater. Fuel storage shall be accomplished by the use of corrosion resistant, double wall subbase fuel tank only; no underground storage will be allowed. Provide an access platform, as necessary. A leak detection device shall be provided in the interstitial space for sensing fuel leakage. The device contact shall be connected to the generator control panel terminals for telemetry.
- D. Generator sets shall be mounted on a concrete slab. Slab shall be appropriately sized and designed by the Owner/Developer's Engineer as required to meet current electrical and structural codes and standards.

8.9.5 Instrumentation

- A. Level Monitoring
 - 1) All lift stations shall be equipped with both a radar level transducer and submersible pressure (hydrostatic) level transducer for continuous analog level monitoring.
 - 2) Radar level transducers shall be installed on the top of the wet well on a flange adapter mounted to a minimal six-inch ductile iron floor pipe with an integrally cast seep ring. If radar is not feasible due to obstructions in the wet well, a secondary submersible pressure transducer shall be installed.



3) Submersible pressure (hydrostatic) level transducer shall be installed in 1 1/2-inch PVC Schedule 80 encasement (stilling well). The stilling well shall be supported to the wet well wall by stainless steel straps. The encasement shall be accessible from the top of the wet well.

4) Install a stainless-steel hook mount bracket system inside the wet well.

B. Flow Monitoring

1) All pump stations shall be equipped with an inline electromagnetic flow meter to provide continuous, remote monitoring of station flow.

2) Meter shall be installed inside the valve vault and with required upstream/downstream straight piping sections recommended by the manufacturer.

C. Gauge Pressure Transmitters

1) A pressure transducer with diaphragm mounted flanged annular seals should be located on the sides of each pipe in the valve vault, downstream of the check valve and upstream of the plug valve.

2) On the same tap for the pressure transducer, an oil filled pressure gauge shall be provided for local reading of pressure.

3) Proper isolation valves and disconnects shall be provided to remove devices for repair or replacement.

8.9.6 Telemetry and Controls

A. Level Configuration

All lift stations shall have the following configuration and sequence of operation:

Level		Controlled By
L6	BC Lag Pump On (Redundant)	Backup Controller (Radar)
L5	BC Active/Lead Pump On (Redundant)	Backup Controller (Radar)
L4	Lag Pump On	PLC Normal Operating System (Selectable Level Transducer)
L3	Lead Pump On	
L2	All Pumps Off	
L1	BC Inactive/All Pumps Off (Redundant)	Backup Controller (Radar)

B. RTU / Control Panel

1) All lift stations shall be provided with a separate panel to house both the RTU and the pump controls, which is exclusive of pump starters, VFDs, or other high voltage equipment.



- 2) All lift station RTU/control panels shall be supplied and installed by a City of Tuscaloosa approved supplier.
- 3) Prior to construction, the panel layout shall be submitted to the OCE for review.
- 4) At a minimum, the RTU and control panel shall include the following components:

Manufacturer	Description
Sierra Wireless	Cellular Router, Airlink RV50X
	Uninterruptible Power Supply (UPS)
Allen-Bradley	MicroLogix 1400 PLC
	Intrinsically Safe Barriers
	Surge Protection Device
	AutoCAD Drawings

- C. A City of Tuscaloosa approved integrator shall provide SCADA integration and it shall be paid for by the Owner/Developer.

8.10 Approved Manufacturer's List

Equipment	Approved Manufacturers / Models
Pumps	Sulzer Gorman-Rupp Ebara Flygt Wilo
Check Valves	Clow Crispin
Plug Valves	DeZURIK Crispin
Valve Boxes	Opelika Foundry Tyler Union Foundry Bingham & Taylor
Ductile Iron Pipe	American Cast Iron Pipe Company US Pipe
Ductile Iron Fittings	American Cast Iron Pipe Company U.S. Pipe Mueller Clow Tyler Foundry
Internal Pipe Lining	Permax / CTF amine cured novolac epoxy, 40 mil
External Pipe Coating, Ductile Iron Force Main in Wet Well	Indurall / Coal Tar Epoxy Ruff Stuff 2100



Equipment	Approved Manufacturers / Models
External Pipe Coating, Non-Submerged Ductile Iron Force Main	Surface Prep: Abrasive blast Primer: Tnemec / Series N140 Pota-Pox Plus (6.0 – 8.0 mils) Intermediate: Tnemec / Series 66 Epoxoline (3.0 – 5.0 mils) Finished Coat: Tnemec / 1074U Endura-Shield II (3.0 – 5.0 mils)
Mechanical Joint Restraints	EBAA Iron Inc / MEGALUG
PVC Pressure Sewer Pipe	Sanderson Pipe North American Pipe Corporation Hawk Plastics, LLC
PVC Gravity Sewer Pipe	Sanderson Pipe North American Pipe Corporation Hawk Plastics, LLC
Yard Hydrant	John C. Kupferle Foundry Co / Corn King #903
Generators	Cummins Onan Caterpillar Generac Kohler
Automatic Transfer Switches	Cummins Onan Caterpillar Generac ASCO 300 Series - Preferred City Standard Eaton
Electromagnetic Flow Meters	Endress + Hauser / Proline Promag W 400
Radar Level Transmitters	Endress + Hauser / #FMR 52B/62B 2-wire (B indicates Bluetooth)
Submersible Level Transmitters	Endress + Hauser / Waterpilot FMX21 w/ 50' Cable
Float Switches	MJK / #7030 with counterweights
Gauge Pressure Transmitters	Endress + Hauser / PMP71B
Gauge Pressure Transmitters Annular Seal	Redvalve
Combination Air and Vacuum Valves	A.R.I. / D-025 Combination Air Valve for Wastewater Bermad Model C30-P
Variable Frequency Drives (VFDs)	Eaton / DG1, ABB/ACQ580, Schneider /ATV600
Soft Starter	Eaton/S811, ABB/PSTX
Access Hatch	Halliday East Jordan Iron Works
RTU / Controls	Electric Machine Control
SCADA System and Integration	Electric Machine Control



PART 9
CONSTRUCTION SPECIFICATIONS
SANITARY SEWER DESIGN MANUAL



SECTION 02250

TRENCHING, BACKFILL, AND COMPACTION (FOR SEWER)

PART I GENERAL

1.1 Summary

- A. This Section of Specifications deals with the requirements for Trenching, Backfill, and Compaction for sewer lines placed in roadways, lawns, or unimproved property or any other area.

1.2 Products Installed, but not Furnished Under this Section:

- A. Ductile Iron Pipe and Fittings
- B. Manholes and Covers
- C. PVC Pipe and Fittings

1.3 References

- A. U.S. Department of Labor, Occupational Safety and Health Administration
- B. Alabama Department of Transportation Standard Specifications for Highway Construction
- C. AWWA C600 – Installation of Ductile Iron Water Mains and their appurtenances.

1.4 Project Conditions

- A. Environmental Requirements
 - 1. The Contractor shall maintain all drainage ways, gutters, etc., at all times. Any eroded or washed material that enters pipes, ditches, or streams shall be removed by the Contractor at his own expense.
 - 2. The Contractor shall provide erosion control as required to protect from damage to surrounding and downstream areas. Erosion control measures shall meet all requirements of the City of Tuscaloosa.
 - 3. All areas damaged as a result of erosion shall be repaired to a condition equal or better than the condition prior to construction, as determined by the Engineer.
 - 4. The Contract shall comply with the City of Tuscaloosa Municipal Code in regard to all environmental best management practices.

PART II PRODUCTS

2.1 Materials

A. Select Backfill

1. ***Gravity and Pressure Sewer (all materials):*** Final Select backfill where specified or required in the top 12-inches under asphalt or concrete pavements and/or gravel drives, shall be ALDOT No. 825B crushed limestone.
2. ***Gravity (all materials) and Pressure Sewer (ductile iron):*** Select backfill, where specified or required, shall be ALDOT No. 57 crushed limestone EXCEPT when installed in the top 12-inches under asphalt or concrete pavements and/or gravel drives.
3. ***Pressure Sewer (PVC):*** Select backfill, where specified or required, shall be ALDOT No. 8910 crushed limestone EXCEPT when installed in the top 12-inches under asphalt or concrete pavements and/or gravel drives.
4. Crushed limestone shall meet or exceed the requirements of the Alabama Department of Transportation Standard Specifications for Highway Construction, Section 801, latest edition.

B. Standard Backfill

1. Standard backfill shall consist of native soils free of large rocks, boulders, and other deleterious substances.

C. Bedding

1. Class "1" Bedding shall be Alabama Department of Transportation Standard Specifications for Highway Construction, Section 801, No. 57 crushed limestone.
2. Class "2" Bedding shall be reinforced concrete 3000 psi design mix.
3. Unless specified on the drawings or required by the Engineer, pipe shall be bedded in native soil (Class "3").

D. Trench Foundation

1. Trench foundation material shall be Alabama Department of Transportation Standard Specifications for Highway Construction, Section 801, No. 57 crushed limestone. This material shall only be used when approved in advance by the Engineer.

2.2 Source Quality Control

- A. The Contractor shall supply gradation analysis for each type of crushed stone used.

PART III EXECUTION

3.1 Examination of Conditions

- A. The Contractor shall examine the area to be trenched and verify his requirements for trenching.

3.2 Protection and Removal

A. Fences

1. All fences in conflict with the proposed construction shall be removed in a neat and workmanlike manner and then replaced immediately following construction operations. The Contractor shall protect the normally fenced property at all times when the fence is not in proper or normal services. Where materials removed are not suitable for reuse, they shall be replaced with new material of equal or better quality and construction. All fences shall be rebuilt to line, with posts well set, wires fastened with new staples or ties and well stretched. All corner and end posts shall be well braced and set a minimum of 30 inches in the ground.

B. Utility Poles, Guy Wires, Miscellaneous Poles, Etc.

1. All utility poles, guy wires, signposts, and similar private obstructions which are indicated on the plans or existing on the ground shall be removed and replaced by the Contractor at his own expense. In the event street signposts or signs are damaged or destroyed by the Contractor's operations, they may be replaced by the City at the Contractor's expense.
2. When it is necessary to remove or adjust any utilities, representatives of the utilities involved shall be notified to decide the method and nature of work to be done. The Contractor shall make satisfactory arrangements with other utilities for the required removal or adjustments at the Contractor's expense, unless otherwise specified.
3. The Contractor shall be held liable for damage, including negligent or willful damage to any other utility and shall pay for the cost of all necessary repairs and any damage resulting to public or private property resulting therefrom.
4. The Contractor shall take whatever means necessary to support sewer mains to their true line at grade when they are encountered during excavation. The pipe shall be supported so that no leakage will occur and, under no circumstances, will the Contractor be allowed to bypass raw sewage or allow raw sewage to leak into the trench. If a repair becomes necessary, the Contractor shall use materials of the same type and class of pipe conforming to the City of Tuscaloosa Sanitary Sewer Construction Specifications. All couplings to existing pipes shall be manufactured couplings and all metal parts shall be stainless steel.

C. Ornamental Shrubs and Trees in Public Right of Ways:

1. Ornamental shrubs and trees shall not be removed, unless directed by the Engineer. When ornamental shrubs and/or trees are to be removed and replaced, the following steps shall be followed:
 - a. Remove all trees, shrubs, or plants which interfere with construction intact with root system and protect from drying during construction period.
 - b. Replace plant to original location as soon as possible, taking care to ensure that hole is large enough and no damage is done to root system.
 - c. Fill hole with good topsoil, tamp lightly and firmly into place, and water plant.
2. Contractor shall, at his own expense, replace with like kind and size if any plant, tree, or shrub disturbed by construction dies within one (1) year, at no cost to the Owner.

D. Adjacent Property

1. The Contractor shall confine his operations to the rights-of-ways and/or easements designated. Any damage to the rights-of-ways, easements, or adjacent property shall be repaired by the Contractor at no additional cost to the Owner.

E. Private Drives and Sidewalks

1. The Contractor shall keep all private drives and sidewalks open and accessible at all times.
2. All streets and public roads shall be kept open and accessible to emergency vehicles at all times.

F. Existing Underground Utilities

1. The Contractor shall protect all existing utilities during the trenching operation. The Contractor shall cooperate fully with the utility's request for temporary and permanent supports during the trenching operation and shall furnish and install supports at the Contractor's expense.
2. Storm sewers in conflict with the proposed trench may be carefully dislodged and stockpiled. The pipes shall be cleaned and replaced immediately after new construction is clear. Storm sewers damaged by the Contractor shall be replaced with new pipe at the Contractor's expense. All storm sewers removed shall be re-laid to proper grade on a firm bedding so that settlement will not occur.

3.3 Trench Preparation

A. Clearing and Grubbing

1. Where clearing or partial clearing of the right-of-way or easements is necessary, such work shall be completed prior to trench excavation. Projecting materials such as trees, logs, brush, hedges, etc., shall be cut as near to the surface of the ground as possible, and all stumps and roots shall be grubbed out unless specifically stated otherwise. All materials so cleared and grubbed shall be removed from the site. In no case shall excavated materials be allowed to cover brush or trees prior to disposal.
2. The Contractor shall bear all costs of disposing of all cleared and grubbed materials. Unless otherwise specified, all merchantable timber cut from the area designated to be cleared shall become the property of the Contractor.
3. In no case shall any materials from clearing and grubbing operations be left on the project, or be pushed onto abutting private properties, or be buried in embankments or trenches on the project.
4. On public property, existing trees or limbs over 2 inches in diameter shall not be cut unless they are within 7 feet of pipe centerline or specific permission is received from the Engineer. All limbs that are required to be removed shall be neatly cut and painted. On private easements or in lawns, no trees or brush shall be cleared or cut without prior approval of the Engineer or Inspector. The Contractor shall be required to remove trees, shrubs, or plants on private property intact, and to ball the roots, keep watered as required, and replant in their original location upon completion of pipe laying operations, unless written permission is obtained from the Engineer, or unless otherwise specified. The Contractor shall replace, at his own expense, any trees, shrubs, or plants which shall be damaged as a result of his operations, or which shall die within one (1) year from the time it was disturbed or damaged.

B. Saw Cutting

1. Prior to beginning the trenching operation in paved areas such as roads, drives, sidewalks, and parking lots, all paving shall be saw cut to a minimum depth of 2 inches. If the saw cut lines are damaged prior to patching, the Contractor shall recut the lines prior to patching, if necessary, to have a smooth and neat patch. All paving materials shall be removed and disposed of at the Contractor's expense prior to the trenching operation.
2. Prior to beginning the saw cutting, all traffic control devices, barricades, cones, and permits required shall be obtained and in place.

C. Verification of Existing Utilities

1. Prior to the excavation, but after the saw cutting in paved areas, the

Contractor shall unearth all known utilities and confirm the location and depth of such utility sufficiently far enough in advance to adjust the vertical or horizontal alignment of the pipeline if necessary.

3.4 Trench Construction

A. General

1. Trenching or excavation for pipelines shall consist of the excavation necessary for the installation of sanitary sewers and all appurtenant facilities therefore, including manholes, inlets, outlets, thrust blocks, and pipe protection as called for on the Drawings.
2. Trench excavation shall be made in an open cut unless tunneling or other construction methods are specifically authorized and shall be true to the lines and grades shown on the plans or established by the Engineer.
3. When vertical banks for trench excavation are not practical to construct or create dangerous conditions to workmen, the banks may be sloped provided that such excavation does not damage adjacent structures. However, when trench banks are sloped, such banks shall be cut to vertical planes as specified above for that part of the ditch below the level of one (1) foot above the top of the pipeline. All side slopes shall conform to the requirements established by OSHA.
4. All streets, sidewalks, crossings, fire hydrants, water valves, fire alarm boxes, and other similar public utilities are to be kept open or accessible for their intended use.
5. Every drain, gutter, culvert, or sewer for surface drainage encountered is to be kept open for both temporary and permanent flow, or, if necessarily closed, other adequate provision for drainage is to be made.
6. In all cases where materials are deposited along open trenches, they shall be placed so that in the event of rain, no damage will result to the work and/or to adjacent property.
7. Pipe trenches shall not be excavated more than 300 feet in advance of pipe laying and temporary bridges or crosswalks shall be constructed where required to maintain vehicular or pedestrian traffic.
8. Trench widths and other construction activities shall be confined to dedicated rights-of-way or construction easements unless special written agreements have been made with the affected property owner. Temporarily place all excavated materials within easements or rights-of-way, and do not obstruct any public or private roadways or streets.
9. Materials deposited along open trenches shall be placed so as to avoid damage to the work or adjacent property.

10. Where select backfill is specified or required, all excavated materials shall be promptly removed and disposed of by the Contractor.

B. Rock Excavation

1. Rock encountered in trench excavation for pipe lines shall be removed for the overall width of the trench and to a depth of six inches below the bottom of the barrel of pipe 24 inches in diameter and smaller, 8 inches below the bottom of the barrel of pipe 24 to 36 inches in diameter, and 12 inches below pipe larger than 36 inches in diameter, if rock extends to such depths.
2. Where pipelines are constructed on concrete cradles, rock shall be excavated to the bottom of the cradle as shown on the plans. When necessary to provide sufficient working space, rock shall be excavated to additional depth for bell holes.
3. After the Engineer has inspected the completed excavation, the space below the ultimate pipe or structure grade shall be filled with an approved foundation material and compacted to the proper grade.
4. Drilling and blasting methods used in rock excavation shall be optional with the Contractor but shall be conducted with due regard to the safety of persons and property in the vicinity of the work and in strict conformity with all laws, ordinances, or regulations governing blasting and the use of explosives. The Contractor shall be licensed for this type of blasting and shall follow the insurance requirements of the general conditions. The Contractor shall also notify the fire department at least 48 hours in advance of any blasting.
5. Rock excavation near existing structures of all types shall be conducted with the utmost care, and every precaution shall be taken to prevent damage to such structures. Any damage or injury of whatever nature to persons or property caused directly or indirectly by blasting operations shall be promptly repaired, replaced, or compensated by the Contractor at his own expense and to the satisfaction of the persons injured or the Owners of the property damaged.
6. Safety During Blasting:
 - a. Take all precautions necessary to prevent personal injury, damage to real or personal property, or interference with use and enjoyment of any property resulting from blasting or the vibration or concussions caused by blasting. These precautions shall include, but are not limited to, investigations by the Contractor to establish limits of the size and nature of individual blasts which may be safely accomplished without damage or interference with the use of the property.

- b. All drilling and blasting operations shall be performed in strict conformity with all laws, ordinances, and regulations governing blasting and the use of explosives. The Contractor or blasting subcontractor shall be licensed for this type of blasting and shall take out and maintain, during the term of its contract or subcontract and any extension thereof, insurance equal to that specified for the Contractor in the General Conditions.
- c. The Contractor shall notify the fire department at least 48 hours in advance of any blasting.

7. Damage from Use of Explosives:

- a. Immediately inform the explosive specialist orally and in writing of all matters concerning complaint and claims between the public, or government, and the Contractor. If the Contractor causes damage, injury, or interference, as stated herein, the Contractor shall modify his blasting procedure.
- b. The Contractor hereby assumes all liability for all personal injury, and damage to real or personal property, or interference with the use or enjoyment of any property by reason of blasting or the resulting vibration or concussion. The Contractor assumes full responsibility for opening all equipment and performing all blasting in conformance with Federal and State laws, and regulations prescribed by any other governmental authority limiting the amount of vibration or concussion.

8. Pre-Blast Survey:

- a. The Contractor will conduct a pre-blast survey of the surrounding structures within 500 feet of any blasting operation on either side of the centerline of the blasting right-of-way and document the condition before any blasting or excavation begins. The documentation will include a written description of all defects, digital color photographs of each of these defects, and a complete inspection of all structures on the property. This includes outside structures, walls, sidewalks, etc. No video cameras will be allowed for pre-blast surveys where finished interior surfaces are concerned.
- b. In special situations, crack monitors may be located over existing cracks at selected locations to be measured before and after blasting to determine if the widening or displacement has taken place.
- c. Before carrying out the inspection, the Contractor or his consultant shall notify the Owners of the buildings or structures to be inspected and request permission to carry out the inspection. Should any building Owner refuse permission to carry out this inspection, the Contractor shall notify the Engineers, in writing, giving the Owner's reason for refusal.

9. Blasting Program:

- a. The Contractor shall furnish the Engineer, the name and qualifications of its blasting consultant, for approval.
- b. The Contractor's consultant shall formulate and make recommendations in a written blasting program furnished to the Engineer. Criteria for the selection of this program shall be the prevention of damage to existing structures and the prevention of any interruption of their services.
- c. The blasting program shall include, but not be limited to, data on the locations, hole size, depth, overburden, pattern and inclination of the blast holes, the type, strength, amount distribution, and powder factor for the explosives used, per hole and per blast, the sequence and pattern of delays, maximum amount of explosives in any one period, depth of rock, and depth of overburden, if any, and the description and purpose of special methods to be used. This data shall be accepted by the Contractor as the general procedure of blasting on this job.
- d. Explosion and firing devices shall be of a type that is commercially available, suitable for the intended use, in good condition resulting from proper storage and maintenance.
- e. Blasting mats shall be of a size and type to be suitable for the use intended. All blasts should be covered with at least two (2) feet of overburden. Fly-rock will not be permitted at any time. If a fly-rock incident does occur, the job will be stopped immediately, and a written plan will be submitted by the Contractor to explain how this recurrence of fly-rock will be prevented in the future.

10. Blasting Preparation:

- a. Conduct a pre-blast survey of existing structure, as specified herein.
- b. Prepare a written blasting program, as specified herein.

11. Trial Blasting:

- a. Conduct a trial blasting program as directed by the Contractor's consultant before general excavation blasting may commence. The maximum explosive charge weight per delay period utilized shall be limited to the amount submitted in the blasting plan.
- b. Trial blasting shall consist of determining the relationship between peak particle velocities and weight of the explosive charges by a planned program of trial blasts. Beginning with small explosive weights, successively greater explosive weights shall be detonated and the particle velocities measure at several distances from the blast. The trial blasting and field observations are intended to develop

a relationship between size of the explosive charge, distance from the explosion, and particle velocity. This data shall be used as a basis for controlling the blasting program.

- c. The initial blasts in any blasting area shall be considered test blasts. These test blasts will be monitored, at nearest structures, and modifications of the maximum explosive charge weight per delay may be allowed providing that the vibration effects, at the nearest structure, are maintained below the specified levels. These modifications to the maximum charge weight per delay will only be allowed on the advice of the vibration consultant.

12. General Blasting Procedures

- a. A blast shall be defined as a predetermined number of shots. A period of at least 5 minutes shall elapse between each blast, and a minimum delay time of 8 milliseconds shall elapse between each individual shot within a blast. The interval between individual shots may be increased or decreased, if required by the Contractor and approved in writing by the Contractor's consultant. The Contractor must, however, remain within the vibration limits hereinafter described.
- b. Blast Vibration Limits:
 - 1) Blasting vibrations, as recorded adjacent to the foundation of the nearest above ground structure, shall be limited as follows:
 - a) A peak particle velocity (or any component of a 3-component particle velocity recording seismograph) of 2.00 inches/seconds shall not be exceeded for the structure closest to the blast site when vibration frequencies are greater than 40 hertz. Frequencies less than 40 hertz will be limited to a peak particle velocity of 0.50 inch/second.
 - b) Compliance with the Bureau of Mines Blast Level Chart, as noted in RI 8507, will suffice for the previously mentioned limits.
 - 2) When the existing structures are very close to the blasting area, very slight changes in any blasting variable will result in large changes in vibration intensities. Modifications of the blasting method and reduction of the explosive charge weight per delay shall be used to ensure that one of the above limits is met.
 - 3) At any time, the Engineer reserves the right to reduce or increase explosive amounts, change blasting patterns on any blasting, or eliminate blasting in certain areas should conditions warrant.

- 4) The maximum peak particle velocity may be increased with the written approval of the Contractor's consultant, providing that the Contractor and his consultant prove that no damage to existing structures will result.

13. Air Blast Limits:

a. Air blast from blasting shall be controlled such that:

- 1) The maximum allowable air blast, at any inhabited structure resulting from blasting operations, shall not exceed 128 decibels peak when measured by an instrument having a flat response ± 3 decibels over the range of at least 2 to 200 Hz.

b. Air blast shall be monitored with an approved instrument having the required frequency response and capable of providing a permanent record of the air blast effects. These records, identified by time and recording location, shall be made available upon request to the Engineer monthly or in a tabulated form at other times, as required.

14. Documentation of Blasting Program:

- a. All recommendations, guidelines, findings, and correspondences for the blasting program will be documented in writing and compiled into a final report.
- b. Copies of ground vibration measurements recorded by seismographs will be analyzed and verified by the consultant and included in the appendix of the final report.

C. Sheeting, Shoring, and Bracing

1. The sides of all trenching excavations shall be sufficiently sheeted, shored, and braced whenever necessary to prevent slides, cave-ins, settlements or movements of the banks and to maintain the excavation clear of obstructions that will, in any way, hinder or delay the progress of the Work. The sides of the excavation shall be cut at such a slope that will prevent caving, and the trench shall be adequately supported, and the safety of workers provided for as required by the most recent standards adopted by OSHA. Any sheeting or bracing used in areas of unsuitable material, or required to protect adjacent structures, property, workers, or the public, shall be left in place until the excavation has been backfilled to a sufficient depth to prevent caving. The Contractor is solely responsible for safety and shall take whatever action is necessary to protect his personnel, the general public, and others involved with the project.
2. Wood or steel sheet piling of ample design and type shall be used when necessary.

3. All sheeting, shoring, and bracing shall have sufficient strength and rigidity to withstand the pressures exerted and to maintain the walls of the excavation properly in place and protect all persons and property from injury and damage.
4. Where excavations are made adjacent to existing buildings or other structures or in paved streets or alleys, the Contractor shall take particular care to sheet, shore, and brace the sides of the excavation adequately so as to prevent any undermining or settlement beneath such structures or pavement. Underpinning of adjacent structures shall be done when necessary. The Contractor will be liable for any damage to any structure that results from his operations.
5. Sheeting, shoring, or bracing materials shall not be left in place unless so shown by the plans or ordered by the Engineer. Such materials shall be removed in such manner as to not endanger or damage the new structure or any existing structures or property, either public or private, in the vicinity, and so as to avoid cave-ins or slides. No trench sheeting and bracing shall be removed until the trench has been backfilled one foot above the top of the pipe.

D. Trenching Through Dikes and Fill Sections

1. Trenching through existing dikes or fill sections shall be accomplished in accordance with general trenching requirements as specified elsewhere.
2. Trenching pipelines or other utilities through dikes or fill sections under construction shall not begin until the new dike or fill section has been constructed, enlarged, or otherwise improved to an elevation 3 feet above the top of the pipe or other utility being installed.
3. Where existing dikes or fill sections are being used for the storage of liquids such as a lagoon, reservoir, pond, lake, canal, or other structure, the Contractor shall take whatever means necessary to preserve the integrity of the structure. No leakage of the stored liquid out of the structure will be allowed without the written approval of the owners of said structure.

E. Minimum Trench Widths

1. All excavations shall be made to the lines and grades as established by the drawings and shall be open cut through whatever material encountered. The Engineer may, if requested and deemed appropriate by the Engineer, make changes in the trench alignment to avoid major obstructions, if such changes can be made within the easement or right-of-way without adversely affecting the intended function of the facility. In areas where soil conditions permit normal and safe excavation of the trench, the sides shall be cut as nearly vertical as possible from the bottom of the trench to a point at least 12 inches above the top of the pipe. As per section 4.3.2.3 of AWWA C600 Specifications, the width of the trench at the top of the pipe shall permit the pipe to be laid and joined

properly and to allow the backfill to be placed in accordance with City Standards. As a guide, trench widths should be the nominal pipe diameter plus 24 inches. When required, trenches shall be wider to permit the placement of timber supports, sheeting, bracing, and appurtenances as required by the safety requirements of the agency having jurisdiction or to allow the use of effect mechanized tamping equipment. For pipe diameters larger than 18-inches, minimum trench widths shall be as previously described or as determined from the formula, $4/3d$ plus 12-inches, in which "d" is the inside diameter of the pipe in inches, whichever is greater. When sheeting is used, the distance between vertical planes shall be measured from the inside faces of the sheeting.

3.5 Dewatering

- A. The Contractor shall at all times provide and maintain the necessary equipment and means for removal of all water from excavated areas. All excavated areas shall be kept free of water while any work is in progress. Particular precautions shall be taken to prevent the displacement of structures or pipelines as a result of accumulated water.
- B. Bedding material or pipe shall not be placed in wet or unstable trenches. Soil that cannot be properly dewatered shall be excavated and dry material tamped in place to such a depth as may be required to provide a firm trench bottom.
- C. All water removed or diverted from excavation shall be disposed of in a manner which will prevent damage to adjacent property or any flooding of streets or property. Disposal of trench water through the pipeline under construction shall not be allowed.
- D. Water shall be removed and disposed of so as not to damage adjacent property or existing drainageways.

3.6 Trench Foundation Material

- A. Where unsuitable materials for supporting pipe cushion are encountered, these materials shall be removed and replaced with trench foundation material, as directed by the Engineer.
- B. Trench foundation material shall be placed at the specified trench width from the bottom of the excess excavation to the bottom grade line of the pipe bedding.
- C. Trench foundation material so placed shall consist of sand or crushed stone as directed by the Engineer. Crushed stone and sand foundation material shall be the same as specified for crushed stone cushion and sand cushion.

3.7 Bedding and Backfill

- A. General

1. All areas where bedding is not specifically called for or required by the Engineer, the pipe shall be bedded in native soils. Bell holes shall be excavated so that the entire pipe length rests on firm soil.
2. Areas undercut by the Contractor through negligence, or his convenience, shall be backfilled and tamped with approved materials at the expense of the Contractor. In paved areas, the backfill material shall be select backfill.
3. Bedding shall meet the requirements of Section 2.1 of these specifications.
4. Backfilling shall not begin before the Engineer or Inspector has inspected the grade and alignment of the pipe. No backfilling operations shall occur unless the Engineer's Inspector is present at the backfilling operation.
5. All backfill (from the bedding to the top of the backfill) shall be select backfill when crossing or beneath streets, driveways, parking lots, sidewalks, and other structures (major or minor) or paving. It is essential that the entire backfill operation be done in such a manner as to prevent voids in the backfill. The use of granular materials for backfill in the pipe zone shall constitute a pay item only when so directed by the Engineer.
6. If select backfill is not specified, backfilling (in 8-inch lifts) to a point 12 inches above the top of the pipe, defined as the pipe zone, shall be done with select backfill, good earth, sand, or gravel and shall be free from large rocks or hard lumpy materials. Large rocks shall be defined as any larger than 2 inches in diameter. No materials of perishable, spongy, or otherwise unsuitable nature shall be used in backfilling.
7. Place trench backfill material at approximately the same rate along both sides of the pipe and compact by tamping in layers not to exceed eight inches loose fill up to the horizontal centerline (Springline) of the pipe. Compaction shall achieve 95% of standard proctor density, except that 100% minimum shall be achieved when select backfill is utilized. The Contractor shall place the backfill to cradle the pipe so that the full length is uniformly supported on firm bedding and the weight of the pipe and backfill is borne uniformly by the lower half of the pipe barrel. Special attention should be given to the backfilling and tamping procedures to ensure that no voids or uncompacted areas occur beneath the pipe and that no settlement occurs after the backfilling operation is completed. The Contractor shall utilize whatever methods, and equipment may be necessary to accomplish this.

Where trench boxes, shoring, or other trenching procedures are utilized, the Contractor shall utilize the trench boxes, etc., in a safe manner and in compliance with OSHA standards and regulations to allow tamping to proceed continuously from the wall of the pipe to the native trench wall. It shall not be allowable to compact the lift while the trench box is contained in the lift unless the entire width of each lift is recompacted in lifts after the trench box is moved. In all cases, the trench width must be sufficient to

allow the thorough tamping of the stone beneath the haunches of the pipe. Where a trench box is not utilized, there shall be sufficient clearance between both trench walls and the pipe (one-foot minimum unless a larger width is indicated by the plans or other places in these specifications) to allow for mechanized tamping equipment to be effectively utilized. If a trench box is utilized, there shall be sufficient clearance between both the inside walls of the trench box and the outside of the pipe (one-foot minimum unless a larger width is indicated by the plans or other places in these specifications) to allow for mechanized tamping equipment to be effectively utilized. Where a trench box is utilized, the clearance between the outside of the trench box and the trench walls shall be kept to a minimum, generally no more than three inches maximum on either side, and this area shall also be properly compacted. Regardless of whether a trench box is utilized, sufficient clearance must be available on both sides of the pipe for the entire trench depth, to allow for proper compaction. The Contractor shall comply with all OSHA regulations and provide safe working conditions for all aspects of the work. After this, fill and compact the trench as specified below, depending upon the location of the work and danger from subsequent settlement.

8. All backfilling shall be done in such a manner that it will not disturb or injure the pipe or structure over or against which it is being placed or any other structure in the vicinity of the pipe laying operation. Any pipe, utility, or structure injured, damaged, or moved from its proper line or grade during backfilling operations, shall be replaced or repaired and then re-backfilled as herein specified, at the expense of the Contractor.

B. Pipe Bedding and Trench Backfill

1. Pipe bedding and trench backfill shall be constructed as shown on the Trench Details in the Drawings. If no Trench Details are shown in the Drawings, then the Contractor shall install the utilities as described herein paragraph 3.7.B.
2. Where pipes are installed in unpaved areas, unless specifically shown on the drawings or called out in the Bid Schedule to be unimproved, the areas shall be considered **Improved** and shall be constructed accordingly.
3. Backfilling Unimproved Areas:
 - a. From the centerline at the pipe to the surface of the ground, backfill may be deposited by front end loader, bulldozer, or other suitable equipment. Tamping will not be required. Sufficient surplus excavated materials may be neatly rounded over the trench to compensate for subsequent settlement.
4. Backfilling in Lawns or Other Improved Areas:

- a. Backfill may be placed from the centerline of the pipe to six inches below the ground by any suitable equipment but shall be tamped or rolled in layers not to exceed 8 inches loose depth to a density of 95% standard proctor density. The top 6 inches of backfill shall be topsoil free from rocks, roots, or other debris. In lawns, no material that could interfere with mowing shall be used.
- 5. Backfilling Across and Beneath Streets, Driveways, Parking Lots, Sidewalks, and Other Minor Structures:
 - a. All backfill material shall be select backfill as specified in Section 2.1.A and shall be placed and compacted in lifts not to exceed 8 inches loose depth to a minimum of 100% of standard proctor density. Additional compaction shall be provided as necessary to prevent any settlement of the backfill. No backfilling operations shall occur unless the Engineer's Inspector is present at the backfilling operation.
 - b. If settlement occurs after paving, the Contractor shall take the appropriate measures to relevel the street in a professional manner and overlay the entire street with one-inch minimum paving at no expense to the Owner. The completed backfilled surface shall be brought to the same level as the original surface less the thickness of the required asphalt or concrete patch, unless a thicker patch is indicated elsewhere.
 - c. In poor soil conditions, When ALDOT No. 57 crushed limestone is used for select backfill, the trench shall be lined with filter fabric to prevent smaller native material from migrating into the void spaces of the stone. Poor soil conditions are soils that are too soft, too wet, loose, or contain organics or debris, and cannot support the pipe or be compacted properly.

3.8 Trench Compaction

- 1. During the initial stages of the project, the Contractor shall place the backfill in the required lifts and compact with the equipment he plans to use for compaction until the density is obtained. The tamping equipment utilized shall be in first condition and capable of effectively tamping the backfill. If the Engineer feels the proposed tamping equipment is inadequate, the Contractor shall provide tamping equipment satisfactory to the Engineer at no extra cost to the Owner.
- 2. The density shall be verified by tests. The number of passes required by this equipment shall be used as the minimum number of passes required throughout the job. If a different type of equipment is used, then another trial section shall be performed. If there is any doubt on behalf of the Engineer regarding the test or conditions of the test, the Contractor shall make as many passes as necessary to satisfy the Engineer that the required compaction is being achieved.
- 3. Regardless of the equipment used, a minimum of three passes per 8-inch lift shall be made over each square inch of the backfill.

3.9 Cleaning

- A. The Contractor shall thoroughly clean all areas damaged during construction of excess fill, construction debris, etc.
- B. All gutters and adjacent curbing shall be swept clean.

3.10 Protection

- A. The Contractor shall protect the newly constructed pipeline from damage until final acceptance of the work.

END OF SECTION

SECTION 02260

SUBSURFACE CROSSING (FOR SEWER)

PART I GENERAL

1.1 Summary

- A. This section of specifications covers the requirements for making subsurface crossings by the bore and jack method or tunneling method where specified on the drawings.

1.2 Related Sections

- A. Section 02250 - Trenching, Backfill and Compaction
- B. Section 02600 - Ductile Iron Pipe and Fittings
- C. Section 02732 - Sanitary Sewerage System

1.3 Unit Prices

- A. Subsurface Crossings:

- 1. The method of payment for the carrier pipe shall be by the linear foot.
- 2. The method of payment for the encasement pipe shall be by the linear foot and include all casing, straps, seats, casing spacers, carrier piping between each end of casing, and all mortar plugs. This price shall also include all excavation, shoring, barricades, etc. necessary for installation of a bore pit and a receiving pit at the opposite end of the crossing for accommodating extension of the carrier line.

1.4 References:

- A. AWWA C600, Installation of Ductile Iron Water Main and Appurtenances.
- B. Alabama Department of Transportation Standards for the Accommodating Utilities on Highway Right-of-Ways.
- C. American Railway Engineering Association Manual for Railway Engineering.

1.5 Regulatory Requirements

- A. The contractor shall follow and abide by any and all requirements imposed by the local Alabama Department of Transportation (ALDOT) concerning Traffic Control measures and barricades around the bore pits. However, the local Department of Transportation shall be under no duty to require such barricades.
- B. The contractor shall follow any requirements imposed by the Alabama Department of Transportation on roads and highways under their jurisdiction.

- C. Crossings under railroads shall be subject to the requirements of the particular railroad being crossed. In general, the railroad companies will furnish, at the contractor's expense, day and night watchmen, flagmen, and inspectors. The contractor shall include in his bid monies to cover said inspectors, watchmen, and flagmen.
- D. The Contractor shall strictly comply with all OSHA requirements, standards, regulations and guidelines. In addition, the Contractor shall take whatever measures are necessary to ensure the safety of his personnel and subcontractors, the Owner, its representatives, and the public.

1.6 Site Conditions

- A. The contractor shall familiarize himself with the existing conditions and have the proper material and equipment on hand prior to commencing the work.
- B. Subsurface Crossings:
 - 1. The contractor shall install, as a minimum, reflective tape and barricades, consisting of wooden handrails installed in a manner to protect the public around all open pits.
 - 2. Open pits shall be marked with flashing lights and wooden handrails to protect pedestrians.
 - 3. Any requirements imposed by the Tuscaloosa Department of Transportation, or the Alabama Department of Transportation shall be in addition to the above requirements.
 - 4. The contractor shall maintain drainage in all open ditches around open bore pits.
 - 5. The contractor shall take all precautions against damage to the roadbed structure, railway roadbed and any structures crossed by a subsurface crossing.

1.7 Scheduling

- A. The contractor shall schedule all subsurface crossings with the City of Tuscaloosa Water and Sewer Department and the Tuscaloosa Department of Transportation and other appropriate agencies.
- B. Subsurface Crossings under railroads shall be scheduled with the appropriate railroad company prior to the start of any work.

PART II PRODUCTS

2.1 Materials

A. Subsurface Crossings:

1. Steel Casing Pipe:

- a. All casing pipe shall be fabricated with straight seam steel conforming to ASTM A252, Grade 2, and be of the diameter and wall thickness called for on the plans. In general, the casing pipe shall be large enough in diameter to accommodate the flange or joint on the carrier pipe, spacers, etc. Spiral welded pipe shall not be acceptable.
- b. Steel casing shall have a minimum yield point of 35,000 psi.
- c. Steel casing pipe shall have as a minimum the following wall thickness:

Pipe Diameter Inches	Minimum Wall Thickness Inches
8-16	0.250
24	0.375
30"	0.500
>30"	0.5625

- d. Steel casing having a wall thickness greater than the minimum listed above shall be considered for approval during the submittal process. The steel casing diameter selected for this project is based on available clearances at these minimum wall thicknesses. As such, the required clearances must be confirmed by a manufacturer's submittal for approval. The method of payment for the casing and carrier pipe shall be by the linear foot at the unit price as listed on the bid form. No extra payment will be made for an approved "thicker" encasement pipe.
- e. All pipe shall be coated inside and out with at least one coat of approved primer paint. In addition, the external surface shall be treated with coal tar epoxy as per AWWA C203 latest edition. Other protection material may be used if approved by the Engineer.
- f. Tunnel liners used in the tunneling method shall be approved by the Engineer prior to installation.
- g. Where more than one segment of steel casing pipe is required to complete the crossing, each segment must be welded to form one continuous casing. All segments to be welded shall be squarely

cut, cleanly beveled (exterior only), and welded. Welding of steel casing shall conform to the requirements of AWS D1.1 and be full penetration, butt welds around the full circumference of the casing. The exposed metal shall be coated with coal tar epoxy as per AWWA C203 latest edition. All casing pipe shall be fabricated with no more than one (1) longitudinal welded seam joint and have no more than one (1) mid-section (vertical) weld per ten (10) linear feet of casing pipe. Casing segments fabricated with multiple plate sections will not be acceptable.

2. Carrier pipe shall be ductile iron pipe as called for in Section 02600, on the plan drawings, and on the utility permits and licenses. The carrier pipe shall be installed with gripper type gaskets or restrained joint DI pipe.
3. Casing Spacers:
 - a. Spacers used with ductile iron or PVC pipe 12" diameter, or less, shall be 8" wide, and spacers used with ductile iron or PVC pipe greater than 12" diameter shall be 12" wide. A total of three (3) spacers shall be utilized with each section of ductile iron pipe.
 - b. Spacer shell shall be constructed of high-density polyethylene. End flanges shall be ribbed for extra strength. Spacer liner shall be constructed of PVC, 85-90 durometer, and runners shall be constructed of chemically modified, ultra high molecular weight polymer for strength and lowered frictional characteristics. End caps shall be placed on each end of the casing pipe.
 - c. Spacers and their appurtenances shall be equivalent to the manufacture of Advance Products and Systems, Inc.

PART III EXECUTION

3.1 Preparation

A. Subsurface Crossing

1. The contractor shall excavate a bore pit of ample size to safely accommodate boring equipment, casing and carrier pipe, but not of a size that will damage the roadbed, railway or surrounding utilities.
2. The contractor shall protect existing roadbeds, railway roadbeds, sidewalks, utility or other existing structures from damage.
3. The contractor shall use shoring and bracing and other measures as necessary to prevent slides and cave-ins of the pit walls and to comply with OSHA and/or other safety requirements.
4. The contractor shall use wooden railing, barricades, flashing lights, reflective tape and/or other measures deemed necessary to protect

vehicles and pedestrians.

5. The contractor shall dispose of, at his expense, all the material excavated from the pit, bore or tunnel in a manner acceptable to the Engineer. This may require disposing of the materials off the project site. No material will be allowed to spill onto any travel path of a vehicle, onto any sidewalk, or damage any private property. If necessary, the contractor will store excavated material off-site if surrounding conditions do not permit ample storage on site.
6. The contractor shall maintain all open ditches and channel all water around the bore or tunnel pit in such a manner as to prevent the obstruction of storm runoff, etc.

3.2 Installation

A. Subsurface Crossing

1. Where the tunneling method is used, the carrier pipe shall be ductile iron, and the tunnel liner must be of a design approved by the Engineer prior to beginning the tunneling operation.
2. After completion of the bore and jack or tunneling operation, the carrier pipe will be fitted with appropriate straps or seats to hold the pipe to the correct line and grade. Straps or seats provided for the carrier line must be of a design approved by the Engineer and coated with a coal tar epoxy paint as per AWWA C203 latest edition, prior to installation.

All carrier pipe installed in casing that has been placed by the "bore and jack" method shall be firmly fitted inside the casing pipe with the use of stainless-steel pipeline casing spacers.

Each end of the casing and/or tunnel shall be sealed with a brick-and-mortar plug of sufficient thickness and construction to eliminate any water or soil from entering the casing pipe. Rubber casing end-seals with stainless steel bands may substitute for mortar plug if approved by the engineer.

3. After installation of the casing and carrier pipe is complete, the bore pit shall be backfilled and tamped. Compaction shall meet the requirements of the trench leading up to the bore pit but in no case shall the compaction be less than 90% of the maximum density as determined by AASHTO T-99.
4. After completion of the backfill operation, the bore pit and surrounding area damaged by construction shall be seeded and mulched. No separate payment shall be made for clean-up, seeding or mulching.

END OF SECTION

SECTION 02600

DUCTILE IRON PIPE AND FITTINGS (FOR SEWER)

PART I GENERAL

1.1 Section Includes

- A. Ductile Iron Pipe and Fittings

1.2 Related Sections

- A. Section 02250 Trenching, Backfill, and Compaction
- B. Section 02732 Sanitary Sewer System

1.3 References

- A. AWWA C104/A21.4 American National Standard for Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
- B. ANSI/AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems
- C. AWWA C110/A21.10 American National Standard for Ductile- Iron and Gray-Iron Fittings, 3-in. through 48 in. for water and other liquids.
- D. AWWA C111/A21.11 American National Standards for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
- E. ANSI/AWWA C115/A21.15 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
- F. AWWA C150/A21.50 American National Standard for the Thickness Design of Ductile Iron Pipe.
- G. AWWA C151/A21.51 American National Standard for Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water and Other Liquids.
- H. AWWA C153/A21.53 Ductile-Iron Compact Fittings, 3-in through 64-in for Water Service
- I. AWWA C600 AWWA Standard for the Installation of Ductile Iron Water Mains and Their Appurtenances.

1.4 Submittals

- A. The Contractor shall supply copies of the manufacturer's test reports, manufacturer's installation recommendations and manufacturer's certification that materials provided meet their specifications.

1.5 Quality Assurance

- A. All ductile iron piping, fittings, and appurtenances shall be new and unused and shall be suitable for the intended purpose.
- B. The Contractor shall submit test certificates on all pipe and fittings.
- C. Each joint of pipe shall be plainly marked at the site of the manufacturer to indicate the class, thickness, and strength.
- D. All manufacture and testing of ductile iron pipe will be conducted in facilities located in the USA and operating under laws and regulations of the USA.

1.6 Delivery, Storage, and Handling

- A. All ductile iron pipe and fittings are subject to inspection at delivery and other times as deemed necessary by the Engineer. Any pipe and/or fittings damaged during delivery shall be promptly removed from the job site.
- B. Ductile iron pipe shall be stored off the ground, supported by timbers, railings, or concrete supports, and shall be of sufficient size to avoid contact with the ground or adjacent piping. Supports shall have chocks to prevent movement. Stacking shall be low enough to provide a safe condition, especially in neighborhoods and accessible areas.
- C. Pipe and fittings shall be stored to prevent damage to the interior or exterior lining. The interior of all pipe and fittings shall be kept free of dirt and debris. Ductile iron pipe shall not be stacked higher than specified in Table 5 of AWWA C600.
- D. Pipe and fittings shall be loaded and unloaded by joists or skids to avoid sudden impact on the material. In no case shall the pipe or fittings be dropped. Slings, hooks, or pipe tongs shall be padded to avoid damage to the exterior or interior linings.
- E. Gaskets for mechanical joint and push-on joint pipe and fittings shall be stored in a cool, dry place out of direct sunlight. Contact with petroleum-based substances is prohibited.

PART II PRODUCTS

2.1 Approved Manufacturers

- A. All Pipe must be new and shall be manufactured in accordance with ANSI/AWWA C151/A21.51 in the United States of America (USA); all ductile iron pipe shall be cast, cleaned, lined, coated, tested, and certified at a manufacturing facility located in the USA. The raw material for ductile iron shall have an average minimum content consisting of at least 90% or more of recycled ferrous scrap iron and steel.
- B. Approved manufacturers are:
 - 1. American Cast Iron Pipe Company
 - 2. U.S. Pipe
 - 3. McWane Pipe
 - 4. Others as approved by the Owner and City

2.2 Material

- A. Ductile Iron Pipe and Fittings
 - 1. In general, ductile iron pipe for underground work shall have push-on or mechanical joints; ductile iron pipe for exposed work shall have flanged joints. Where shown on the drawings, grooved-end pipe shall be used to allow removal of valves and fittings.
 - 2. Ductile iron pipe shall have a minimum nominal laying length of 18 feet.
 - 3. For pipe sizes equal to or greater than 16", green banded pipe (gauged full) shall be provided for the required number of cuts on the project. The green banded pipe shall be set aside and utilized for sections of pipe that have to be "cut to fit". Unless otherwise approved by the City, all "cut to fit" ductile iron pipe must be green banded.
 - 4. Restrained joints shall be "Flex-Ring" or "Lok-Ring" restrained joints as manufactured by American Ductile Iron or approved equal. Field-adaptable restraint shall be provided using "Amarillo Fast-Grip" or "Field Flex-Ring" as manufactured by American Ductile Iron Pipe or approved equal.
 - 5. Ductile iron pipe with push-on or mechanical joints shall conform to ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51, latest revision. Push-on or mechanical joints shall conform to the requirements of ANSI/AWWA C111/A21.11. Pipe pressure classes and wall thicknesses shall be in accordance with bury depths and laying conditions as specified in C150/A21.50 and C151/A21.51. Minimum pressure classes for buried pipe shall be:
 - a. 350 psi for pipes ≤ 12 inches
 - b. 250 psi for pipes ≤ 24 inches
 - c. 150 psi for pipes ≥ 30 inches

6. Ductile iron pipe with flanged or grooved joints and flanges for threading onto ductile iron pipe shall conform to the requirements of ANSI/AWWA C115/A21.15, latest revision (including appendix). Minimum classes for flanged or grooved joint pipe shall be:
 - a. 350 psi for pipes ≤ 12 inches
 - b. 250 psi for pipes ≥ 14 inches
7. Ductile iron fittings with push-on or mechanical joints shall conform to ANSI/AWWA C110/A21.10 or compact fittings conforming to ANSI/AWWA C153/A21.53, latest revision. Mechanical joints and gaskets shall conform to the requirements of ANSI/AWWA C111/A21.11. Minimum pressure classes for ductile iron mechanical joint fittings shall be:
 - a. 350 psi for pipes ≤ 24 inches
 - b. 250 psi for pipes ≥ 30 inches
8. Fittings for flanged ductile iron pipe shall conform to the requirements of ANSI/AWWA C110/A21.10, latest revision (including appendix). And shall have a minimum pressure rating of 250 psi. Gaskets for flanged joints shall be full face of first quality red rubber, 1/8-inch thick.
9. All fittings with mechanical joints shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases.
 - a. Flexibility of the joint shall be maintained after burial. Glands shall be manufactured of ductile iron conforming to ASTM A536-80. Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN.
 - b. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to ANSI/AWWA A21.11 and ANSI/AWWA/A21.53 of the latest revision. Twist-off nuts shall be used to insure proper actuating of the restraining devices. The mechanical joint restraint device shall have a working pressure of at least 250 psig with at minimum safety factor of 2:1 and shall be MEGALUG by EBAA Iron Inc. or approved equal.
10. All bolts for fittings shall be furnished by the same company as the pipe manufacturer and shall be American made. Bolts shall be corrosion resistant alloys as recommended by the pipe manufacturer.
 - a. Corten steel bolts and nuts shall be utilized for below ground installations.

B. Gaskets

1. Gaskets shall be made by the same manufacturer as ductile iron pipe.
2. Furnish, when no containment is identified, plain rubber (SBR) gasket material; for flanged joints 1/8-inch thick gasket in accordance with ANSI A21.11.
3. Pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed pipeline, shall have the following gasket materials for the noted contaminants:

Contaminant	Gasket Material Required
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As Recommended by the Pipe Manufacturer

C. Coatings and Linings

1. All ductile iron pipe and fittings shall be cement mortar lined conforming to AWWA C104 and C151. Cement mortar lining shall be standard thickness with a bituminous seal coat.
2. All ductile iron pipe and fittings for underground installation shall receive an exterior bituminous coating of 1-mil minimum thickness.
3. Exposed piping shall have exterior rust inhibitive primer coating compatible with finished paint.
4. For protection against hydrogen sulfide corrosion, all ductile iron pipe sewer pipe and fittings for the City of Tuscaloosa shall be lined with a 40-mil thickness coating of Permox CTF amine cured novolac epoxy or approved equal. Coating shall be red in color.
5. Where shown on the drawings or required by the Engineer, ductile iron pipe and fittings situated in aggressive soils or crossing steel gas mains shall be polyethylene wrapped in accordance with ANSI/AWWA C105/A21.5. Polyethylene encasement for use with ductile iron pipe systems shall consist of three layers of co-extruded linear low-density polyethylene (LLDPE), fused into a single thickness of not less than eight mils. The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of antimicrobial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion (V-Bio).
6. For steel gas crossings, ductile iron pipe shall be polyethylene encased a minimum of fifty (50) feet to either side of the crossing.
7. Unless otherwise noted on the Plans, all piping located inside sewage wetwells shall be coated with coal tar epoxy paint.

PART III EXECUTION

3.1 Examination

- A. The Contractor shall examine the site, trench, and surrounding conditions to ensure proper installation of the pipe and associated fittings.
- B. The Contractor shall examine pipe and fittings for any scratches or abrasions to the coating or linings, or other physical damage prior to its installation.
- C. Trenches shall be inspected for proper alignment and grade. Check trench bottom to assure proper clearance from other utilities, pipelines, or existing structures.
- D. Any bedding required by the drawings or specifications shall be installed prior to pipe placement.

3.2 Installation

- A. Every care shall be taken in the handling, cutting, and laying of pipe and fittings to avoid damaging the interior or exterior coating. Damaged or defective areas shall be repaired or replaced to the satisfaction of the City.
- B. Each section of ductile iron pipe shall be placed in the prepared trench with the full length of the barrel resting upon the pipe bed and with the pipe bell over a bell hole excavated at the proper location to accommodate the bell. No temporary supports under the pipe such as bricks, rocks, etc., shall be permitted.
- C. Any pipe found defective shall be replaced at the Contractor's expense. Cracked pipe may be cut as specified previously in this section, if authorized by the City.
- D. Pipeline shall be laid with bells in direction of laying unless it is necessary to do otherwise to make connections to existing pipe. Where pipe is to be laid on a slope, the direction of laying shall be from downstream to upstream.
- E. All lumps, blisters, and excess coating shall be removed from the socket and plain ends of each pipe and the outside of the plain end, and the inside of the bell shall be wiped clean and dry and free from dirt, sand, grit, or any foreign material before the pipe is laid. Foreign material shall be prevented from entering the pipe while it is being placed in the trench. During laying operations, no debris, tools, clothing, or other materials shall be placed in the pipe.
- F. As each length of pipe is placed in the trench, the joint shall be assembled, and the pipe brought to correct line and grade as shown on the drawings.
- G. Assembly of ductile iron push on joints and mechanical joints shall be in accordance with AWWA Specifications C600, Section 4.3. The Contractor shall use particular care in cleaning the socket, plain end, and gasket. Mechanical joint bolts shall be tightened to the proper torques shown in Table 4, AWWA Standard C600.

- H. Deflections of ductile iron pipe having mechanical joints, if authorized by the Engineer, shall not exceed the deflection limits shown in Table 3, AWWA Standard C600. All bolts and set screws shall be checked immediately before backfilling.
- I. Deflections for push-on joint pipe shall conform to Table 2 of AWWA C600.
- J. At times when pipe laying is not in progress, the open ends of pipe shall be closed by the use of pipe plugs or other methods approved by the Engineer to keep mud, water, and other debris out of the pipe.
- K. Pipe cutting for the insertion of valves and fittings shall follow the manufacturer's recommendations. No torch cutting shall be allowed.
- L. Trenches shall be backfilled according to Section 02250, Trenching, Backfilling, and Compaction.
- M. During the course of the work, all existing pipe, valves, fittings, etc., that are removed and salvageable shall remain the property of the Owner and shall be delivered by the Contractor to the Owner or other area designated by Owner.

3.3 Field Testing

- A. After completion of the backfilling of trenches, pipe and fittings shall be tested according to applicable Section 02732 Sanitary Sewer System of the project specifications.

3.4 Protection

- A. After a completed installation, the Contractor shall take measures to protect the newly installed pipeline and associated fittings from damage until final acceptance by the Owner.

END OF SECTION

SECTION 02607

MANHOLE AND COVER INSTALLATION

PART I GENERAL

1.1 Section Includes:

- A. Material and installation requirements for precast concrete manhole sections with tongue-and-groove joints, masonry transition to manhole frame, covers, anchorage and accessories.

1.2 Related Sections:

- A. Section 02250 - Trenching, Backfill, & Compaction
- B. Section 02700 - Wastewater Flow Control

1.3 References:

- A. ANSI/ASTM C55 - Concrete Building Brick
- B. ASTM A48 - Gray Iron Castings
- C. ASTM C478 - Precast Reinforced Concrete Manhole Sections
- D. ASTM C923-Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipe
- E. International Masonry Industry All-Weather Council (IMIAC). Recommended Practices and Guide Specification for Cold Weather Masonry Construction.

1.4 Submittals

- A. Submit as per project requirements.
- B. Product Data. Provide manufacturer's specifications for manhole covers and frames, method of anchorage, component construction, features, configuration, dimensions, and weights.

1.5 Qualifications

- A. Manufacturer. Company specializing in manufacturing products specified in this section with minimum of five years documented experience.

1.6 Environmental Requirements

- A. Masonry construction shall not be performed when ambient temperatures are 40 degrees F and falling, unless provisions for heating and protecting the work area are approved. Protect new masonry from freezing for 48 hours after completion of the masonry work.

PART II PRODUCTS

2.1 General:

- A. Manholes, frames, and covers shall conform to these specifications, details as shown on the Plans, all referenced standards, the requirements of the manhole manufacturer, and appropriate industry standards.
- B. Manhole covers shall be of either Standard Type (non-bolted), Bolt-Down Type, or Hinged Type as indicated on the Plans or as otherwise specified. If not otherwise indicated, manhole covers shall be Standard Type.
- C. The Contractor shall provide manhole covers and frames which have been approved by the Owner. Approved covers and frames are as shown in the details on the Plans.

2.2 Materials:

A. Precast Manhole Base and Sections:

- 1. All precast manholes shall be new, unused manholes delivered directly from the manufacturer to the job site. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the outside of the barrel.
- 2. Precast concrete manholes shall be of reinforced concrete manhole sections conforming to the requirements of ASTM C478. The concrete when tested in compression shall not be less than 4000 psi and absorption shall not exceed 9%.
- 3. Precast manhole base and sections shall be a minimum of 48 inches inside diameter. Precast manhole base shall have a minimum wall thickness of five inches with minimum bottom thickness of six inches minimum. Minimum wall thickness of the manhole riser sections shall be 5 inches for 48" I.D. sections, 6 inches for 60" I.D. sections, and 7 inches for 72" I.D. sections.
- 4. Manhole base riser, riser, transition, and cone sections shall have offset tongue and groove joints and shall be made watertight with pre-lubricated rubber gaskets conforming to ASTM C443 and butyl sealant waterstops. Pre-lubricated gaskets shall be Tylox Superseal as manufactured by Hamilton-Kent; butyl sealant waterstop shall be Conseal CS-231, in widths as recommended by the manufacturer.
- 5. Manholes shall be assembled with the fewest number of sections to makeup the required height, thereby reducing the number of joints. The use of more than one riser section of 16 inches or less shall be prohibited. The City may require that any manhole not composed of the minimum number of sections be replaced.

6. Precast eccentric cone shall be provided at top section of manhole. Eccentric cone shall have the same reinforcing as manhole base and sections. Cone sections shall be made with a minimum 5-inch wall thickness at the bottom and 8-inch wall thickness at the top. Where watertight manhole frame and covers are indicated on the drawings, cone sections shall be supplied with four (4) stainless steel anchor bolts.
7. Two lift holes shall be cast into each cone or riser section for purposes of handling and placement.
8. Openings for inlet and discharge sewer pipes shall be provided in the manhole base section and in the riser section for drop manholes. Openings shall be at positions and elevations as indicated on the plans and may be cast into the manhole wall mechanically cored at the manufacturing facility. Openings shall be sized to accommodate the flexible manhole sleeve.
9. Manhole steps shall be cast in the precast section by the manufacturer.

B. Precast Concrete Adjusting Rings

1. Provide precast concrete adjusting rings, as required, between top of eccentric cone and finished grade.
2. Precast concrete adjusting rings shall be of same materials of construction as manhole bases and sections, grooved top and bottom.
3. Adjusting rings shall be three inches high by five inches thick. Maximum combined height of adjustment rings shall be limited to eight (8) inches.
4. Provide 1/4 inch thick minimum bed of mortar between adjustment rings and ring and cone.

C. Flexible Manhole Sleeves

1. Flexible manhole sleeves suitable for use in precast or cored openings utilizing premolded shapes positioned with expansion rings shall comply with the requirements of ASTM C923 and shall be manufactured by Kor-N-Seal or approved equal. Flexible connectors shall be installed as recommended by the manufacturer.

D. Manhole Steps

1. Manhole steps shall be Copolymer Polypropylene Plastic Coating with ½ inch minimum Grade 60 steel reinforcing, 12 inches wide, with slip resistant surface.
2. Manhole steps shall conform to ASTM 478 as manufactured by M. A. Industries, Model PSI-PF, or equal. Steps shall be centered under the manhole cover opening and be vertically aligned on 16-inch centers.

E. Manhole Frame and Cover

1. Manhole covers and frames shall be constructed of cast iron conforming to ASTM A48-83, Class 30, as a minimum. Tensile strength of the cast iron shall be a minimum of 30,000 psi. Covers and frames shall be made in the United States and shall be made of materials from the United States.
2. Covers and frames shall be "Heavy Duty" type, rated for a minimum of H-20 loading.
3. All castings shall be sound, smooth and clean, free of blisters, pits, cracks, and other defects. Castings judged to be defective by the Owner or the Engineer will be rejected and shall be replaced by the Contractor at no additional cost to the Owner.
4. Casting tolerances shall be $\pm 1/16"$, with an additional $1/16"$ per foot of dimension.
5. Manhole covers shall be cast with two (2) non-penetrating type pick-holes. Manhole covers shall not have vent holes.
6. All frames shall have integrally cast, full perimeter mud rings. Frames shall be cast with four (4) one-inch diameter holes in the flange for anchor bolts.
7. The seating surfaces of frames and covers shall be machined flat to ensure contact between the cover and frame along the full perimeter, in accordance with Federal Specifications RR-F-621.
8. Gaskets shall be provided for all and installed on all manhole frames. Gaskets shall be secured to the seating surface of the frame with a non-degrading glue by the manufacturer. Gaskets shall be flat, $1/8"$ thick, black neoprene with a tensile strength of 2,000 psi.
9. For manhole covers indicated as Bolt-Down Type, frames shall be cast and machined to accept four (4) cover bolts. Covers shall be cast with four (4) holes, $3/4"$ diameter. Bolts shall be stainless steel, $5/8"-11 \times 1"$ hex-head cap screws and shall be provided with all Bolt-Down Type covers. Bolts shall include stainless steel washers and a rubber sealing gasket.
10. The manhole covers shall be cast with The City of Tuscaloosa Logo indented in the top design with "SANITARY SEWER" also cast in the cover. See Plans for Detail.
11. Covers shall be cast with four (4) stacking lugs, each $5/8"$ wide by 2" long, on the bottom of the lid.
12. Sanitary sewer manhole castings shall comply with the requirements of the City, the Standard Drawings, or as called for in the Plans. The

contact surfaces between the cover and its corresponding supporting ring in the frame shall be machined so that cover will rest on the ring for the full perimeter of the contact surfaces. Castings shall be thoroughly cleaned of foreign matter and rust and shall be painted with a bituminous coating.

13. Defective castings which have been plugged or otherwise treated shall be rejected.

F. Non-Shrink Grout

1. Non-shrink grout shall be used to seal openings in the manhole base and riser sections such as lift holes and around flexible sleeve connections as shown on the standard details. Non-shrink grout shall be Thoro WaterPlug or approved equal.
2. Surface preparation, mixing and application shall strictly adhere to manufacturer's recommendation.

PART III EXECUTION

3.1 Excavation and Backfill

- A. Perform excavation to lines and grades established by the Drawings. Construct excavation a minimum of two feet in diameter larger than the outside dimensions of the manhole base and sections.
- B. If material in bottom of excavation is unsuitable for supporting manhole, excavate unsuitable material to a depth specified by the City and backfill resulting void with Alabama Department of Transportation #57 crushed limestone.
- C. Backfill around manholes constructed in paved areas or areas to be paved with Alabama Department of Transportation #57 crushed limestone to within 12 inches of the finished subgrade elevation. Provide and install Alabama Department of Transportation #825 crushed limestone in the 12-inch void. Compact backfill in six-inch lifts with vibratory compaction equipment to minimum density of 100% Standard Proctor Density.
- D. Backfill around manholes in unimproved areas and lawns with native materials, compacted in 8-inch lifts to minimum density of 95 percent Standard Proctor Density.

3.2 Granular Base

- A. Remove standing water from excavation. Place 12 inches minimum of Alabama Department of Transportation #57 crushed limestone and compact with vibratory compaction equipment.

- B. Excavations deeper than 12 inches below required grade of manhole base, not approved by the Engineer, shall be filled with Alabama Department of Transportation #57 crushed limestone and compacted by vibratory compaction equipment at no additional cost to the Owner.

3.3 Placing Manhole Base and Sections

- A. Manhole shall be constructed to the size, shapes, dimensions, and at the locations shown on the Plans.
- B. Precast manhole bases shall be set plumb and true to the lines and grades specified by the Drawings. Manholes out of plumb in excess of 1/4 inch in 8 feet shall be reset.
- C. Clean ends of manhole sections of foreign materials and inspect ends for damage.
- D. Place prelubricated gasket into recess. Place butyl sealant waterstop. Follow gasket and waterstop manufacturers' installation instructions. Set manhole section.
- E. When new openings are required in existing manholes, openings shall be core drilled.
- F. Install flexible manhole sleeves on pipes at the precast or core drilled openings according to manufacturer's recommendations.
- G. Seal lifting holes and flexible manhole sleeves in manhole on the interior and exterior with non-shrink grout to divert infiltration.
- H. Seal interior section joints with non-shrink grout.

3.4 Manhole Invert

- A. Manhole inverts shall be constructed of cement mortar and shall have the same cross-section as the invert of the sewers which they connect. The manhole invert shall be carefully formed to the required size and grade by gradual and even changes in sections. Changes in direction of flow through the sewer shall be made to a true curve and with as large a radius as the size of the manhole will permit.
- B. For pipe diameters less than 48 inches, a bench shall be constructed on each side of the flow channel. The bench shall slope one (1) inch per foot. Bench shall be made of non-shrink grout.
- C. Where the difference in the invert elevation of two or more sewers 18-inches in diameter or smaller intersecting in one manhole is 2-feet or more, a drop manhole shall be constructed in the manner shown on the Drawings. They shall be similar in construction to the standard manhole except that a drop connection of pipe and fittings of the proper size and material shall be constructed outside the manhole and supported by 3,000 psi concrete. The manhole and drop

connection shall be placed on a 12-inch reinforced concrete foundation base. The drop connection piping assembly shall be bolted to the barrel of the manhole riser. Drop connection piping shall be ductile iron.

- D. When noted on the Plans and/or where sewer mains have to be placed in service less than 24 hours after installation, precast inverts are required.

3.5 Manhole Frame and Covers

- A. Install manhole frames and covers with top surface adjoining surrounding grade in improved areas, or 6 inches above grade in unimproved areas. Where manholes are constructed in paved areas, the top surface of the frame and cover shall be tilted so as to conform to the exact slope, crown and grade of the existing pavement adjacent thereto. Set manhole frames at the required elevation in a full bed of grout to provide proper bonding to cone section and/ or concrete adjusting rings.
- B. Where manhole frame elevation requires adjustment, precast concrete adjusting rings shall be used. A minimum of ¼-inch bed of non-shrinking grout shall be placed between the manhole cone section and the adjusting ring. Same grout thickness shall be provided in between adjusting rings when multiple rings are necessary. Butyl sealant waterstop shall be placed beneath the frame in between each concrete adjusting ring. Butyl sealant shall be Conseal CS-231
- C. Manhole frame shall be positioned concentrically above the precast cone section or adjusting rings and set in a full bed of non-shrinking grout. A thick ring of non-shrinking grout extending to the outer edge of the precast cone section or adjusting ring shall be placed all around and on top of the manhole frame. The non-shrinking grout shall be smoothly finished and have a slight slope to shed water away from the frame and cover.
- D. Check the manhole covers for fit in their frame. If a manhole is either excessively loose or tight in the frame, or rocks, wobbles, or otherwise moves in its frame, the frame and cover shall be removed and replaced by the Contractor at no additional cost to the Owner.
- E. The Contractor shall install and tighten stainless steel bolts on all Bolt-Down type covers.

3.6 Manholes Over Existing System (Doghouse)

- A. "Doghouse" type manholes are not approved for use when connecting to the City of Tuscaloosa Sewer System unless:
 - 1. Explicit approval has been obtained in writing from the City of Tuscaloosa.

3.7 Connection to Existing Manholes

- A. Connect sewers to existing manholes at locations shown on the Drawings.

- B. Provide diversion facilities, as required, to maintain flow in existing sewers.
- C. Break out manhole sections, or grouting, as necessary to install pipe and re-grout to provide smooth flow into and through existing manholes.

3.8 Protective Coatings

- A. Where shown on the Drawings or directed by the City, manholes shall be protected from corrosion using factory applied linings.
- B. The lining shall be a geopolymer, multilayered polyurethane/polymeric stress skin panel system, a 100 percent solids epoxy or polyurethane coating, or a composite system consisting of an epoxy or polyurethane topcoat over a cementitious base coat.

END OF SECTION

SECTION 02622

POLYVINYL CHLORIDE GRAVITY SEWER PIPE

PART I GENERAL

1.1 Section Includes:

- A. This section of specifications covers the material requirements for polyvinyl chloride (PVC) pipe, fittings, and laterals for use in gravity sewer applications.
- B. The installation requirements for pipe specified under this section shall conform to Section 02250 – Trenching, Backfill, & Compaction.
- C. The testing requirements for materials, in-place, specified under this section shall conform to Section 02732 – Sanitary Sewer System.

1.2 Related Sections:

- A. Section 02250 – Trenching, Backfill, & Compaction
- B. Section 02732 – Sanitary Sewerage System

1.3 References

- A. ASTM D1784, latest revision, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- B. ASTM D3034, latest revision, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC Sewer Pipe and Fittings).
- C. ASTM D2412, latest revision, External Properties of Plastic Pipe by Parallel Plate Loading.
- D. ASTM D3212, latest revision, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- E. ASTM F477, latest revision, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- F. ASTM D2321, latest revisions, Standard Recommended Practice for Installation of Flexible Thermoplastic Sewer Pipe.
- G. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-inches to 12-inches, for Water Distribution.

1.4 Quality Control and Assurance

- A. All pipe and fittings shall be inspected at the factory and on the job site. The pipe shall be homogeneous throughout and free from cracks, holes, foreign

inclusions, or other defects. The pipe shall be as uniform in color as commercially practical. PVC pipe shall have a ring painted around the spigot ends in such a manner as to allow field checking of setting depth of pipe in the socket.

- B. PVC sewer pipe shall be marked with the manufacturer's name, production, lot number, ASTM designation, PVC cell classification or material code, dimension ratio or standard dimension ratio, and the nominal diameter. All PVC pipe shall be manufactured in the United States.
- C. All PVC pipe shall be new and unused and properly stored at the manufacturer to prevent degradation of the pipe due to the exposure to sunlight and excessive heat.
- D. Pipe must be delivered to job site by means, which will adequately support it, and not subject it to undue stresses. In particular, the load shall be so supported that the bottom rows of pipe are not damaged by "egging" or crushing. Pipe shall be unloaded carefully and strung or stored as close to the final point of placement as is practical. Pipe shall not be stored outside where subject to sunlight.
- E. Pipe which has been stored by the Contractor for three (3) months or longer shall not be acceptable.

PART II MATERIALS

2.1 PVC Gravity Sewer

- A. PVC gravity sewer pipe shall be made from compounds conforming to ASTM D1784. PVC pipe and fittings, 8 to 12 inches in diameter, shall conform to and be tested under all of the requirements of ASTM D3034. This designation specifies minimum requirements and test methods for materials, dimensions, workmanship, flattening resistance, impact resistance, pipe stiffness, extrusion quality, and pipe marking. PVC gravity sewer shall have a wall thickness equal to or greater than SDR 26.
- B. Minimum pipe stiffness ($F / \Delta Y$) at 5 percent deflection shall be 115 for all sizes when calculated in accordance with ASTM D2412.
- C. PVC sewer pipe shall be supplied in standard lengths of at least 12 feet 6 inches. Longer lengths are permitted. PVC gravity sewer pipe shall be green in color.
- D. Fittings for service connections shall be of the factory made inline type conforming to the requirements of ASTM D3034 and shall have a wall thickness equal to or greater than SDR 26. Service connections shall be made with wye fittings. Saddle type fittings shall not be used.
- E. All pipe and fittings shall be joined by means of an integral wall bell and spigot with a flexible watertight elastomeric seal. Joint material and testing requirements shall conform to ASTM D3212 and ASTM F477.

2.2 PVC Laterals

- A. PVC service laterals for PVC sewer mains shall be Schedule SDR 26.
- B. PVC service laterals for ductile iron sewer mains shall be AWWA C-900 pipe and shall have a wall thickness equal to or greater than DR 25.
- C. Contractor shall provide an easily removable, watertight and airtight, gasketed plug at the end of the service lateral.

PART III EXECUTION

3.1 PVC Gravity Sewer

- A. Installation of PVC gravity sewer pipe shall conform to City of Tuscaloosa requirements for hydrostatic pressure testing, and a mandrel test as well as ASTM D2321 and manufacturer's recommendations unless otherwise amended in these Specifications.
- B. Trenching, backfill, and compaction shall conform to Section 02250 – Trenching, Backfill, and Compaction of these Specifications.
- C. The inside of all bells and outside of all spigots shall be wiped to remove all dirt, water, or other foreign matter so that their surfaces are clean and dry when the pipes are joined.
- D. Immediately before joining PVC pipe, the joining surfaces shall be completely coated by brushing with the lubricant sealer furnished by the pipe manufacturer. The spigot end shall then be centered to exact line and grade and then sealed by forcing the spigot into the bell in an approved manner.
- E. Pipe that has been field cut must be beveled for insertion into the gasketed joint. Bevel can be made with hand or power tool. In either case, the finished bevel should be the same as the factory bevel.

3.2 PVC Laterals

- A. Installation of PVC gravity sewer pipe shall conform to City of Tuscaloosa requirements for hydrostatic pressure testing, and a mandrel test as well as ASTM D2321 and manufacturer's recommendations unless otherwise amended in these Specifications. Connection between service lateral and sewer mains shall be watertight. PVC service laterals shall be installed for each lot and extend from the collector sewer to user's property line.
- B. Trenching, backfill, and compaction shall conform to Section 02250 – Trenching, Backfill, and Compaction of these Specifications.
- C. A PVC-coated electronic service marker shall be located six inches above the top of the lateral just beyond the curb.

3.3 Location of PVC Pipe

- A. A metallic tape and wire shall be installed in the same trench with all non-metallic pipe (PVC) in order that the pipe may be located with electronic metal detection equipment. Wire shall be T.W. 12-gauge solid copper conforming to specifications for annealed copper, ASTM B-3 and Underwriters Laboratories Thermoplastic Insulated Wire Standard No. 83, latest revision. Wire shall be Simplex BW3001, or equal. Pipe detector tape shall be two (2) inch wide minimum metalized tape. Tape shall be Griffolyn Company, Inc., Terratape 2" D., or equal. Wire and/or Tape shall be secured to pipe at intervals of 20 feet.

END OF SECTION

SECTION 02623

POLYVINYL CHLORIDE PRESSURE SEWER PIPE

PART I GENERAL

1.1 Section Includes:

- A. This section of specifications covers the material requirements for polyvinyl chloride (PVC) pipe, fittings, and laterals for use in pressure sewer applications. These include low pressure sewers and force mains.
- B. The installation requirements for pipe specified under this section shall conform to Section 02250 – Trenching, Backfill, & Compaction.
- C. The testing requirements for materials, in-place, specified under this section shall conform to Section 02732 – Sanitary Sewer System.

1.2 Related Sections:

- A. Section 02250 – Trenching, Backfill, & Compaction
- B. Section 02732 – Sanitary Sewer System
- C. Section 02600 – Ductile Iron Pipe and Fittings

1.3 References

- A. ASTM D1784, latest revision, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- B. ASTM D2241, latest revision, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- C. ASTM D2412, latest revision, External Properties of Plastic Pipe by Parallel Plate Loading.
- D. ASTM D3139, latest revision, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- E. ASTM F477, latest revision, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- F. ASTM D1785, latest revision, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- G. ASTM D2665, latest revision, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- H. ASTM D2672, latest revision, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.

- I. ASTM D2855, latest revision, Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

1.4 Quality Control and Assurance

- A. All pipe and fittings shall be inspected at the factory and on the job site. The pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions, or other defects. The pipe shall be as uniform in color as commercially practical. PVC pipe shall have a ring painted around the spigot ends in such a manner as to allow field checking of setting depth of pipe in the socket.
- B. PVC sewer pipe shall be marked with the manufacturer's name, production, lot number, ASTM designation, PVC cell classification or material code, dimension ratio or standard dimension ratio, and the nominal diameter. All PVC pipe shall be manufactured in the United States.
- C. All PVC pipe shall be new and unused and properly stored at the manufacturer to prevent degradation of the pipe due to the exposure to sunlight and excessive heat.
- D. Pipe must be delivered to job site by means, which will adequately support it, and not subject it to undue stresses. In particular, the load shall be so supported that the bottom rows of pipe are not damaged by "egging" or crushing. Pipe shall be unloaded carefully and strung or stored as close to the final point of placement as is practical. Pipe shall not be stored outside where subject to sunlight.
- E. Pipe which has been stored by the Contractor for three (3) months or longer shall not be acceptable.

PART II MATERIALS

2.1 PVC Force Main (SDR 21, 4-inch diameter and larger)

- A. PVC force mains shall be made from compounds conforming to ASTM D1784. PVC force main pipe and fittings, 4 to 12 inches in diameter, shall conform to and be tested under all requirements of ASTM D2241. This designation specifies minimum requirements and test methods for materials, dimensions, workmanship, sustained pressure, burst pressure, flattening, extrusion quality, and pipe markings. PVC force main pipe shall have a wall thickness equal to or greater than SDR 21. Pipe shall have a pressure rating of 200 psi.
- B. Minimum pipe stiffness ($F / \Delta Y$) at 5 percent deflection shall be 224 for all sizes when calculated in accordance with ASTM D2412.
- C. PVC force main shall be supplied in standard lengths of at least 12 feet 6 inches. Longer lengths are permitted. PVC force main pipe shall be green in color.

- D. PVC force main pipe shall be joined by means of an integral wall bell and spigot with a flexible watertight elastomeric seal. Joint material and testing requirements shall conform to ASTM D3139 and ASTM F477.
- E. Fittings for PVC force main shall be ductile iron with mechanical joints conforming to Section 02600 – Ductile Iron Pipe and Fittings. Special transition gaskets shall be used to join SDR 21 PVC pipe to mechanical joint fitting.

2.2 PVC Low Pressure Sewer (SDR 21, less than 4-inch diameter)

- A. PVC low pressure sewer pipe and fittings shall be made from compounds conforming to ASTM D1784. PVC lower pressure sewer pipe, less than 4 inches in diameter, shall conform to be and be tested under all requirements of ASTM D2241. This designation specifies minimum requirements and test methods for materials, dimensions, workmanship, sustained pressure, burst pressure, flattening, extrusion quality, and pipe markings. PVC low pressure sewer pipe shall have a wall thickness equal to or greater than SDR 21. Pipe shall have a pressure rating of 200 psi.
- B. Minimum pipe stiffness ($F/\Delta Y$) at 5 percent deflection shall be 224 for all sizes when calculated in accordance with ASTM Designation D2412.
- C. PVC low pressure sewer pipe shall be supplied in standard lengths of at least 12 feet 6 inches. Longer lengths are permitted. PVC low pressure sewer pipe shall be green in color.
- D. PVC low pressure sewer pipe shall be joined by means of an integral wall bell and spigot with a flexible watertight elastomeric seal. Joint material and testing requirements shall conform to ASTM D3139 and ASTM F477.
- E. Fittings for PVC low pressure sewer pipe shall have a wall thickness equal to or greater than SDR 21.

2.3 PVC Low Pressure Sewer (SCH 40, less than 4-inch diameter)

- A. Alternatively, PVC low pressure sewer pipe and fittings, less than 4 inches in diameter, shall be Schedule 40 made in accordance with ASTM D1785 and ASTM D2665 from a PVC compound conforming to a cell classification of 12454 as defined by ASTM D1784. Belled end of solvent weld pipe shall meet the requirements of ASTM D2672 when installed in accordance with ASTM D2855.
- B. PVC SCH 40 pipe and fittings shall have a minimum pressure rating of 260 psi.

PART III EXECUTION

3.1 PVC Pressure Pipe

- A. In addition to the requirements for installation and testing specified in Section 02732 – Sanitary Sewer System, installation of PVC pressure sewer pipe shall

conform to manufacturer's recommendations unless otherwise amended in these Specifications.

- B. Trenching, backfill, and compaction shall conform to Section 02250 – Trenching, Backfill, and Compaction of these Specifications.
- C. The inside of all bells and outside of all spigots shall be wiped to remove all dirt, water, or other foreign matter so that their surfaces are clean and dry when the pipes are joined.
- D. Immediately before joining PVC pipe, the joining surfaces shall be completely coated by brushing with the lubricant sealer furnished by the pipe manufacturer. The spigot end shall then be centered to exact line and grade and then sealed by forcing the spigot into the bell in an approved manner.
- E. Pipe that has been field cut must be beveled for insertion into the gasketed joint. Bevel can be made with hand or power tool. In either case, the finished bevel should be the same as the factory bevel.

END OF SECTION

SECTION 02700

WASTEWATER FLOW CONTROL

PART I GENERAL

1.1 Section Includes:

- A. General
- B. Depth of Flow
- C. Plugging and Blocking
- D. Pumping and Bypassing
- E. Flow Control Precautions

1.2 Related Sections:

- A. Section 02600 - Ductile Iron Pipe & Fittings for Sewer
- B. Section 02622 – PVC Gravity Sewer
- C. Section 02623 – PVC Pressure Sewer
- D. Section 02732 – Sanitary Sewerage System
- E. Section 02952 – Closed Circuit Television Inspection

1.3 Submittals:

- A. Prior to commencing work, the Contractor shall submit a complete and detailed wastewater containment and management Plan wastewater flow control plan to the Engineer for review as per Section 16-78 of the City of Tuscaloosa Code.

PART II PRODUCTS

2.1 Pipe for Flow Diversion:

- A. Ductile Iron Pipe is acceptable for use for flow diversion during construction.
- B. Polyethylene Pipe. Polyethylene material shall comply with the requirements for Type III polyethylene, C-5 and P-34 as tabulated in ASTM D-1248 and have the Plastic Pipe Institute recommended designation PE3406. The material shall also have an average specific base resin density of between 0.94 g/cc and 0.955 g/cc (ASTM D-1505). Pipe made from these resins must have a long term strength (50 years) rating of 1,250 psi or more per hydrostatic design basis categories of ASTM D-2837. The polyethylene resin shall contain antioxidants and be stabilized against ultraviolet degradation to provide protection during processing and subsequent weather exposure. The polyethylene resin shall have an environmental stress crack resistance, condition C as shown in ASTM D-1693, to be greater than 500 hours, 20% failure. All pipe shall be made from virgin quality

material. No rework compound, except that obtained from the manufacturer's own production of the same formulation shall be used. The polyethylene resin shall have an average melt flow index, condition E as shown in ASTM D-1238, not in excess of 0.25 g/10 min. Pipe shall be homogeneous throughout, and free of visible cracks, holes, foreign material, blisters, or other deleterious faults. Diameters and wall thickness shall be measured in accordance with ASTM D-2122. Pipe joining will be done by thermal butt fusion method in accordance with ASTM D-2657.

- C. Acrylonitrile-Butadiene-Styrene (ABS). ABS pipe shall comply with the requirements of ASTM D-2751.

PART III EXECUTION

3.1 General:

- A. All materials used for wastewater flow control shall be pre-approved by the Engineer prior to commencing wastewater flow control activities.
- B. When wastewater flows at the upstream manhole of the manhole section being repaired are above the maximum allowable requirements for television inspection, or do not allow the proper sewer or manhole repair, the flows shall be reduced to the levels required by one of the following methods: plugging/blocking of the flows, or pumping/bypassing of the flows as approved by the Engineer.
- C. In some applications, the wastewater flow may be plugged and contained within the capacity of the collection system. This shall only be done when it has been determined, by the Engineer, that the system can accommodate the surcharging without any adverse impact.
- D. For the initial television inspection, before a liner is installed, the Contractor shall block the sewer line completely. No flow, except infiltration/inflow, will be allowed through the respective sewer line being televised on the pre-repair television survey.
- E. When sewer line flows at the upstream manhole of the line being repaired, in the opinion of the Engineer, are too excessive to plug while the rehabilitation is being performed, the Contractor shall submit a written plan and pump/bypass the flow as acceptable to the Engineer.
- F. When existing storm or sanitary sewers are required to be taken up, moved, or rebuilt, the Contractor, at his own expense, shall provide and maintain temporary outlets and connections for all private or public drains, sewers, and sewer outlets connected to or served by the sewers to be rebuilt, and where necessary, shall provide adequate plumbing facilities, and shall maintain these services until such time as the permanent sewers and connections are built and in service at no cost to the Owner.
- G. During construction, flows in sections of the existing sewer being rehabilitated by removal and replacement shall be accommodated by temporary flow diversion.

Wastewater flow diversion shall be accomplished as specified in this section, unless otherwise shown on the plans.

- H. The Contractor shall use the provided construction easement for the flow diversion, if no otherwise shown on the plans. It shall be the Contractor's option to lay diversionary pipe within the construction easement. The Contractor shall use ingenuity and skill to develop a flow diversion program. The program must keep the wastewater flowing without discharge or spills into the creek or on the ground. The Contractor will seek and obtain inspection of each section of newly laid sewer before taking the diversion out of service and placing the newly laid section in service.
- I. In sections of the existing sewer being rehabilitated by laying a new line parallel to the existing sewer, the existing sewer may be used to accommodate the existing flow, and no temporary flow diversion will be necessary if the existing sewer is not damaged or its use restricted by the Contractor's operations.
- J. All pipe materials utilized in wastewater flow diversion during construction shall be in good condition, and free of defects, and leaks. Any defective material shall be replaced by the Contractor at no cost to the Owner. Upon completion of the job, pipe materials shall be removed from the site.

3.2 Depth of Flow:

- A. For the initial (pre-installation) television inspection, before a liner is installed, the Contractor shall block the sewer line completely. No flow, except infiltration/inflow, will be allowed through the respective sewer line being televised on the pre-repair television survey.
- B. When sewer line flows at the upstream manhole of the line being repaired, in the opinion of the Engineer, are too excessive to plug while the rehabilitation is being performed, the Contractor shall submit a written plan and pump/bypass the flow as acceptable to the Engineer.
- C. When approved by the Engineer that flows are too excessive and bypassing is required, the Contractor shall control the depth of flow in the sewer within the following guidelines:

MAXIMUM PIPE FLOW DEPTH			
Television Inspection		Joint Testing and Sealing	
<i>Pipe Size</i>	<i>% Pipe Diameter</i>	<i>Pipe Size</i>	<i>% Pipe Diameter</i>
6" - 10"	20	6" - 12"	25
12" - 24"	25	15" - 24"	30
27" or larger	30	27" or larger	35

- D. When sewer line flows, as measured in the first manhole upstream of the sewer segment being rehabilitated, exceed the maximum depth listed above or inspection of the complete pipe periphery is necessary for effective testing,

sealing, or line work, the Contractor shall implement wastewater flow control methods at no additional cost to the Owner.

3.3 Plugging and Blocking:

- A. The Contractor shall insert a sewer line plug into the line at a manhole upstream from the section being inspected or repaired. The plug shall be so designed that all or any portion of the operation flow can be released. During the survey portion of the operation, flows shall be shut off or reduced to within the maximum flow limits specified. During repairs, the flows shall be shut off or pumped/bypassed as approved by the City. Wastewater flow shall be restored to normal following completion of work within the subject manhole section.

3.4 Pumping and Bypassing:

- A. When pumping/bypassing is required, as determined by the Engineer, the Contractor shall supply the necessary pumps, conduits, and other equipment, to divert the flow of wastewater around the manhole section in which the work is to be performed. The bypass system shall be of sufficient capacity to handle existing flows plus additional flow that may occur during periods of rainstorms. The Contractor shall be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing system. A “setup” consists of the necessary pumps, conduits, standby vacuum truck and other equipment required to divert the flow of wastewater around a manhole section, from the start to finish of work performed in the manhole section.
- B. Wastewater shall be pumped directly into the nearest available downstream manhole, provided that the existing sewer has capacity to transport the flow. The Contractor shall be responsible for keeping the pumps running continuously 24-hours a day, if required, until the bypass operation is no longer required. The Contractor shall have standby pumps at all times.
- C. Pumps and equipment shall be continuously monitored by a maintenance person capable of starting, stopping, refueling, and maintaining these pumps during the rehabilitation. If pumping is required on a 24-hour basis, engines shall be equipped in a manner to keep noise to a minimum.

3.5 Flow Control Precautions:

- A. Where the wastewater flow is blocked or plugged, the Contractor shall be responsible for taking sufficient precautions to protect public health. The sewer lines shall also be protected from damage. The following shall apply:
 - 1. No wastewater shall be allowed to back up into any homes or buildings.
 - 2. No wastewater shall overflow any manholes, clean out, or any other access to the sewers.
 - 3. Users upstream of the repair area shall be able to use all their water and sewer utilities without interruption.

4. If any of the above occur or are expected to occur, the Contractor shall provide bypass pumping to alleviate one or all of the conditions. Additionally, the Contractor shall observe the conditions upstream of the plug and be prepared to immediately start bypass pumping, if needed.
- B. Any sump pumps, bypass pumps, trash pumps, or any other type of pump which pulls wastewater or any type of material out of the manhole or sewer shall discharge the material into another manhole, or appropriate vehicle or container approved by the Engineer. Under no circumstances shall this material be discharged, stored, or deposited on the ground, swale, road, or open environment.
- C. The Contractor shall take appropriate steps to ensure that all pumps, piping, and hoses that carry raw wastewater are protected from traffic. Traffic control shall be performed in accordance with the requirements of Project Construction Plans and Specifications and comply with the latest version of the MUTCD.
- D. In the event, during any form of "wastewater flow control", that the raw wastewater is spilled, discharged, leaked, or otherwise deposited in the open environment, due to the Contractor's work, the Contractor shall be responsible for any cleanup of solids and stabilization of the area affected. This work shall be performed at the Contractor's expense with no additional cost to the Owner. The Contractor shall also be responsible for notifying the sewer system maintenance personnel and complying with any and all regulatory requirements for cleaning up the spill at no additional cost to the Owner.
- E. During wastewater flow control operations, the Contractor shall take proper precautions to prevent damage to existing sanitary sewer facilities, flooding, or damage to public or private property.
- F. The Contractor shall make repairs or replacements or rebuild such damaged section or sections of existing sewers, as directed by the City. All such repairs, replacements, and rebuilding shall be paid for by the Contractor.
- G. The Contractor shall make such provisions as are necessary for handling all flows in existing sewers, connections, and manholes by pipes, flumes, or by other approved methods at all times, when his operations would, in any way, interfere with the normal functioning of those facilities.
- H. The Contractor shall be responsible for the removal of any debris and sedimentation in the existing sewers, laterals, and manholes, etc., which is attributable to his work under this Contract.
- I. All operations shall be performed by the Contractor in strict accordance with OSHA and any applicable local safety requirements. Particular attention is directed to safety regulations for excavations and entering confined spaces.
- J. It is the Contractor's responsibility to notify, in writing, any property owner having a sewer service connection on the sewer being rehabilitated or replaced, that such work is being performed. The Contractor shall notify property owners 48 hours prior to commencing sewer rehabilitation or replacement. The Contractor

shall be solely responsible for any damaged caused by property service connection backups caused by the sewer rehabilitation operations.

END OF SECTION

SECTION 02732

SANITARY SEWER SYSTEM

PART I GENERAL

1.1 Section Includes:

- A. This section of specifications covers installation requirements of gravity sewer pipe and pressure sewer pipe. Testing requirements for gravity sewers, manholes, and force mains are also provided in this section.
- B. All materials used in the construction of sewers shall be new and unused when delivered to the job site and shall be suitable for installation and operation under the conditions for which they are to be used.

1.2 Related Sections

- A. Section 02622 – Polyvinyl Chloride Gravity Sewer Pipe
- B. Section 02623 – Polyvinyl Chloride Pressure Sewer Pipe
- C. Section 02600 – Ductile Iron Pipe and Fittings
- D. Section 02607 – Precast Concrete Manholes
- E. Section 02250 – Trenching, Backfill, and Compaction

PART II PRODUCTS (NOT USED)

PART III INSTALLATION

3.1 Gravity Sewer Pipe Laying – General

- A. Before sewer pipe is placed in position in the trench, the bottom and sides of the trench shall be carefully prepared, and the necessary bracing and sheeting installed.
- B. Unless noted otherwise on the drawings, all gravity sewer lines shall be installed with a minimum thirty-six (36) inches of cover.
- C. A properly designed and operated laser beam device may be used to align and grade the pipe. Laser beam devices used shall be carefully calibrated at intervals not to exceed 30 calendar days.
- D. Air lowers must be used in conjunction with laser beam devices and must be sufficient to provide an air flow through the pipe of 4 to 6 mph.
- E. If approved by the City, the batter board method may be used. A mason's line shall then be tightly stretched above ground level, parallel to and directly above the axis of the pipe to be installed; this line to be supported at intervals not exceeding 50 feet. The exact line and grade for each section of the pipe shall be determined by measuring down from this line to the invert of the pipe in place. Each pipe shall be accurately placed to the exact line and grade called for on the

plans. The Contractor shall furnish all labor and materials necessary for erecting batter boards.

- F. Water shall not be allowed to run or stand in the trench while pipe laying is in progress or before the joints are completed or before the trench has been backfilled. The Contractor shall not open up, at any time, more trench than his available pumping facilities are able to dewater.
- G. Each piece of pipe and special fitting shall be carefully inspected before it is placed, and no defective pipe shall be laid in the trench. Pipe laying shall proceed up grade, starting at the lower end of the grade and with the bells uphill.
- H. After pipe laying has begun, it shall continue progressively up grade. No section of pipe installation will be skipped without a written request for such procedures from the Contractor and approved by the City.
- I. Bell holes shall be of sufficient size to allow ample room for properly making the pipe joints. Bell holes shall be cut not more than five joints ahead of pipe laying. The bottom of the trench and the crushed stone cushion between bell holes shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe and so as to avoid sudden offsets and inequalities in the flow line.
- J. Backfilling of trenches shall be started immediately after the pipe is in place and the joints completed and inspected by the Developer's Engineer.
- K. A metallic tape and wire shall be installed in the same trench with all non-metallic pipe (PVC) in order that the pipe may be located with electronic metal detection equipment. Wire shall be T.W. 12-gauge solid copper conforming to specifications for annealed copper, ASTM B-3 and Underwriters Laboratories Thermoplastic Insulated Wire Standard No. 83, latest revision. Wire shall be Simplex BW3001, or equal. Pipe detector tape shall be two (2) inch wide minimum metalized tape. Tape shall be Griffolyn Company, Inc., Terratape 2" D., or equal. Wire and/or Tape shall be secured to pipe at intervals of 20 feet.
- L. Manholes shall be installed according to Section 02607 – Precast Concrete Manholes.

3.2 Lateral Installation

- A. Wye shall be installed in sanitary sewer lines at all points shown on the plans or specified herein. If such branches are not to be used immediately, they shall be closed with gasketed plugs specifically designed for such purpose.
- B. If the work consists of the construction of a sewer that is to replace an existing sewer, all of the existing service lines shall be connected to the new line.
- C. Wyes shall be installed in sanitary sewers so as to properly serve each existing house and each vacant lot facing or abutting on the street or alley in which the sewer is being laid, and at such other locations as may be designated by the

Engineer. The exact location of each connection shall be determined by the Engineer before backfilling.

- D. Should ductile iron pipe lining be scratched, chipped, or otherwise damaged during the tapping process, it shall be properly repaired or recoated by the Contractor.
- E. Laterals shall be bedded and backfilled according to Section 02250 – Trenching, Backfill, and Compaction.
- F. Where the depth of cut is over 8 feet or where the grade of a sanitary sewer is lower than necessary to drain abutting property, and when designated by the Engineer, connecting risers shall be installed to serve each existing house and each vacant lot facing or abutting on the street in which the sewer is being laid.
- G. Connecting risers shall be either 4 or 6 inches in diameter installed from a wye connection to the elevation designated by the Engineer. Open ends of connecting risers shall be closed, as herein before specified for wye branches. Backfilling shall be carefully done around these risers.

3.3 Pressure Sewer Pipe Laying – General

- A. Before sewer pipe is placed in position in the trench, the bottom and sides of the trench shall be carefully prepared, and the necessary bracing and sheeting installed.
- B. Unless noted otherwise on the drawings, all pressure sewers shall be installed with a minimum of thirty-six (36) inches of cover.
- C. Water shall not be allowed to run or stand in the trench while pipe laying is in progress or before the joints are completed or before the trench has been backfilled. The Contractor shall not open up at any time more trench than his available pumping facilities are able to dewater.
- D. Each piece of pipe and special fitting shall be carefully inspected before it is placed and no defective pipe shall be laid in the trench. No section of pipe installation will be skipped without a written request for such procedures from the Contractor and approved by the City.
- E. All pressure pipe, four inches and over in diameter, shall be provided with adequate thrust restraints. Thrust restraints, consisting of concrete thrust locks and/or mechanical restraining rod attachment, shall be furnished at all fittings, plugs, and all pipe bends as shown on the Standard Detail Drawing.
- F. Air release valves, Air/Vacuum release valves, and Combination air valves shall be installed at the locations shown on the drawings.
- G. A metallic tape and wire shall be installed in the same trench with all non-metallic pipe (PVC) in order that the pipe may be located with electronic metal detection equipment. The tape or wire shall be attached to the top of the pipe. Wire shall be T.W. 12-gauge solid copper conforming to specifications for annealed copier,

ASTM B-3 and Underwriters Laboratories Thermoplastic Insulated Wire Standard No. 83, latest revision. Wire shall be Simplex BW3001, or equal. Pipe detector tape shall be two (2) inches wide, minimum, metalized tape. Tape shall be Griffolyn Company, Inc., Terratape 2" D, or equal. Wire and/or Tape shall be secured to pipe at intervals of 20 feet.

3.4 Pipe Protection

- A. Unless otherwise noted on the Plans, sewer pipe which, when completed, will have less than three (3) feet of cover, shall be constructed of ductile iron pipe.
- B. Where foundation conditions are not satisfactory, as determined by the City, sewer pipe shall be either laid on a concrete cradle, sand backfill, foundation material, and/or constructed of ductile iron pipe, as shown on the plans, or as directed by the City.

3.5 Testing of Gravity Sewers and Manholes

A. General

- 1. The approval and acceptance of gravity sewer lines and manholes shall be based on final testing. The Contractor must provide a 72-hours' notice prior to final testing to the Engineer. A representative from the Engineer and/or City must be present to witness final testing procedures. Tests performed in the absence of a City representative shall be considered invalid and shall be repeated by the Contractor.
- 2. Final testing of gravity lines shall only be performed after all work adjacent to and over the pipeline has been completed. Trench backfilling, grading, roadway subgrade, concrete work, other utility installation, and any other superimposed loads shall be completed and in place prior to final testing.
- 3. Prior to any testing and final inspection, all gravity lines shall be cleaned of debris and flushed clean with water, as necessary, by the Contractor. Debris and flush water shall be contained at a lower manhole and removed from the line. Debris and flush water shall not be allowed to enter live existing sanitary sewers. The Contractor shall be responsible for collection and proper disposal of debris and flush water.
- 4. All apparatus and equipment required for testing shall be furnished by the Contractor.
- 5. Contractor shall provide the Engineer and City with copies of all field notes and documentation obtained during final testing.

B. Scope

- 1. All gravity sewers shall be tested by one or more of the following methods, as directed by the City.
 - a. Direct Visual Inspection by the City

- b. Exfiltration of Water
- c. Infiltration of Water
- d. Exfiltration of Air Under Pressure (low pressure air testing)
- e. Video Inspection

- 2. In addition to the above testing requirements, all PVC gravity sewers shall pass mandrel testing to verify roundness and proper installation.
- 3. All manholes shall be vacuum tested.

C. Direct Visual Inspection by the City

- 1. The City and/or the city's representative shall visually inspect all gravity sewer pipe installed to verify alignment and ensure the pipe is free from obstructions and debris. Each segment of sewer shall be "flushed" using sunlight and mirrors. When the full diameter of the pipe is visible between adjacent manholes, the segment of the pipe is deemed properly aligned and free of sags and debris.
- 2. If segment of pipe fails visual inspection, the pipe shall be cleaned and/or replaced and re-tested by the Contractor.

D. Exfiltration of Water

- 1. The section of sewer to be tested shall be sealed by inserting inflatable rubber bags or plugs in the pipes or by other means approved by the City. Water shall then be introduced into a manhole until the pipeline section is completely filled. The Contractor shall fill the pipe to the required test level prior to the time of exfiltration testing to permit normal absorption into the pipe walls if concrete or concrete lined ductile iron pipe is being tested. Throughout the test period of two (2) hours minimum, the water level in the upper manhole shall be maintained at least 18-inches above the crown of the upper end of the pipe or at least 18-inches above the groundwater table, whichever is greater. The length of pipe tested shall be limited such that the pressure on the centerline of the lower pipe end tested does not exceed six (6) feet water column.
- 2. Exfiltration of water shall not exceed 100-gallons per mile of sewer per inch of inside diameter per 24-hours in any section of the completed work. In no case shall the exfiltration of water exceed 2,500 gallons per mile per 24 hours. All observed leaks shall be corrected by the Contractor even though exfiltration is within the allowable limits.
- 3. The Engineer may direct the Contractor to test selected sections of the sewer in the following manner: After the selected sections of the sewer are laid in the trench and all the joints completed but before any backfill is placed, Contractor shall install suitable bulkheads or stoppers in each end of the sewer and fill the sewer with water. The sewer shall be filled through one length of sewer pipe installed vertically at a wye or at the end of the pipe being tested. Water shall be maintained in the line approximately to the top of the fill pipe until the Engineer can inspect the

section of sewer being tested. Any leaks in the sewer system being tested shall be repaired by the Contractor. The total amount of sewer thus tested shall not exceed five percent (5%) of the total length of sewer constructed. Should the results of any of these tests indicate leakage, the City may direct the Contractor to change the methods of construction to reduce the leakage on the remaining part of the work.

E. Infiltration of Water

1. The section of sewer to be tested shall have been trench backfilled and the test conducted by inducing infiltration conditions by jetting the sewer trench for a sufficient length of time to insure that the water level in the trench is a minimum of eighteen (18) inches over the crown of the sewer pipe. The test must be performed before existing sewers are connected and before sewage load is allowed in the sewers.
2. Infiltration of ground water or other leakage into the sewer (including manholes) shall not exceed 100 gallons per mile of sewer per inch of inside diameter of the sewer per 24 hours in any section of the completed work, and in no case shall it exceed 2,500 gallons per mile per 24 hours.
3. Infiltration flow shall be measured in wet weather by a 90-degree "V-notch" weir with free discharge or other means acceptable to the City. These weirs shall be furnished, installed, and removed by the Contractor.
4. Any leaks into the sewer that can be located shall be repaired or corrected by the Contractor, as directed by the City, regardless of infiltration test results.

F. Exfiltration of Air Under Pressure (low pressure air testing)

1. Scope
 - a. This recommended practice defines the proper procedures for acceptance testing of installed gravity sewer pipe, using low pressure air, to provide assurance that the pipe, as installed, is free from significant leaks. Included are requirements for equipment accuracy, safety precautions, line preparation, test methods, and minimum holding times. This recommended practice does not cover the testing of manholes. All new pipe shall be low pressure air tested to ensure the integrity of the pipe and joints.
 - b. Only lines tested after backfilling to final grade will be considered for acceptability. However, this test may also be used by the installer as a presumptive test to determine the condition of the line prior to backfilling. At no time will more than four manhole to manhole reaches of pipe be installed before air testing is performed.

- c. Low Pressure Air Testing shall be conducted in accordance with ASTM C828, C924, F1417, and UBPPA UNI-B-6.

2. Responsibilities

- a. Responsibility of the Contractor: Unless otherwise specified, the Contractor shall furnish all the necessary equipment and be responsible for conducting all low pressure air tests. In addition, the Contractor is responsible for any necessary repair work on sections that do not pass the test. No sealant shall be used in any newly installed sewer without the prior approval of the City. Proper structural repair work will be required by the Engineer or the City.
- b. Responsibility of the Engineer: The Engineer and/or a qualified inspector shall witness all low-pressure air tests and verify the accuracy and acceptability of the equipment utilized. The Engineer should inform the Contractor regarding acceptable methods of repair in the event one or more sections fail to pass the low pressure air test. The Engineer should also report to the City regarding the acceptability of the Contractor's work.
- c. Responsibility of the City: The City shall make a final decision as to the acceptability of the Contractor's work based upon the Engineer's recommendation.
- d. Regulatory Agencies: Regulatory Agencies in the State, Federal, and/or Local levels may be legally entitled to witness any air testing and/or review the results. The City, or their Engineer, should check to see that the low pressure air test specified for his installation is at least as stringent as those which may be required by such regulatory bodies.

3. Equipment

- a. Air testing shall be performed by the Contractor using equipment manufactured by Cherne Industries, Inc., or approved equal. Equipment used shall meet the following minimum requirements.
- b. Pneumatic plugs shall resist internal testing pressures without requiring external bracing or blocking. However, the Contractor should internally restrain or externally brace the plugs to the manhole wall as an added safety precaution throughout the test. No one shall be allowed in the manhole adjoining a line being tested so long as pressure is maintained in the line.
- c. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.
- d. To facilitate test verification by inspecting Engineer, all air used shall pass through a single, above ground control panel.

- e. The above ground air control equipment shall include a shut-off valve, pressure regulating valve, pressure relief valve, input pressure gauge, and a continuous monitoring pressure gauge having a pressure range from 0 to at least 10 psi.
- f. Three individual hoses shall be used for the following connections:
 - i. From control panel to pneumatic plugs for inflation
 - ii. From control panel to sealed line for introducing the low pressure air.
 - iii. From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

4. Line Preparation

- a. During sewer construction, all service laterals, stubs, and fittings into the sewer test section shall be properly capped or plugged so as not to allow for air loss that could cause an erroneous air test result.
- b. A wetted interior pipe surface is desirable and will produce more consistent test results. Where practical, clean the line with cleaning balls, manufactured by Cherne Industries, Incorporated, or equal, prior to testing, to wet the pipe surface and eliminate debris.

5. Test Procedure

- a. All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to the manufacturer's recommended inflation pressure. The sealed pipe shall be pressurized to 9 PSIG. The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.
- b. After a manhole to manhole reach of the pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to manufacturer's recommended inflation pressure. When plugs are being placed, the pipe adjacent to the manhole shall be visually inspected to detect any evidence of shear in the pipe due to differential settlement between the pipe and the manhole.
- c. Low pressure air shall be slowly introduced into this sealed line until the internal air pressure reaches 4.0 PSIG greater than the average back pressure of any groundwater above the pipe, but not greater than 9.0 PSIG. If groundwater is present, refer to the

following Paragraph 6. Determination of Groundwater Elevation and Air Pressure Adjustment, of Section 3.5.F. in this Specification.

- d. After a constant pressure of 4.0 PSIG (greater than the average groundwater back pressure) is reached, the air supply shall be throttled to maintain the internal pressure for at least 2 minutes.
- e. When the pressure has stabilized at 4.10 PSIG, the air hose from the control panel to air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased at no less than 3.5 PSIG. At a reading of 3.5 PSIG, or any convenient observed pressure reading between 3.5 PSIG and 4.0 PSIG, timing for the test may begin.
- f. The portion of line being tested shall be termed "acceptable" if the allocated line pressure decreases less than one PSI in the time shown for the given diameters and lengths in the following table. Consult the City for test lengths greater than those provided.

MINIMUM SPECIFIED TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP

Pipe Dia. (inches)	Specification Time for Length Shown (min:sec)							
	100 FT	150 FT	200 FT	250 FT	300 FT	350 FT	400 FT	450 FT
8	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33

- g. If there has been no leakage (0 PSIG drop) after one hour of testing, the test section shall be accepted and the test complete. If there is any pressure drop, the complete test shall be run to determine whether or not the test section is acceptable.
- h. If the pressure drops 1.0 PSIG before the appropriate time shown in the table has elapsed, the air loss rate shall be considered excessive, and the section of pipe has failed the test.
- i. If the section fails to meet these requirements, the Contractor shall determine the source(s) of leakage, and he shall repair or replace all defective materials and/or workmanship to the satisfaction of the City. The extent and type of repair which may be allowed, as well as results, shall be subject to the approval of the Engineer. The completed pipe installation shall then be retested and required to meet the requirements of this test.

6. Determination of Groundwater Elevation and Air Pressure Adjustment

- a. In areas where groundwater is known to exist, the Contractor shall install a 1/2-inch diameter capped pipe nipple, approximately 10 inches long, through the manhole wall directly on top of one of the sewer lines entering the manhole. A permanent, watertight seal shall be provided around the pipe nipple at the manhole wall. This shall be done at the time the sewer line is installed.
- b. Immediately prior to the performance of the air testing, the ground water shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to the nipple. The plastic tube shall be held vertically and a measurement of the height in feet of water over the invert of the pipe shall be taken after the water has stopped rising in this plastic tube. The height in feet shall be divided by 2.331 to establish the pounds of pressure that will be added to all readings. (For example, if the height of water is 11-1/2 feet, then the added pressure will be 5 PSIG. This will increase the 3.5 PSIG (mentioned in item e above) to 8.5 PSIG, and the 2.5 PSIG to 7.5 PSIG.)
- c. The allowable pressure drop of 1.0 PSIG and the timing in the previous table are not affected and shall remain the same.
- d. In no case shall the starting test pressure exceed 9.0 PSIG. If the average vertical height of groundwater above the pipe invert is more than 12.7 feet, the section so submerged may be tested using 9.0 PSIG as the starting test pressure.
- e. After determining the air pressure adjustment, the test shall resume according to Item 5 – Test Procedures stated above.
- f. After determining groundwater height, each pipe nipple shall be recapped and sealed to prevent future infiltration.

G. Mandrel Testing

1. Mandrel test (deflection test) shall be performed by the Contractor in order to verify the roundness and proper installation of the PVC gravity sewer line.
2. Equipment systems used to perform mandrel tests shall be specifically designed for the pipe material being tested. Mandrels that do not specifically state the size and type of piping for which it is applicable shall not be allowed.
3. Deflection Test
 - a. The deflection test shall consist of testing PVC gravity sewer pipe for proper installation by the method outlined (see ASTM D3034). The testing shall be accomplished prior to final acceptance, but at

least 30 days after the pipe has been backfilled completely to permit stabilization of the soil-pipe envelope.

- b. After the pipeline has been installed and backfill materials have been compacted to their required standard densities, the mandrel shall be pulled by hand through the pipeline with a suitable rope or cable that is connected to an eyebolt at one end of the gauge. A similar rope or cable shall be attached to the eyebolt at the opposite end of the mandrel and tension shall be applied to it. This will insure that the mandrel maintains its correct position during testing and also to remove the mandrel if it should become lodged in an excessively deflected pipeline. Winching or other mechanical means of forcing the mandrel through the pipeline is unacceptable. Pipeline deflection testing shall have a deflection not exceeding 5% of the base inside pipe diameter as established by ASTM Standards D3034 and F679.
- c. Permanent record of all testing with locations where excessive pipeline deflections occur shall be kept by the Contractor and forwarded to the City after completion of testing on each line.
- d. The Contractor shall immediately correct or replace all sections of pipe which deflect more than 5%.
- e. All material and labor required for testing and/or replacement of pipelines shall be furnished by the Contractor.
- f. Pipelines requiring correction and/or replacement shall be retested after an additional 30 day backfill stabilization period.

H. Manhole Vacuum Testing

- 1. Vacuum tests shall be conducted on newly constructed manholes. Preliminary manhole testing shall take place following construction after all connections are made, and before backfilling. Test results derived from this test will allow time for necessary repairs to be completed before further construction proceeds and hinders such repairs. Final tests must be performed after the manhole has been backfilled.
- 2. Equipment
 - a. Manhole vacuum tester assembly and vacuum pumps shall be manufactured by Cherne Industries, Inc., or approved equal.
 - b. Pneumatic plugs shall be manufactured by Cherne Industries, Inc., or approved equal. These plugs shall have a sealing length equal to or greater than the diameter of the connecting pipe to be sealed.
- 3. Procedures

- a. Plug all manhole entrances and exits, other than the manhole top access, using suitably sized pneumatic or mechanical pipeline plugs and follow all manufacturer's recommendations and warnings for proper and safe installation of such plugs. Plugs should be inserted a minimum of 6 inches beyond manhole wall. Make sure such plugs are properly rated for the pressures required for the test. The standard test of 10" Hg. (mercury) is equivalent to approximately 5 PSIG (0.3 bar) backpressure. Unless such plugs are mechanically restrained, it is recommended that the plugs are used with a minimum of two times (2x) safety factor or a minimum of 10 PSIG (0.7 bar) backpressure usage rating.

CAUTION: BRACE INVERTS, IF LINES ENTERING THE MANHOLE HAVE NOT BEEN BACKFILLED, TO PREVENT PIPE FROM BEING DISLODGED AND PULLED INTO THE MANHOLE.

- b. Any other openings, such as lifting holes, shall be sealed with an approved non-shrink grout.
- c. Install the vacuum tester head assembly at the top of the manhole. Adjust the cross brace to ensure that the inflatable sealing element inflates and seals against the straight top section of the manhole or the ring assembly, if possible. (If using a "plate" style manhole tester, position the plate on the manhole ring assembly.).
- d. Attach the vacuum pump assembly to the proper connection on the test head assembly. Make sure the vacuum inlet/outlet valve is in the closed position.
- e. Following safety precautions and manufacturer's instructions, inflate sealing element to the recommended maximum inflation pressure. CAUTION: DO NOT OVER INFLATE.
- f. Start the vacuum pump and allow pre-set RPM to stabilize.
- g. Open the inlet / outlet ball valve and evacuate the manhole to 10" Hg. (approximately negative 5 PSIG, 0.3 bar).

CAUTION: DO NOT PRESSURIZE MANHOLE! THIS MAY RESULT IN MANHOLE DAMAGE AND/OR RESULT IN MANHOLE TEST HEAD DISLODGING FROM MANHOLE INLET.

- h. Close vacuum inlet/outlet ball valve and monitor vacuum for specified test period (see table). If vacuum does not drop in excess of 1" Hg., manhole is considered acceptable and the manhole passes the test. If manhole fails the test, Contractor shall complete necessary repairs and repeat test procedures until satisfactory results are obtained.

MINIMUM TEST TIMES FOR VARIOUS MANHOLE DIAMETERS

Depth (feet)	Manhole Diameter (inches)			
	48	60	72	96
8	20 seconds	26 seconds	33 seconds	38 seconds
10	25 seconds	33 seconds	41 seconds	48 seconds
12	30 seconds	39 seconds	49 seconds	47 seconds
14	35 seconds	46 seconds	57 seconds	67 seconds
16	40 seconds	52 seconds	67 seconds	76 seconds
18	45 seconds	59 seconds	73 seconds	86 seconds
20	50 seconds	65 seconds	81 seconds	95 seconds
+2 ft. Increments	+ 5 seconds	+6.5 seconds	+8 seconds	+9.5 seconds

(The values listed above are based upon ASTM Specification C1244 "Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test".)

4. Repeat the above test procedure after backfilling manhole for final acceptance test.
5. All manholes that fail the test or have visible leaks, even if they pass the test, shall be repaired or replaced by the Contractor until the manholes pass the test, to the complete satisfaction of the City. Manholes that have any visible leaks will not be accepted.

3.6 Testing of Force Mains

A. General

1. This Section shall cover testing of sanitary sewer force mains for pipe sizes of four inches (4") in diameter and larger for flushing, hydrostatic pressure, and leakage. Testing shall be accomplished so that all portions of the system are flushed and tested according to these requirements. These requirements are for both Ductile Iron and Polyvinyl Chloride (PVC) pipe. The Contractor shall furnish test equipment, labor, materials, and water for all tests. All test equipment shall be approved by the Engineer.
2. The Contractor must provide to the City a 24-hour notice prior to final testing.
3. All apparatus and equipment required for testing shall be furnished by the Contractor.
4. Contractor shall provide Engineer and City with copies of all field notes, documentation, and recording charts obtained during final testing.

B. Flushing

1. Prior to beginning the pressure test, the line shall be flushed to remove all dirt and debris trapped in the line.

2. All valves shall be partially opened and closed during the flushing process.
3. All lines shall be flushed with a velocity of at least two and one-half feet per second.
4. The Contractor is responsible for the proper disposal of all flushed water.

C. Testing

1. Before applying the specified test pressure, all entrained air shall be expelled completely from the second pipe under test. Air shall be bled from the highest elevations in the line. If permanent air vents are not located in the high points in the test section, corporation cocks meeting the approval of the City shall be installed at such points so that air may be expelled as the line is filled with water. At the conclusion of the pressure test, the corporation cocks shall be removed and tightly plugged, or left in place at the direction of the City.
2. All exposed pipe, fittings, and joints shall be examined carefully during the test. Any damaged or defective pipe or fittings or any visible or audible leaks, discovered during or following the pressure test shall be repaired or replaced, regardless of the pressure test results, with sound material by the Contractor. The test shall be repeated until the results are satisfactory to the City.
3. The test pressure shall be the working pressure of the line as defined below, but in no case less than one hundred pounds per square inch (100 psi).
 - a. The working pressure shall be defined as one and one half (1.5) times the shut-off head of the system pump, or as defined by the City.
4. Leakage shall be defined as the quantity of water that must be supplied into the section of pipe being tested to maintain pressure within ± 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage **shall not** be measured by a drop in pressure in a test section over a period of time.
5. Upon complete removal of all air entrapped in the line, the line shall again be filled with water and pressurized to the required test pressure. The line shall be allowed to stabilize at the test pressure for a minimum of four (4) hours before conducting the pressure test.
6. Duration of the test shall be two (2) hours for uncovered pipe and six (6) hours for covered pipe. The test pressure shall not vary by more than plus or minus five pounds per square inch (± 5 psi) during the duration of the test. The specified test pressure shall be applied by means of a pump connected to the pipe.

7. A recording pressure gauge, approved by the City, shall be installed and pressure fluctuations recorded for the duration of the test. For each test, copies of all test charts and records shall be furnished to the City.

D. Acceptance

1. Acceptance shall be determined on the basis of allowable leakage. If any test of pipe laid discloses leakage greater than that specified, the failure shall be located and repaired using approved materials and acceptable construction practices until the leakage is within specified allowance. All visible leaks are to be repaired regardless of the amount of leakage.

2. Maximum allowable leakage in a test period shall not exceed:

$$L = \frac{ND(P^{1/2})}{7,400}$$

Where: L = allowable leakage in gallons per hour
N = Number of joints in the tested line (pipe and Fittings)
D = nominal diameter of pipe in inches
P = average test pressure during the leakage test in pounds per square inch, gauge (psig)

3.7 Clean Up and Grassing

- A. After the ditch lines have been sufficiently compacted, all excess material shall be removed from the job site by the Contractor.
- B. Any trees or undergrowth shall also be removed by the Contractor.
- C. All disturbed areas shall have topsoil replaced, equal to that before construction began. If necessary, the Contractor shall provide topsoil.

END OF SECTION

SECTION 02952

CLOSED-CIRCUIT TELEVISION INSPECTION

PART I GENERAL

1.1 Scope

- A. The Work covered by this section includes furnishing all labor, equipment, insurance, transportation and materials required to inspect the designated sanitary sewer lines specified.
- B. Closed-circuit television inspection of sanitary sewers as follows:
 - 1. CCTV inspection for condition assessment of line segments shall identify structural defects, pipe physical condition, sources of I/I entry, lateral location and visual assessment of laterals from the view of the camera in the mainline.
 - 2. CONTRACTOR shall use Television Inspection Form and Rehabilitation Tables approved by CITY prior to beginning of inspection.
- C. The CONTRACTOR will provide certification that they have undergone training prior to undertaking internal condition assessment work for the CITY. Defects Coding, as well as Material, Shape and Lining Coding used throughout the project will conform to PACP, or equivalent approved by CITY.
- D. The CONTRACTOR will provide sufficient survey/inspection units and all relevant ancillary equipment, including standby units in the event of breakdown, in order to complete all sewer and manhole surveys/inspections as specified.
- E. Flow Control shall be incidental to the CCTV inspection.
- F. Cleaning shall be incidental to the CCTV inspection.
- G. Traffic Control shall be incidental to the CCTV inspection.

1.2 Submittals

- A. Informational Submittals:
 - 1. Catalog and manufacturer's data sheets for television equipment.
 - 2. References: Contact names and telephone numbers.
 - 3. List of staff and equipment to be used on Project.
 - 4. Crew chief qualifications.

5. Certification that staff to be used for the Work is properly trained in confined space entry and hazardous atmospheres.
 6. Proposed defect-coding scheme for CITY approval.
 7. Proposed defect coding scheme.
- B. Operational Submittals:
1. Traffic control plan.
 2. Look-ahead inspection schedules, minimum of 7 days in advance of the Work.
 3. Initial first days' CCTV digital videos and inspection logs on DVD within 24 hours of start of CCTV inspection.
 4. Final report including defect coding information in MicroSoft Access or other CITY-approved format. A sample of the final report format and associated database format shall be submitted for the CITY's approval within 30 days of the notice to proceed.
 5. CCTV digital video shall be submitted in a format compatible with Windows Media Player. Viewing of the digital videos shall not require special software.
- C. Any submittal requirement may be waived at the discretion of the CITY.

1.3 Quality Assurance

- A. Qualifications:
1. CONTRACTOR: Performed work successfully for at least three other projects, within last 5 years, with pipe lengths and pipe diameters similar to this Project.
 2. Crew Chief: Minimum of 5 years' experience on projects similar to this Project and experience using proposed equipment for this Project.
- B. Prestartup Meeting: At least 5 days prior to beginning CCTV inspection work, schedule with CITY to review proposed sewer flow bypassing plan, traffic control plans, and inspection methods.
- C. Submit digital videos, photos and logs for quality review and comment to CITY within 24 hours after the first days' work is completed. Submit DVD's and logs on a routine basis within 7 days after completing each DVD. Picture quality and definition shall be to the satisfaction of CITY. Inspection equipment that fails to produce satisfactory inspection quality shall be removed.

1.4 Notifications

A. Notify CITY:

1. A minimum of 5 days prior to the anticipated commencement of inspections in any one area and 24 hours in advance of actual start.
2. When obstruction, restricting flow in pipeline, is discovered.
3. If depth of flow in pipeline exceeds 33 percent of pipe diameter.
4. If conditions for CCTV inspection are found to be unsafe or impractical.
5. Pipe configuration in field is different than shown on maps. Notification shall include diagram clearly indicating location of structures in relation to immediately adjacent structures along with pipe size, material, and diameter.
6. Complete and submit map correction sheets provided by CITY when map discrepancies are identified.

PART II PRODUCTS

2.1 Television Inspection Equipment

- A. CONTRACTOR shall provide a mobile vehicle with video monitoring equipment specifically compatible with the camera equipment being used. The equipment shall include dual video recorders, dual monitors, and picture capture capability. The vehicle shall be large enough to accommodate at least three people at any time for viewing of the monitor. CITY shall have unrestricted access to observe the television screen and all other operations at all times. There shall be no smoking in the vehicle.
- B. The basic equipment for use in cleaning and inspection operations shall consist of hydraulically propelled or mechanical cleaning equipment and a self-propelled full color television inspection camera with footage meter, pan, and tilt functions.
- C. The television camera used for the inspection shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear color picture of the entire periphery of the pipe. The camera shall be capable of a 360-degree viewing area. The camera, television monitor, and other components of the video system shall be capable of producing a minimum 500-line resolution picture. Backup camera shall be available on the Project Site. The camera shall be operational in 100 percent humidity conditions. Camera shall be operational in a hazardous and corrosive environment.
- D. The camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction of CITY.

- E. The television inspection equipment shall have an accurate footage counter that shall display on the monitor the exact distance of the camera from the centerline of the starting manhole.

PART III EXECUTION

3.1 Preparation

- A. Prior to televising, CONTRACTOR shall thoroughly clean the pipelines of debris, grease, roots, sediment, broken pipe or other obstructions that could retard the movement of the television camera. Precautions shall be taken to protect the sewer lines being cleaned from damage by the cleaning equipment. Any solids or semisolids resulting from the cleaning operations shall be removed from the site and deposited at the Hillard Fletcher Wastewater Treatment Plant located in Tuscaloosa, at no additional charge to the CONTRACTOR.
- B. The City will provide a hydrant meter at the beginning of the project to be located by the City on hydrants selected by the contractor and acceptable by the City. The meter may only be used for the contractor to fill trucks for cleaning sewers in the City's sewer system and shall be monitored for volume of usage. The CITY will move the meter provided advance notice is given one-week ahead of time.
- C. The CONTRACTOR shall anticipate a minimum of one pass with the jet washing equipment in each pipeline segment (from manhole to manhole) prior to inserting CCTV camera and transporter. The CONTRACTOR shall then operate the cleaning/cutting tool in tandem with the camera equipment so that residual roots and debris may be cleaned. Roots must be removed with cutting tools approved by the CITY prior to initiating work. The CONTRACTOR will not be responsible for cutting any protruding laterals.
- D. Immediately after cleaning, the sewer line section shall be visually inspected by means of closed-circuit television to determine the condition of the line. The inspection will be done one pipe section at a time (i.e. manhole to manhole) and the flow in the section being inspected will be suitably controlled as specified.
- E. All internal pipe damage shall be photographed in color by CONTRACTOR utilizing picture capture equipment. The photograph shall be clearly labeled with the upstream and downstream manhole ID numbers, footage, and type of defect. The upstream and downstream manholes shall always be referenced in the downstream direction regardless of the direction the camera traveled. The photographs shall be the property of CITY.

3.2 Television Inspection

- A. Information to be recorded during the inspection shall include the following:
 - pipe size and material (including change in pipe size and material)
 - location (footage) and severity of defects including cracks, broken pipe, collapsed pipe, misaligned joints, root intrusion, protruding laterals, sags, corrosion, visible infiltration, and grease.

- location (footage and quadrant) and type (wye, tee, tap) of lateral connections.
 - For defects extending in a longitudinal direction along the pipe (e.g., longitudinal cracks, sags, corrosion), the starting and ending location of the defect shall be recorded.
 - In line segments that are found to be free of such defects, electronic photographs of typical sections shall also be taken. The photographs shall be labeled with the ID number (upstream and downstream manholes) of the line segment.
- B. The camera shall be moved through the line in either direction at a moderate rate, stopping when necessary to permit proper documentation of the sewer line section condition. In no case will the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions shall be used to move the camera through the sewer line.
- C. When manually operated, winches are used to pull the television camera through the line, telephones or other suitable means of communication shall be set up between the two manholes of the section being inspected to ensure good communications between members of the crew.
- D. The importance of accurate distance measurements is emphasized. Measurement for location of defects shall be above ground by means of a meter device. Marking on the cable, or the like, which would require interpolation for depth of manhole, will not be allowed. Accuracy of the distance meter shall be checked by use of a walking meter, roll-a-tape, or other suitable device; the accuracy shall be acceptable to the CITY.
- E. The camera height shall be adjusted such that the camera lens is always centered in the pipe being televised.
- F. Lighting system shall be adequate for quality pictures. A reflector in front of the camera may be required to enhance lighting in black pipe.

3.3 Passage of TV Camera

- A. There may be occasions during the TV inspection of a sewer line section, when the camera will be unable to pass an obstruction even though flow is continuing. CONTRACTOR shall televise the pipe section from the other direction in order to obtain a "full" video of this pipe section. Whenever such condition arises, CITY shall be notified to determine if a point repair is necessary. No additional payment shall be made for reverse set-ups required due to an obstruction.
- B. TV videos shall be submitted in one continuous section from manhole to manhole, and not in broken pieces, unless specifically approved by CITY.

- C. When the camera is being pulled from the “other end” and a second repair location is encountered away from the first repair/obstruction location, CITY shall be notified and allowed to review the TV DVD in a timely manner.
- D. CITY makes no guarantee that all of the sanitary sewer mains proposed to be TV inspected after the cleaning are clear for the passage of the camera set-up. The equipment, tools and method(s) used for securing the passage of the camera are to be at the discretion of CONTRACTOR, with the approval of CITY. The decision to repair or not to repair a location shall always be made by CITY.
- E. The television camera shall be moved through the line in either direction at a uniform rate, stopping when necessary to insure proper documentation of the sewer's condition, but in no case shall the television camera travel at a speed greater than 30 feet per minute.
- F. The television camera shall travel through the lines using its own power. The pictures taken of the entire inside periphery of the pipe shall be clear and visible. Picture quality and definition shall be to the satisfaction of CITY, and if unsatisfactory, the equipment shall be removed with no payment made for the unsatisfactory inspection.
- G. At all service laterals the camera shall be stopped and panned to such an angle that an internal view of the service lateral is available to determine if the lateral is active or dead or plugged. Where other pipe deficiencies are noted, the camera shall be stopped to observe the condition, record information and take photographs. Any service lateral or deficiency observed in the sewer line shall be photographed and described on the photograph.

3.4 Data Requirements

- A. No later than fourteen (14) days following the completion of a pipeline survey/inspection, the CONTRACTOR will submit to the CITY two (2) hard copies of all details, i.e. typed “Full Detail” report for each inspection, showing the position and full text of each defect encountered and their grades. The CONTRACTOR will also supply an overall Summary report detailing major defects and those inspections that require attention and a statistical report showing lengths of sewers inspected and a breakdown of sizes and lengths inspected. Two (2) DVD's will be submitted to the CITY containing the encoded videos, database(s), reports (in PDF format) and databases. The supplied data and information will remain the property of the CITY.
- B. An example of a typical CCTV survey final deliverable will be submitted for approval by the CITY within 30 days of the Notice to Proceed. The example deliverable will contain the proposed viewing software, be shown to be using PACP nomenclature, or equivalent approved by the CITY, and be computer validated. The example will be fully cross referenced to the videos, sonar images and reports. The example will be presented both in hard copy and on a suitable media (DVD/CD).

The CONTRACTOR will supply free issue software for both the viewing of the media files and the sonar images. Four (4) hours training in the use of any supplied free issue software will be included in the rates.

3.5 Flow Control

- A. TV inspection shall be done one sewer line section at a time, and the flow in the section being televised shall be suitably controlled. The depth of wastewater flow shall not exceed that shown below:

6" – 10" Pipe: 20% of pipe's diameter
12" – 24" Pipe: 25% of pipe's diameter
- B. When the depth of flow in the section being worked is above the maximum allowable for the television inspection, the flow shall be reduced to allowable levels by performing the inspection during minimum flow hours, with diversion pumping or by pulling camera with swab or a high velocity jet nozzle, as approved by CITY.
- C. No separate payment shall be made for sewer flow. Bypass pumping shall be performed per Section 02700, WASTEWATER FLOW CONTROL.
- D. CONTRACTOR shall not be allowed to float the camera, unless permitted by CITY.
- E. When flow in a sewer line is plugged, blocked, or bypassed; sufficient precautions must be taken to protect the sewer lines from damage that might result from sewer surcharging. Further, precautions must be taken to insure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved.

3.6 Documentation

- A. CONTRACTOR shall submit in electronic format digital videos, photos, and evaluation reports, to CITY for review. CITY's review and comment period may require up to 30 working days from the date of submittal.
- B. The digital video shall be recorded at Standard Play and each digital video segment information entered in a log. The delivery format shall be compatible with Windows Media Player.
- C. If digital videos are of such poor quality that CITY is unable to evaluate the condition of the sanitary sewer main, locate the sewer service connections, or verify proper cleaning, CONTRACTOR shall be required to re-televiser the sanitary sewer and provide new digital videos of good quality, at no additional cost to CITY.
- D. All digital videos will become the property of CITY.
- E. Payment deduction of \$100 per digital video shall apply for poor and unacceptable quality digital videos or for portions of sewer not televised. Camera distortions, inadequate lighting, dirty lens or blurred/hazy picture will be cause for rejection of the Work.

3.7 Evaluation Reports

- A. Each video shall be accompanied by a TV inspection report, which shall be an electronic log of all pipe defects, sags, service connection locations and conditions, etc., recorded on a footage basis.
- B. The size/length of the defect shall be reported. The beginning of all sags of the pipe, the length that is underwater as well as where the camera pulls out of the sag shall be reported. The clock position of each service connection and the condition shall be reported. The condition of each service connection will include the distance protruding when appropriate and the type.
- C. This log shall also identify the section being televised, flow, camera direction, and type of pipe, pipe condition, weather conditions, type of surface cover, or any other information required by CITY.
- D. CITY may provide CONTRACTOR a log form for the above-mentioned defects.
- E. At the end of the Project CONTRACTOR shall provide a summary listing of all videos provided under this Project.

3.8 Payment

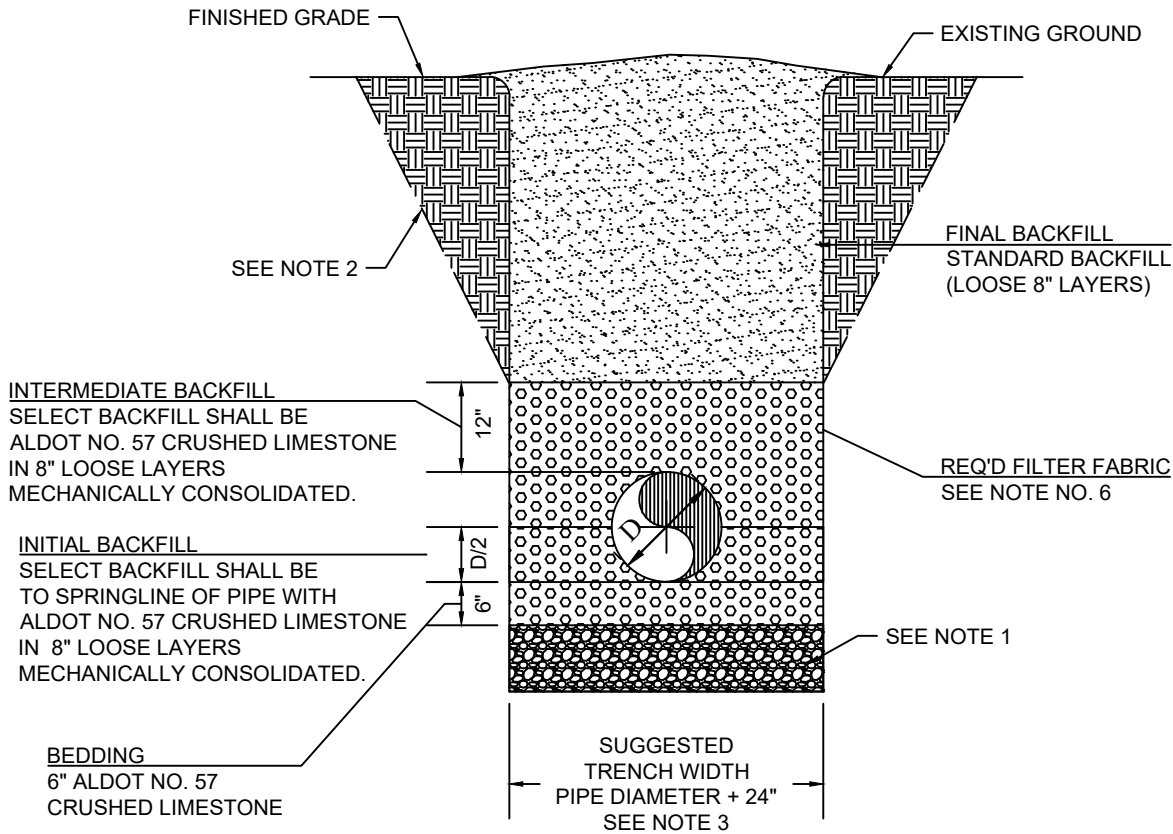
- A. Payment for the work included in this Section will be in accordance with the prices set forth in the proposal for the quantity of work performed. Payment for cleaning will be separate. Payment will be made after satisfactory review of each submittal. All submittals will be incidental to CCTV work.
- B. The CITY will review submittals within thirty days of submittal date.
- C. Contractor can submit request for payment one time per month.

END OF SECTION

PART 10
STANDARD DETAILS
SANITARY SEWER DESIGN MANUAL



IN UNIMPROVED AREAS COMPACTION SHALL
BE SUFFICIENT TO ELIMINATE SETTLEMENT.
EXCESS MATERIAL SHALL BE MOUNDED UP.



NOTES:

- 1.) TRENCH FOUNDATION REQUIRED IF DIRECTED BY ENGINEER. DEPTH VARIES.
- 2.) VERTICAL CUT TO EXTEND FROM TRENCH BOTTOM TO 1 FT ABOVE TOP OF PIPE.
- 3.) AS PER AWWA C600 SEE 4.3.2.3, THE WIDTH OF THE TRENCH AT THE TOP OF THE PIPE SHALL PERMIT THE PIPE TO BE LAID AND JOINED PROPERLY AND TO ALLOW THE BACKFILL TO BE PLACED IN ACCORDANCE WITH CITY STANDARDS. AS A GUIDE, TRENCH WIDTHS SHOULD BE THE NOMINAL PIPE DIAMETER PLUS 24 IN. WHEN REQUIRED, TRENCHES SHALL BE WIDER TO PERMIT THE PLACEMENT OF TIMBER SUPPORTS, SHEETING, BRACING, AND APPURTENANCES AS REQUIRED BY THE SAFETY REQUIREMENTS OF THE AGENCY HAVING JURISDICTION.
- 4.) ALL PIPE BACKFILL SHALL BE PLACED IN APPROPRIATE THICKNESSES AND COMPACTED IN THE FOLLOWING SEQUENCE:
 1. BEDDING
 2. SPRINGLINE OF PIPE
 3. ONE FOOT ABOVE TOP OF PIPE
- 5.) STANDARD BACKFILL TO CONSIST OF NATIVE SOILS OF GOOD EARTH(ASHTO A.4 SOILS OR BETTER), SAND, AND GRAVEL, AND SHALL BE FREE OF LARGE ROCKS AND OTHER DELETERIOUS SUBSTANCES.
- 6.) IN AREAS OF POOR SOIL CONDITIONS, FILTER FABRIC SHALL BE INSTALLED FROM THE BOTTOM OF THE TRENCH TO THE TOP OF THE INTERMEDIATE BACKFILL LAYER ALONG BOTH SIDES TO ENCAPSULATE THE CRUSHED LIMESTONE AND PREVENT NATIVE SOIL MIGRATION. POOR SOIL CONDITIONS CANNOT HOLD SHAPE OR BE COMPACTED WELL ENOUGH TO SUPPORT THE PIPE.
- 7.) BEDDING MATERIAL SHALL NOT BE PLACED IN WET OR UNSTABLE TRENCHES. IF REQUIRED, DEWATERING SHALL BE PERFORMED IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATION.

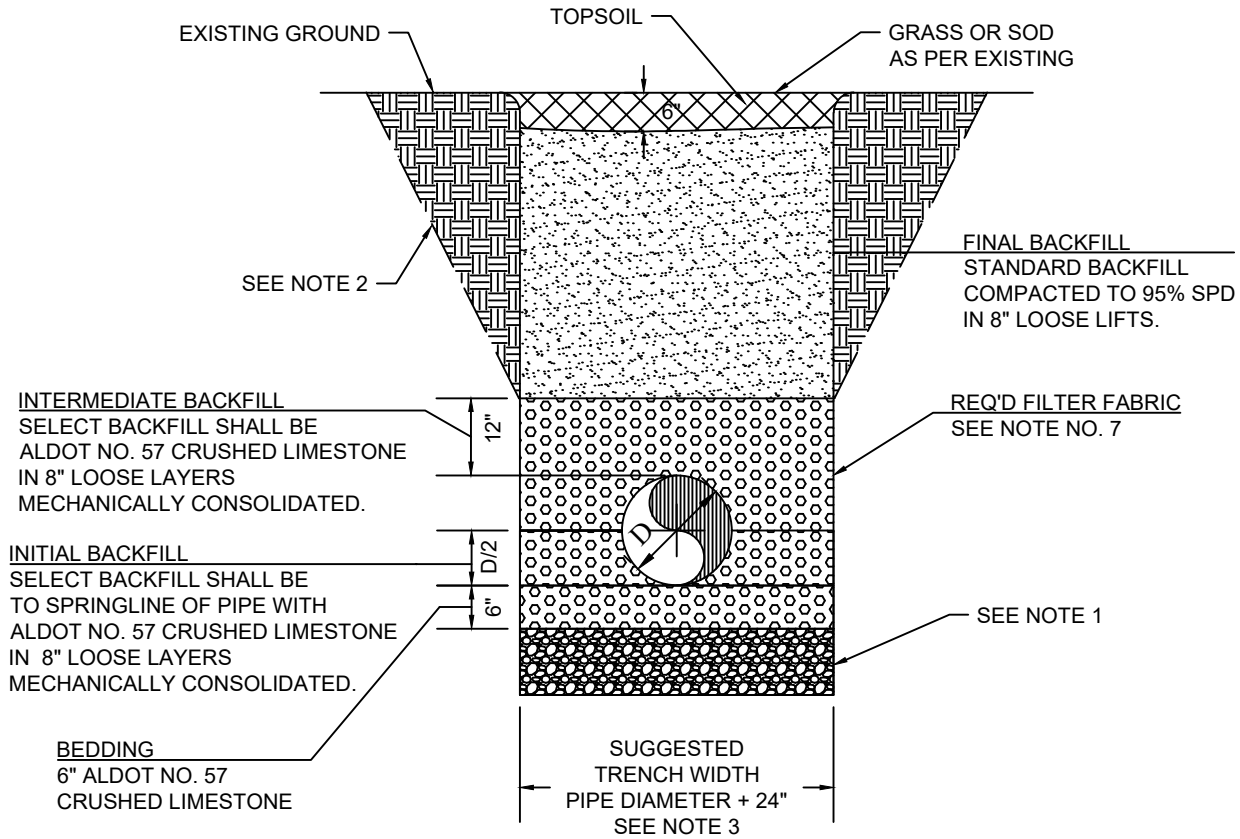


TRENCH DETAIL GRAVITY - UNIMPROVED AREAS

SANITARY SEWER STANDARD DETAILS

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NOTES:

- 1.) TRENCH FOUNDATION REQUIRED IF DIRECTED BY ENGINEER. DEPTH VARIES.
- 2.) VERTICAL CUT TO EXTEND FROM TRENCH BOTTOM TO 1 FT ABOVE TOP OF PIPE.
- 3.) AS PER AWWA C600 SEE 4.3.2.3, THE WIDTH OF THE TRENCH AT THE TOP OF THE PIPE SHALL PERMIT THE PIPE TO BE LAID AND JOINED PROPERLY AND TO ALLOW THE BACKFILL TO BE PLACED IN ACCORDANCE WITH CITY STANDARDS. AS A GUIDE, TRENCH WIDTHS SHOULD BE THE NOMINAL PIPE DIAMETER PLUS 24 IN. WHEN REQUIRED, TRENCHES SHALL BE WIDER TO PERMIT THE PLACEMENT OF TIMBER SUPPORTS, SHEETING, BRACING, AND APPURTENANCES AS REQUIRED BY THE SAFETY REQUIREMENTS OF THE AGENCY HAVING JURISDICTION.
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- 5.) STANDARD BACKFILL TO CONSIST OF NATIVE SOILS OF GOOD EARTH (ASHTO A.4 SOILS OR BETTER), SAND, AND GRAVEL, AND SHALL BE FREE OF LARGE ROCKS AND OTHER DELETERIOUS SUBSTANCES.
- 6.) TOP 6" SHALL BE TOPSOIL FREE FROM ROCKS, ROOTS, ETC.
- 7.) IN AREAS OF POOR SOIL CONDITIONS, FILTER FABRIC SHALL BE INSTALLED FROM THE BOTTOM OF THE TRENCH TO THE TOP OF THE INTERMEDIATE BACKFILL LAYER ALONG BOTH SIDES TO ENCAPSULATE THE CRUSHED LIMESTONE AND PREVENT NATIVE SOIL MIGRATION. POOR SOIL CONDITIONS CANNOT HOLD SHAPE OR BE COMPACTED WELL ENOUGH TO SUPPORT THE PIPE.
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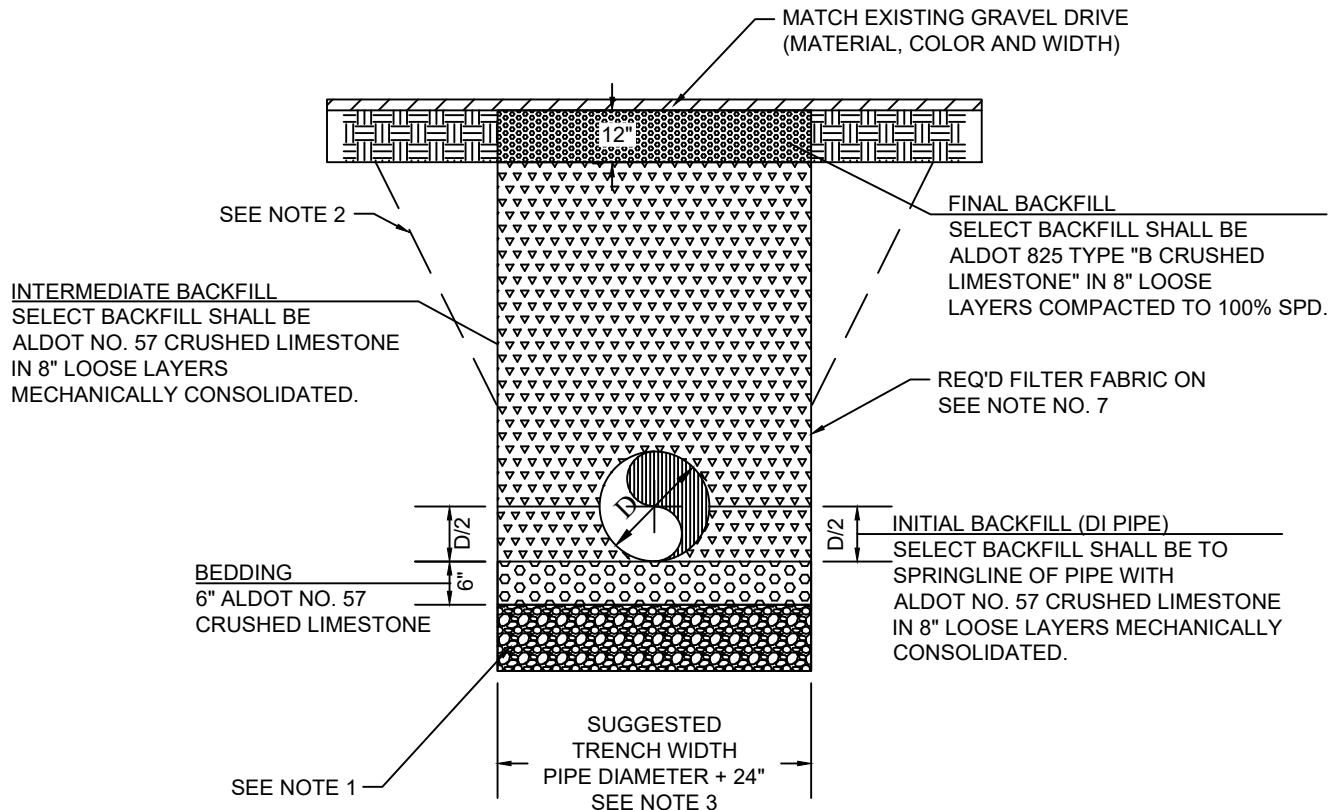


TRENCH DETAIL GRAVITY - IMPROVED AREAS

SANITARY SEWER STANDARD DETAILS

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- 4.) ALL PIPE BACKFILL SHALL BE PLACED IN APPROPRIATE THICKNESSES AND COMPACTED IN THE FOLLOWING SEQUENCE:
 1. BEDDING
 2. SPRINGLINE OF PIPE
 3. ONE FOOT ABOVE TOP OF PIPE
- 5.) BACKFILL AND BEDDING FOR GRAVEL DRIVES TO MATCH THAT OF ASPHALT PAVING AREAS. FINAL SELECT BACKFILL FINISHED GRADE TO MATCH EXISTING.
- 6.) ALL SELECT BACKFILL USED AS ROADWAY BASE MATERIAL AND/OR GRAVEL DRIVE MATERIAL SHALL BE CRUSHED LIMESTONE AGGREGATE. THIS INCLUDES THE TOP 12-INCH FINAL BACKFILL LAYER. CRUSHED SANDSTONE AGGREGATE WILL BE ALLOWED FOR SELECT BACKFILL IN TRENCHES BELOW THE ROADWAY BASE LAYER (FINAL BACKFILL LAYER).
- 7.) IN AREAS OF POOR SOIL CONDITIONS, FILTER FABRIC SHALL BE INSTALLED FROM THE BOTTOM OF THE TRENCH TO THE TOP OF THE INTERMEDIATE BACKFILL LAYER ALONG BOTH SIDES TO ENCAPSULATE THE CRUSHED LIMESTONE AND PREVENT NATIVE SOIL MIGRATION. POOR SOIL CONDITIONS CANNOT HOLD SHAPE OR BE COMPACTED WELL ENOUGH TO SUPPORT THE PIPE.
- 8.) BEDDING MATERIAL SHALL NOT BE PLACED IN WET OR UNSTABLE TRENCHES. IF REQUIRED, DEWATERING SHALL BE PERFORMED IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATION.



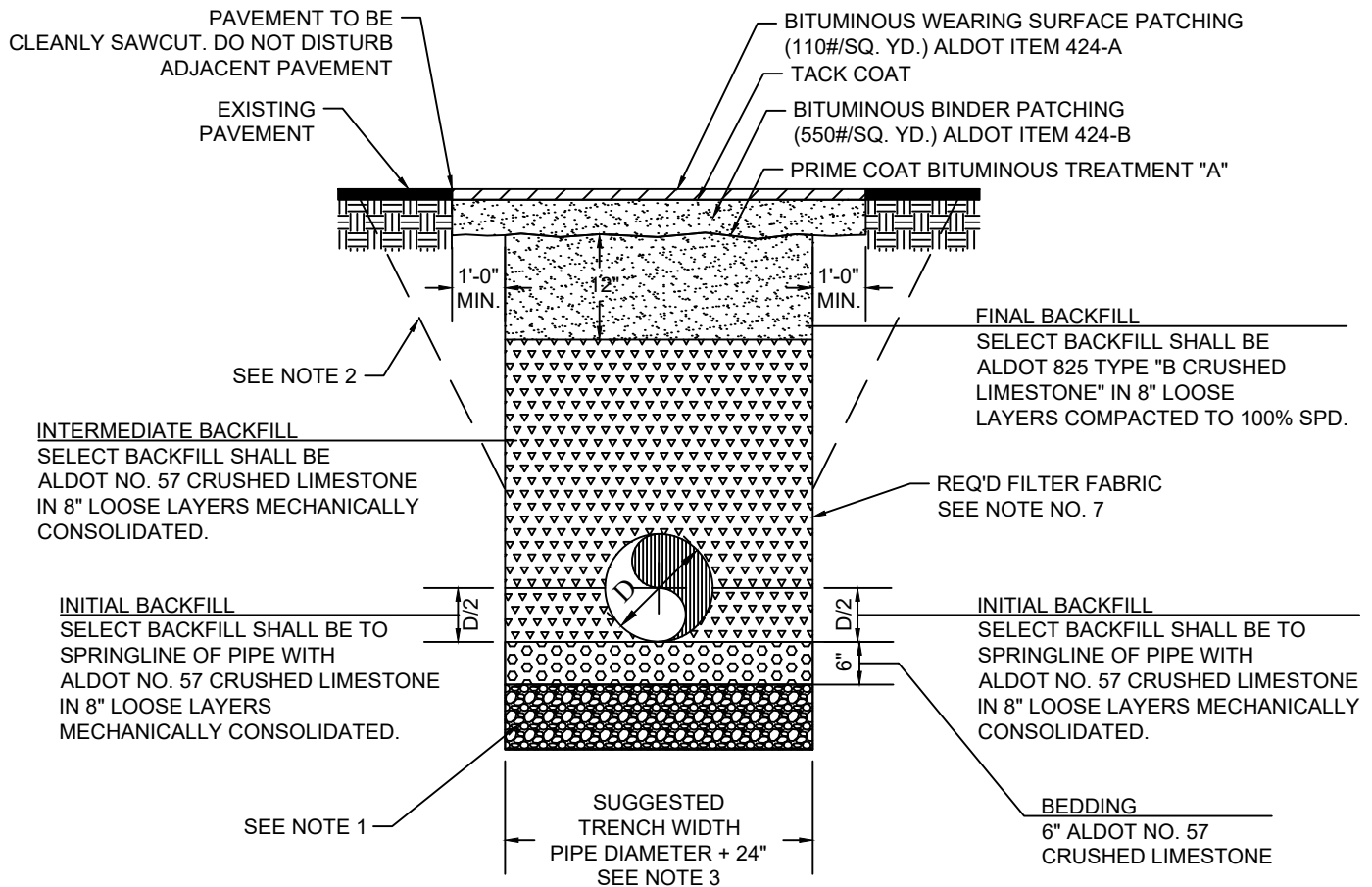
TRENCH DETAIL

GRAVITY - GRAVEL DRIVE

SANITARY SEWER STANDARD DETAILS

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 1. BEDDING
 2. SPRINGLINE OF PIPE
 3. ONE FOOT ABOVE TOP OF PIPE
- 5.) ASPHALT BINDER LAYER SHALL BE USED FOR PATCHING OF TRENCH EXCAVATION. TOP OF BINDER LAYER SHALL MATCH FLUSH WITH THE TOP OF EXISTING PAVEMENT.
- 6.) WEARING SURFACE WIDTH PER PAVING PLAN.
- 7.) IN AREAS OF POOR SOIL CONDITIONS, FILTER FABRIC SHALL BE INSTALLED FROM THE BOTTOM OF THE TRENCH TO THE TOP OF THE INTERMEDIATE BACKFILL LAYER ALONG BOTH SIDES TO ENCAPSULATE THE CRUSHED LIMESTONE AND PREVENT NATIVE SOIL MIGRATION. POOR SOIL CONDITIONS CANNOT HOLD SHAPE OR BE COMPACTED WELL ENOUGH TO SUPPORT THE PIPE.
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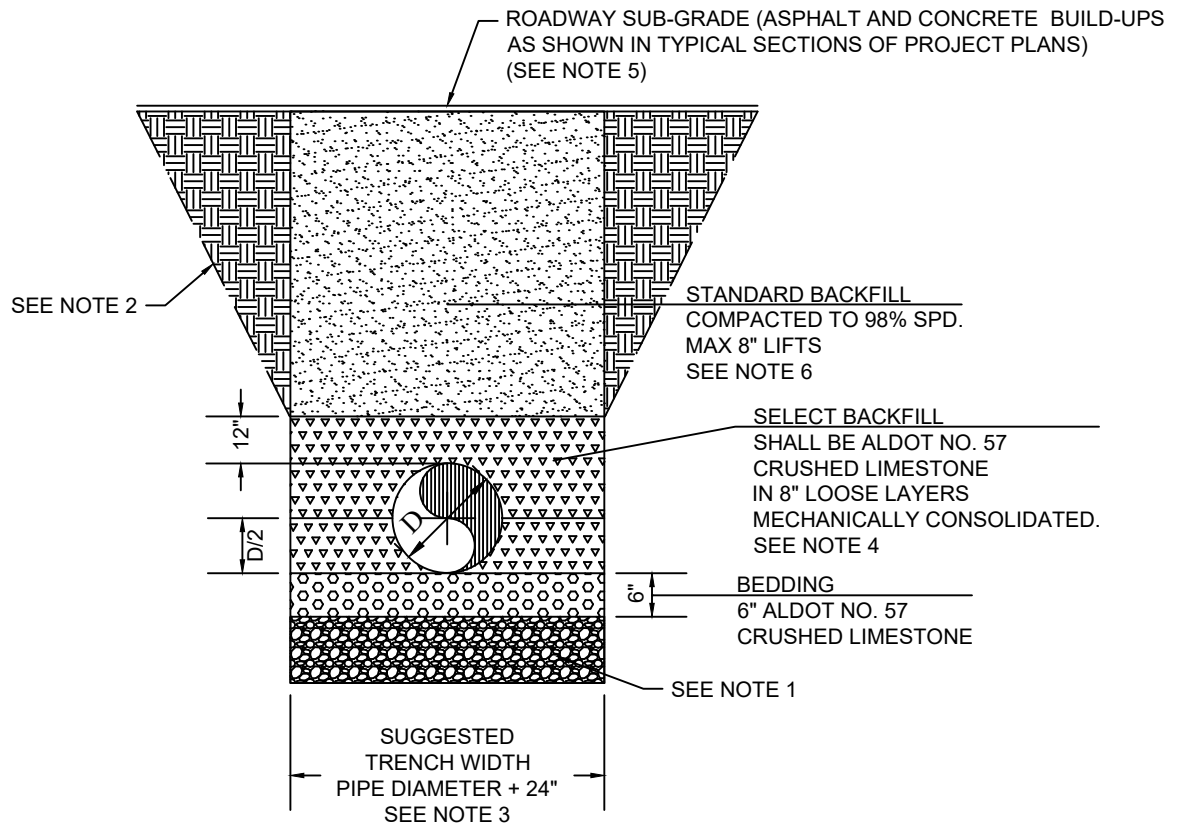
TRENCH DETAIL

GRAVITY - ASPHALT PAVING - EXISTING

SANITARY SEWER STANDARD DETAILS

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NOTES:

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- 4.) ALL PIPE BACKFILL SHALL BE PLACED IN APPROPRIATE THICKNESS AND COMPACTED IN THE FOLLOWING SEQUENCE:
 1. BEDDING
 2. SPRING-LINE OF PIPE
 3. ONE FOOT ABOVE TOP OF PIPE
- 5.) WEARING SURFACE WIDTH SHALL BE AS PER THE PAVING PLAN.
- 6.) THIS DETAIL APPLIES TO NEW ROADWAY CONSTRUCTION ONLY AS IT ALLOWS FOR THE USE OF EARTHEN BACKFILL AND REQUIRES THE CONTRACTOR TO PROVIDE SUFFICIENT WIDTH FOR THE OWNER'S GEOTECHNICAL REPRESENTATIVE TO TAKE PERIODIC COMPACTION TESTS IN A FREQUENCY THAT SHALL BE IN ACCORDANCE WITH THE SUBDIVISION REGULATIONS OR AT THE DISCRETION OF THE CITY ENGINEER.
- 7.) IN AREAS OF POOR SOIL CONDITIONS, FILTER FABRIC SHALL BE INSTALLED FROM THE BOTTOM OF THE TRENCH TO THE TOP OF THE INTERMEDIATE BACKFILL LAYER ALONG BOTH SIDES TO ENCAPSULATE THE CRUSHED LIMESTONE AND PREVENT NATIVE SOIL MIGRATION. POOR SOIL CONDITIONS CANNOT HOLD SHAPE OR BE COMPACTED WELL ENOUGH TO SUPPORT THE PIPE.
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TRENCH DETAIL

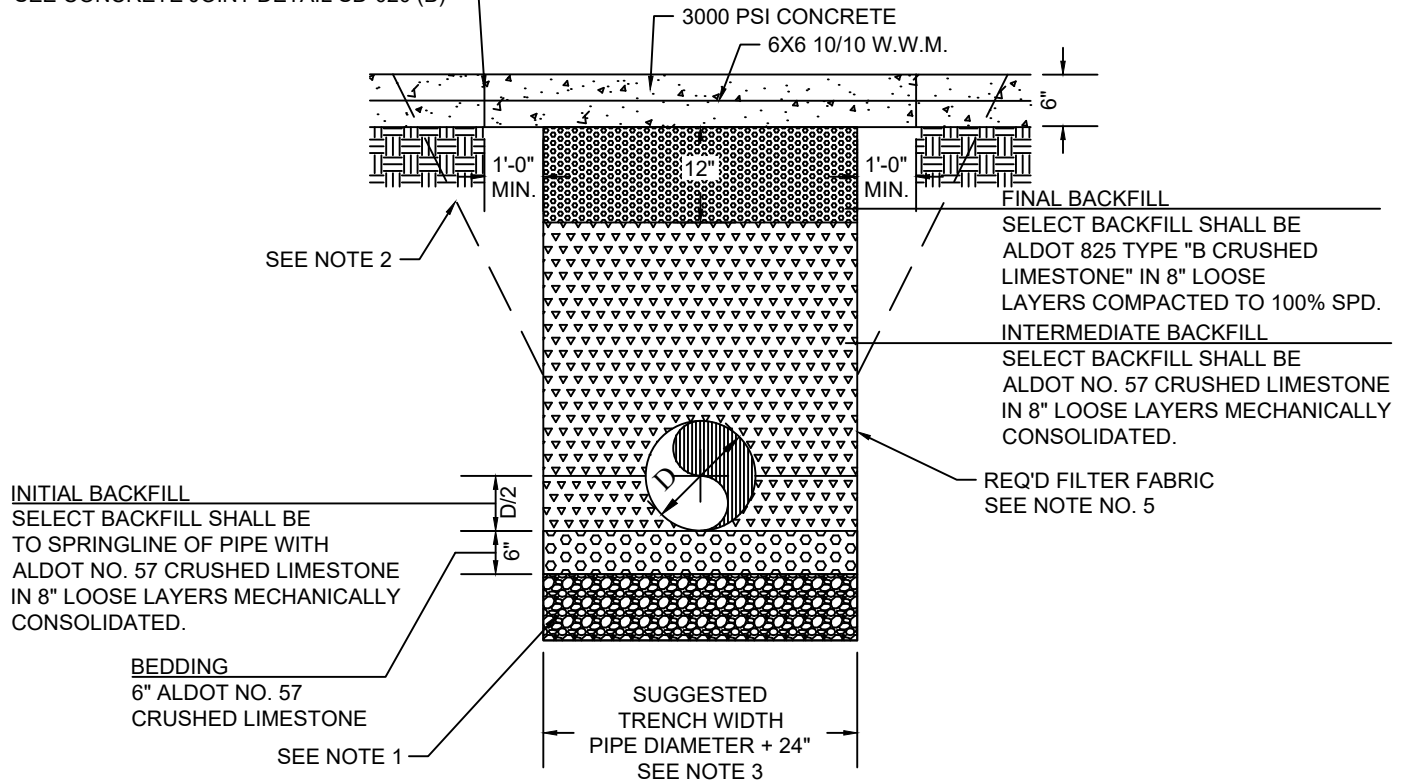
GRAVITY - ASPHALT PAVING - NEW CONSTRUCTION

SANITARY SEWER STANDARD DETAILS

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CONCRETE TO BE CLEANLY
SAWCUT DO NOT DISTURB
ADJACENT PAVEMENT
SEE CONCRETE JOINT DETAIL SD-020 (B)



NOTES:

- 1.) TRENCH FOUNDATION REQUIRED IF DIRECTED BY ENGINEER. DEPTH VARIES.
- 2.) VERTICAL CUT TO EXTEND FROM TRENCH BOTTOM TO 1 FT ABOVE TOP OF PIPE.
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- 6.) BEDDING MATERIAL SHALL NOT BE PLACED IN WET OR UNSTABLE TRENCHES. IF REQUIRED, DEWATERING SHALL BE PERFORMED IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATION.



TRENCH DETAIL

GRAVITY - CONCRETE PAVING

SANITARY SEWER STANDARD DETAILS

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SD-020(A)

SHEET 1 OF 2

EXISTING CONCRETE PAVEMENT

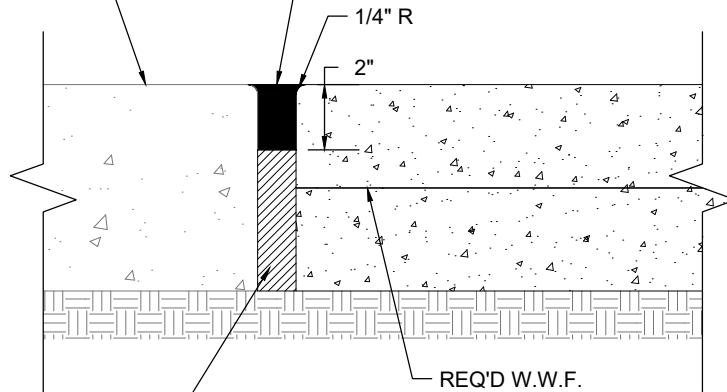
SEALING COMPOUND, TWO COMPONENT
ELASTOMETRIC, POLYMER TYPE
COLD APPLIED.

1/4" R

2"

NON-EXTRUDING PREMOLDED
COMPRESSIBLE MATERIAL

REQ'D W.W.F.
SEE TRENCH DETAILS FOR SIZE



TRENCH DETAIL

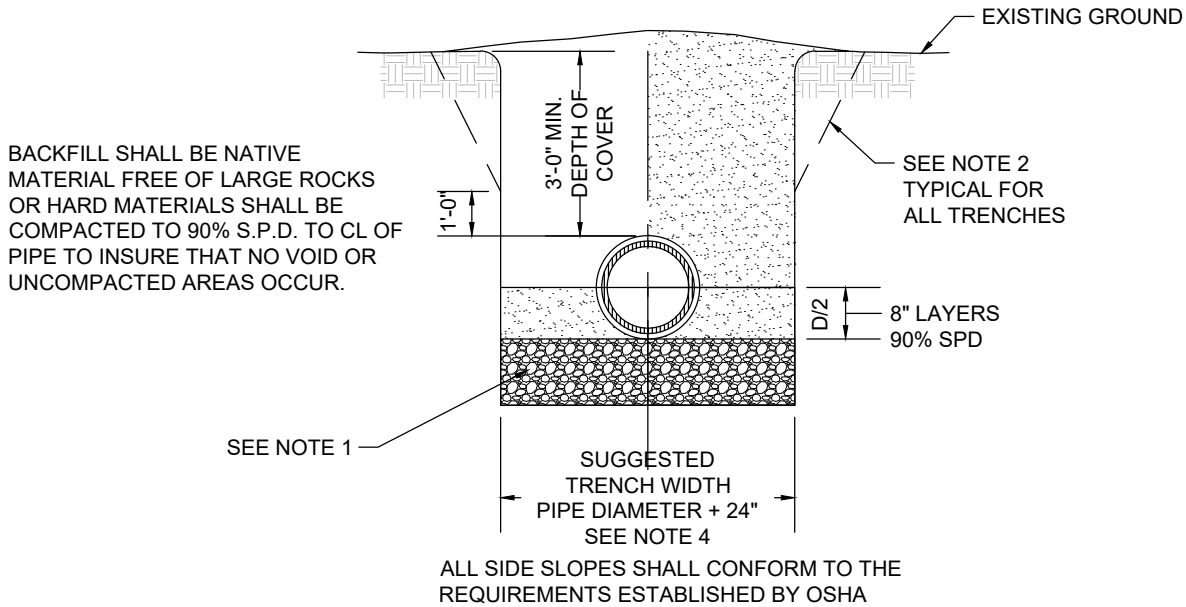
CONCRETE PAVING - EXPANSION JOINT

SANITARY SEWER STANDARD DETAILS

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		SHEET 2 OF 2

IN UNIMPROVED AREAS COMPACTION SHALL BE SUFFICIENT TO ELIMINATE SETTLEMENT. EXCESS MATERIAL SHALL BE MOUNDED UP.



NOTES:

- 1.) PIPE TO BE BEDDED IN NATIVE SOIL, UNLESS SITE CONDITIONS REQUIRE OTHERWISE OR IF DIRECTED BY THE ENGINEER.
- 2.) ALL SLOPES SHALL CONFORM TO OSHA REQUIREMENTS. ADDITIONAL PROTECTIVE MEASURES MAY BE REQUIRED ABOVE AND BEYOND OSHA DEPENDING ON SPECIFIC TRENCH CONDITIONS. CONTRACTOR IS SOLELY RESPONSIBLE FOR THE SAFETY OF WORKERS, THE GENERAL PUBLIC, AND OTHERS INVOLVED IN THE PROJECT AND SHALL PROVIDE SHEETING, BRACING, OR WHATEVER ACTION NECESSARY TO INSURE THE SAFETY OF PEOPLE, PROPERTY, AND STRUCTURES.
- 3.) VERTICAL CUT TO EXTEND FROM TRENCH BOTTOM TO 1 FT ABOVE TOP OF PIPE.
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- 6.) STANDARD BACKFILL TO CONSIST OF NATIVE SOILS OF GOOD EARTH (ASHTO A.4 SOILS OR BETTER), SAND, AND GRAVEL, AND SHALL BE FREE OF LARGE ROCKS AND OTHER DELETERIOUS SUBSTANCES.
- 7.) BEDDING:
 - (A) CLASS "1" SHALL BE ALDOT NO. 57 CRUSHED LIMESTONE (FOR P.V.C. PIPE USE ALDOT 8910)
 - (B) CLASS "2" SHALL BE REINFORCED CONCRETE 3000 PSI DESIGN MIX
 - (C) CLASS "3" SHALL BE NATIVE SOIL



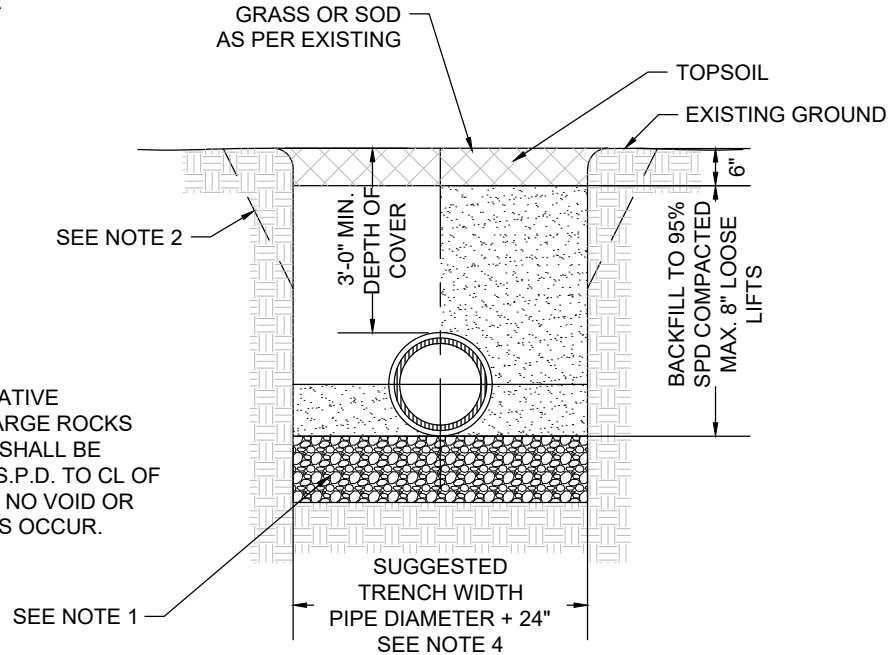
TRENCH DETAIL **PRESSURE - UNIMPROVED AREAS**

SANITARY SEWER STANDARD DETAILS

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IMPROVED AREAS OR LAWNS, FROM CENTER LINE OF PIPE, MATERIAL SHALL BE PLACED IN 8" LAYERS. TOP 6" SHALL BE TOPSOIL, FREE FROM ROCKS, ROOTS & ETC.



BACKFILL SHALL BE NATIVE MATERIAL FREE OF LARGE ROCKS OR HARD MATERIALS SHALL BE COMPACTED TO 90% S.P.D. TO CL OF PIPE TO INSURE THAT NO VOID OR UNCOMPACTED AREAS OCCUR.

NOTES:

- 1.) PIPE TO BE BEDDED IN NATIVE SOIL, UNLESS SITE CONDITIONS REQUIRE OTHERWISE OR IF DIRECTED BY THE ENGINEER. (SEE NOTE 7)
- 2.) ALL SLOPES SHALL CONFORM TO OSHA REQUIREMENTS. ADDITIONAL PROTECTIVE MEASURES MAY BE REQUIRED ABOVE AND BEYOND OSHA DEPENDING ON SPECIFIC TRENCH CONDITIONS. CONTRACTOR IS SOLELY RESPONSIBLE FOR THE SAFETY OF WORKERS, THE GENERAL PUBLIC, AND OTHERS INVOLVED IN THE PROJECT AND SHALL PROVIDE SHEETING, BRACING, OR WHATEVER ACTION NECESSARY TO INSURE THE SAFETY OF PEOPLE, PROPERTY, AND STRUCTURES.
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- 8.) BEDDING:
 - (A) CLASS "1" SHALL BE ALDOT 801 NO. 57 CRUSHED LIMESTONE (FOR P.V.C. PIPE USE ALDOT 8910)
 - (B) CLASS "2" SHALL BE REINFORCED CONCRETE 3000 PSI DESIGN MIX
 - (C) CLASS "3" SHALL BE NATIVE SOIL



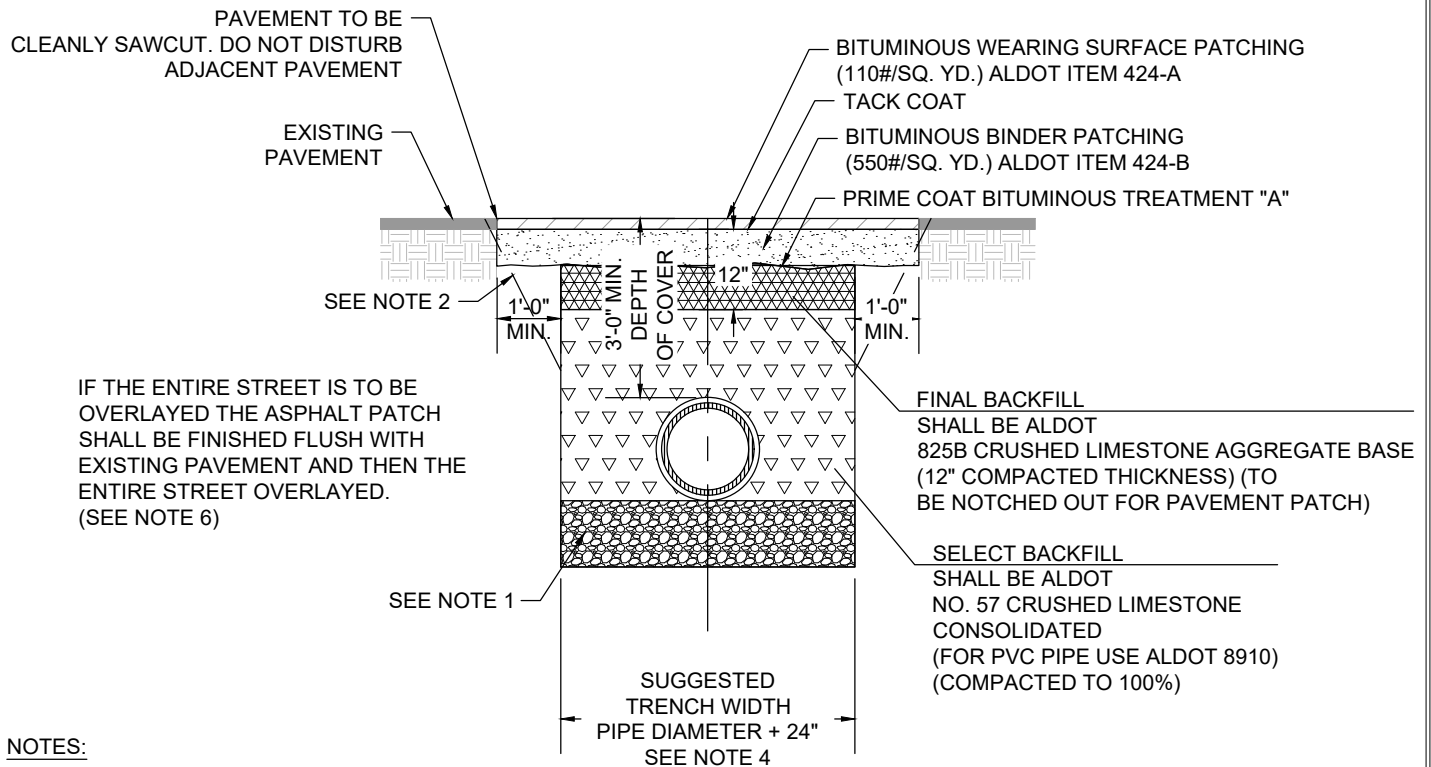
TRENCH DETAIL

PRESSURE - IMPROVED AREAS

SANITARY SEWER STANDARD DETAILS

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NOTES:

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- 5.) ALL PIPE, BACKFILL SHALL BE PLACED IN APPROPRIATE THICKNESSES AND COMPACTED IN THE FOLLOWING SEQUENCE
 1. SPRINGLINE OF PIPE
 2. ONE FOOT ABOVE TOP OF PIPE
- 6.) IF UTILITY LOCATION FALLS WITHIN AN AREA THAT IS TO BE REMOVED DURING ROADWAY CONSTRUCTION. ELIMINATE THE WEARING SURFACE PATCHING AND MATCH THE BINDER PATCHING WITH EXISTING PAVEMENT.
- 7.) BEDDING:
 - (A) CLASS "1" SHALL BE ALDOT 801 NO. 57 CRUSHED LIMESTONE (FOR P.V.C. PIPE USE ALDOT 8910)
 - (B) CLASS "2" SHALL BE REINFORCED CONCRETE 3000 PSI DESIGN MIX
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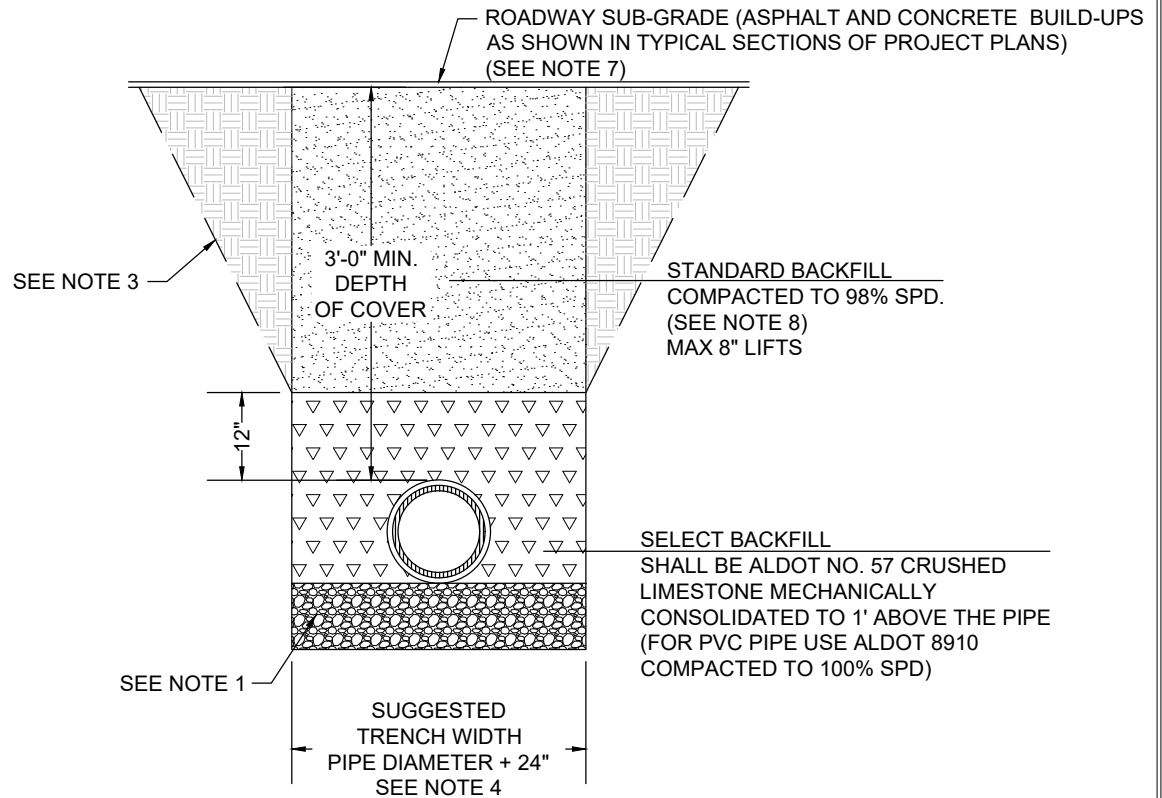
TRENCH DETAIL

PRESSURE - ASPHALT PAVEMENT - EXISTING

SANITARY SEWER STANDARD DETAILS

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NOTES:

- 1.) PIPE TO BE BEDDED IN NATIVE SOIL, UNLESS SITE CONDITIONS REQUIRE OTHERWISE OR IF DIRECTED BY THE ENGINEER.
- 2.) ALL SLOPES SHALL CONFORM TO OSHA REQUIREMENTS. ADDITIONAL PROTECTIVE MEASURES MAY BE REQUIRED ABOVE AND BEYOND OSHA DEPENDING ON SPECIFIC TRENCH CONDITIONS. CONTRACTOR IS SOLELY RESPONSIBLE FOR THE SAFETY OF WORKERS, THE GENERAL PUBLIC, AND OTHERS INVOLVED IN THE PROJECT AND SHALL PROVIDE SHEETING, BRACING, OR WHATEVER ACTION NECESSARY TO INSURE THE SAFETY OF PEOPLE, PROPERTY, AND STRUCTURES.
- 3.) VERTICAL CUT TO EXTEND FROM TRENCH BOTTOM TO 1 FT ABOVE TOP OF PIPE.
- 4.) AS PER AWWA C600 SEE 4.3.2.3, THE WIDTH OF THE TRENCH AT THE TOP OF THE PIPE SHALL PERMIT THE PIPE TO BE LAID AND JOINED PROPERLY AND TO ALLOW THE BACKFILL TO BE PLACED IN ACCORDANCE WITH CITY STANDARDS. AS A GUIDE, TRENCH WIDTHS SHOULD BE THE NOMINAL PIPE DIAMETER PLUS 24 IN. WHEN REQUIRED, TRENCHES SHALL BE WIDER TO PERMIT THE PLACEMENT OF TIMBER SUPPORTS, SHEETING, BRACING, AND APPURTENANCES AS REQUIRED BY THE SAFETY REQUIREMENTS OF THE AGENCY HAVING JURISDICTION.
- 5.) ALL PIPE, BACKFILL SHALL BE PLACED IN APPROPRIATE THICKNESSES AND COMPACTED IN THE FOLLOWING SEQUENCE
 1. SPRINGLINE OF PIPE
 2. ONE FOOT ABOVE TOP OF PIPE
- 6.) BEDDING:
 - (A) CLASS "1" SHALL BE ALDOT 801 NO. 57 CRUSHED LIMESTONE (FOR P.V.C. PIPE USE ALDOT 8910)
 - (B) CLASS "2" SHALL BE REINFORCED CONCRETE 3000 PSI DESIGN MIX
 - (C) CLASS "3" SHALL BE NATIVE SOIL
- 7.) WEARING SURFACE WIDTH SHALL BE AS PER THE PAVING PLAN.
- 8.) THIS DETAIL APPLIES TO NEW ROADWAY CONSTRUCTION ONLY UNDER ASPHALT WHICH IS ONLY ALLOWED AS A PERPENDICULAR CROSSING UNLESS OTHERWISE APPROVED BY THE CITY ENGINEER
- 9.) SINCE NEW CONSTRUCTION ALLOWS FOR THE USE OF EARTHEN BACKFILL, THE CONTRACTOR SHALL PROVIDE SUFFICIENT WIDTH FOR THE OWNERS GEOTECHNICAL REPRESENTATIVE TO TAKE PERIODIC COMPACTION TESTS AT A FREQUENCY IN ACCORDANCE WITH THE SUBDIVISION REGULATIONS AT THE DISCRETION OF THE CITY ENGINEER.



TRENCH DETAIL

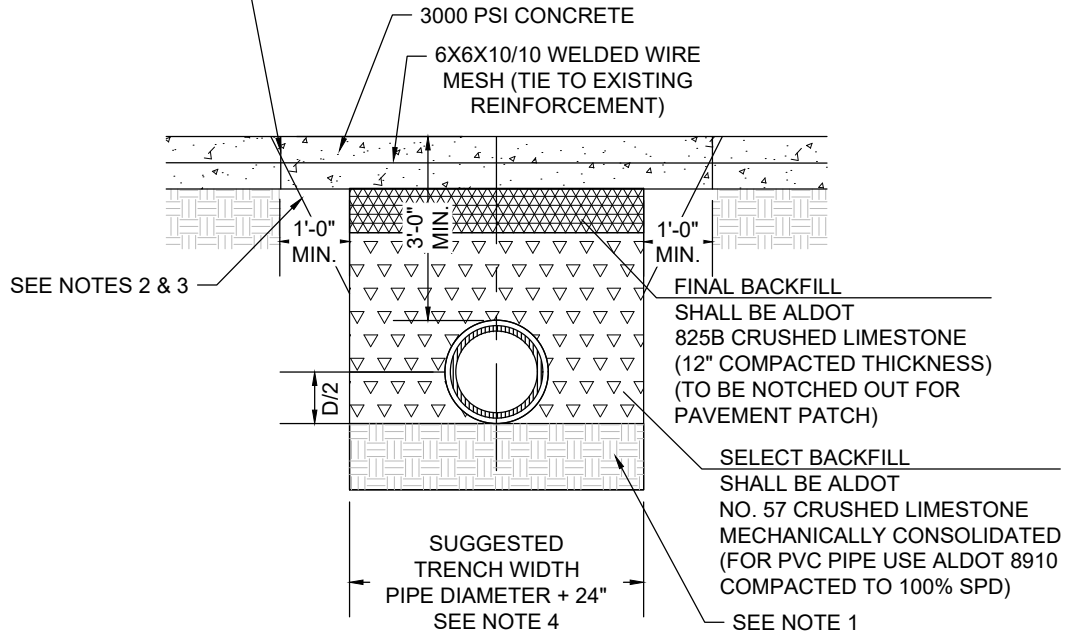
PRESSURE - ASPHALT PAVEMENT - NEW CONSTRUCTION

SANITARY SEWER STANDARD DETAILS

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CONCRETE TO BE CLEANLY
SAWCUT DO NOT DISTURB
ADJACENT PAVEMENT
SEE CONCRETE JOINT DETAIL SD-021



NOTES:

- 1.) PIPE TO BE BEDDED IN NATIVE SOIL, UNLESS SITE CONDITIONS REQUIRE OTHERWISE OR IF DIRECTED BY THE ENGINEER. (SEE NOTE 6)
- 2.) ALL SLOPES SHALL CONFORM TO OSHA REQUIREMENTS. ADDITIONAL PROTECTIVE MEASURES MAY BE REQUIRED ABOVE AND BEYOND OSHA REQUIREMENTS. CONTRACTOR IS SOLELY RESPONSIBLE FOR THE SAFETY OF WORKERS, THE GENERAL PUBLIC, AND OTHERS INVOLVED IN THE PROJECT AND SHALL PROVIDE SHEETING, BRACING, OR WHATEVER ACTION NECESSARY TO INSURE THE SAFETY OF PEOPLE, PROPERTY, AND STRUCTURES.
- 3.) VERTICAL CUT TO EXTEND FROM TRENCH BOTTOM TO 1 FT ABOVE TOP OF PIPE.
- 4.) AS PER AWWA C600 SEE 4.3.2.3, THE WIDTH OF THE TRENCH AT THE TOP OF THE PIPE SHALL PERMIT THE PIPE TO BE LAID AND JOINED PROPERLY AND TO ALLOW THE BACKFILL TO BE PLACED IN ACCORDANCE WITH CITY STANDARDS. AS A GUIDE, TRENCH WIDTHS SHOULD BE THE NOMINAL PIPE DIAMETER PLUS 24 IN. WHEN REQUIRED, TRENCHES SHALL BE WIDER TO PERMIT THE PLACEMENT OF TIMBER SUPPORTS, SHEETING, BRACING, AND APPURTENANCES AS REQUIRED BY THE SAFETY REQUIREMENTS OF THE AGENCY HAVING JURISDICTION.
- 5.) ALL PIPE, BACKFILL SHALL BE PLACED IN APPROPRIATE THICKNESSES AND COMPACTED IN THE FOLLOWING SEQUENCE
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 2. ONE FOOT ABOVE TOP OF PIPE
- 6.) BEDDING:
 - (A) CLASS "1" SHALL BE ALDOT 801 NO. 57 CRUSHED LIMESTONE (FOR P.V.C. PIPE USE ALDOT 8910)
 - (B) CLASS "2" SHALL BE REINFORCED CONCRETE 3000 PSI DESIGN MIX
 - (C) CLASS "3" SHALL BE NATIVE SOIL



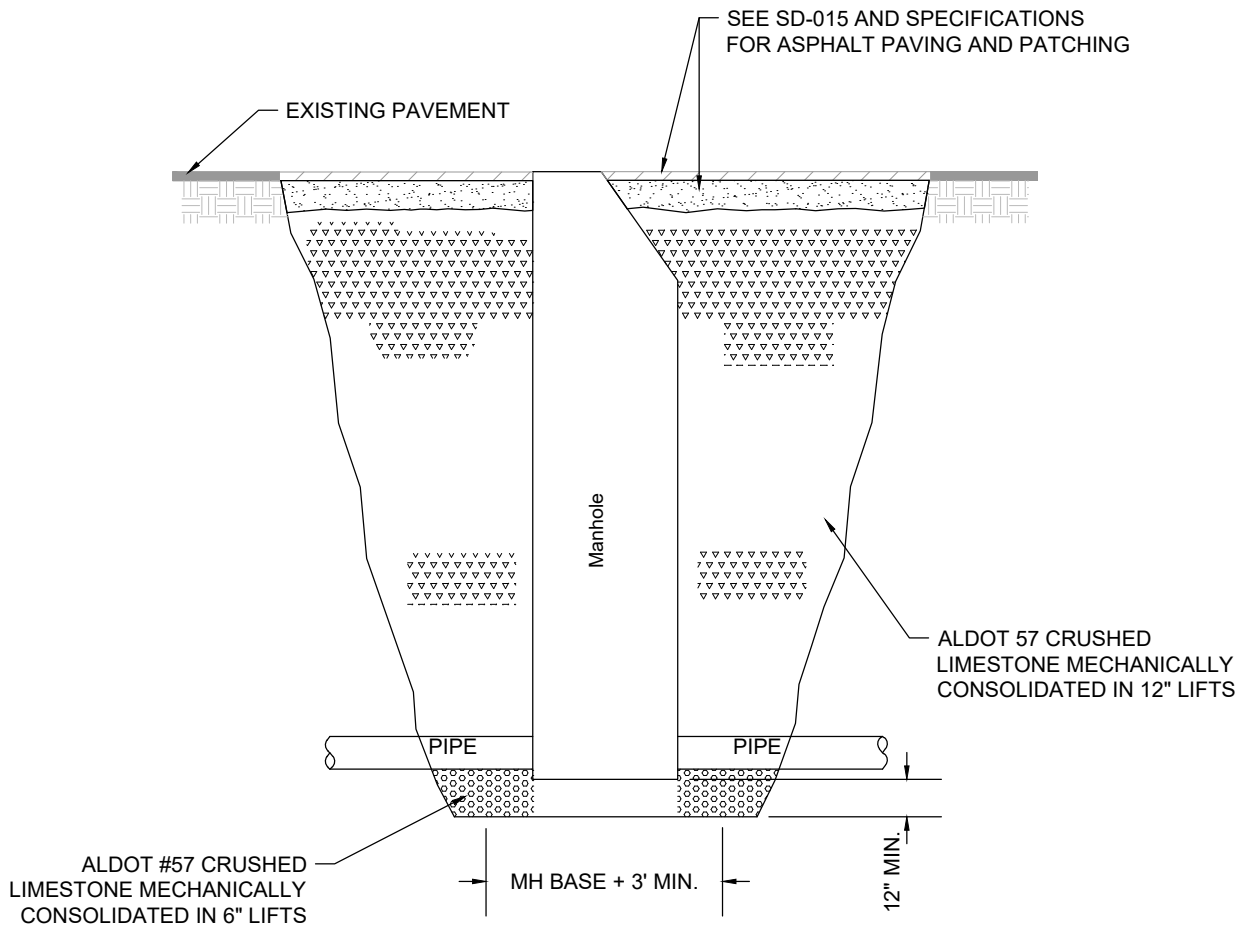
TRENCH DETAIL

PRESSURE - CONCRETE PAVING

SANITARY SEWER STANDARD DETAILS

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NOTES:

- 1) TRENCH FOUNDATION MATERIAL REQUIRED IF DIRECTED BY ENGINEER. MATERIAL TO BE ALDOT #57 CRUSHED LIMESTONE.
- 2) ALL SLOPES SHALL CONFORM TO OSHA REQUIREMENTS. ADDITIONAL PROTECTIVE MEASURES MAY BE REQUIRED ABOVE AND BEYOND OSHA DEPENDING ON SPECIFIC TRENCH CONDITIONS. CONTRACTOR IS SOLELY RESPONSIBLE FOR THE SAFETY OF WORKERS, THE GENERAL PUBLIC, AND OTHERS INVOLVED IN THE PROJECT AND SHALL PROVIDE SHEETING, BRACING, OR WHATEVER ACTION NECESSARY TO INSURE THE SAFETY OF PEOPLE, PROPERTY, AND STRUCTURES.

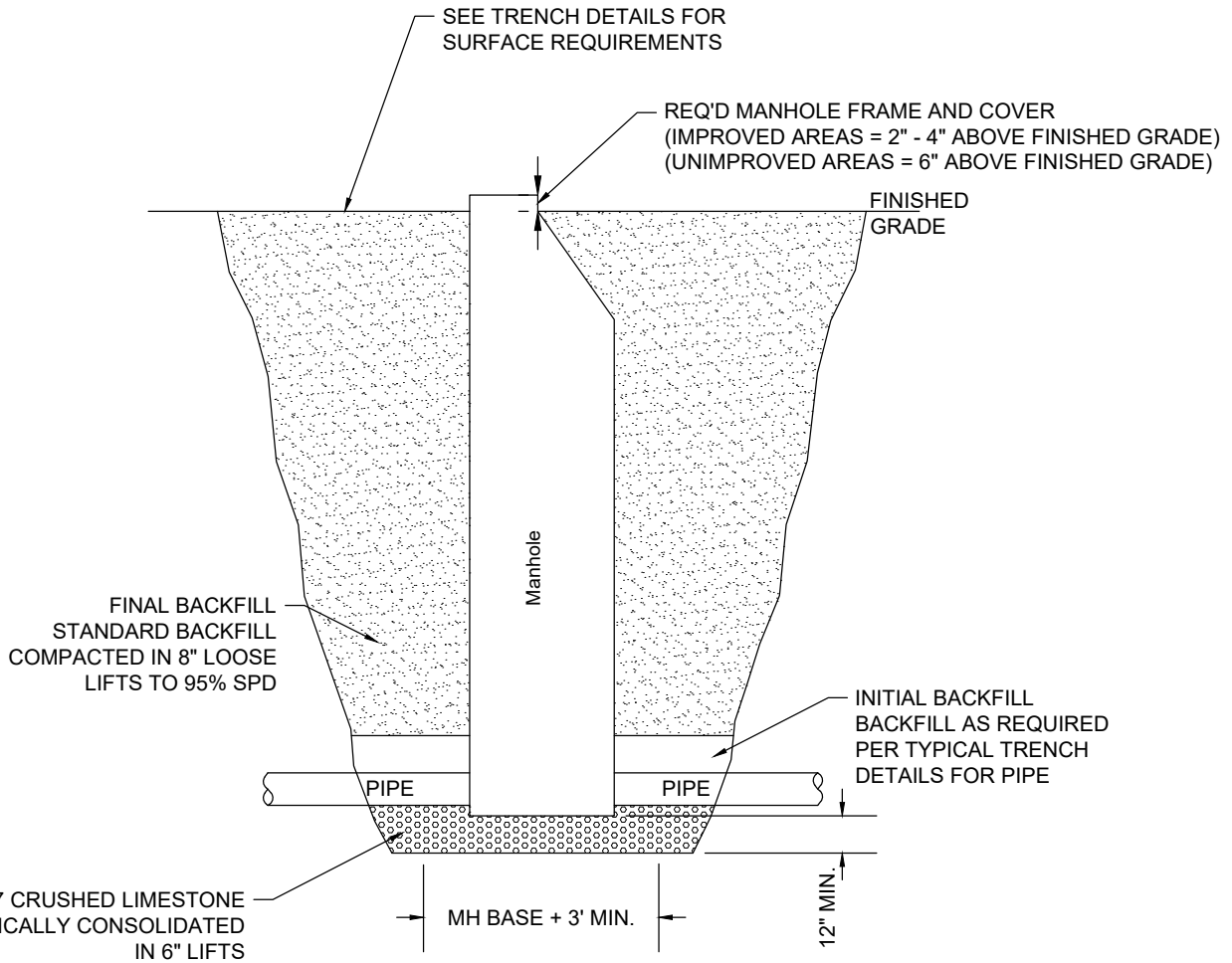


MANHOLE DETAIL BEDDING AND BACKFILL REQUIREMENTS TRAFFIC AREAS

SANITARY SEWER STANDARD DETAILS

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NOTES:

- 1) TRENCH FOUNDATION MATERIAL REQUIRED IF DIRECTED BY ENGINEER. MATERIAL TO BE ALDOT #57 CRUSHED LIMESTONE.
- 2) STANDARD BACKFILL SHALL BE NATIVE MATERIAL FREE OF LARGE ROCKS OR HARD MATERIAL.
- 3) ALL SLOPES SHALL CONFORM TO OSHA REQUIREMENTS. ADDITIONAL PROTECTIVE MEASURES MAY BE REQUIRED ABOVE AND BEYOND OSHA DEPENDING ON SPECIFIC TRENCH CONDITIONS. CONTRACTOR IS SOLELY RESPONSIBLE FOR THE SAFETY OF WORKERS, THE GENERAL PUBLIC, AND OTHERS INVOLVED IN THE PROJECT AND SHALL PROVIDE SHEETING, BRACING, OR WHATEVER ACTION NECESSARY TO INSURE THE SAFETY OF PEOPLE, PROPERTY, AND STRUCTURES.



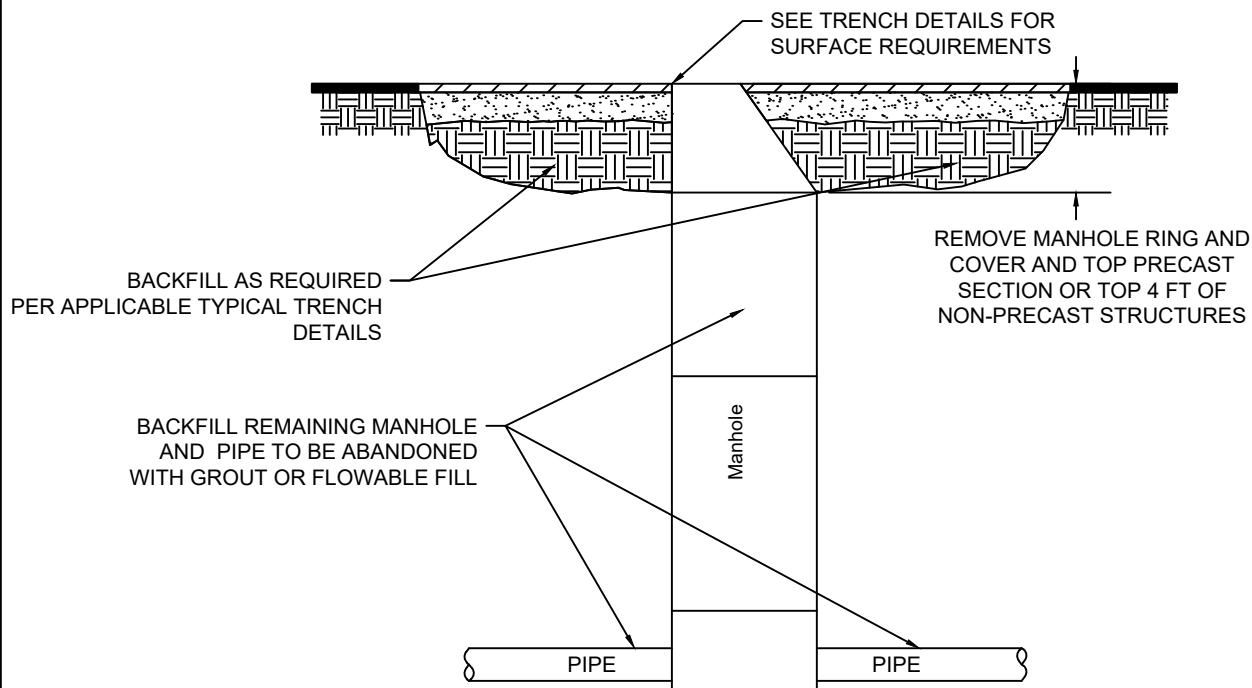
MANHOLE DETAIL

BEDDING AND BACKFILL REQUIREMENTS NON-TRAFFIC AREAS

SANITARY SEWER STANDARD DETAILS

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NOTES:

- 1) ALL SLOPES SHALL CONFORM TO OSHA REQUIREMENTS. ADDITIONAL PROTECTIVE MEASURES MAY BE REQUIRED ABOVE AND BEYOND OSHA DEPENDING ON SPECIFIC TRENCH CONDITIONS. CONTRACTOR IS SOLELY RESPONSIBLE FOR THE SAFETY OF WORKERS, THE GENERAL PUBLIC, AND OTHERS INVOLVED IN THE PROJECT AND SHALL PROVIDE SHEETING, BRACING, OR WHATEVER ACTION NECESSARY TO INSURE THE SAFETY OF PEOPLE, PROPERTY, AND STRUCTURES.



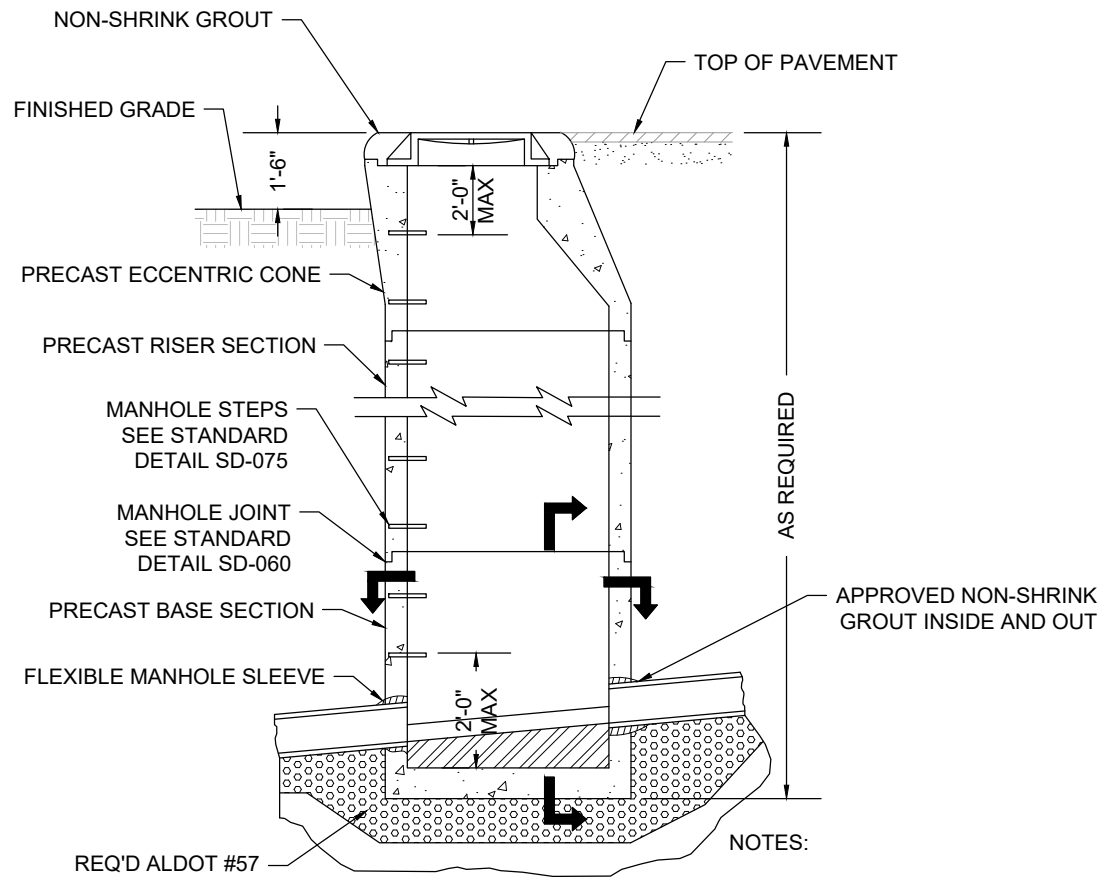
MANHOLE DETAIL

DEMOLITION OF EXISTING MANHOLE

SANITARY SEWER STANDARD DETAILS

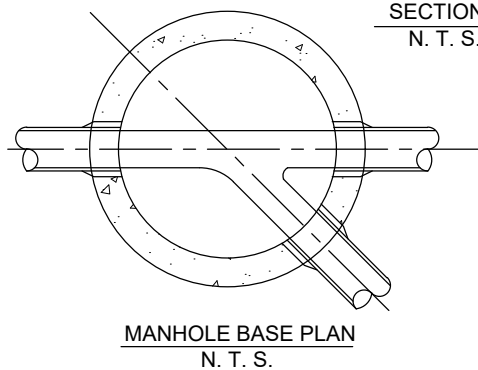
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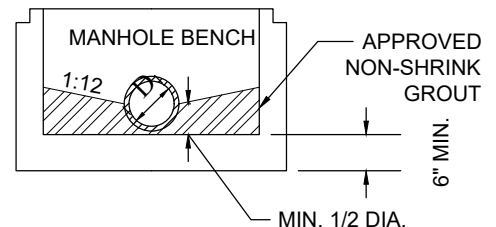
NOTES:

- 1) MANHOLES IN STREETS AND IMPROVED AREAS SHALL BE FINISHED FLUSH WITH FINISHED SURFACE. IN UNIMPROVED AREAS, 18" ABOVE FINISHED SURFACE OR AS DIRECTED BY ENGINEER.
- 2) FOR MANHOLE BACKFILL REQUIREMENTS REFER TO STANDARD DETAILS SD-045 AND SD-050.



NOTES:

- 1) PLACE STEPS ON LEAST OBSTRUCTED WALL.
- 2) MAX. DEFLECTION ANGLE OF SEWER ALIGNMENT = 90°
- 3) OPENINGS FOR PIPES TO BE FACTORY CAST OR CORED.



MANHOLE BASE SECTION
N. T. S.

NOTES:

- 1) BENCH REQUIRED FOR PIPE DIAMETER LESS THAN 48"

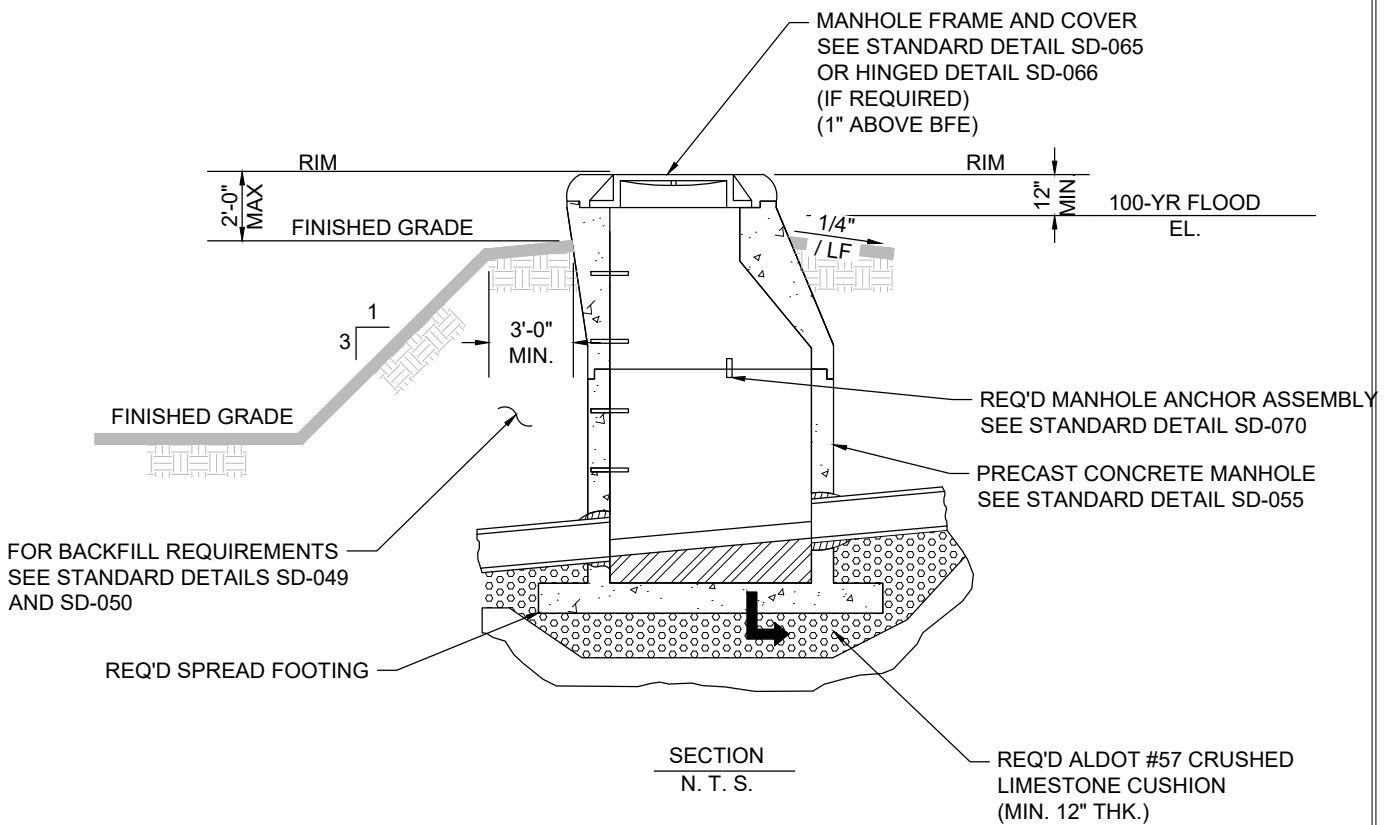


MANHOLE DETAIL STANDARD PRECAST

SANITARY SEWER STANDARD DETAILS

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NOTES:

- 1) FOR MANHOLE BACKFILL REQUIREMENTS REFER TO STANDARD DETAILS SD-045 AND SD-050.
- 2) WHERE REQUIRED BY OCE, AN ACCESS ROAD SHALL BE CONSTRUCTED TO ALLOW ACCESS TO ALL MANHOLES.
- 3) SPREAD FOOTING DESIGN SHALL BE PROJECT SPECIFIC AND SHALL BE SUBMITTED FOR APPROVAL BY OCE.
- 4) WHERE RAISED MANHOLES ARE NOT ALLOWED, MANHOLES SHALL BE EQUIPPED WITH WATERTIGHT FRAMES AND COVERS REFER TO STANDARD DETAIL SD-070.
- 5) WHERE MANHOLES ARE MORE THAN 2 FT ABOVE GRADE, HINGED MANHOLES COVERS SHALL BE USED. REFER TO STANDARD DETAIL SD-066.



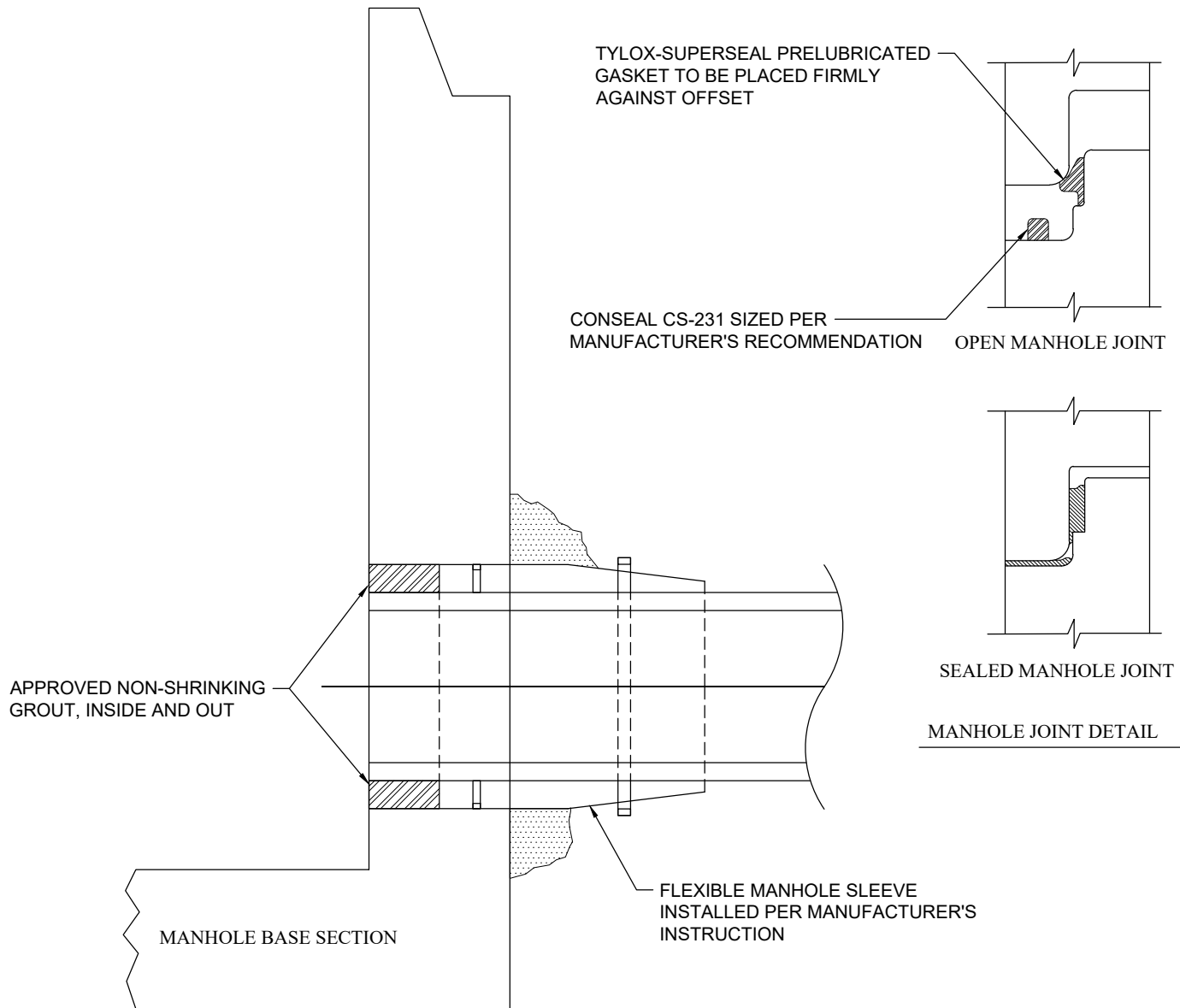
MANHOLE DETAIL

100 YR FLOOD ZONE AND/OR FILL AREA

SANITARY SEWER STANDARD DETAILS

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FLEXIBLE MANHOLE SLEEVE DETAIL



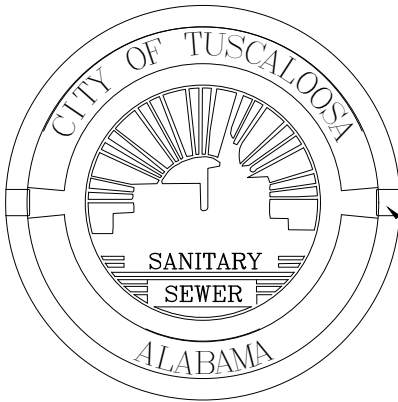
MANHOLE DETAIL

FLEXIBLE MANHOLE SLEEVE AND JOINT DETAILS

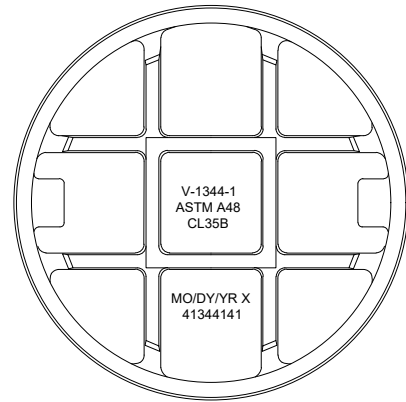
SANITARY SEWER STANDARD DETAILS

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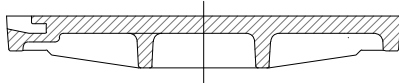
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(2) CLOSED
PICKHOLES



350 POUND RING AND COVER



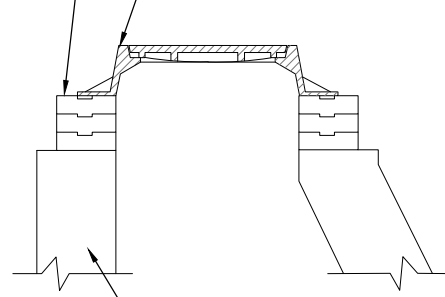
SECTION

NOTE:

1. FRAME & COVER VULCAN FOUNDRY No. V-1344-1 OR U.S. FOUNDRY & MFG. CORP. CATALOG NUMBER USF 420 WITH CITY OF TUSCALOOSA LOGO OR APPROVED EQUAL.
2. ALL CASTINGS SHALL BE CLEARLY MARKED WITH THE MANUFACTURER'S NAME, PRODUCT CATALOG NO. AND MADE IN THE U.S.A. IN CAST LETTERS

STANDARD CONCRETE ADJUSTING RINGS. PLACE MINIMUM $\frac{1}{2}$ INCH BED OF NON-SHRINK GROUT WITH BUTYL SEALANT WATERSTOP BETWEEN EACH LAYER. MAXIMUM COMBINED HEIGHT OF ADJUSTING RINGS SHALL BE 8 INCHES.

STANDARD FRAME & COVER



STANDARD MANHOLE

MANHOLE FRAME AND ADJUSTING RING DETAILS
NO SCALE



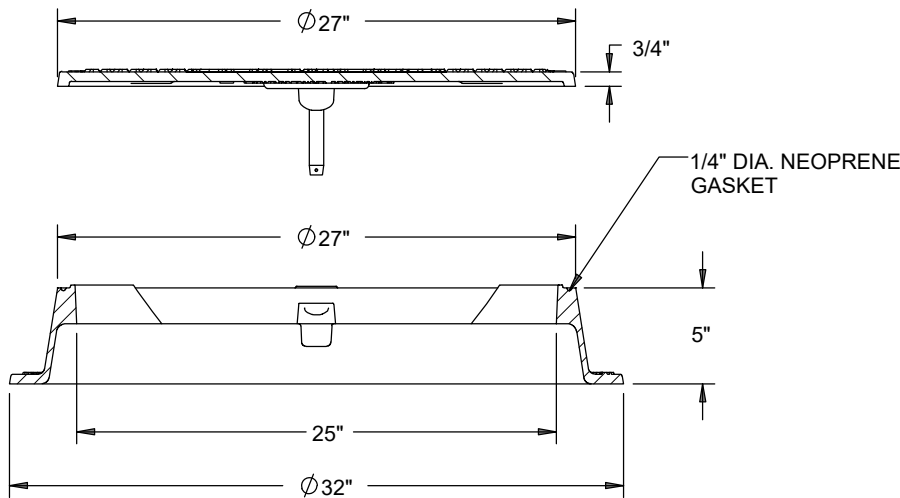
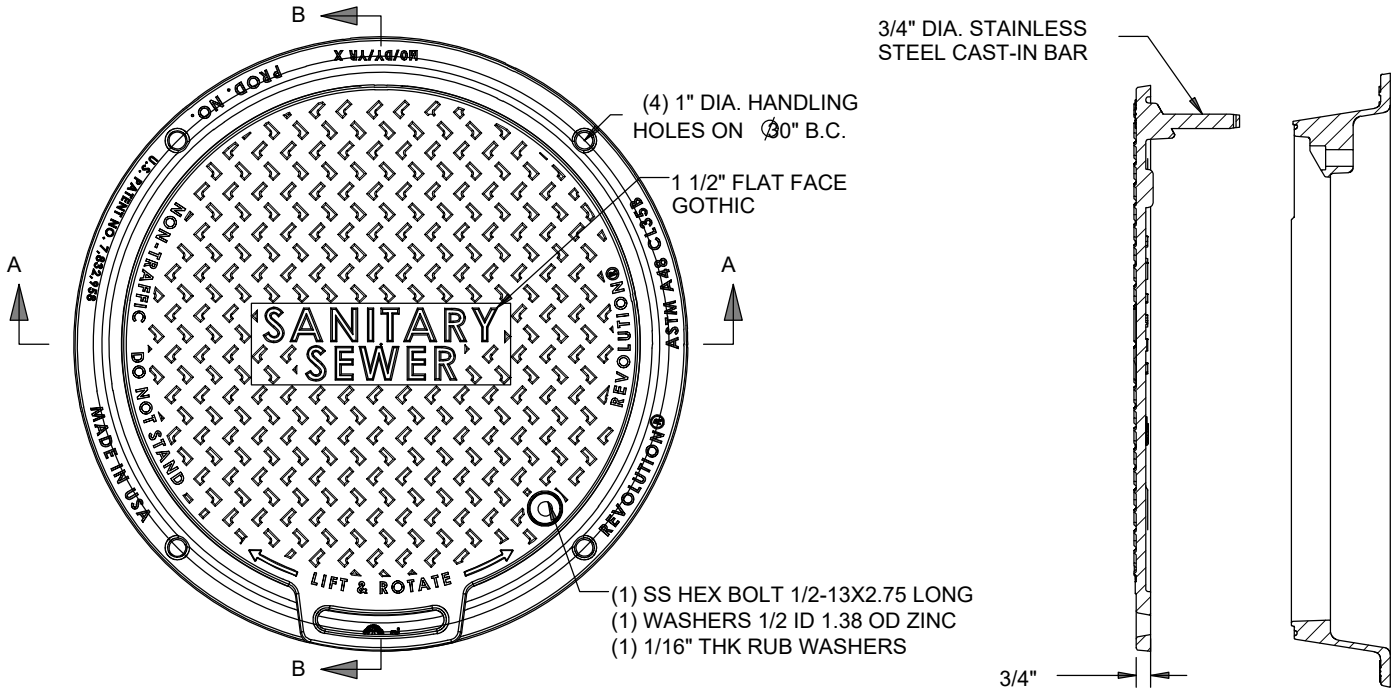
MANHOLE DETAIL

STANDARD COVER AND ADJUSTING RING DETAILS

SANITARY SEWER STANDARD DETAILS

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- NOTES:
- FOR USE ON MANHOLES OVER 2 FEET ABOVE GRADE
 - NEW MANHOLE COVER SHALL BE EAST JORDAN IRONWORKS REVOLUTION OR EQUAL AS APPROVED BY OCE.



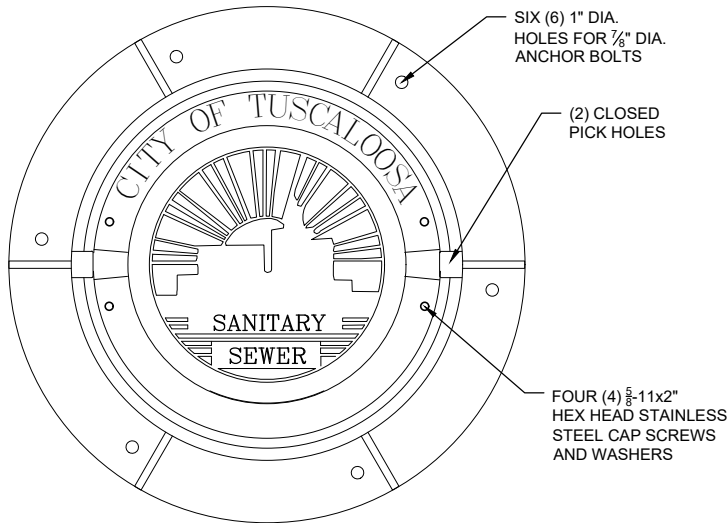
MANHOLE DETAIL

HINGED MANHOLE COVER

SANITARY SEWER STANDARD DETAILS

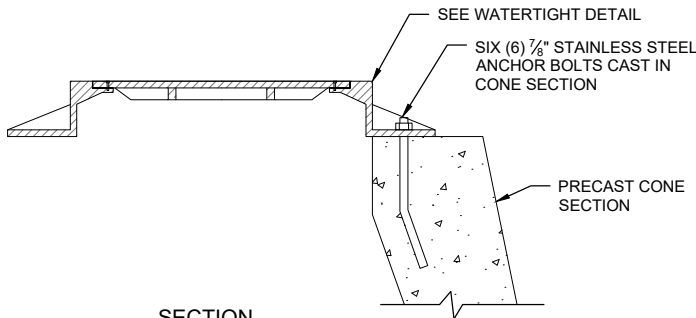
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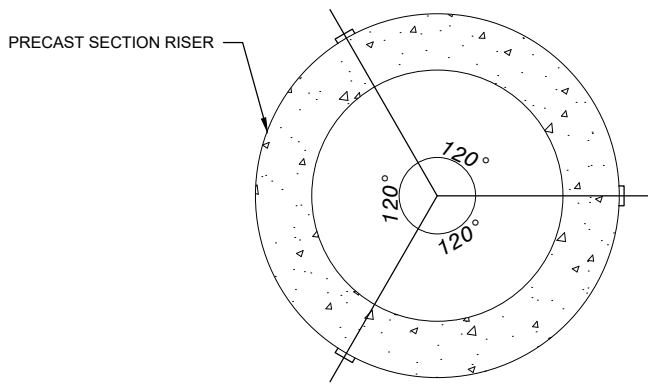
PLAN

NOTE: MANHOLE COVER SHALL BE CAST IRON AS FURNISHED EJIW V-2358, USF 1452 OR APPROVED EQUAL. (WITH CITY OF TUSCALOOSA LOGO OR APPROVED EQUAL) MANHOLE RIM AND COVER SHALL BE WATERTIGHT. APPROXIMATE WEIGHT OF FRAME & COVER - 350 LBS. MIN.

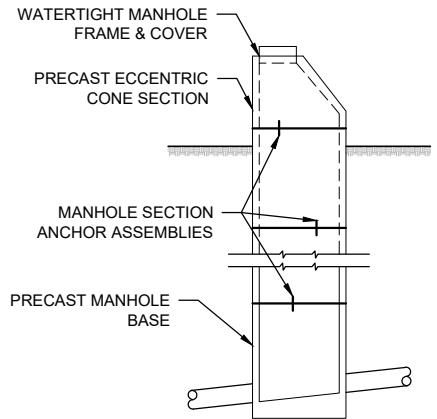


SECTION

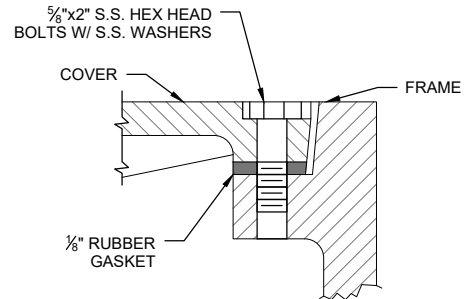
WATERTIGHT MANHOLE COVER DETAILS



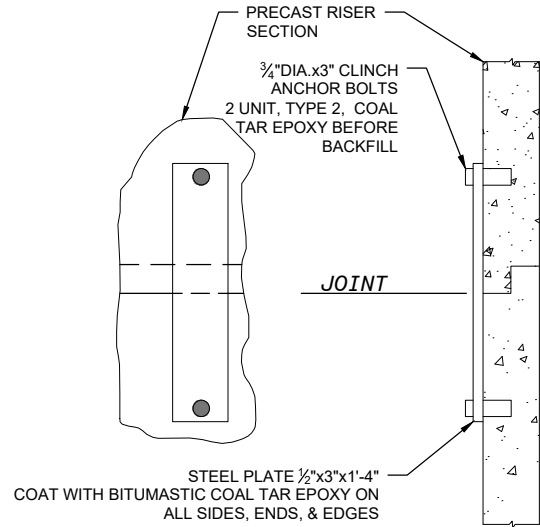
SECTION



NOTE: MANHOLE SECTION ANCHOR ASSEMBLIES SHALL BE INSTALLED BETWEEN ALL PRECAST RISER SECTIONS AT EVERY MANHOLE WHERE WATERTIGHT MANHOLE FRAMES AND COVERS ARE SPECIFIED



WATERTIGHT DETAIL



PRECAST RISER SECTION

NOTE: ANCHOR ASSEMBLIES REQUIRED PER JOINT 120° APART



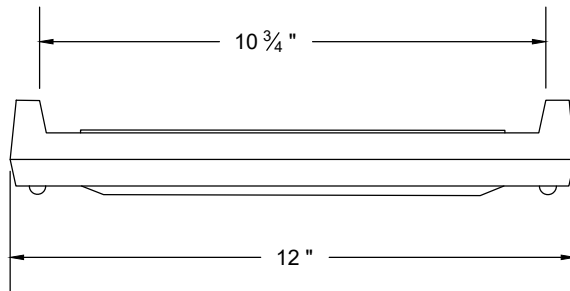
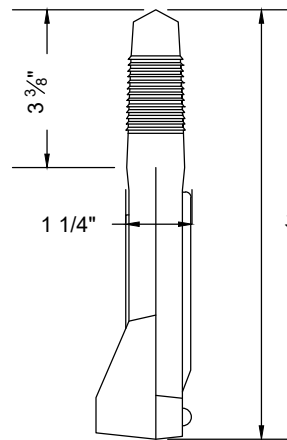
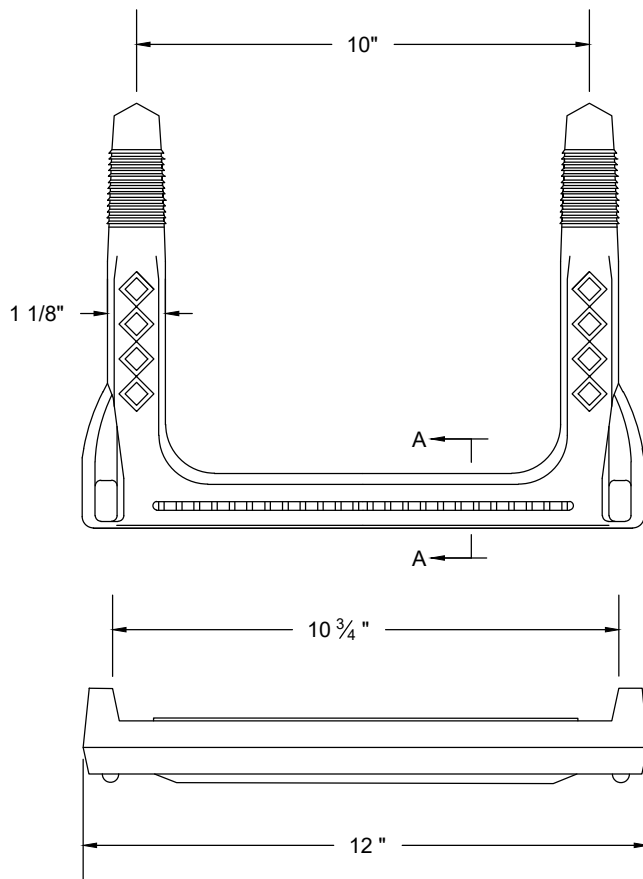
MANHOLE DETAIL

WATERTIGHT FRAME AND COVER AND ANCHOR ASSEMBLY

SANITARY SEWER STANDARD DETAILS

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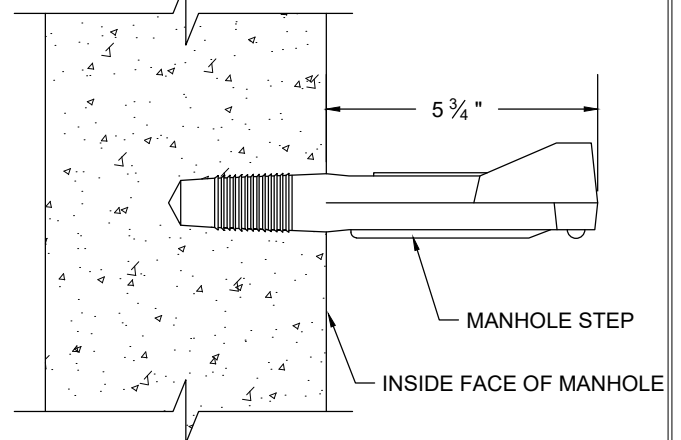
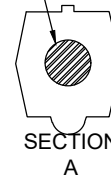
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NOTES:

1. MANHOLE AND INLET STEPS SHALL BE PLASTIC COATED REINFORCED STEEL. PLASTIC COATED MANHOLE STEPS SHALL BE POLYPROPYLENE COATED STEEL REINFORCING RODS WITH ROD AND PULL OUT RATINGS MEETING OSHA STANDARDS.
2. MANHOLE AND INLET STEPS SHALL BE INSTALLED AT MAXIMUM 16" INTERVALS

COPOLYMER POLYPROPYLENE PLASTIC
1/2" GRADE 60 STEEL REINFORCEMENT



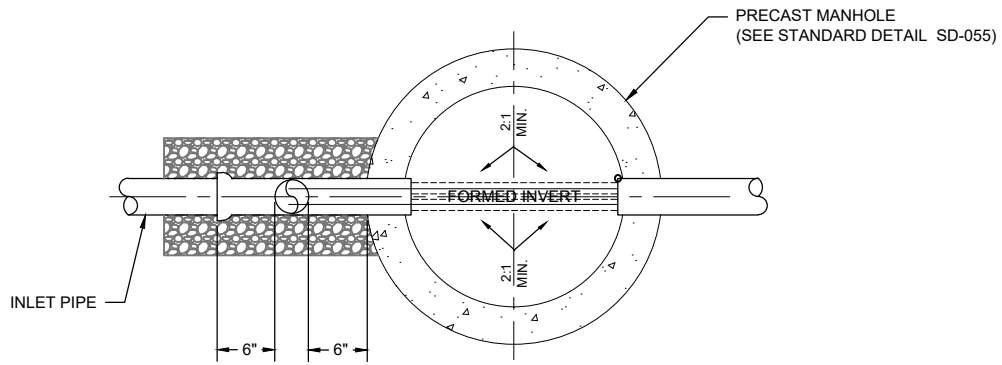
MANHOLE DETAIL

STEP

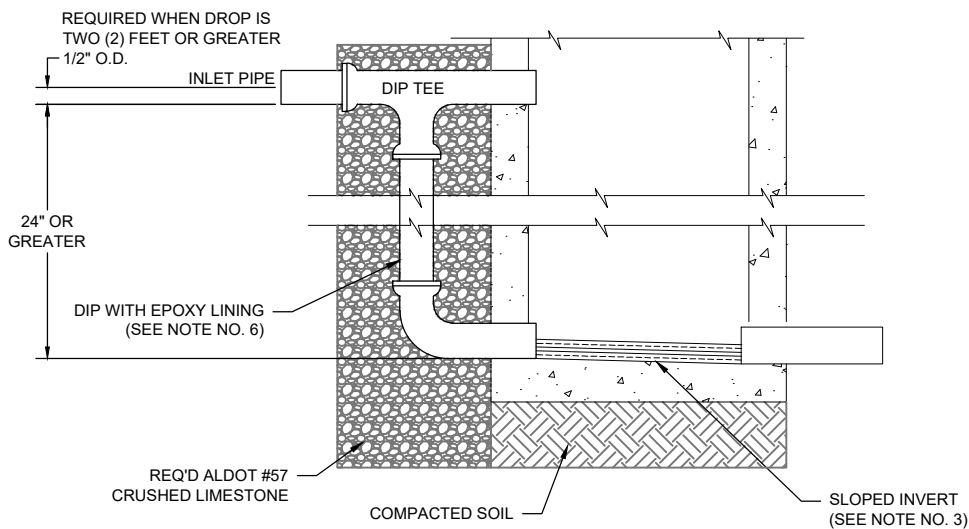
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SECTIONAL PLAN



SECTIONAL ELEVATION

NOTES:

1. ALL MANHOLES SHALL BE REQUIRED TO HAVE A CLEAR LINE OF SIGHT FROM THE RIM TO ALL PIPE INVERTS.
2. ALL MANHOLES SHALL BE CYLINDRICAL SHAPED PRECAST STRUCTURE CONCRETE.
3. ALL MANHOLES SHALL BE PROPERLY GROUTED AND WATER TIGHT.
4. INVERT SLOPE SHALL PROVIDE 0.10' ACROSS THE MANHOLE WHERE THERE IS NOT A TURN GREATER THAN 22 DEGREES AND A 0.25' DROP ACROSS THE MANHOLE WHERE THE TURN IS GREATER THAN 22 DEGREES.
5. VERTICAL PIPE SHALL BE EPOXY LINED DIP WITH RESTRAINED JOINTS.
6. DIP EPOXY LINING SHALL BE A 40-MIL THICKNESS COATING OF PERMOX CTF AMINE CURED NOVOLAC EPOXY. COATING SHALL BE RED IN COLOR.



MANHOLE DETAIL

DROP MANHOLE WITH MEMPHIS TEE

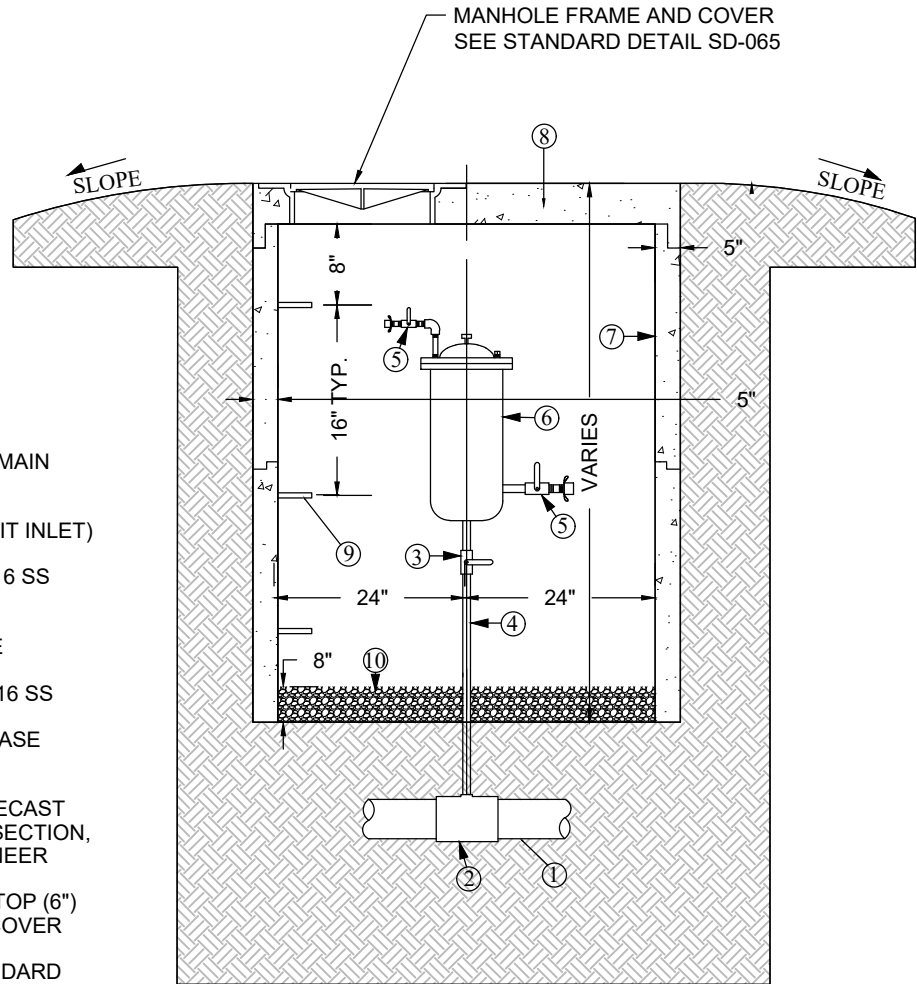
SANITARY SEWER STANDARD DETAILS

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MATERIAL IDENTIFICATION

1. PRESSURE SEWER FORCE MAIN
(SIZE VARIES)
2. THREADED TEE (SIZE TO SUIT INLET)
3. 2" SHUT OFF BALL VALVE, 316 SS
APOLLO
4. 2" THREADED 316 SS NIPPLE
5. 1" BLOW OFF BALL VALVE, 316 SS
6. SEWAGE AIR/VACUUM RELEASE
VALVE. MODEL A.R.I. D-025
7. STANDARD 4' DIAMETER PRECAST
CONCRETE MANHOLE TOP SECTION,
AS DIRECTED BY THE ENGINEER
8. PRECAST CONCRETE FLAT TOP (6")
WITH MANHOLE RING AND COVER
9. MANHOLE STEPS, SEE STANDARD
DETAIL SD-075
10. CRUSHED LIMESTONE (8" MIN.
DEPTH)



AUTOMATIC VAC/AIR RELEASE VALVE DETAIL
NO SCALE

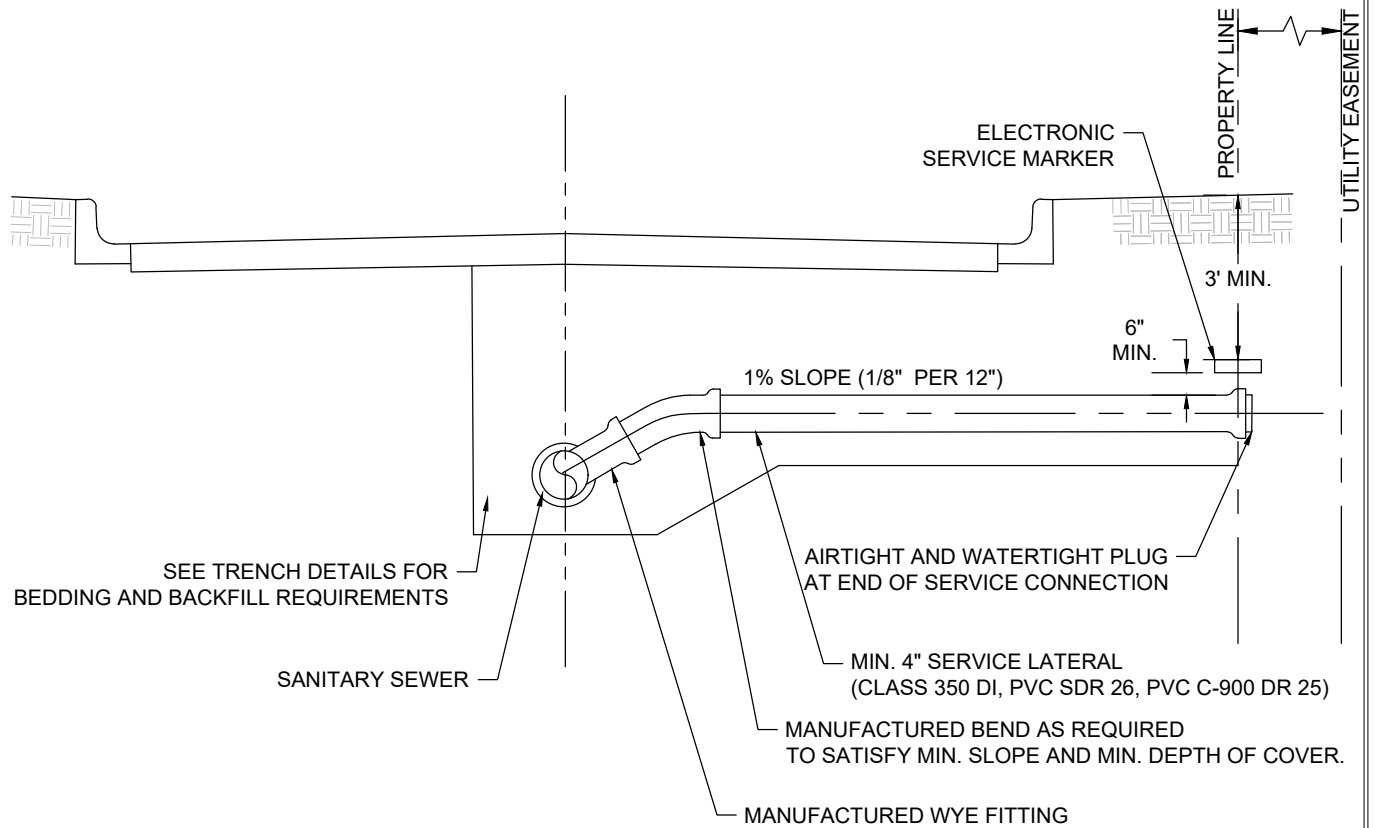


FORCE MAIN DETAIL AIR/VACUUM RELEASE VALVE MANHOLE DETAIL

SANITARY SEWER STANDARD DETAILS

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NOTES:

1. SERVICE LATERALS SHALL BE INSTALLED FOR EACH LOT AND EXTEND TO USER'S PROPERTY LINE.
2. MINIMUM DEPTH OF COVER FROM TOP OF CURB SHALL BE 3 FEET.
3. METALLIC TAPE OR WIRE SHALL BE INSTALLED ABOVE PVC SERVICE LATERALS.



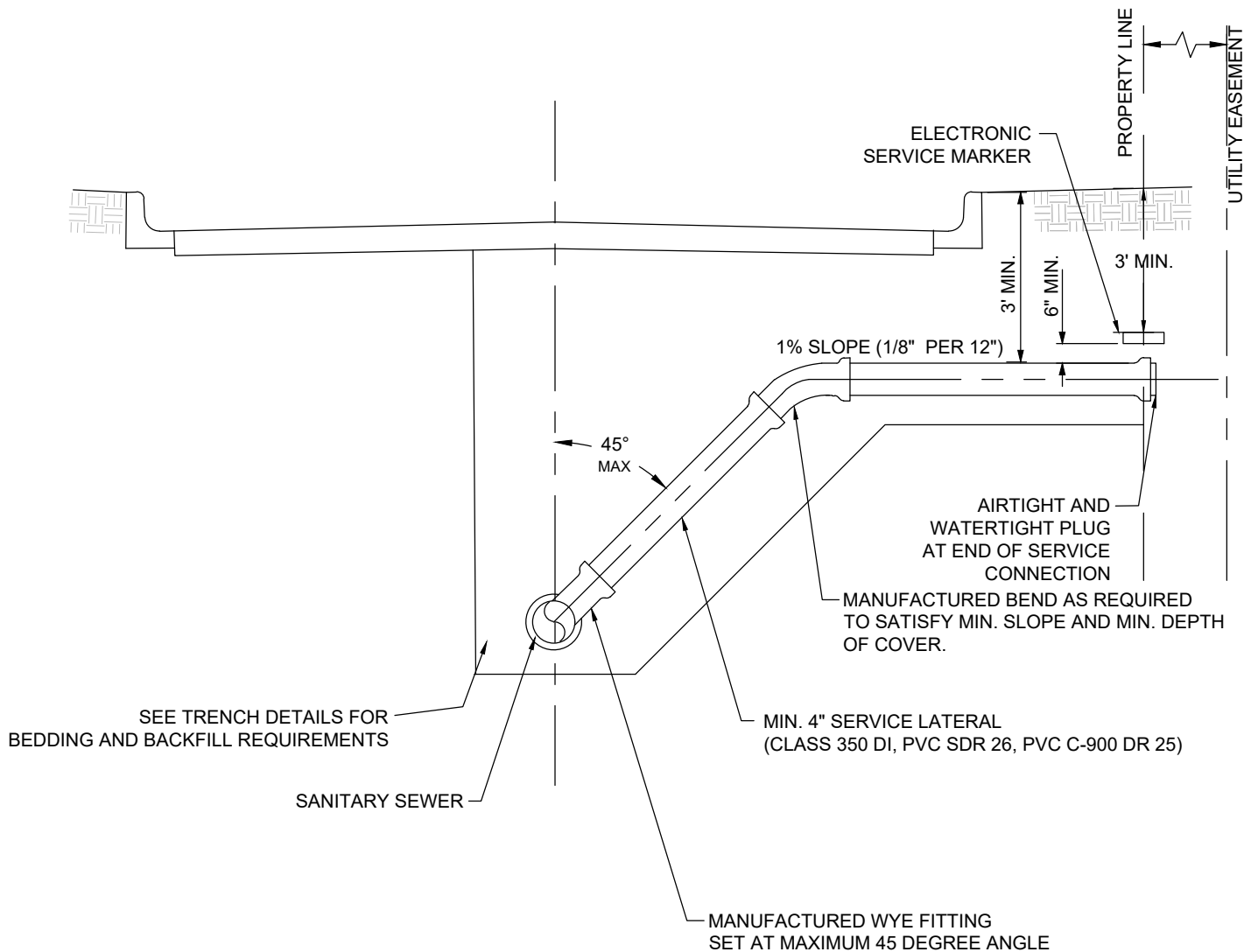
SERVICE LATERAL DETAIL

LATERAL CONNECTION SHALLOW SEWER

SANITARY SEWER STANDARD DETAILS

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NOTES:

1. SERVICE LATERALS SHALL BE INSTALLED FOR EACH LOT AND EXTEND TO USER'S PROPERTY LINE.
2. MINIMUM DEPTH OF COVER FROM TOP OF CURB SHALL BE 3 FEET.
3. METALLIC TAPE OR WIRE SHALL BE INSTALLED ABOVE PVC SERVICE LATERALS.

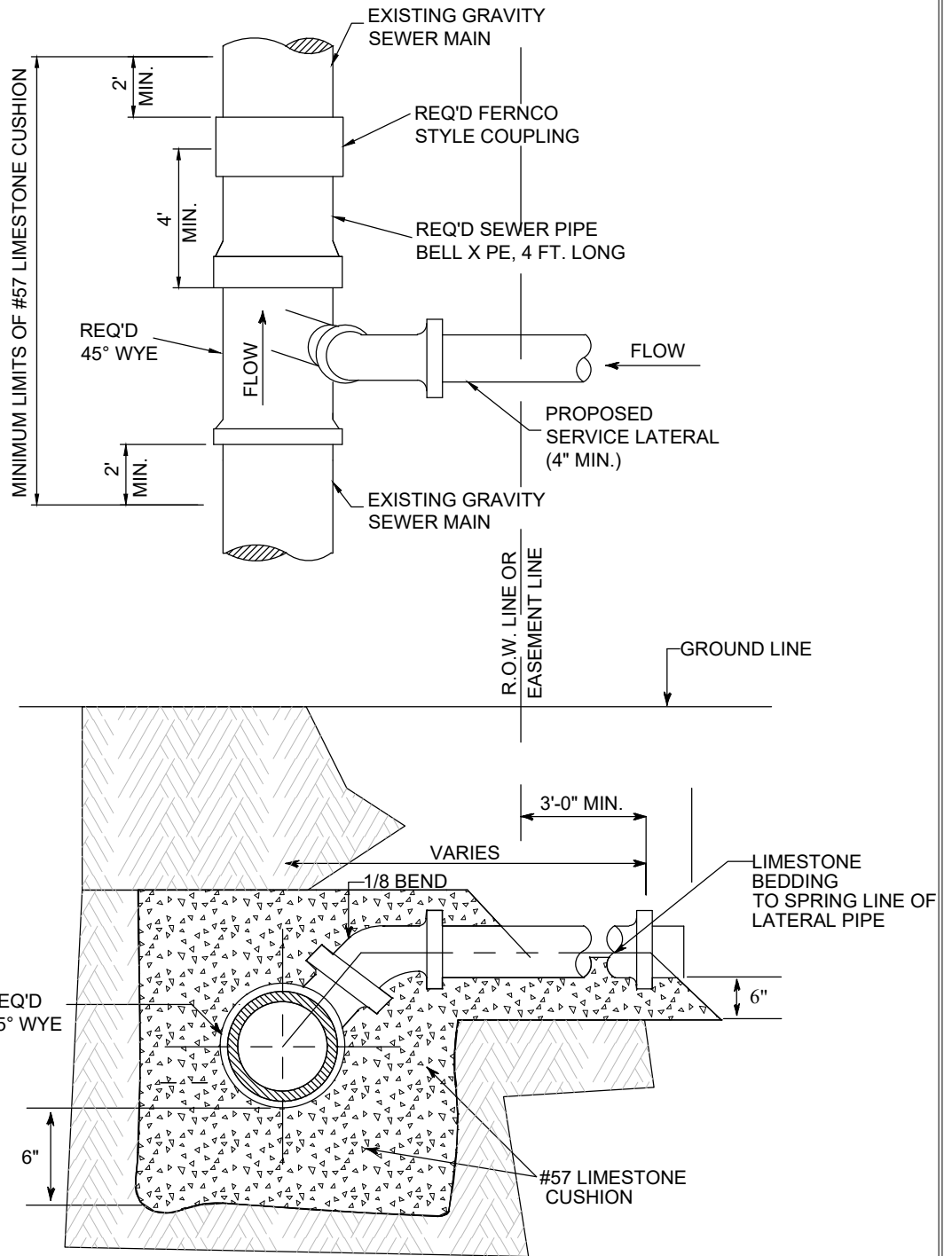


SERVICE LATERAL DETAIL LATERAL CONNECTION DEEP SEWER

SANITARY SEWER STANDARD DETAILS

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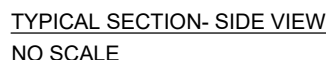
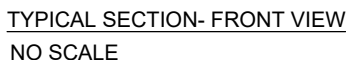
SERVICE LATERAL DETAIL

LATERAL CONNECTION TO EXISTING GRAVITY SEWER

SANITARY SEWER STANDARD DETAILS

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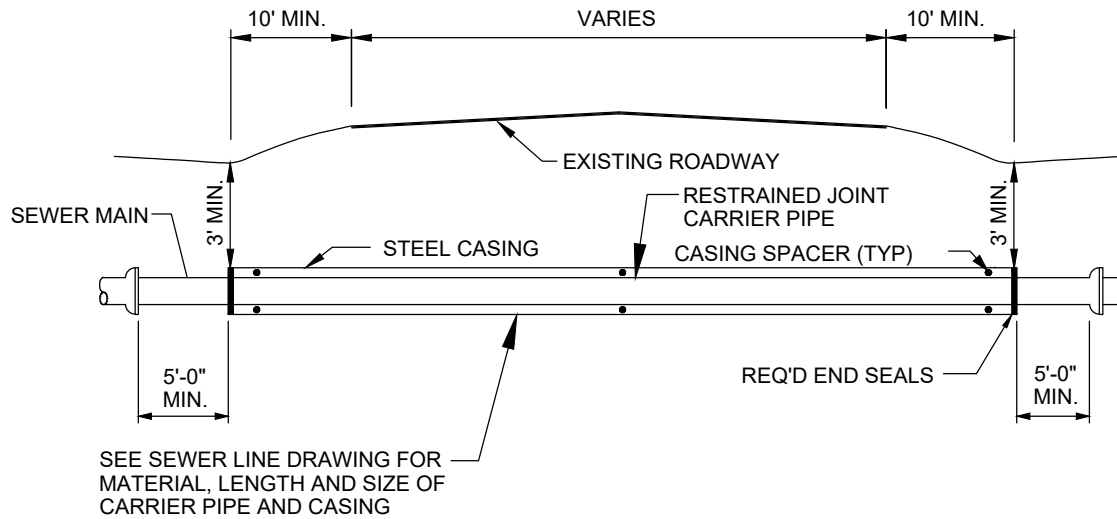
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5) THIS DETAIL IS TYPICAL FOR SUPPORTING AN 8-INCH ELEVATED SEWER INSIDE A 16-INCH STEEL ENCASEMENT. HOWEVER, IT SHALL BE THE RESPONSIBILITY OF THE DESIGN ENGINEER TO MAKE ADJUSTMENTS AS REQUIRED FOR PROJECT SPECIFIC PIPE DIAMETER AND SOIL CONDITIONS.

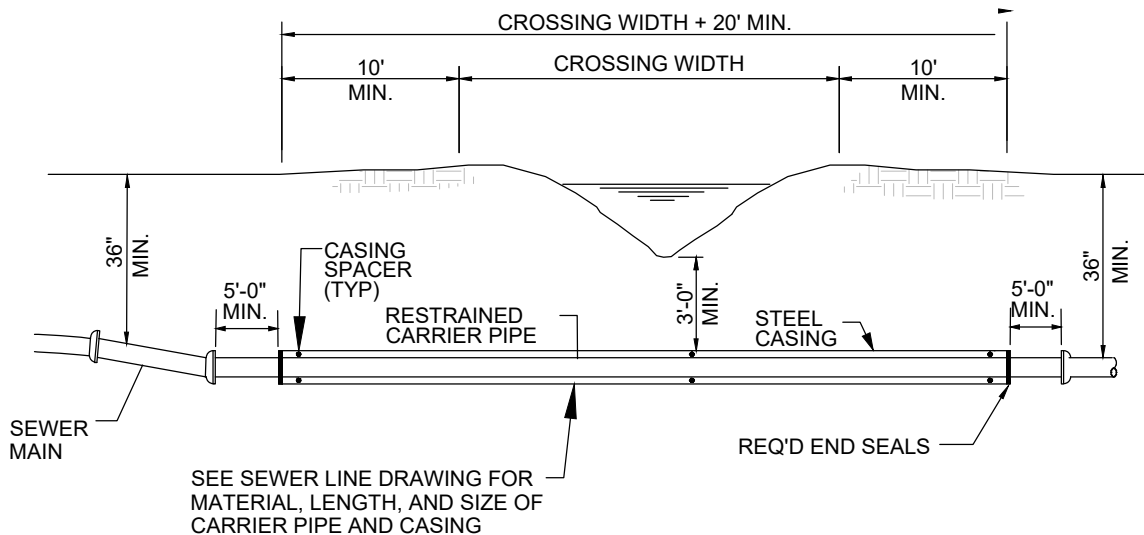


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TYPICAL ROAD BORE DETAIL

NO SCALE



TYPICAL WET DITCH/CREEK CROSSING

NO SCALE

STEEL ENCASEMENT

PIPE DIAMETER (IN.)	MINIMUM WALL THICKNESS (IN.)
8" - 16"	0.250
24"	0.375
30"	0.500
> 30"	0.5625

ENCASEMENT NOTES

1. 3 - SPACERS PER JOINT OF PIPE
2. CARRIER PIPE SPACERS SHALL BE MODEL B-55 AS MANUFACTURED BY CONTRACTORS MANUFACTURING INC. OR EQUAL
3. PROVIDE END SEALS FOR ALL CASINGS. APS MODEL AC OR EQUAL



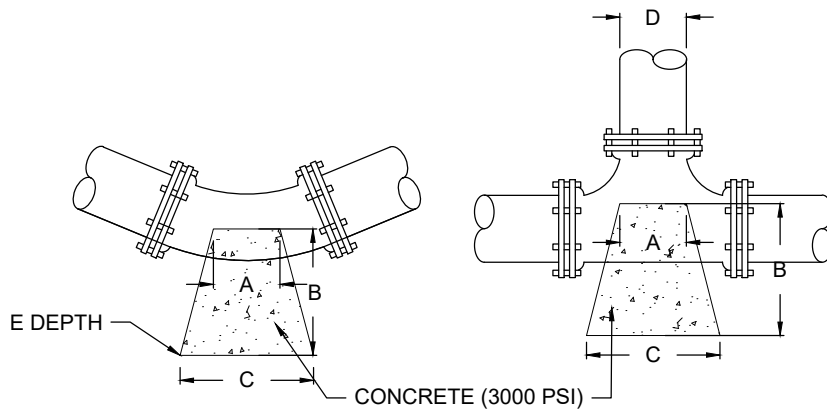
ENCASEMENT DETAIL

TYPICAL WET DITCH/CREEK CROSSING AND BORE - ROADWAY

SANITARY SEWER STANDARD DETAILS

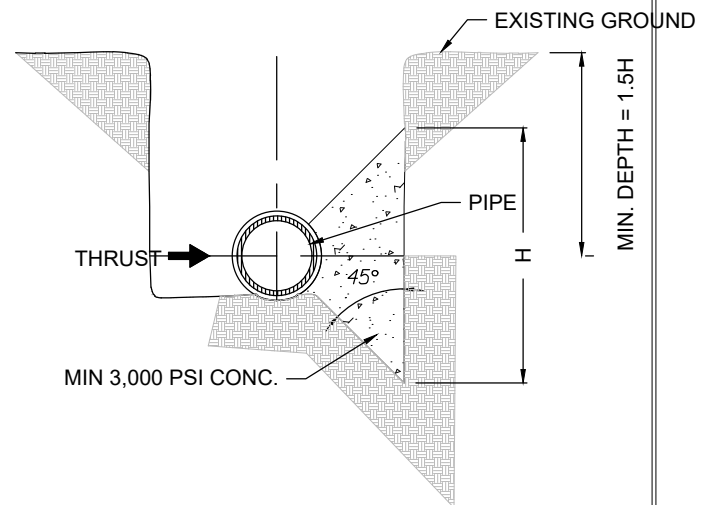
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PIPE SIZE D	BLOCK DIMENSION				FITTING SIZE
	A	B	C	E	
6" OR LESS	10"	2'-0"	2'-6"	2'-6"	90°, 45°, 22 1/2°, 11 1/4° BENDS
6" OR LESS	10"	2'-0"	2'-6"	2'-0"	DEAD ENDS, TEES
8"	10"	2'-0"	3'-0"	2'-6"	90°, 45°, 22 1/2°, 11 1/4° BENDS
8"	10"	2'-0"	3'-0"	2'-0"	DEAD ENDS, TEES
10"	1'-2"	3'-0"	3'-6"	3'-0"	90°, 45°, 22 1/2°, 11 1/4° BENDS
10"	1'-2"	3'-0"	3'-6"	2'-6"	DEAD ENDS, TEES
12"	1'-2"	3'-0"	4'-6"	3'-6"	90°, 45°, 22 1/2°, 11 1/4° BENDS
12"	1'-2"	3'-0"	4'-6"	3'-0"	DEAD ENDS, TEES
14"	1'-6"	3'-6"	5'-0"	4'-0"	90°, 45°, 22 1/2°, 11 1/4° BENDS
14"	1'-6"	3'-6"	5'-0"	3'-0"	DEAD ENDS, TEES
16"	1'-6"	3'-6"	5'-0"	5'-0"	90°, 45°, 22 1/2°, 11 1/4° BENDS
16"	1'-6"	3'-6"	5'-0"	4'-0"	DEAD ENDS, TEES

* THRUST BLOCKS FOR LINES GREATER THAN 16" SHALL BE DESIGNED BY THE DESIGN ENGINEER FOR THE INDIVIDUAL PROJECT.



TYP. SECTION @ THRUST BLOCK
NO SCALE

GENERAL NOTES FOR HORIZONTAL AND VERTICAL BLOCKING

1. ALL PRESSURE PIPE 4 INCHES IN DIAMETER AND LARGER SHALL BE PROVIDED WITH CONCRETE THRUST RESTRAINT.
2. THRUST BLOCKING SHALL BE POURED AGAINST UNDISTURBED EARTH.
3. CONCRETE SHALL BE KEPT CLEAR OF JOINT AND JOINT ACCESSORIES.
4. BEARING AREA OF THRUST BLOCKS ARE BASED ON 150 PSI TEST PRESSURE AND AN ALLOWABLE SOIL BEARING OF 2000 PSF. BEARING AREA VALUES SHALL BE ADJUSTED IF THE SPECIFICATIONS REQUIRE A DIFFERENT TEST PRESSURE OR ALLOWABLE SOIL BEARING. PROVIDE ADDITIONAL AREA IF DICTATED BY THE CONDITIONS ACTUALLY ENCOUNTERED.
5. ANY SPECIAL THRUST BLOCKING DETIALED ON THE PLANS SHALL SUPERCEDE THIS DETAIL

SOURCE: DIPRA THRUST RESTRAINT FOR DUCTILE IRON PIPE



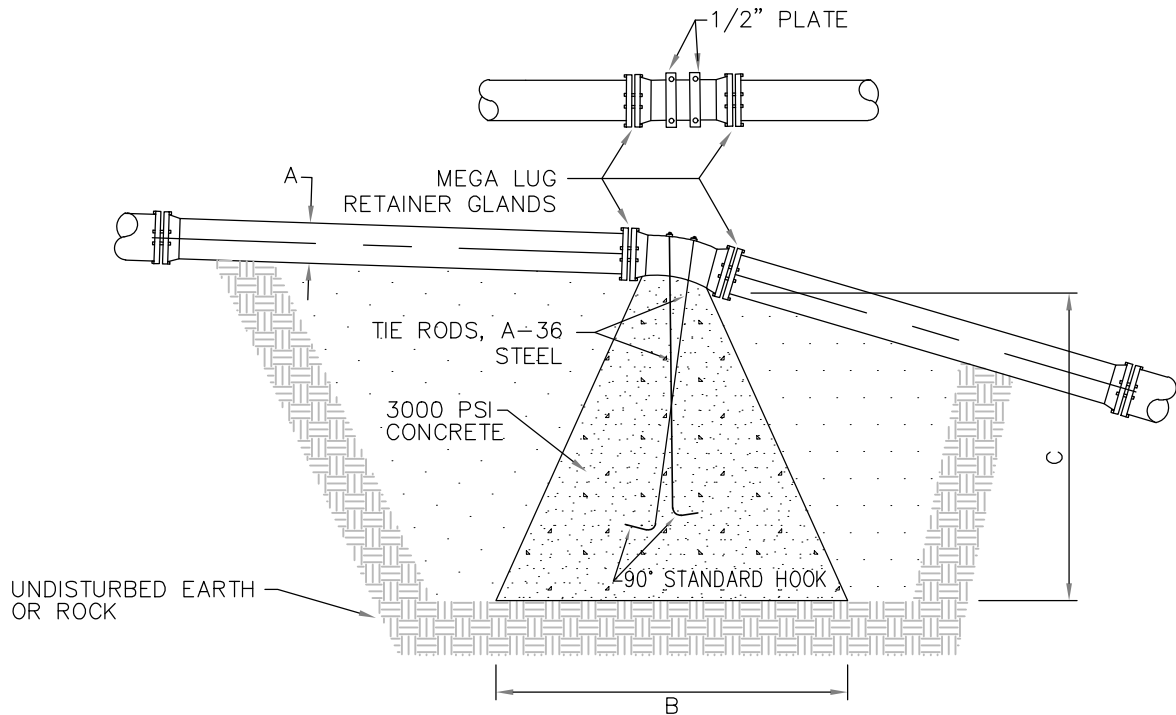
THRUST RESTRAINT DETAIL

HORIZONTAL CONCRETE BLOCKING

SANITARY SEWER STANDARD DETAILS

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PIPE DIAMETER A	C.Y. REQ'D 45° BEND	BASE B	HEIGHT C	ANCHOR SIZE	ANCHOR EMBEDMENT
6" OR LESS	2.7	8' x 8'	4'-0"	3/4"	2'-0"
8"	4.0	9' x 9'	4'-6"	3/4"	2'-0"
10"	6.0	10' x 10'	5'-0"	3/4"	2'-0"
12"	8.5	12' x 12'	6'-0"	3/4"	2'-0"
14"	11.5	13' x 13'	6'-6"	3/4"	2'-0"
16"	14.8	14' x 14'	7'-0"	3/4"	2'-0"

* GRAVITY THRUST BLOCKS FOR LINES GREATER THAN 16" SHALL BE DESIGNED BY THE DESIGN ENGINEER FOR THE INDIVIDUAL PROJECT.

GENERAL NOTES FOR HORIZONTAL AND VERTICAL BLOCKING

1. ALL PRESSURE PIPE 4 INCHES IN DIAMETER AND LARGER SHALL BE PROVIDED WITH CONCRETE THRUST RESTRAINT.
2. THRUST BLOCKING SHALL BE POURED AGAINST UNDISTURBED EARTH.
3. CONCRETE SHALL BE KEPT CLEAR OF JOINT AND JOINT ACCESSORIES.
4. BEARING AREA OF THRUST BLOCKS ARE BASED ON 150 PSI TEST PRESSURE AND AN ALLOWABLE SOIL BEARING OF 2000 PSF. BEARING AREA VALUES SHALL BE ADJUSTED IF THE SPECIFICATIONS REQUIRE A DIFFERENT TEST PRESSURE OR ALLOWABLE SOIL BEARING. PROVIDE ADDITIONAL AREA IF DICTATED BY THE CONDITIONS ACTUALLY ENCOUNTERED.
5. ANY SPECIAL THRUST BLOCKING DETIALED ON THE PLANS SHALL SUPERCEDE THIS DETAIL
6. VERTICAL BENDS THAT REQUIRE A THRUST BLOCK VOLUME GREATER THAN 5 C.Y. REQUIRE SPECIAL BLOCKING DETAILS.

SOURCE: DIPRA THRUST RESTRAINT FOR DUCTILE IRON PIPE



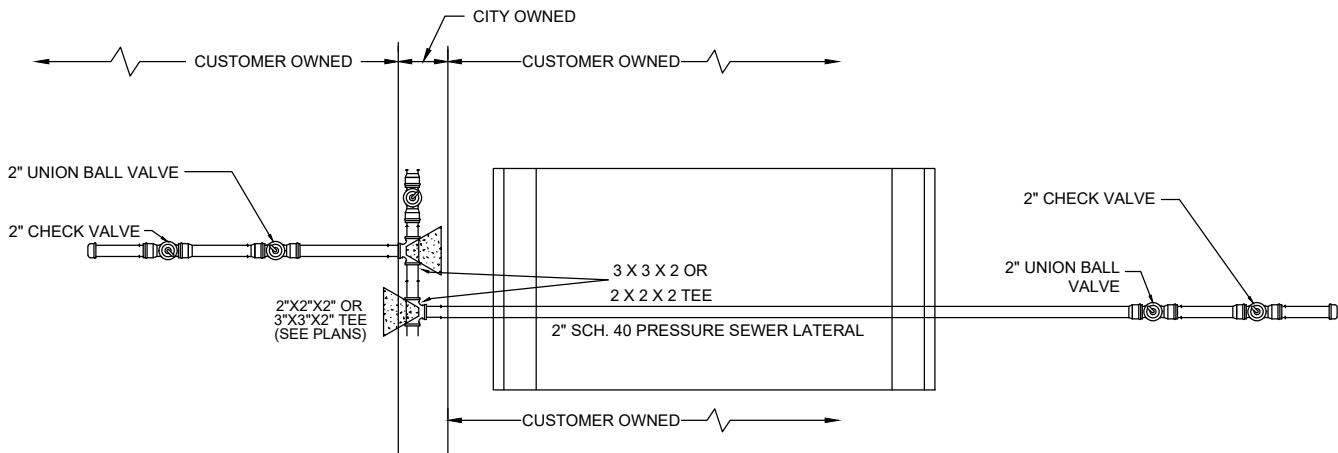
THRUST RESTRAINT DETAIL

VERTICAL CONCRETE BLOCKING

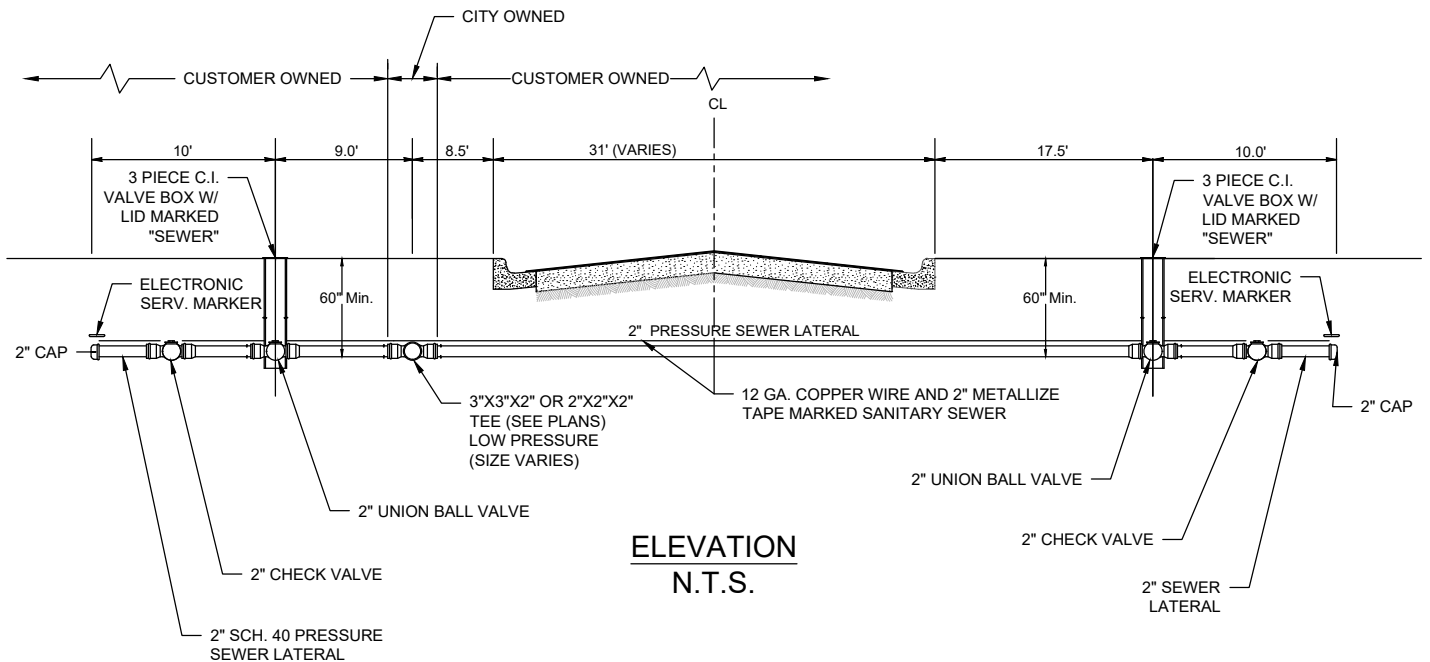
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PLAN
N.T.S.



ELEVATION
N.T.S.

NOTES:

1. ALL PIPE AND FITTINGS SHALL BE SCH. SDR 26, SCH. 40 OR 80 P.C.V.

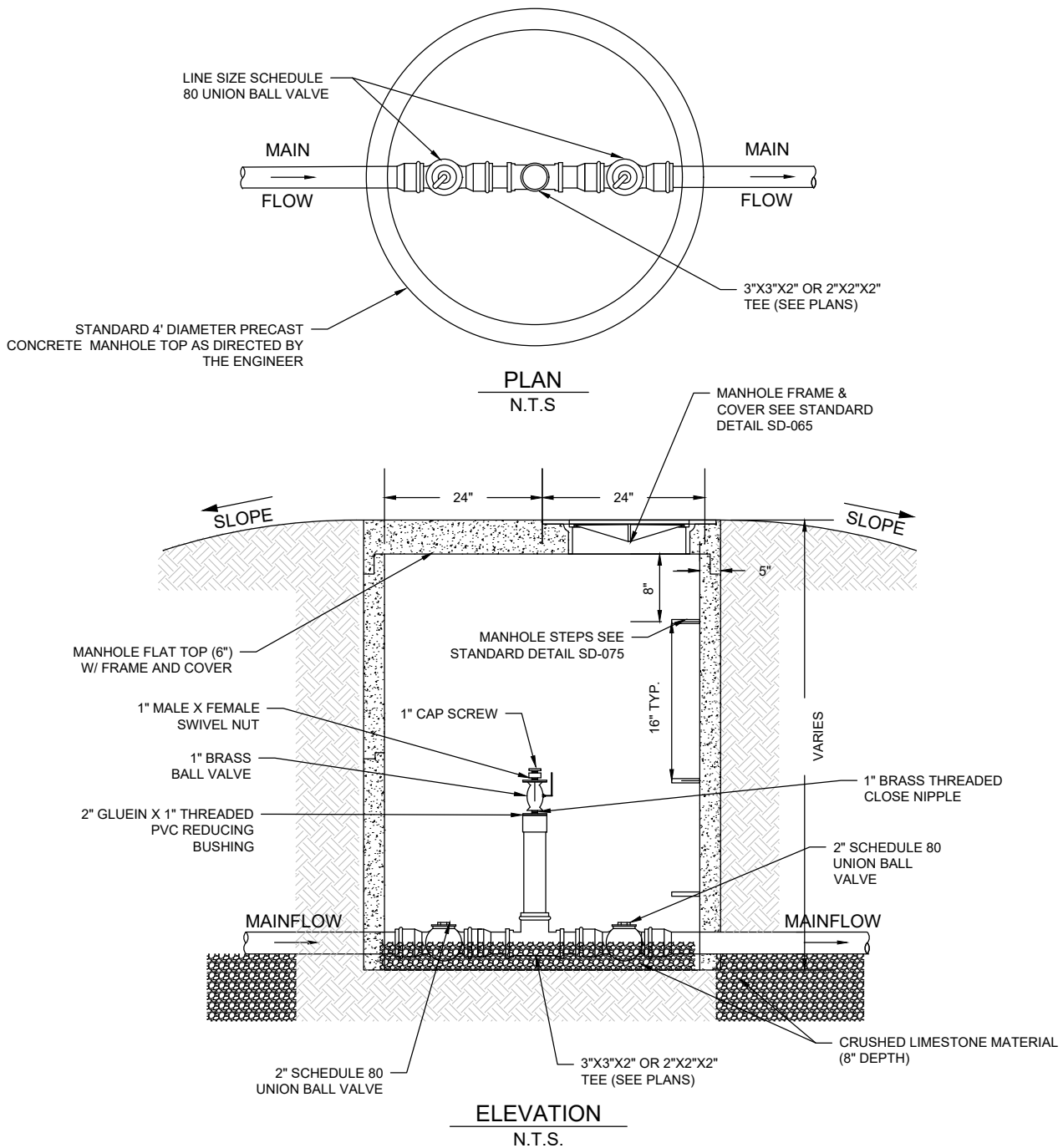


LOW PRESSURE DETAIL SERVICE LATERAL

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ALL PIPE AND FITTINGS
SHALL BE P.V.C. SDR 26, SCH.
40 OR 80



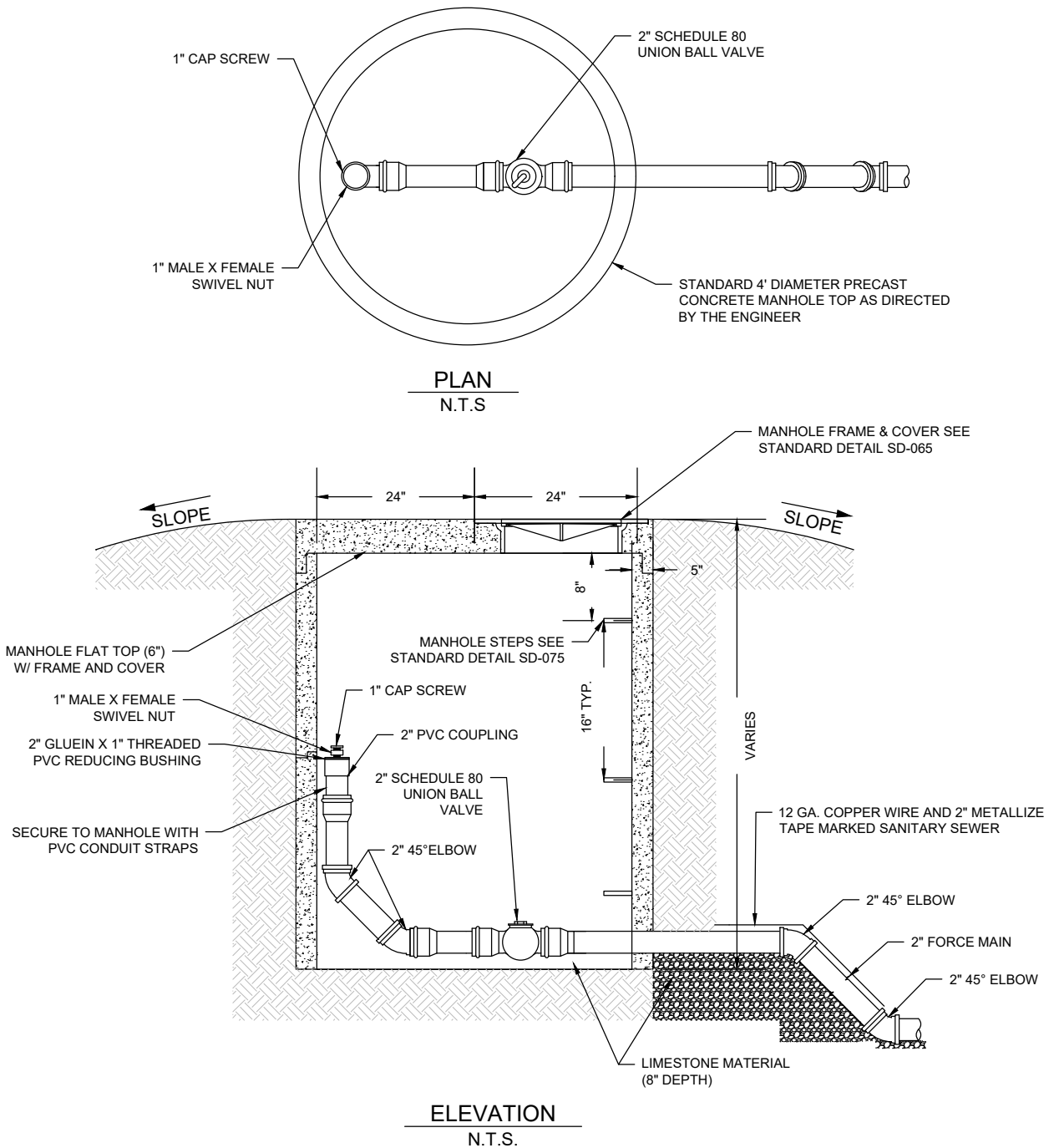
LOW PRESSURE DETAIL

INTERMEDIATE FLUSHING CONNECTION (B)

SANITARY SEWER STANDARD DETAILS

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ALL PIPE AND FITTINGS
SHALL BE P.V.C. SDR 26, SCH.
40 OR 80



LOW PRESSURE DETAIL TERMINAL FLUSHING CONNECTION

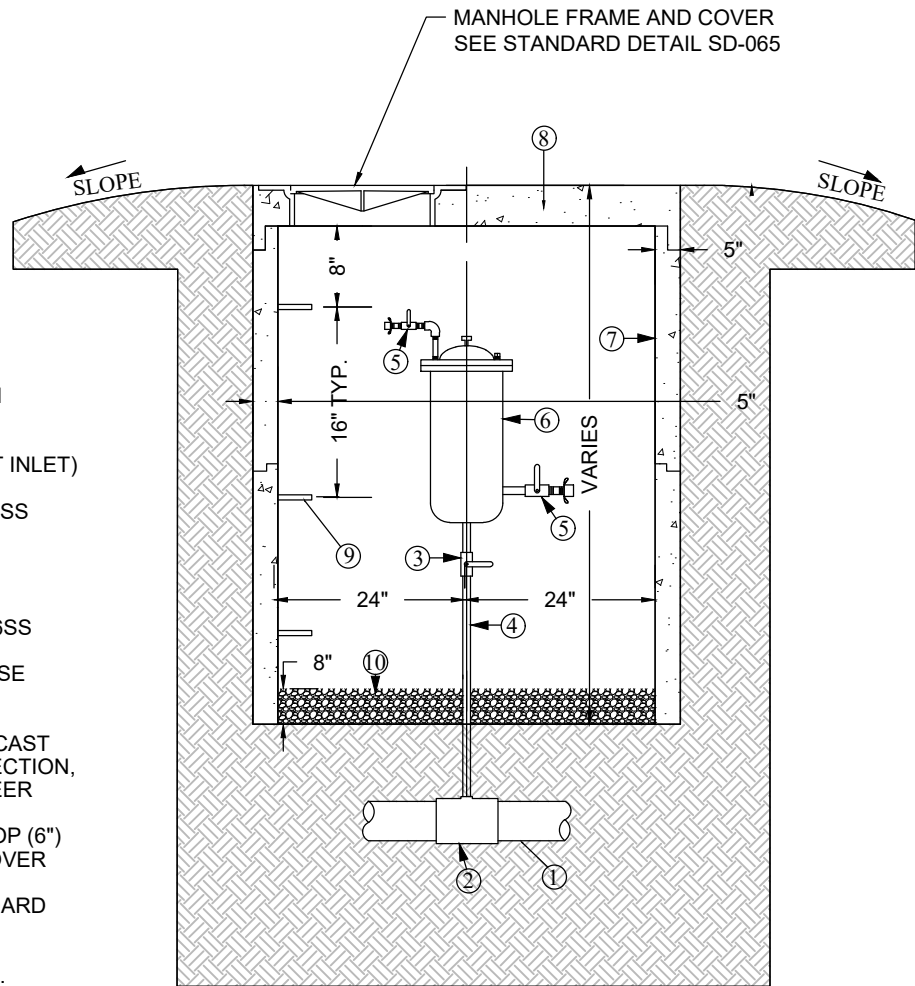
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MATERIAL IDENTIFICATION

1. LOW PRESSURE SEWER MAIN (SIZE VARIES)
2. THREADED TEE (SIZE TO SUIT INLET)
3. 2" SHUT OFF BALL VALVE, 316SS APOLLO
4. 2" THREADED 316SS NIPPLE
5. 1" BLOW OFF BALL VALVE, 316SS
6. SEWAGE AIR/VACUUM RELEASE VALVE. MODEL A.R.I. D-025
7. STANDARD 4' DIAMETER PRECAST CONCRETE MANHOLE TOP SECTION, AS DIRECTED BY THE ENGINEER
8. PRECAST CONCRETE FLAT TOP (6") WITH MANHOLE RING AND COVER
9. MANHOLE STEPS, SEE STANDARD DETAIL SD-075
10. CRUSHED LIMESTONE (8" MIN. DEPTH)



AUTOMATIC VAC/AIR RELEASE VALVE DETAIL
NO SCALE



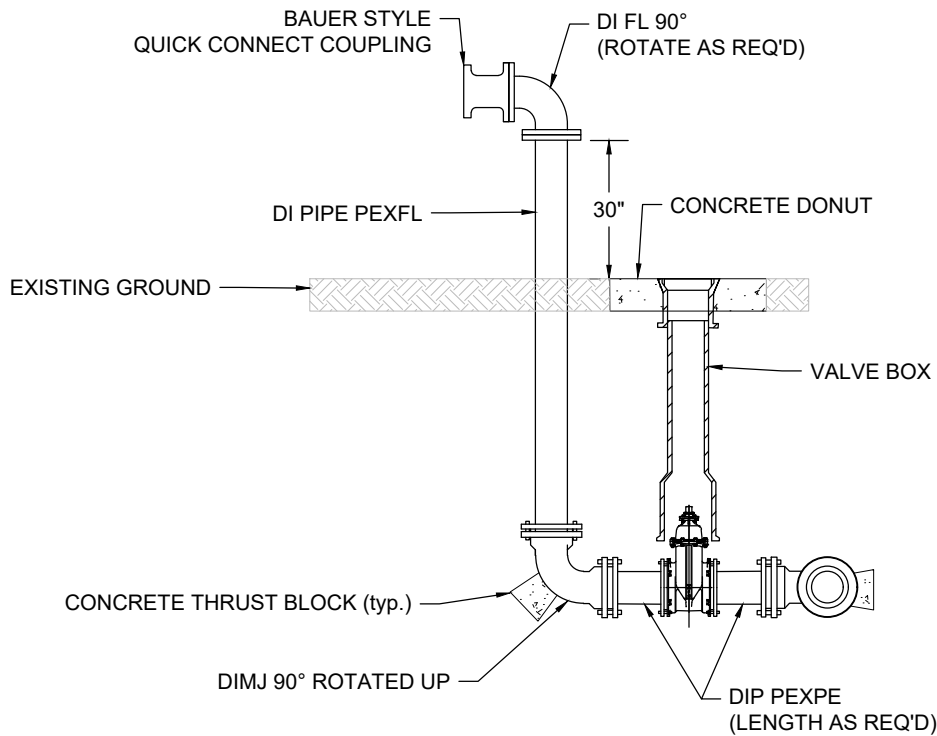
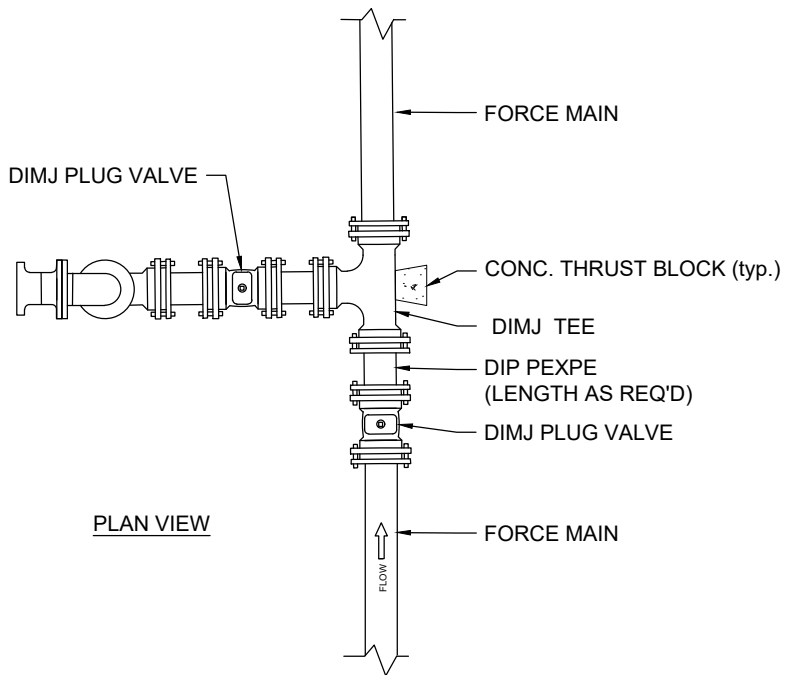
LOW PRESSURE DETAIL

AIR/VACUUM RELEASE VALVE

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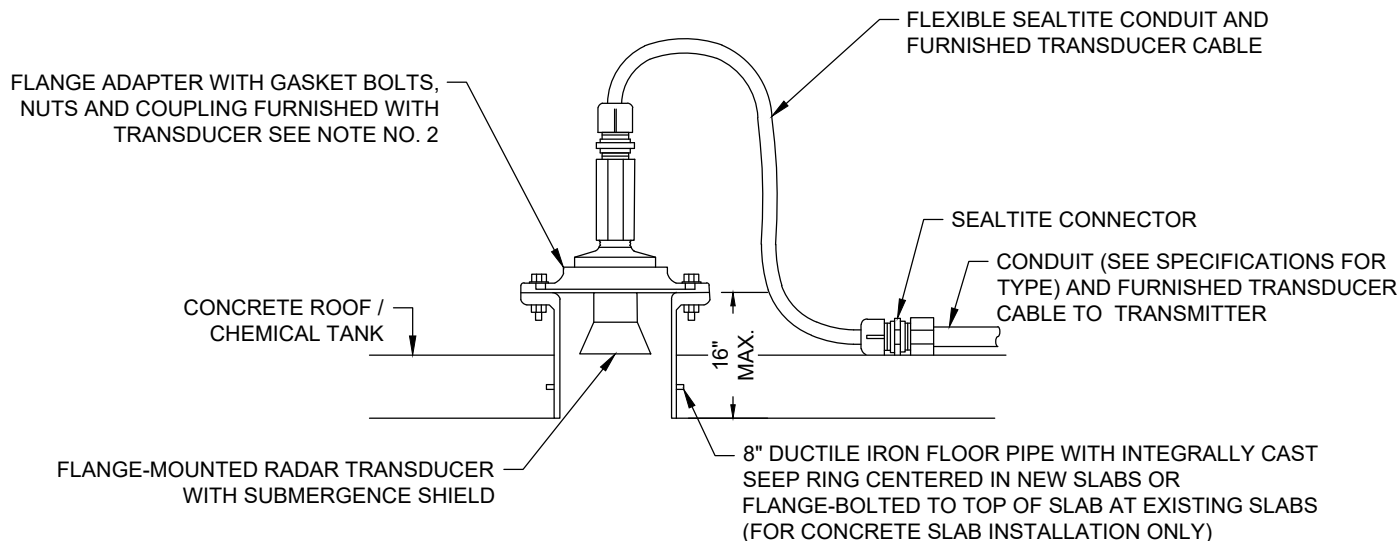
LIFT STATION DETAIL

TYPICAL BYPASS CONNECTION ASSEMBLY

SANITARY SEWER STANDARD DETAILS

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TYPICAL RADAR LEVEL TRANSDUCER
CONCRETE ROOF INSTALLATION DETAIL

DETAIL NOTES:

1. INSTALLATION SHOWN IS TYPICAL. EXACT REQUIREMENTS SHALL BE DETERMINED BY APPROVED MANUFACTURER'S SHOP DRAWINGS.
2. CONTRACTOR SHALL COORDINATE ALL EQUIPMENT MOUNTING HARDWARE REQUIREMENTS WITH INSTRUMENTATION PROVIDER.
3. TRANSDUCER SHALL BE LOCATED AS REQUIRED TO AVOID OBSTRUCTIONS INTERFERING WITH THE RADAR BEAMSPREAD AND TO PROVIDE PROPER MEASUREMENT OF THE ASSOCIATED LEVEL PER THE RECOMMENDATIONS OF THE TRANSDUCER SUPPLIER.



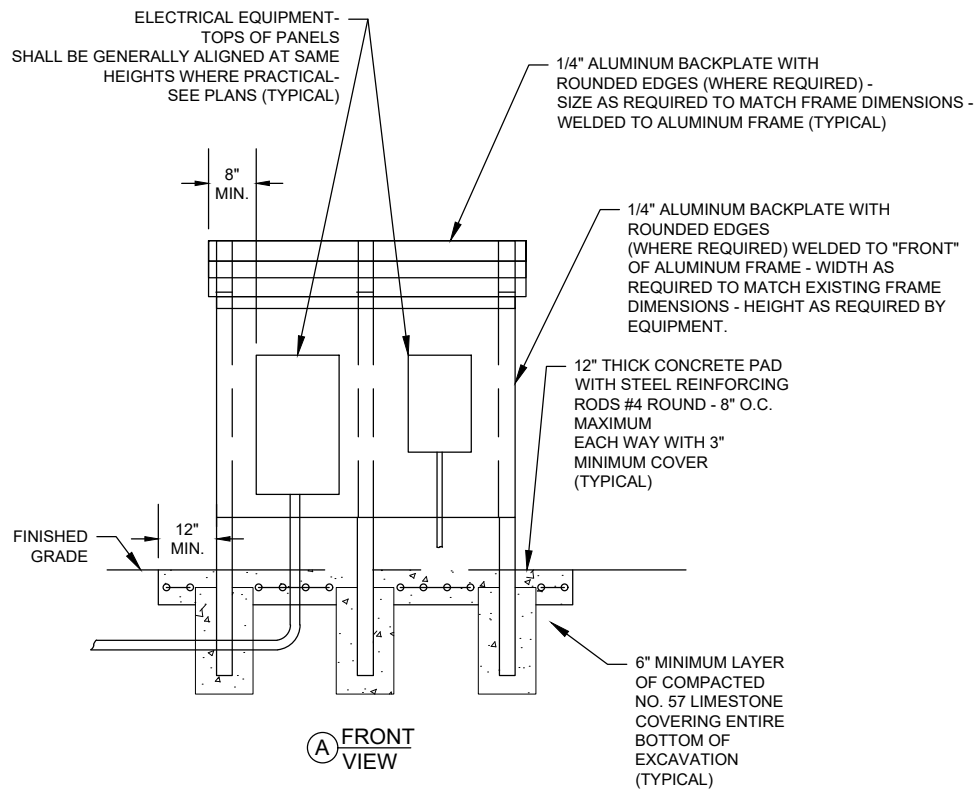
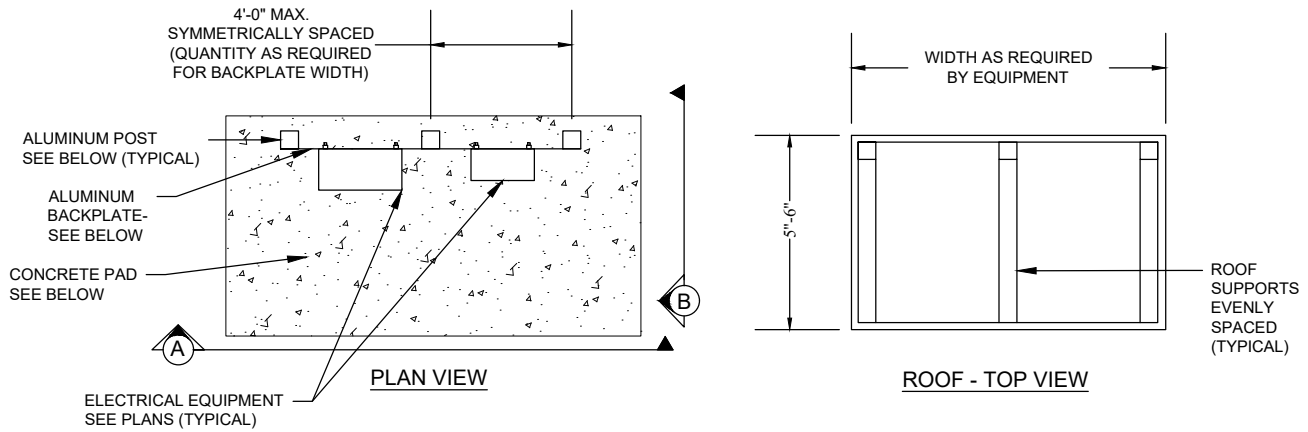
LIFT STATION DETAIL

RADAR LEVEL TRANSDUCER CONCRETE ROOF/TANK INSTALLATION

SANITARY SEWER STANDARD DETAILS

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DETAIL NOTES:

1. ALL DIMENSION SHOWN ARE TYPICAL.
2. PROVIDE TWO (2) 1" E.C. FROM ALL DISTRIBUTION PANELS, LIGHTING PANELS, PLC'S AND CONTROL PANELS ROUTED BELOW CONCRETE PAD TO THE NEAREST PULLBOX OR ACCESSIBLE STUB OUT LOCATION (NOT UNDERNEATH CONCRETE/ROCK/STRUCTURE/ ETC.)



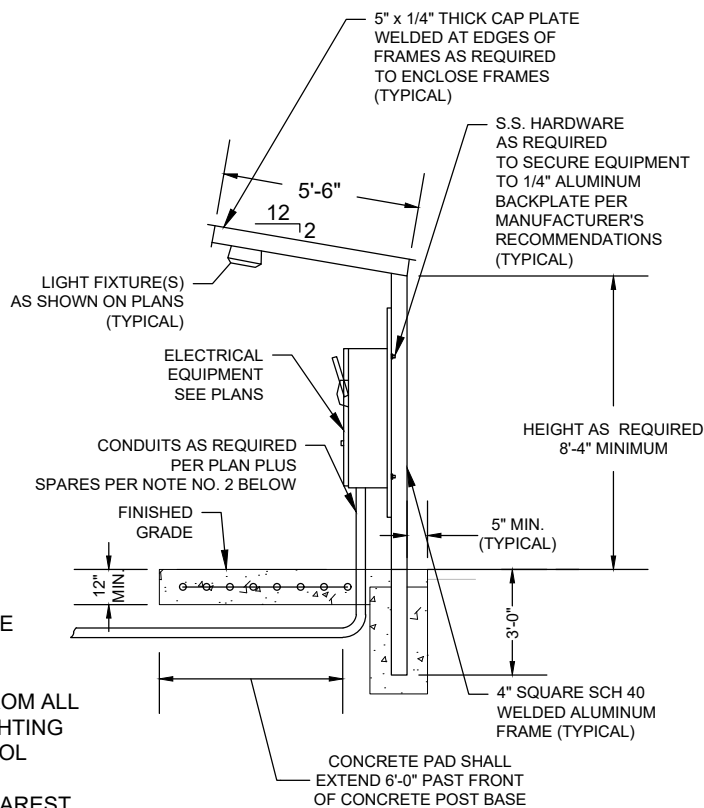
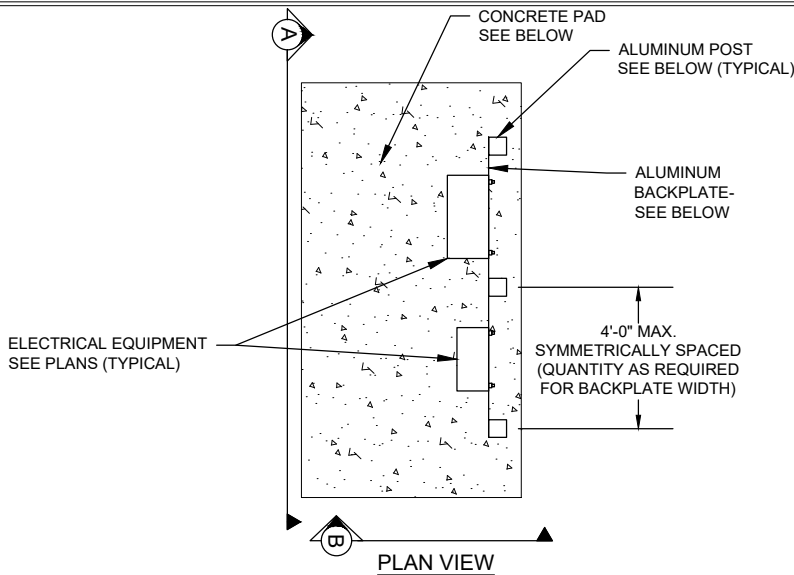
LIFT STATION DETAIL

ELECTRICAL EQUIPMENT SUPPORT WITH CANOPY DETAIL (FRONT VIEW)

SANITARY SEWER STANDARD DETAILS

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DETAIL NOTES:

1. ALL DIMENSION SHOWN ARE TYPICAL.
2. PROVIDE TWO (2) 1" E.C. FROM ALL DISTRIBUTION PANELS, LIGHTING PANELS, PLC'S AND CONTROL PANELS ROUTED BELOW CONCRETE PAD TO THE NEAREST PULLBOX OR ACCESSIBLE STUB OUT LOCATION (NOT UNDERNEATH CONCRETE/ROCK/STRUCTURE/ ETC.)

(B) PROFILE VIEW



LIFT STATION DETAIL

ELECTRICAL EQUIPMENT SUPPORT WITH CANOPY DETAIL (PROFILE VIEW)

SANITARY SEWER STANDARD DETAILS

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