

**DORCHESTER COUNTY
WATER & SEWER DEPARTMENT**



**MINIMUM STANDARDS FOR THE DESIGN AND
CONSTRUCTION OF WATER AND SANITARY
SEWER SYSTEMS**

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SECTION 1

INTRODUCTION

SECTION 1

INTRODUCTION

The Dorchester County Water & Sewer Department has established these standards for water distribution and sanitary sewer systems being deeded to or constructed for the Department. The benefits of standardization for the Department include:

- A reduction in overall cost of operations and maintenance.
- A reduction in the total inventory of spare or replacement components.
- Familiarity with systems resulting in reduced down time during emergencies.

The Department realizes that there are occasions when extenuating circumstances occur, and these guidelines will not work in all situations. Developers and engineers wishing to deviate from the guidelines are to contact the following and clearly discuss the reasoning for a deviation prior to proceeding with any project:

Dorchester County Water & Sewer Department
2120 East Main Street
Dorchester, SC 29437
(843) 832-0070

For very complex situations, a meeting can be scheduled to discuss any deviations.

Copies of the “**MINIMUM STANDARDS FOR THE DESIGN AND CONSTRUCTION OF WATER AND SANITARY SEWER SYSTEMS**” can be downloaded from the Dorchester County website.

These guidelines will be subject to updates on a periodic basis. Revisions will be posted on the Dorchester County website.

If you have any comments concerning these guidelines, please feel free to contact the Department.

The Department will only consider for operation and maintenance water systems and sanitary sewer systems installed under the following conditions:

1. The systems are within the boundaries of the Department service area.
2. The systems are built in accordance with plans and specifications approved by the Department and only following the procedures outlined in these standards.

3. Prior to any project's approval the Developer makes the necessary arrangements with the Department of the commitment of water and/or sanitary sewer system capacity. Projects will not be submitted to the South Carolina Department of Health and Environmental Control (SCDHEC) until such commitments are obtained.

SECTION 2

ADMINISTRATIVE

SECTION 2

ADMINISTRATION

The following is a general description of the responsibilities of the parties involved with the design, review and approval of projects for the Department.

A. DORCHESTER COUNTY WATER & SEWER DEPARTMENT

1. The Department will review plans and specifications submitted and grant approval after all requested revisions, if any, have been completed.
2. The Department will reserve the right to request changes in the work that is not in accordance with the Department's Design and Construction Specifications or if work is being performed in an improper manner that may result in incorrect installation of the water distribution system and/or the sanitary sewer system.
3. All work rejected by the Department shall be removed and redone to the satisfaction of the Department.
4. The Department reserves the right to request any work to be uncovered if the work was covered contrary to the Department's request, if defective work is suspected or to correct defects discovered during the Department's inspections.
5. The Department reserves the right to disallow work from an Engineer or Developer who consistently does not comply with the Department's Design and Construction Guidelines.
6. The Department reserves the right to request revisions to the Developer's or to the Developer's Design Engineer's plans for any discrepancies found during construction that may have been overlooked during review of the plans and specifications.

B. DEVELOPER'S DESIGN ENGINEER

1. The Developer's Design Engineer is the Engineer hired by a Developer or property owner to prepare a set of plans and specifications and/or an Engineer hired by a Developer who is responsible for construction administration of a project from plans and specifications prepared by another Engineer.

2. The Developer's Design Engineer will:

- a. Prepare plans and specifications in accordance with the Department's Design and Construction Guidelines, South Carolina Department of Health and Environmental Control Regulations and all other local, state and federal regulations pertaining to the project.
- b. Submit plans and specifications for review to the Department.
- c. Make revisions necessary for the plans and specifications to comply with the Department's Design and Construction Standards.
- d. Review all phases of the work in progress during construction and observe required testing of systems with the Department's field representative.
- e. Certify that work performed is in accordance with the plans and specifications and the Department's Design and Construction Specifications.
- f. Promptly furnish the Department with pertinent information concerning any changes which may be necessary during the progress of the work. No major changes shall be performed without the prior approval of the Department.
- g. Obtain final approval from the Department and applicable local, state, and federal agencies.

C. DEVELOPER

1. The Developer shall be considered the person or entity initiating the development of a new residential, commercial, industrial or institutional property. The Developer may or may not be the property owner. This person or entity shall have the legal authority to execute necessary permits, applications, and legal documents which require the Developer's/Owner's signature. This same person or entity will execute all documents throughout the project unless the project is sold, in which case this authority is transferred to the new Developer.
2. The Developer will:
 - a. Provide accurate information as to the person or entity responsible for the development and their contact information.
 - b. Be responsible for payment of all fees required in accordance with Department Standards.
 - c. Be financially responsible for future requests for repairs if any arise during the bond period after take-over of the system.

SECTION 3

SUBMITTALS AND APPROVALS

SECTION 3

SUBMITTALS AND APPROVALS

In order to expedite the approval process of new water distribution systems and sanitary sewer collection system extensions, the Department has divided the process into the following: Preliminary Approval, Final Approval, Shop Drawings, Project Completion, Operation and Maintenance Manuals and Project Completion and Takeover. The submittals required for each part are described herein:

A. GENERAL

1. Developers shall secure all necessary permits for any projects that are submitted to the Department office for review. Copies of permits shall be forwarded to the Department for final approval and signature.
2. All connections to the existing Department water system or sanitary sewer system must be approved and inspected by the Department's personnel.
3. No water or sanitary sewer system shall be put into service, nor will any service application be accepted, until all approved project completion and closeout documents, all required fees and the permit to operate as issued by the South Carolina Department of Health and Environmental Control (SCDHEC) are received by the Department.
4. The Department shall have exclusive retail rights.
5. Prior to designing water and wastewater systems, the Developer and the Developer's Engineer are encouraged to take into careful consideration the County's Water and Sewer Ordinance. The Developer and Engineer may want to see the Department's Developer Guide as well.
6. Submittal packages are to be sent to the Department as follows:

Dorchester County Water & Sewer Department
2120 East Main Street
Dorchester, SC 29437

B. PRELIMINARY APPROVAL

1. Developers, Designers, Planners, Engineers and others associated with implementing projects should meet with the Department's Engineering Staff

to review plans and specifications and coordinate proposed projects with the Department.

2. The Developer's Design Engineer shall submit a preliminary review package to the Department. The package shall include the following:
 - a. Two (2) complete sets of Plans should include:
 - i. Complete system design
 - ii. Location and width of all the Department's easements
 - iii. All rights-of-way indicated as either public or private. Plans should also indicate ownership of existing roadways (City, County, or State). Indicate the agency to operate and maintain proposed roadways. Show all easements and rights-of-way and their ownership (SCE&G, SCPSA, Bell South, etc.)
 - iv. Location and size of all proposed water and sewer services and size
 - v. County Tax Map Reference Number of Property
 - vi. All other items on the plan review checklist in Appendix B
 - b. One (1) set of typed and bound, or stapled, Specifications if required by the Department.
 - c. One (1) copy of all design calculations.
3. The Department will return to the engineer:
 - a. Written design change comments and, if applicable one, (1) set of plans/specifications, which will indicate corrections if necessary. If there are no comments, written Preliminary Approval will be returned.
 - b. Notification of any required encroachment applications, certifications, permits, or easements known by the Department. The Developer's Engineer is still responsible for determining other permits or easements that may affect the project.
 - c. Request for any other required information pertinent to the proposed project.

C. FINAL APPROVAL

1. Once preliminary approval is received and all required fees in the Ordinance are paid, the Developer's Design Engineer is to submit the following:
 - a. For sewer projects, the complete SCDHEC DRP submittal package except the transmittal and acceptance letters from the Department. The package will be checked by the Department before submitting to SCDHEC. For water projects, the engineer shall
 - b. One (1) copy of each item in the water and/or sewer SCDHEC submittal packages plus two (2) additional copies of the plans.

D. SHOP DRAWINGS

1. The Developer's Design Engineer shall review shop drawings in compliance with the Department's approved plans and specifications and the Department's Design and Construction Minimum Standards.
2. Make shop drawings accurately to a scale sufficiently large to show all pertinent aspects of the item and its method of connection to the Project.
3. Where contents of submittal literature from manufacturers includes data not pertinent to the submittal, clearly show which portions of the contents are being submitted for review.

E. PROJECT CONSTRUCTION

1. **The Developer's Contractor shall notify the Department in writing of commencement of work three (3) working days prior to starting construction.**
2. A pre-construction conference shall be held with the Department Inspector, the Developer's Contractor, and the Developer's Engineer

F. OPERATION AND MAINTENANCE MANUALS

1. Prior to start-up, provide the Department with operation, maintenance, and service manuals (O&M Manuals) for each piece of equipment.
2. Prepare and submit two (2) copies of O&M Manuals for each piece of equipment.
3. The O&M Manuals will be prepared in the format that follows:
 - a. Manuals shall be specific to the equipment supplied.

- 1) Manuals applicable to many different configurations and which require the operator to selectively read portions of the instructions will not be accepted.
 - 2) The equipment model that the manual applies to shall be indicated by an arrow.
- b. Table of Contents specific to each manual.
- c. At the beginning of each manual, provide a description of the equipment to include model numbers, purchase order numbers, serial numbers, motor information, and performance and design criteria.
- d. Correlate manuals with approved shop drawings and include the following minimum information:
- 1) Parts list, including recommended spare parts list.
 - 2) Guaranties.
 - 3) Recommended maintenance instructions.
 - 4) Recommended lubricants and lubrication instructions.
 - 5) Address and telephone numbers of the source for repairs, spare parts, and service.
 - 6) Detailed description of operating procedures for the item of equipment specifically written for this installation, including start-up and shut-down procedures.
 - 7) Equipment performance specifications, including pump curves.
 - 8) Results of start-up and any further recommendations resulting from start-up.
- e. Provide a maintenance and lubrication schedule to be a summary of all preventative maintenance and lubrication, including the following information:
- 1) Title
 - 2) Type of activity (inspection, adjustment, oil changes, etc.)
 - 3) Brief description of activity

- 4) Type of lubricant
- 5) Frequency (daily, weekly, etc.)
- f. Provide clear and legible copies. Type parts lists, etc.
- g. Layout and detail drawings shall be reduced to a maximum size of 11" x 17", unless written approval is received from the Department prior to submittal of manuals.
- h. Provide a clearly labeled three-ring binder for manuals having thickness greater than 1/4".
 - 1) Provide sheet lifters.

G. PROJECT COMPLETION AND TAKEOVER

1. Upon completion of construction, the Developer's Design Engineer shall submit two copies of the record drawings and request an inspection by the Department's Utility Inspector.
2. The Developer's Design Engineer shall provide one review copy of each required plat and legal document prior to recording of documents and submittal of the final closeout documents. The final closeout submittal shall include following as one package:
 - a. Certification in writing from the Developer's Design Engineer that the water and/or sanitary sewer system has been constructed in accordance with the Department's approved Plans, Specifications, applicable permits and good engineering practice.
 - b. Statement from the Design Engineer of the value of the water system and the value of the sewer system, as applicable.
 - c. One (1) set of white mylar reproducible (not sepia mylar), one (1) set of full size prints and one (1) set of half size or 11x17 prints of "**As Constructed Record Drawings**". These drawings shall reflect all "as constructed" conditions for mains, water service and sewer lateral placement in the format that follows:
 - 1) Plan View for all water and wastewater systems.
 - 2) Profile View for all wastewater mains of any size and water mains 12" and larger.
 - 3) Plan view of the pump station site.

- 4) Cross section of the pump station wetwell.
- 5) Property lines, block designations, lot numbers and, when available, TMS numbers.
- 6) Station and state plane coordinates at all valves, manholes, fire hydrants, bends, blow-offs, tees, reducers, increasers, water and sewer services and air release valves.
- 7) Line lengths, connection points and termination points.
- 8) Valves located by distance to two permanent reference points.
- 9) Indicate top elevations and invert elevations of manholes.
- 10) Reference benchmarks on drawings and elevation datum used.
- 11) All recorded plat and easement information.
- 12) Drawings clearly legible and of good quality.
- 13) The Department will review the "Record Drawings" **but the Department is not responsible for the accuracy of record drawings**. If the drawings indicate inaccuracies, they will be returned to the Developer's Design Engineer for revisions. The system acceptance letter will not be issued until the drawings are acceptable.
- 14) Engineer's certification, seal, and signature. The engineer may use the following statement: "It is my opinion that the water/sewer system shown hereon has been constructed substantially in accordance with the plans and specifications approved by Dorchester County Water and Sewer and SCDHEC.

e. Digital Data Submission

- 1) A completed original CAD drawing in Autocad 2007 or earlier format of each record drawing and valve card. The files shall be named using the development name or Department project number.
- 2) The water and sewer lines shall be easily identified by layer name (i.e. New_Water, N-W, etc.)

- 3) The drawings shall use South Carolina State Plane (SCSP) coordinates. Features in drawing files that are stored in drawing units must be translated to represent real world locations as referenced by SCSP coordinates.
 - 4) Each record drawing or valve card in .pdf format
- f. Legal documents in the Department's standard form. The documents shall be prepared and signed by the Developer and recorded by the Department. The Developer shall provide the required Register of Deed (ROD) recording fee. The documents shall include:
- 1) Title to the water and/or sewer systems.
 - 2) Bill of Sale
 - 3) Easement (if the Department must access private property to maintain the system.
 - 4) Title to real estate for projects with pump stations, wells or water towers.
- g. One (1) print of the recorded easement and/or subdivision plats. Each must have original signature and seal and must be no larger than 22" x 34" in accordance with Register of Deeds (ROD) Office requirements. The Department may record plats if they are for the sole purpose of providing an easement. The Developer will be responsible for providing the appropriate recording fee. The Department will not accept compiled maps as land surveys. The width of the easements for water and sewer mains shall be a minimum of twenty (20) feet. All water and sewer mains within the easement shall be platted so as to provide equal distance on each side of the as-construction location of the main. **Plats cannot be accepted unless these requirements are met.**
- h. Certified Contractor's Affidavit and Final Waiver of Lien.
- i. Results and documentation of all testing and inspections except items prepared by the County.
- j. Payment of all fees, bonds, and other financial obligations as required in the current Dorchester County Water and Sewer Ordinance.

3. When the above items are completed to the Department's satisfaction, the Department will issue an acceptance letter to SCDHEC with copies to all involved parties. Until such time as this letter is provided and SCDHEC's letter allowing the systems to be placed into operation has been received, **NO CONNECTIONS TO THE SYSTEMS WILL BE PERMITTED.**

SECTION 4

EASEMENTS

SECTION 4

EASEMENTS

1. Easements shall be conveyed to the Department in a standard acceptable form.
2. The Developer will record all easements.
1. All water mains and sanitary sewer facilities shall be installed outside of pavement when possible.
4. The width of the easements for water mains, sewer mains, and force mains shall be a minimum of twenty (20) feet.
5. Widths of easements for gravity sewers greater than fourteen (14) feet in depth or between buildings shall be a minimum of thirty (30) feet. Widths of easements for gravity sewers greater than eighteen (18) feet in depth shall be a minimum of forty (40) feet.
6. Widths of easements for facility access roads shall be a minimum of twenty-five (25) feet.
7. All water and sewer mains within the easement shall be platted so as to provide equal distance on each side unless the Department determines this to be impractical.
8. Structures are not permitted within the easement.
9. When water and sewer mains are placed in the same easement, increase the width of the easement to comply with the "Recommended Standards for Water Works" and "Recommended Standards for Wastewater Facilities" ("Ten States Standard") with a distance from the edge of the easement to the sewer main not less than ten (10) feet.
10. Clear all easements of trees and debris unless an exception is approved during design review to meet the applicable tree ordinance or to avoid disturbing wetlands. The easement is to be grassed unless other treatment is specifically approved by the Department.
11. When a water or wastewater main within a public right-of-way is within 5 feet of the right-of-way line, an easement will be required. The easements shall be determined by 4 and 5 above or as otherwise determined by the Department.

12. The Department reserves the right to increase the width of easements when conditions are determined to require the increase.

SECTION 5

WATER DISTRIBUTION SYSTEM DESIGN GUIDELINES

SECTION 5

WATER DISTRIBUTION SYSTEM

DESIGN GUIDELINES

A. GENERAL

1. The following water system design guidelines are based on Federal, State and local health requirements and the Department's engineering design criteria.
2. Design criteria not indicated herein shall comply with "Ten States Standards" where applicable.
3. All installations are to meet the bacteriological and chemical quality standards of the South Carolina Department of Health and Environmental Control (SCDHEC).
4. These design guidelines are applicable to all developments including but not limited to residential, commercial and industrial developments, subdivisions, and/or parks requiring water service from the Department.

B. SYSTEM DESIGN CRITERIA

1. Distribution main size: minimum 6" diameter unless otherwise approved by the Department. Water main providing fire service shall be a minimum of 6".
2. Arrange mains so they are looped and interconnected at intersections.
3. Comply with all application requirements of Federal, State, and local regulations.
4. When a design is being considered for a project, a main depth of between 3'-5' below finish grade should be used to establish main and branch line profiles.

C. SIZING OF LINES

1. Pipe size 6" and larger:

- a. Size piping based on either 1/5 the maximum instantaneous demand plus fire flow or maximum instantaneous demand, whichever is greater. When fire protection is to be provided, system design should be such that fire flows and facilities are in accordance with the requirements of the Department and the state Insurance Service Office (ISO). Minimum fire flow shall be 1000 gpm unless it is determined by the Developer's Engineer and the Department that this requirement cannot be met and a lower flow will be sufficient. The design flow to fire hydrants shall not be less than 500 gpm over and above the total peak hourly flow.
2. Design for 2.5 feet per second flushing velocity per SCDHEC regulations.
3. All water mains, including those not designed to provide fire protection, shall be sized using a hydraulic analysis based on flow demands and pressure requirements. The minimum pressure in all public water mains under conditions of maximum instantaneous demand shall be twenty-five (25) pounds per square inch at every customer's tap. Twenty (20) pounds per square inch will be acceptable at any tap when fire flows are provided in excess of maximum peak hourly flow [R61-58.4(D)(4)(a)]. The normal working pressure in the distribution system should be approximately 60 psi and not less than 35 psi.
4. The Developer's Design Engineer is to determine available static and residual pressures at the delivery point for the water to a new development. The pressure and flow shall be certified by an engineer who is registered in the State of South Carolina.
5. The Developer's Design Engineer shall use a maximum Hazen-Williams design coefficient of 130 for PVC and PE pipe or 120 for ductile iron pipe.
6. The maximum instantaneous demand is to be calculated using the Community Water System Source Book by Joseph S. Ameen or other method approved by the Department.

D. VALVES

1. Provide three (3) valves for a tee intersection.
2. Provide four (4) valves for a cross intersection.
3. Sufficient valves shall be provided on water mains so that inconvenience and sanitary hazards will be minimized during repairs. Valves should be located at not more than 500 foot intervals in commercial districts and one

block or 800 foot intervals in other districts. Valves should be placed to minimize the number of the Department's customers out of service due to a main break and/or any maintenance operation. The Department reserves the right to require additional valves if it is deemed in the best interest of current and future Department customers.

E. INDUSTRIAL OR SPECIAL DESIGN CONDITIONS

1. Design of water systems for industrial or other systems not covered under this section shall be approved on a special case basis only. Special requests need to be made to the Department.
2. Fire line sprinkler systems and dedicated fire lines, except those in the high hazard category, as defined by SCDHEC, shall be protected by an approved double check valve assembly.

F. DEAD ENDS

1. Minimize dead ends by looping of all mains.
2. Where dead ends occur, provide a fire hydrant on lines 6" and larger. The Department does not permit installation of Post Hydrants for the purposes of flushing. Flushing devices should be sized to provide flows which will give a velocity of at least 2.5 feet per second in the water main being flushed. No flushing device shall be directly connected to any sewer or storm sewer.
3. Blowoffs on dead ends will be considered on a case by case basis where fire flow is not feasible and not required by the appropriate fire department and/or fire inspector. Blowoffs on temporary dead ends will be considered on a case by case basis.

G. SEPARATION OF WATER MAINS AND SEWERS

1. Where possible, locate water line at least ten (10) feet away horizontally from sewer mains. The distance shall be measured to outside edges of pipes.
2. Should ten (10) foot separation not be practical, then the water main may be located closer provided:
 - a. It is laid in a separate trench.
 - b. It is laid in the same trench with the water main located at one side of a bench of undistributed earth.

- c. In either of the above cases, crown elevation of the sewer shall be at least 18" below invert elevation of water line at a diagonal of 45°.
 3. Where water lines cross over or under sewers, maintain 18" minimum vertical distance between the outside of the water main and the outside of the sewer. If water mains are within 18" of a sewer main, both the water and sewer main will be ductile iron. At crossings, one full length of water pipe shall be located so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.
 - a. Special Cases
 - 1) Water mains may not be placed in contaminated areas unless piping material is adequate to protect the water quality [R.61-58.4(D)(11)(h)].
 - 2) Water mains may not be less than 25 feet from any waste water tile field or spray field [R.61-58.4(D)(12)(f)].
 - 3) There may not be any connection between the distribution system and any pipes, pumps, hydrants, or tanks whereby unsafe water or other contaminated materials may be discharged or drawn into the system [R.61-58.4(D)(14)(a)].
 - 4) Neither stream condensate nor cooling water from jackets or other heat exchange devices may be returned to the potable water supply [R.61-58.4(D)(14)(b)].

H. SEWER AND STORM DRAINAGE SYSTEM INTERFERENCE

1. No water pipe shall pass through or come in contact with any part of a sewer manhole or storm drainage pipe or structure.

I. EXCEPTION

1. The Department must specifically approve any variance from any requirements when it is impossible to obtain the specified distances.

J. SURFACE WATER AND WETLANDS CROSSINGS

1. Surface water and wetland crossings, whether over or under water, present special problems. The Department should be consulted before plans are prepared. Water mains crossing surface waters must be adequately supported and anchored, protected from damage and freezing, and be accessible for repair or replacement [R.61-58.4(D)(13)(a)]. Maintain a minimum cover of 2 feet for water mains crossing under water. When

crossing water courses which are greater than 15 feet in width, the following must be provided.

- a. The pipe material and joints shall be designed appropriately [R.61-58.4(D)(13)(b)(I)].
- b. Valves must be located so that the section can be isolated for testing or repair; the valves must be easily accessible, and not subject to flooding; and [R.61-58.4(D)(13)(b)(ii)],
- c. A blow-off must be provided on the side opposite the supply service, sized in accordance with [R.61-58.4(D)(7)][R.61-58.4(D)(13)(b)(iii)].

K. WATER MAIN RESTRAINT

1. Provide restrained joint pipe and fittings in accordance with Section 6 Part I.
2. The Department may approve the use of thrust blocks on a case by case basis. The concrete mix shall have 28-day compressive strength of not less than 3,000 pounds per square inch. The design shall use a maximum soil pressure of 2000 lbs/sq ft and a safety factor of 2. Place the block so that the pipe and fitting joints will be accessible to repairs, unless otherwise shown.

L. COVER

1. Provide suitable cover on all distribution mains. Minimal cover depth as follows:
 - a. Typical minimum cover: 36".
 - b. All piping located within the right-of-way of the South Carolina Department of Transportation and the Department shall have a minimum cover of 48" below the crown of the road when installed within the limits of the paved roadway, 36" cover when installed in the shoulder of right-of-way and a minimum of 18" separation under the design invert of drainage structures. The greater dimension of the above shall dictate minimum depth where applicable.
 - c. Special conditions other than those listed above may be approved if requested in writing from the Department.
 - d. Water lines crossing open ditches shall have a minimum of 24" of cover from bottom of ditch invert to top of pipe. If this is not possible, install ductile iron pipe (DIP) with a minimum cover of 12".

M. DUCTILE IRON PIPE LOCATIONS

1. Where water crosses beneath the sewer, the sewer main shall transition to ductile iron pipe and the length of pipe shall be centered on the water main so that joints will be equidistant.
2. Main lines on residential lots shall be ductile iron. Other main lines outside of a public right-of-way will be reviewed on a case by case basis to determine if ductile iron will be required.

N. TAP SIZE IN RELATION TO MAIN SIZE

1. Water taps shall not be larger than the main being tapped.
2. The Department reserves the right to stipulate the maximum size tap available off of any water main regardless of the main size and configuration.

O. AIR RELEASE VALVES

1. Mains shall be designed to minimize high points. At high points in water mains where air can accumulate, provisions shall be made to remove the air by means of an air release valve. Automatic air release valves shall not be used in situations where flooding of the manhole or chamber may occur. Air valves should be sized based on the size of the water main. Air valves should be detailed on the design drawings and approved by the Department. Air release valves must incorporate an open end of an air relief pipe from automatic valves or from a manually operated valve must be extended to the top of the pit and provided with a screened downward facing elbow [R.61.58.4(10)(b)].

P. BLOW OFF CHAMBERS

1. General
 - a. Lines 6" and larger require 500 gpm to achieve a 2.5 fps scouring velocity. This would require a standard fire hydrant or other approved blow-off for flushing. The line must be designed to provide at least 500 gpm in excess of peak hourly flow and a minimum residual pressure of 20 psi. [R.61-58.4.D(7)(e)].
 - b. Chambers, pits, or manholes containing valves, blow-offs, or other such appurtenances on a distribution system shall not be connected directly to any storm drain or sanitary sewer, nor shall blow-offs or air relief valves be connected directly to any sewer.

- c. The Department may allow a temporary blowoff on a case by case basis where the main is to be extended in the near future.

SECTION 6

WATER DISTRIBUTION SYSTEM MATERIALS FOR CONSTRUCTION

SECTION 6

WATER DISTRIBUTION SYSTEM

MATERIALS FOR CONSTRUCTION

A. GENERAL

1. Unless otherwise noted or approved by the Department all materials shall be manufactured in the United States. This section includes pipe and fitting material specification, joint material and encasement requirements.

B. MATERIALS

1. General:

- a. All standards cited in the text refer to the latest revision of that standard under the same specification number or to superseding specifications under a new number.
- b. All chemicals/products added to public water supply must be third party certified as meeting the specifications of ANSI/NSF Standard 60.
- c. All materials/products that contact potable water must be third party certified as meeting the specifications of ANSI/NSF Standard 61.
- d. The pressure rating of pipe must be capable of handling 1.5 times the normal working pressure.
- e. No asbestos cement pipe allowed except in the repair of existing asbestos cement lines.
- f. PVC pipe may not be used above grade.
- g. All pipe fitting, packing, jointing materials, and valves must conform to Section C of the AWWA Standards.
- h. Previously used water lines that have been out of service will not be accepted by the Department.

C. POLYVINYLCHLORIDE (PVC) PIPE

1. Plastic pipe (PVC):
 - a. General:
 - 1) Marked with National Sanitation Foundation approval at 18" intervals.
 - 2) Gaskets to comply with ASTM F477.
 - a) Natural rubber gaskets are not acceptable.
 - b. 6" - 12":
 - 1) Comply with ANSI/AWWA C900, Table 2, Pressure Class 150 marked with National Sanitary Foundation (NSF) approved at 18" intervals. Solvent-weld PVC pipe and fittings will not be accepted by the Department.
 - c. 14" and larger:
 - 1) Comply with ANSI/AWWA C905 Table 2, pressure class 165 marked with National Sanitary Foundation (NSF) approved at 18" intervals. Solvent-weld PVC pipe and fittings will not be accepted by the Department.

D. DUCTILE IRON PIPE (DIP)

1. All sizes of pipe shall be laying length of 18'-0" to 20'-0" and shall only be used on ditch crossings or when crossing above or below sewer mains.
2. Quality Assurance
 - a. Reference Standards of the American National Standards Institute (ANSI)
 - 1) A21.4 Cement-mortar lining for cast iron and ductile iron pipe and fittings for water (AWWA C104).
 - 2) A21.10 Gray iron and ductile iron fittings, 3" through 48" for water and other liquids (AWWA C110).
 - 3) A21.11 Rubber gasket joints for cast iron and ductile iron pressure pipe and fittings (AWWA C111).

- 4) A21.15 Flanged cast iron and ductile iron pipe with threaded flanges (AWWA C115).
 - 5) A21.50 Thickness design of ductile iron pipe (AWWA C150).
 - 6) A21.51 Ductile iron pipe centrifugally cast, in metal molds or sand lined molds, for water or other liquids (AWWA C151).
 - 7) A21.53 Ductile iron compact fitting for 3" through 12" (AWWA C153).
- 8) B16.1 Cast iron pipe flanges and flanged fittings, Class 25, 125, 250, and 800.
- b. Reference Standards of the American Water Works Association (AWWA)
- 1) C600 Installation of ductile iron water mains and their appurtenances.
 - 2) C651 Disinfecting water mains.
3. Wall thickness in accordance with Table 51.1 of ANSI/AWWA C151/A21.51 with working pressure of 150 psi, depth of cover indicated and Type 2 bedding conditions. Final pipe class shall be determined based on specific structural calculations as they relate to conditions encountered during design. The Department reserves the right to designate the final pipe thickness.
- a. 6" - 12" class 52
 - b. 14" - 64" pressure class 250
 - c. Flanged pipe shall be class 53 (minimum)
 - d. Underwater pipe shall be a minimum of class 52.
4. Use cement mortar lining: ANSI/AWWA C104/A21.4, standard thickness.
5. Use mechanical or push-on joints: ANSI/AWWA C111/A21.11 as modified by ANSI/AWWA C151/A21.51.
6. Use rubber gaskets and lubricant: ANSI/AWWA C111/A21.11.
- a. Natural rubber gaskets are not acceptable.

7. No metric sized pipe shall be permitted.
8. All pipe to be shipped with gaskets, glands, and bolts unless specified otherwise. High tensile strength tee bolts and nuts shall be low alloy steel. Bolted joints for underwater pipe shall be furnished with 316 stainless steel nuts and bolts. The 316 grade shall be clearly indicated with marks on the bolt and nut.
9. All pipe lengths must be tested to 500 psi working pressure prior to shipping.
10. Threaded flange pipe must be tested after the installation of the threaded flange. Pipe with threaded components, i.e. flange or bell must be tested after installation of threaded component.
11. All new transmission water mains must be permanently marked in the Department's easement with Department-approved above-ground markers.
12. Acceptable products: American Cast Iron Pipe Company, Griffin Pipe Company, U.S. Pipe Company, and McWane Cast Iron Pipe Company

E. HIGH DENSITY POLYETHYLENE (HDPE) PIPE

3. High Density Polyethylene (HDPE) pipe shall be used only for directional drilling under creeks or marsh crossings unless otherwise approved by the Department.
2. Comply with AWWA C-906, SDR 11 and working pressure of 160 psi minimum.
3. The pipe supplied shall be SDR high performance, high molecular weight, high density polyethylene pipe, and shall conform to ASTM D 1248 (Type III C, Category 5, P34). Minimum cell classifications values shall be 345434C as referenced in ASTM D-3350 - latest edition. All pipe resin shall be manufactured by the same company that manufactures the pipe itself in accordance with these specifications to insure complete resin compatibility and total product accountability. The fittings supplied in this specification shall be molded or manufactured from a polyethylene compound having a cell classification equal to or exceeding the compound used in the pipe. To insure compatibility of polyethylene resins, all fittings supplied under this specification shall be of the same manufacture as the pipe being supplied.
4. Physical properties:
 - a. The pipe shall conform to the physical properties as described herein.

b. Typical pipe physical properties:

<u>Property</u>	<u>Test Method</u>	<u>Unit</u>	<u>Value</u>
Density	ASTM Method	gms/cc	0.955
Melt Index	ASTM D-1238 (190/2.16)	gms/10 min	

Environmental Stress Cracking Resistance:

Condition A, B, & C, F-0	ASTM D-1693	hrs	>5000**
Compressed Ring, F-60	ASTM F-1248	hrs	>1500
Tensile Strength, Yield Type IV Specimen	ASTM D-638 (2"/min)	psi	3200
Elongation at Break Type IV Specimen	ASTM D-638 (2"/min)	%	>750
Vicat Softening Temp	ASTM D-1525	°F	257
Brittleness Temp	ASTM D-746	°F	<-180
Flexural Modulus	ASTM D-790	psi	135,000
			0
Modulus of Elasticity	ASTM D-638	psi	130,000
Hardness	ASTM D-2240	Shore D	65
Linear Thermal Expansion Coef.	ASTM D-696	in./in./°F	1.2x10-4
Thermal Conductivity	Dynatech-Colora BTU, In./Thermoconductor ft./2hrs/°F		2.7

Long Term Strength:

73°F	ASTM D-2837	psi	1600
UV Stabilizer	ASTM D-1603	%C	2.5
Material Cell Classification	ASTM D-1248		345434C
Material Description	PPI Recommendation		PE 3408

5. Quality control:

- a. The resin used for manufacture of the pipe shall be manufactured by the pipe manufacturer, thus maintaining complete control of the pipe quality. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogenous throughout and free of visible cracks, holes, foreign

inclusions, or other deleterious defects and shall be identical in color, density, melt index, and other physical properties.

The polyethylene resin used shall have all ingredients pre-compound prior to extrusion of pipe, in plant blending is not acceptable. Owner may request, as part of the quality control records submittal, certification that the pipe produced is represented by the quality assurance testing. Additionally, test results from manufacturer's testing or random sampling by the Engineer that do not meet appropriate ASTM standards or manufacturer's representation, may be cause for rejection of pipe represented by the testing. These tests may include density and flow rate measurements from samples taken at selected locations within the pipe wall and thermal stability determinations according to ASTM D 3350, 10.1.9. Certified lab data may be requested to verify the physical properties of the materials supplied under this specification or may take random samples and have them tested by an independent laboratory.

6. Rejection:

- a) The Department reserves the right to reject any polyethylene pipe and fittings failing to meet any of the requirements of this specification.

F. FUSABLE POLYVINYLCHLORIDE (FPVC) PIPE

FPVC pipe shall be used only for directional drilling under creeks or marsh crossings. All other uses of FPVC pipe shall be approved by the Department.

2. Comply with AWWA C900 for 6"-12" diameter pipe and AWWA C905 for 14" and larger diameter pipe. Comply with manufacturer's specifications.

FPVC pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.

FPVC shall be blue in color for potable water use.

Unless otherwise specified, FPVC pipe lengths shall be assembled in the field with butt-fused joints. The Contractor shall follow the pipe supplier's guidelines for this procedure.

F. SERVICE PIPE

1. Minimum size - 3/4"

2. High molecular weight polyethylene pipe complying with ASTM D1248, Type III, and AWWA C-901 for flexible pipe with SDR 9.
 - a) Pipe shall be stamped with National Sanitation Foundation approval for use with potable water at 18" intervals.

G. FITTINGS AND SPECIALS

1. General:
 - a. Cast iron fittings are not acceptable.
 - b. Comply with ANSI A 21.4 (AWWA C104), ANSI A 21.53 (AWWA C153), and ANSI A 21.51 (AWWA C151)
2. PVC
 - a. Plastic pipe 4" and larger:
 - 1) Use 150 psi pressure rated ductile iron fittings or specials unless otherwise indicated, complying with ANSI/AWWA C110/A21.10.
 - 2) Provide adapter glands, gaskets, etc. as required to accommodate any differences in pipe and fitting dimensions.
 - b. Plastic pipe 3" and smaller:
 - 1) Use PVC fittings, 160 psi at 73°F pressure rating, joint design to conform to pipe joints.
3. Ductile iron pipe:
 - a. Use 250 psi pressure rated ductile iron fittings or specials unless otherwise indicated.
 - 1) ANSI/AWWA C110/A21.10.
 - 2) ANSI/AWWA C153.
 - b. Fittings for use with push-on joint pipe.
 - 1) ANSI/AWWA C111/A21.11.
 - c. Compact fittings for piping 3" - 16" may be provided in accordance with ANSI/AWWA C153/A21.53.88.

- d. Use cement mortar lining: ANSI/AWWA C104/A21.4, Standard thickness.
4. No metric sized fittings shall be permitted.
5. All fittings to be shipped with gaskets, glands, nuts, and bolts unless specified otherwise. Nuts and bolts shall be low alloy steel. Tee bolts and nuts shall be high tensile strength, low alloy steel or 316 stainless steel. Material shall be marked on the nuts and bolts.
6. Acceptable products: American Cast Iron Pipe Company, Griffin Pipe Company, U.S. Pipe Company, Tyler Pipe Company, Harco Company, and McWane Cast Iron Pipe Company

H. JOINT MATERIAL

1. Push-on joints, mechanical joints and restrained joints conform to: ANSI A21.11 (AWWA C111).
 - a. Lubricants
 - 1) Lubricants which will support microbiological growth shall not be used for slip-on joints. Vegetable shortening shall not be used to lubricate joints.
 - 2) Natural rubber or other material which will support microbiological growth may not be used for any gaskets, O-rings, and other products used for joining pipes, setting meters or valves, or other appurtenances which will expose the material to the water.
2. Flanged joints conform to ANSI A21.15 (AWWA C115) ANSI B16.1 Faced and drilled 125 pound.
3. Bolts, Nuts, and All-Threaded Rod:
 - a. Tee bolts shall be made of high tensile strength low alloy steel containing a minimum of 0.50 percent copper, or high-strength low carbon steel per ASTM A307, specifications for carbon steel externally threaded standard fasteners, Grade B, having a minimum yield strength of 45,000 psi.
 - b. Stainless steel materials shall be grade 316 and shall contain sufficient chromium to resist corrosion, oxidation, and rust.

- c. Materials shall be sound, clean, and coated with a rust resistant lubricant.
- d. Threads shall be in accordance with ANSI B1.1, Unified Inch Screw Threads, and with B1.2, Screw Threads, Gages, and Gaging, conforming to the coarse thread series (UNC) Unified Coarse, with threads Class 2A internal and Class 2B external.
- e. Bolts $\frac{3}{4}$ " and smaller shall be furnished with heavy hex heads conforming to ANSI B18.2.1.
- f. Bolts larger than $\frac{3}{4}$ " may have either standard or heavy hex heads conforming to ANSI B18.2.1.
- g. Bolts and nuts shall be a high strength, low alloy steel tee head or hex head and shall comply with the dimensions outlined in ANSI/AWWA C111/A.21.11. The steel shall have a minimum yield strength of 45,000 psi and contain the levels of carbon, manganese, sulfur, nickel, copper and chromium.

I. RESTRAINED JOINT PIPE AND FITTINGS

- 1. Provide restrained joint pipe and fittings on all piping at each fitting, valve, fire hydrant connection, and on the pipe joints to a minimum distance of 18' on each side of the fitting or valve for 12" piping and smaller and to a minimum distance of 36' on each side of the fitting for piping over 12" as a minimum. Use the ductile iron pipe research association (DIPRA) procedure for calculating restrained joint lengths.
- 2. Provide for use with mechanical joint pipe and fittings.
- 3. Quality Assurance:
 - a. Reference Standards of the American National Standards Institute (ANSI).
 - 1) A21.11 Rubber gasket joints for cast iron and ductile iron pressure pipe and fittings (AWWA C111).
 - 2) A21.53 Ductile iron compact fittings for 3" through 48" (AWWA C153).
 - 3) A21.51 Ductile iron pipe centrifugally cast in metal molds or sand lined for water or other liquids (AWWA C151).

- b. Reference Standards of the American Standards for Testing and Materials (ASTM).
 - 1) A536-84 Specifications for ductile iron castings (AWWA C110).
- 4. Acceptable products:
 - a. American cast iron pipe: Fast Grip, Flex-Ring, Field Flex-Ring or Lock-Ring.
 - b. US Pipe: TR Flex or Field Loc 350 Gaskets.
 - c. Griffin Pipe: Snap-Lok Restrained Joint.
 - d. EBBA: Megalug Restraint Gland.
- 4. Restrained joint pipe will be indicated clearly on plans. The length of restrained joint pipe will be clearly marked on the drawings for all points where the direction or cross-sectional area of the pipe changes as well as at all bends, reducers, offsets, tees, wyes, deadends, valves, and fire hydrants. Restrained lengths may be shown in plan view or in a table.
- 5. Components
 - a. Ductile iron glands sizes 4" through 24" shall conform to ASTM A536-80 Specification for ductile iron casting.
 - b. Coating shall be a bituminous seal coat to conform with ANSI/AWWA C151/A21.51. Ductile iron pipe centrifugally cast in metal molds or sand lined molds for water or other liquids.
- 6. Joint Sizes
 - a. Dimensions of gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to:
 - 1) ANSI/AWWA C111/A21.11 Rubber gasket joints for gray iron and ductile iron pressure pipe and fittings.
 - 2) ANSI/AWWA C153/A21.53 Ductile iron compact fittings for 3" through 48".
- 7. Other Requirements

- a. The gland shall have a working pressure of at least 250 psi with a minimum safety factor of 2:1.
- b. No metric sized nuts or bolts shall be permitted.
- c. Twist off nuts shall be used to insure proper actuating of restraining devices.

J. COUPLINGS - 6" AND LARGER

- 1. Provide couplings where needed to make piping connections.
- 2. Provide full length mechanical joint ductile iron sleeve, 12" minimum length.
- 3. Provide cutting-in sleeve where installing fittings in an existing line.
 - a. Provide ductile iron with mechanical joint.
- 4. Provide restrained joint couplings: where restrained joints are indicated on the plans or when coupling is located within 18' for 12" piping and less and 36' for larger piping of a bend, tee or valve. For typical soil conditions, a safety factor of 2, and 150 psi pressure, the following table should be used for restrained joint couplings.

Pipe Diameter	Length
6"	30'
8"	39'
10"	46'
12"	54'
14"	61'
18"	76'
24"	95'

- 5. Fittings to be installed in the new construction of water systems shall conform to those of standard design and in current inventory of the Department. No special manufactured fittings will be allowed without prior approval of the Department.

K. PLUGS OR CAPS

- 1. Provide at all pipe ends and unused branches of fittings.

2. Tap and provide with 2" plug for installation of blow off.
3. Provide restrained joint.

L. METALLIC DETECTION TAPE AND TRACER WIRE

1. Provide 2" wide metallic detection tape and tracer wire on all buried piping.
 - a. Provide 5.0 mil overall thickness with no less than a 50 gauge solid aluminum foil core.
 - b. Foil to be visible from both sides.
 - c. No inks or printing extended to the edges of the tape.
 - d. Encase printing to avoid ink rub-off.
 - e. Tensile strength - 28 lbs/inch.
 - f. Use heat set mylar inks.
2. Locate 12" below ground surface in pipe trench.
3. Color to be Safety Precaution Blue.
4. Wording on tape to indicate "Potable Water" at no greater than 24" on center.
5. All water main installations shall also include the installation of metallic tracer wire laid 6" above the pipe.

M. VALVES

1. General:
 - a. 6" through 12": Use gate valves.
 - b. 14" and larger: Use butterfly valves.
 - c. Open by turning counter clockwise with arrow cast in top indicating the direction of the opening.
 - d. End connections as required for the piping in which they are installed.

- e. Two inch metal operating nut with arrow indicating direction of opening.
- f. Use valves designed for a working pressure of not less than 150 psi unless otherwise specified herein.
- g. Provide stem extensions on all valves where the top of the operator nut is located greater than 36" below the top of the valve box.

2. Quality Assurance

- a. Reference Standards of the American National Standards Institute (ANSI)
 - 1) A21.5 Polyethylene encasement for gray and ductile cast iron piping for water and other liquids (AWWA C105).
 - 2) A21.11 Rubber gasket joints for cast iron and ductile iron pressure pipe and fittings (AWWA C111).
 - 3) B16.1 Cast iron pipe flanges and flanged fittings, Class 25, 125, 250, and 800.
- b. Reference Standards of the American Water Works Association (AWWA).
 - 1) C600 Installation of Ductile Iron Water Mains and Their Appurtenances.
 - 2) 601 Disinfecting Water Mains
 - 3) C504 Rubber Seated Butterfly Valves
 - 4) C509 Resilient Seated Gate Valves

3. Gate valves:

- a. Use resilient seated wedge valves: ANSI/AWWA C500/C509.
- b. Internal ferrous metal surfaces to be fully coated with two part thermosetting epoxy conforming to AWWA C550 or fusion bonded, holiday free epoxy coating material to be AWWA and U.S. Food and Drug Administration approved for use with potable water.
- c. Provide fusion bonded or two part thermosetting epoxy coating on valve exterior conforming to AWWA C550.

- d. Provide integrally cast bronze or stainless steel stem nut.
 - e. Design for external stem failure when excessive closing torque is applied with no failure of the pressure retaining parts.
 - f. Gate valves to have bevel gears with grease case, provide all necessary appurtenances for horizontal installation.
 - g. Provide valves with working pressure of not less than 250 psi and a 500 psig static test pressure.
 - h. Provide 316 stainless steel fasteners.
 - i. Ends shall be mechanical joint conforming to ANSI/AWWA C111/A21.11.
 - j. Acceptable product: Mueller, American AVK, American-AD, or American Flow Control.
4. Butterfly valves:
- a. Provide butterfly valves conforming to AWWA Standard C504, latest revision, for Class 150B, unless otherwise specified.
 - b. Resilient seats are to be synthetic rubber (BUNA N).
 - c. Shafts to be turned, ground and polished, constructed of 18-8 Type 316 stainless steel.
 - 1) Shafts to be of one piece design.
 - 2) Attach disc to shaft with stainless steel tapered pins and locking nuts.
 - d. Spray coat all interior wetted ferrous surface with two component epoxy applied to a nominal thickness of 3 to 4 mils.
 - 1) Coating material to be AWWA and U.S. Food and Drug Administration approved for use with potable water.
 - e. Provide operators with not less than maximum operator torque, as determined in accordance with Appendix A of AWWA C504, to operate valves under actual line pressures and velocities.

- 1) Provide worm and gear, or traveling nut type, self-locking to prevent the valve disc from creeping or fluttering when it is in any intermediate position between open and closed.
 - 2) Gear operators to be permanently lubricated, totally enclosed, with adjustable stops for the open and closed position, and except on units for buried service, shall have a valve disc position indicator.
- f. Provide position indicator and extension shaft for all valves and operators.
- 1) Position indicator shall be hermetically sealed for installation in a C.I. valve box.
 - 2) Show valve disc position, direction of rotation and number of turns from full open to full close.
 - 3) Shaft extension and pins to be stainless steel.
 - 4) Base plate and housing to be aluminum.
 - 5) Provide all bronze gearing.
 - 6) Provide 2" AWWA square nut.
 - 7) Approved manufacturer: Dyna-Torque, Inc. of Mukeygon, Michigan.
- g. Epoxy coated inside and outside conforming to AWWA C550.
- h. Ends shall be flanged conforming to ANSI B16.1, Class 125.
- i. Rated for a 150 psi working pressure.
- j. Acceptable product: DeZurik, Mueller, American AD, Valmatic, or Pratt.
5. Tapping Valves 12" and smaller shall conform to the following:
- a. Resilient seat type conforming to AWWA C509.
 - b. Epoxy coated inside and outside conforming to AWWA C550.
 - c. Ends shall be flanged by mechanical joint conforming to ANSI B16.1, Class 125 and ANSI/AWWA C111/A21.11 respectively.

- d. Rated for a 250 psi working pressure.
- 6. Tapping valves 14" and larger shall conform to the following:
 - a. Bronze seat, double disk type conforming to AWWA C500.
 - b. Epoxy coated inside and out conforming to AWWA C550.
 - c. Equipped with 4" by-pass valves.
 - d. Ends shall be flanged by mechanical joint conforming to ANSI B16.1, Class 125 and ANSI/AWWA C111/A21.11 respectively.
 - e. Allow full port opening cutters up to 24".
 - f. Rated for a 150 psi working pressure.
- 7. Other Requirements
 - a. All valves shall have Grade B cast iron or ductile iron bodies conforming to ASTM A126 or ductile iron ASTM A536.
 - b. All valves shall have a 2" square operating nut for buried service.
 - c. All valves shall have open left operation.
 - d. All valves shall be equipped with a non-rising stem.
 - e. All valves shall be constructed with 316 stainless steel bolts on bonnets, thrust collars, and operating nuts.
 - f. All valves shall be in conformance with the latest revision of all reference standards of AWWA or ANSI.
 - g. Valve boxes with drop covers will be of cast iron.

N. VALVE OPERATOR

- 1. Provide one T-handle operator for each ten buried valves with nut operator.
- 2. Operator to be epoxy coated.

O. VALVE BOXES

- 1. Provide at each buried valve.

2. Shall be full cast iron with cast iron covers suitable for heavy traffic use and conform to ASTM A-48, Class 20 Specifications.
3. Valve boxes shall be screw type and have a 5 ¼" inside shaft diameter.
4. Have the word "WATER" cast into the cover.
5. No part of the valve box is to rest on the buried valve.
6. Acceptable product: Products of Tyler Pipe/Utility Division #6850 Series and Bingham and Taylor #4905 of U.S. manufacture only.

P. VALVE BOX PROTECTION RING

1. Provide at each valve box a precast concrete protection ring.
2. Provide two (2) rings of #3 reinforcing steel, one (1) 21" in diameter, and one (1) 24" in diameter; or one (1) ring of #3 reinforcing steel, 22" in diameter with fibermesh concrete.
3. Inside dimensions to be 9 ¼".
4. Outside diameter to be 27".
5. Provide 5" thickness at interior with a continuous slope to 2" thickness at the outside.
6. Minimum weight of 110 lbs.

Q. SERVICE AND TAPPING SADDLES

1. Provide of the following materials:
 - a. Body - Ductile Iron ASTM-A536.
 - b. Bales and straps - Type 316 stainless steel.
 - c. Studs - Type 316 stainless steel.
 - d. Hardware - Type 316 stainless steel.
 - e. Copper tube size (CTS).
2. Provide double strap for sizes 5" and larger.

3. Finish - Provide fusion bonded nylon to an average thickness of 12 mils.
4. Acceptable product: Smith Blair 317, Ford 202, Romac 202N, Mueller, or JCM 406.

R. TAPPING SLEEVE AND VALVE

1. Tapping sleeve:
 - a. Provide ductile iron, split-type sleeve with flanged outlet.
 - b. Provide bolts, follower rings and gaskets on each end of the sleeve.
 - c. Provide for maximum working pressure of 150 psi.
 - d. Provide square head bolts with hexagonal nuts.
 - e. Provide $\frac{3}{4}$ " NPT test plug.
2. Tapping valve:
 - a. Construct of material compatible with tapping sleeve.
 - b. Valve to conform to gate valve specifications.
 - c. Joints - Flange to tapping sleeve, for pipe end.
 - d. Acceptable product: Mueller, American Darling

S. AIR RELEASE VALVES

1. Provide cast iron body with stainless steel internal trim and float.
2. Provide stainless steel seat with BUNA-N rubber valve.
3. Provide 1" NPT inlet with 1" x $\frac{3}{4}$ " bronze bushing.
4. Provide Crispin Type "N" Model PL10, Golden Anderson Figure 912.
 - a. $\frac{1}{4}$ " orifice.
 - b. 0 to 150 psi working pressure.
 - c. 1" NPT connection.
5. Provide a heavy duty cast iron meter box to house valve.

T. CORPORATION STOPS

1. Acceptable product:
 - a. Ford Model F1100 with compression nut, gasket, and gripper inlet; iron pipe thread outlet. IPT x grip nut.
 - b. Mueller Model H-15028; McDonald - 4707T.

U. CURB STOPS

1. Acceptable product:
 - a. Ford Model #B11, iron pipe threads inlet and outlet with lockwing.
 - b. Mueller, McDonald #6101W.

V. REPAIR COUPLINGS

1. Pipe larger than 2 ½": Full length mechanical joint ductile iron couplings, 12" minimum length.

W. MISCELLANEOUS PARTS AND ACCESSORIES

1. Use standard commercial grade suitable for the type of installation or system involved, and conforming to the applicable standards and specifications of the AWWA.

X. CASING, SPACERS AND END SEALS FOR UTILITIES

1. General
 - a. Provide bore and jack with casing for pipes larger than 2".
 - b. Casing pipe to be 2" larger in diameter than the bell of the carrier pipe based on the following:
 - 1) Casing pipe to be a minimum of 2" larger than the largest outside diameter of the carrier pipe (joints and couplings) if the carrier pipe is less than 6" in diameter. If the diameter of the carrier pipe is 6" or larger, the diameter of the casing pipe shall be a minimum of 4" larger than the largest outside diameter of the carrier pipe (joints and couplings).

- 2) The end of casing pipe to extend a minimum of six (6) feet from the edge of pavement/back of curb.
- 3) The top of the casing pipe shall be a minimum of four (4) feet below the crown of the finished asphalt roadway.
- 4) The top of the casing pipe shall be a minimum of two (2) feet below the design invert of roadside drainage ditches and pipes.

c. Carrier pipe shall be restrained joint.

2. Casing pipe for dry bores.

- a. Steel complying with ASTM A139 for Grade B with minimum yield strength of 35,000 psi.
- b. Provide ends suitable for field welding.
- c. Minimum wall thickness as follows:

<u>Diameter of Casing</u> (Inches)	<u>Minimum Wall Thickness</u> (Inches)
6 thru 14	1/4
16 and 18	5/16
20 and 22	3/8
24 and 26	7/16
28 thru 32	1/2
34 thru 42	9/16
44 thru 48	5/8
50 thru 54	3/4

3. Pipeline Casing Spacers

- a. Provide pipeline casing spacers for piping installed in casing.
- b. Provide a minimum of one spacer per ten linear feet of pipe for ductile iron pipe and a minimum of one spacer per six linear feet for PVC pipe.
- c. Provide spacer with shell of 14 gauge Type 316 stainless steel.
- d. Provide shell liner of .090" thick PVC, 85-90 durometer.
- e. Provide 5/16" stainless steel connecting bolts and lock nuts, minimum three (3) per flange.

- f. Runners from 2" wide ultra high molecular weight polymer with a high resistance to abrasion and a coefficient of friction of 0.11-0.13 in accordance with ASTM D-1894.
 - g. Support runners on 14 gauge reinforced Type 316 stainless steel risers welded to shell.
 - h. All metal surfaces to be fully passivated.
 - i. The diameter as measured over the runners shall exceed the pipeline bell or coupling outside diameter.
 - j. Acceptable product: Cascade Manufacturing or approved equal.
4. End Seals
- a. Seal each end with brick and mortar to prevent entrance of foreign material.

Y. USE OF LEAD FREE SOLDER

- 1. Note: Section 1417 of the federal safe drinking water act has mandated that any pipe, solder, or flux used after June 19, 1986, in the installation or repair of public water systems and plumbing used for drinking water must be "lead free". The act defines "lead free" as less than 0.2 percent lead in solder and flux and less than 0.8 percent lead in pipes and fittings.

SECTION 7

WATER DISTRIBUTION SYSTEM CONSTRUCTION PROCEDURES

SECTION 7

WATER DISTRIBUTION SYSTEM

CONSTRUCTION PROCEDURES

This section covers construction procedures normally required for work. It does not cover any special construction procedures which may be encountered for abnormal conditions.

Special construction procedures are to be presented to the Department by the Developer's Design Engineer.

A. HANDLING OF MATERIALS

1. Handle pipe so as to ensure delivery to the trench in sound, undamaged condition:
 - a. Carry pipe into position - do not drag.
 - b. Use pinch bars or tongs for aligning or turning the pipe only on the bare end of the pipe.
 - c. Use care not to injure pipe linings.

B. PIPE CUTTING

1. Cut pipe neatly and without damage to the pipe or lining.
2. Unless otherwise recommended by the pipe manufacturer, cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut. Use wheel cutters when practicable. Cuts must be even and perpendicular with length of pipe. Dress cut ends of pipe in accordance with manufacturer's directives for the type of joint to be made.

C. LOCATING

1. Service lines:
 - a. Provide a water service to each subdivision lot.
 - b. Install service lines from the distribution main to the property lines at each lot, or at each location indicated or directed by the Engineer. Normally installed on opposite side from the sewer service.

D. PIPE, VALVE, AND APPURTENANCE INSTALLATION

1. General:

- a. The installation of water mains and appurtenances shall be conducted in accordance with the latest revision of Section C of the AWWA Standards and/or the manufacture's recommended installation procedures.
- b. Lower pipe and accessories into trench by means of derrick, ropes, belt slings, or other equipment approved by the manufacturer.
- c. Do not dump or drop any of the materials into the trench.
- d. Except where necessary in making connections to other lines, lay pipe with the bells facing in the direction of laying.
- e. Rest the full length of each section of pipe solidly on the pipe bed, with recesses excavated to accommodate bells, couplings, and joints.
- f. Take up and relay pipe that has the grade or joint disturbed after laying.
- g. Do not lay pipe in water, or when trench conditions are unsuitable for the work; keep water out of the trench until jointing is completed.
- h. Securely close open ends of pipe, fittings, and valves when work is not in process.
- i. Replace pipe where any part of coating or lining is damaged.
- j. Bell pipe using manufacturer's approved leverage bar.
 - 1) Home line is to be clearly visible when pipe is joined.

2. Ductile iron pipe:

- a. Mechanical and push on joints, install in accordance with ANSI/AWWA C600.
- b. Gaskets: Handle, lubricate where necessary and install in strict accordance with manufacturer's recommendations.

3. PVC

- a. Clean gasket, bell or coupling interior, especially groove area.

- b. Lubricate and insert gasket as recommended by manufacturer.
- c. Align spigot to bell, insert spigot into bell until it contacts gasket uniformly.
- d. Bell pipe using manufacturer's approved leverage bar.
 - 1) Home line is to be clearly visible when pipe is joined.

4. FPVC

- a. Pipe manufacturer's and supplier's procedures shall be followed at all times.
- b. FPVC will be fused by qualified fusion technicians holding current qualification credentials for the pipe size being fused, as documented by the pipe supplier.
- c. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be use for the fusion process. This includes requirements for safety, maintenance and operation with minor modifications made for PVC.
- d. FPVC pipe will be installed in a manner so as not to exceed the recommended bending radius.
- e. Where FPVC pipe is installed by pulling in tension, the recommended Safe Pulling Force, according to the pipe supplier, will not be exceeded.

4. Restrained joints:

- a. Install in accordance with manufacturer's instructions.
- b. Tighten set screws to the manufacturer's rated torque using a torque wrench.
 - 1) If twist-off nuts are provided, tighten screws until nut breaks loose.

5. Underwater crossings:

- a. Use ductile iron pipe, FPVC or HDPE.
- b. Provide a minimum cover of two (2) feet.
- c. Crossings greater than fifteen (15) feet in width:

- 1) Provide ball joint pipe for ductile iron pipe (DIP).
 - 2) Provide valves at both ends of the water crossing.
 - 3) A fire hydrant must be provided on the side opposite the supply service, sized in accordance with [R.61-58.4(D)(7)][R.61-58.4(D)(13)(b)(iii)].
6. Above-water crossings:
- a. Use ductile iron pipe with flanged joints.
 - b. Adequately support and anchor the pipe, protect from damage and freezing and be accessible for repair.
 - c. Hardware, straps, etc. to be 316 stainless steel.
7. Alignment and Grade
- a. Fittings, valves and other appurtenances shall be located where shown on the approved plans, with the pipe being cut if necessary to assure accurate placement. Install the pipe, valves, and appurtenances to the alignment and profile shown on the approved drawings. Maintain a minimum depth of cover of 3' unless actual depths are shown on the approved drawings.
8. Rights-of-way, Easements, and Permits
- a. It is the responsibility of the developer/engineer to obtain all necessary legal documentation and permits and advise Department of the status of each prior to the commencement of work. All installation is to be conducted within the parameters stipulated in the rights-of-way, easements, and permits, etc. Any damages caused by encroachment beyond the legal limits stipulated shall be the responsibility of the Developer and/or Contractor.
9. Protection of Pipe, Valves, and Appurtenances
- a. Protection of Pipe, Gaskets, and Polyethylene Film
 - 1) Store rubber gaskets and polyethylene film under cover and out of direct sunlight. Do not store nuts, bolts, glands, and other accessories directly on the ground. Keep inside of pipe and fittings free of dirt and debris.
 - b. Protection of Valves

- 1) Keep materials off the ground and keep interiors free of dirt and debris. Do not expose valve interior to direct sunlight.

10. Pipe, Valve, Blow-Off and Appurtenance Installation

a. Pipe Distribution

- 1) Deliver the pipe to the job site from the designated storage area in a safe manner.

b. Installation of Pipe and Valves

- 1) Inspect pipe for damage. Remove damaged and unacceptable pipe. Keep interior and joint surfaces clean and free of foreign materials. Install a M.J. or push-on type ductile iron plug whenever work stops for a period of a day or greater.
- 2) Provide and use proper implements, tools, and facilities for the safe and proper installation of the work. Lower all pipe, fittings, and appurtenances into the trench, piece by piece, by means of crane, slings, or other suitable tools or equipment, in such a manner as to prevent damage to the pipeline materials and protective coatings and linings. Do not drop or dump pipeline materials into the trench.
- 3) Remove all lumps, blisters, and excess bituminous coating from the bell-and-spigot ends of each pipe. Clean the spigot and the inside of the bell and wipe clean and dry. Insure surfaces are free from oil and grease before the pipe is laid.
- 4) Wipe the ends of mechanical joint pipe and fittings and rubber gasket joint pipe and fittings clean of all dirt, grease, and foreign matter.

c. Installation of Blow-Offs

- 1) All working parts shall be serviceable from above grade with no digging. See Detail Section.

d. Installation of Retainer Glands

- 1) Adjoining surfaces shall be clean, and lubricated meeting with requirements of ANSI/AWWA C111/A21.11.

2) Install using assembly recommendations established in ANSI/AWWA C111/A21.11 as well as installation instructions provided by the manufacturer.

3) Megalug Retainer Glands - Tighten the T-head bolts to the normal range as indicated on the following table:

Pipe Size (in)	Bolt Size (in)	Range of Torque (ft/lbs)
4"-24"	¾"	75-90

4) Retainer Glands - All set screws will be installed with proper torque as required by manufacturer:

Pipe Size (in)	Bolt Size (in)	Range of Torque (ft/lbs)
4"-6"	¾"	80

5) All megalug retainer glands are furnished with rubber inserts to insure proper positioning. Do not remove them.

E. ALIGNMENT OF PIPE

1. Pipe lines intended to be straight shall be so laid.
2. Where vertical or horizontal alignment requires deflection from straight lines or grade, do not exceed 75% of maximum deflection recommended by the pipe manufacturer or AWWA Standard 600 Tables 5 and 6.
3. If alignment requires deflection exceeding recommended limits, furnish bends to provide angular deflections within the allowable limits.

F. SERVICE LINES

1. Locate service lateral within one (1) foot of property corner on opposite corner of sewer lateral.
2. Install polyethylene CTS flexible service lines in one continuous piece from main to metering point at right-of-way/property line.
3. Depth of the service connection shall be no less than the top of the main connection and shall be 12" deep at right-of-way line. Where service line crosses drainage structure (ditch), the service line will be at a depth of 18" below the design invert of such ditch.
4. Do not exceed an angle of 45° to the horizontal on the top.

5. Connections to mains:
 - a. PVC mains:
 1. Use approved tapping saddle.
 6. Provide corporation stops on all mains.
 7. Terminate each service line with a Mueller institute ¼" NPT plug.
 - a. Mark with a wooden stake installed to 3' above grade.
- G. SETTING VALVES AND VALVE BOXES
1. Center valve boxes on the valves, setting plumb. Valve box shall not at any point rest on any part of the valve.
 2. Tamp earth fill around each valve box to a distance of 4' on all sides, or to the undisturbed trench face if less than 4'.
 3. Install shaft extensions plumb without any binding.
 4. Fully open and close each valve to assure that all parts are in working condition.
- H. VALVE BOX PROTECTION RING
1. Place valve box protection ring around top of valve box as detailed.
 - a. Install ring level with top 1" above finished grade.
 - b. Top of ring to be level with or no more than 1" above the top of the valve box.
- I. THRUST BLOCKS
1. The Department will approve the use of thrust block on a case by case basis.
 2. Maximum soil pressure: 2000 lbs/sq ft. Minimize the use of thrust blocking by installing thrust restraint fittings when possible.
 3. Minimum water pressure: 150 psi.
 4. Safety factor: 2

5. Concrete: 3000 psi.
6. Locate thrust blocking between solid ground and the fitting to be anchored.
7. Provide 8 mil polyethylene film between the thrust block and fitting.
8. Place the base and thrust bearing sides of thrust blocking directly against undisturbed earth.
9. Sides of thrust blocking not subject to thrust may be placed against forms.
10. Place thrust blocking so the fitting joints will be accessible for repair.

J. JOINING PIPE, VALVES, AND APPURTENANCES

1. Mechanical, Push-On, and Restrained Joint
 - a. Join pipe with mechanical or push-on type joints in accordance with the manufacturer's recommendations. Provide all special tools and devices, such as special jacks, chokers, and similar items required for proper installation. Lubricants for the pipe gaskets shall be used and shall be manufacturer's standard. All mechanical joints used on hydrants, hydrant leads, taps and valves should have retainer glands.
2. Flanged
 - a. Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to ensure proper seating of the flange gasket. Bolts shall be tightened so that the pressure on the gasket is uniform. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and reset and bolts re-tightened.
3. Pipe Bedding
 - a. Excavate trench bottom to provide a level cross section with vertical walls extending to the top of the pipe zone. Excavate evenly to provide smooth profile grade without holes and ridges. Keep trench dewatered.
 - b. Lay pipe on bedding such that it is continuously supported along the barrel, and is not bearing on the bell. After joint construction, place bedding material under bell. Unless otherwise directed, lay pipe with bell end facing in the direction of the laying.

4. Valves

- a. Valves shall be carefully handled, cleaned and checked for operation prior to backfilling. Care shall be taken to insure that no dirt, rock, or other obstacles that would interfere with the operation are left in the valve. Valves shall be installed in a position such that the plane of operation or rotation for the operating nut is parallel to the ground surface.
- b. Approximately ½" space shall be left to provide "play" for future removal of flanged valves.

5. Valve Box

- a. A valve box shall be installed on each underground valve. They shall be carefully set, centered exactly over the operating nut and truly plumbed. The base shall be set, and so arranged that the weight of the valve box and superimposed loads will bear on the base and not on the valve or pipe. Extension stems shall be installed where depth of bury places operating nut in excess of 4' beneath finished grade.

K. ANCHORAGE

1. All pipelines shall be securely anchored. Retainer glands or megalugs shall be used on all mechanical joint fittings. All tees, plugs, caps and bends which are equal to or greater than $11\frac{1}{4}^{\circ}$, and at other locations where unbalanced forces exist, must have acceptable thrust restraint.
2. Blocking
 - a. The concrete mix used for thrust blocking shall have 28 days compressive strength of not less than 3,000 pounds per square inch. Place blocking between the undisturbed ground and the fitting to be anchored. Place the blocking so that the pipe and fitting joints will be accessible to repairs, unless otherwise shown.
3. Restrained Joints
 - a. Restrained joints shall be used in lieu of reaction blocking or in combination with blocking where appropriate and as designated by the Engineer or the Department.

L. WET TAP CONNECTIONS

1. Connections to existing water mains shall be done by use of wet taps using tapping sleeves or tapping saddles and tapping valves.

M. HIGHWAY AND RAILROAD CROSSINGS

1. General
 - a. Installation shall conform to the permits of all agencies having jurisdiction. Method of installation shall be specified by the Engineer.
2. Casing Pipe
 - a. Continuously weld lengths of casing pipe to the preceding section in accordance with AWS recommended procedures. Clean all debris from casing interior after casing installation is complete. Pressure grout any void areas apparent outside the casing.

N. INSTALLATION OF CASING, SPACERS AND END SEALS FOR UTILITIES

1. Locate to avoid interference with traffic, adjacent structures, etc. to such extent possible.
2. Excavate to required depth, providing sheeting and shoring necessary for protection of the work and for safety of personnel.
3. Maintain entry pits in dry condition by use of pumps, drains or other approved method.
4. Install casings by dry-boring through the casing while simultaneously jacking the casing.
5. Any proposed alternate method shall be approved in writing by the Department.
6. Weld joints to provide a watertight joint.
7. Install casings for gravity sanitary sewer to grade, not varying more than 3/32" per foot of length from the indicated grade.
8. Installing pipe in casing:
 - a. Inspect carefully, insuring that all foreign material is removed from the casing and the casing meets alignment criteria for the type of carrier pipe being used.
 - b. For pressure systems, the casing deflection shall not exceed the maximum deflection recommended by the carrier pipe.

- c. Install casing spacers on the carrier pipe per the manufacturer's instructions.
 - d. For sanitary sewer provide spacer sizing and length necessary to obtain the pipe slope and elevations as shown on the plans.
 - e. Provide restrained configuration.
 - f. Install the carrier pipe in the casing insuring each joint is pushed "home" before the joint is installed into the casing.
9. Seal each end with brick and mortar to prevent entrance of foreign material.

O. PREPARATION OF RIGHT-OF-WAY

1. Remove obstructions within the trench area or adjacent thereto such as but not limited to tree roots, stumps, abandoned piling, buildings and concrete structures, logs, and debris of all types.
2. Properly dispose of obstructions removed from the excavation in accordance with local municipality directives.
3. Pavement, Curb, and Sidewalk Removal
 - a. Cut all bituminous and concrete pavements, regardless of thickness, and all curbs and sidewalks, prior to excavation of the trenches as specified in the South Carolina Department of Transportation Policy. Width of the pavement cut shall be at least equal to the required width of the trench at ground surface. Pavement cut lines shall be even and parallel. Any ragged or uneven cuts shall be cut smooth before patching. Pavement and concrete materials removed shall be hauled from the site and not used for trench backfill.

P. TRENCH EXCAVATION

1. Trench Width
 - a. Maximum width of unsheeted trenches in which pipe is to be laid shall be 18" greater than the inside diameter of the pipe, but not less than that required for proper compaction around the pipe. Sheetting requirements shall be independent of trench widths.
 - b. The maximum trench width at the top of the pipe zone is limited to 1.33 times the pipe outside diameter plus 18".

- c. In general, the maximum width at the top of the trench will not be limited, except where excess width of excavation would cause damage to adjacent structures or property. However, confine trench widths to dedicated rights-of-way or construction easements, unless special prior written agreements have been made with the affected property owner.
2. Grade
 - a. Excavate the trench to the lines and grades shown on the plans with proper allowance for pipe thickness and for pipe base or special bedding when required. If the trench is over excavated below the required grade, correct any part of the trench excavated below the grade with crushed stone or Class II backfill as specified herein.
 - b. Place the pipe bedding material over the full width of trench in compacted layers not exceeding 6" deep to the established grade.
3. Shoring, Sheet piling and Bracing of Trenches
 - a. Sheet and brace the trench consistent with OSHA Regulations when necessary to prevent caving in during excavation or to protect adjacent structures, property, workmen, and the public. Increase trench widths accordingly by the thickness of the sheet piling. Maintain sheet piling in place until the pipe has been placed and backfilled at the pipe zone. Shoring and sheet piling shall be removed in accordance with OSHA Regulations and, as the backfilling is done, in a manner that will not damage the pipe or permit voids in the backfill. All sheet piling, shoring, and bracing of trenches shall conform to the safety requirements of the Federal, State or local public agency having jurisdiction. The most stringent of these requirements shall apply.
4. Dewatering
 - a. Provide and operate equipment adequate to keep all excavations and trenches free of water. Remove all water during period when concrete is being deposited, when pipe is being laid, during tunneling or jack and bore operations, during the placing of backfill, and at such other times as required for efficient and safe execution of the work. Prevent settlement or damage to adjacent property. Dispose of water in a manner that will not damage adjacent property. When dewatering open excavations, dewater from outside the structural limits and from a point below the bottom of the excavation. Design a dewatering system to prevent removal of fines from existing ground.
5. Foundation Stabilization

- a. When the existing material in the bottom of the trench is unsuitable for supporting the pipe, provide foundation stabilization as described here. Excavate below the pipe zone and backfill to specified grade with crushed stone or Class II backfill. Place the crushed stone or Class II backfill over the full width of the trench and compact to the required grade.

Q. TRENCH BACKFILL

1. When backfill is mechanically placed, push the backfill material onto the slope of the previously placed and allow it to slide down into the trench. Do not push backfill into the trench in such a way as to permit free fall of the material until at least 2' of cover is provided over the top of the pipe. Under no circumstances allow sharp and/or heavy pieces of material to drop directly onto the pipe or the tamped material around the pipe. Do not use backfill material of consolidated masses larger than ½ cubic foot.
2. Backfill material types
 - a. Class I (Concrete) Backfill
 1. Conform to ASTM C94, Alternate 3. Proportion to obtain a 28 day compressive strength of 2,500 pounds per square inch.
 - b. Class II Backfill
 1. Material suitable for backfill in a properly dewatered trench shall consist of any of the following: Well graded coarse granular materials free of roots, branches, stumps, or other material not so suited, with maximum particle size not exceeding 1"; sands, silty-sand or clayey sands. Soils having more than 25% of its weight passing a No. 200 sieve shall not be used for backfill. Soils shall be compacted to 95% dry density (modified proctor).
 - c. Class III Backfill
 1. Class III backfill will be used where suitable throughout the project and will generally be excavated trench material free of roots, branches, stumps, or other organic or unsuitable materials.
3. Backfill the trench for one (1) foot above the pipe with approved backfill material (Type II). Backfill shall consist of approved backfill material free from organic matter and deleterious substances, containing no rocks or lumps over 2" in any dimension. Backfill shall be deposited in 6-inch layers (before compaction) and thoroughly compacted with power tools to 95% of

theoretical maximum density, modified Proctor as determined by ASTM D1557.

4. Backfill with Type II material under all culverts, water, gas, irrigation, and sewer lines, buried telephone, power and television cable, and any other buried pipelines or cables that cross
5. Pipes not installed under pavement in a public right-of-way
 - a. Backfill the trench for one (1) foot above the pipe with approved backfill material (Type II). Backfill shall consist of approved backfill material free from organic matter and deleterious substances, containing no rocks or lumps over 2" in any dimension. Backfill shall be deposited in 6-inch layers (before compaction) and thoroughly compacted with power tools to 95% of theoretical maximum density, modified Proctor as determined by ASTM D1557.
 - d. Unless otherwise required, the remaining backfill material can be Type III.
6. Pipes installed under pavement in a public right-of-way
 - a. Backfill with flowable fill for a minimum of 36-inches below the pavement. For trenches less than 36-inches deep, backfill with flowable fill to the bottom of the trench.
 - b. Backfill the remaining trench with Type II material or with #57 stone.
 - c. Backfill shall meet all requirements of the agency with maintenance responsibility of the road.
7. Moisture Control - Backfill
 - a. During all compacting operations, maintain optimum practicable moisture content required for compaction purposes in each lift of the earth fill. Maintain moisture content uniform throughout the lift. Supplement, if required, by sprinkling the earth fill. During all compaction, the water content of the material shall be at optimum moisture content, plus or minus 2 percentage points.
 - b. Do not attempt to compact fill material that contains excessive moisture. Aerate material by blading, discing, harrowing, or other methods to hasten the drying process.
8. Maintenance of Trench Backfill

- a. Maintain the surface of the backfilled trench level with the existing grade until the entire project is accepted. Any subsequent settlement of the finished surface during the warranty period shall be considered to be a result of improper or insufficient compaction and shall be promptly repaired at no cost to the Department.
- b. Maintain backfilled trench surface until the following operations have been completed and approved by the Department.
 - 1) Valves and valve boxes installed.
 - 2) Hydrostatic testing.
 - 3) Cleanup and restoration of all physical features, utilities restored to their original condition or better, and, in general, all work required with the exception of repaving.
- c. Maintenance shall include, but not be limited to, the addition of crushed stone backfill material to keep the surface of backfilled trenches reasonably smooth, free from ruts and pot-holes, and suitable for normal traffic flow.

9. **Compaction Tests**

- a. The Department, or other agencies having jurisdiction over the work, reserves the right to require the Contractor to provide, at his expense, all testing necessary to determine the in-place density and moisture content of the subgrade and compacted fill according to ASTM D1556. Test results and a certified statement by the soil testing company that the actual soil compaction found meets these specifications shall be submitted to the Department as soon as it is available to the Contractor.

R. **COMPACTION**

- 1. Utilize compaction equipment of suitable type and adequate to obtain a compaction in accordance with ASTM D1557. Operate in strict accordance with the manufacturer's instructions and recommendations and maintain in such condition that it will deliver the manufacturer's rated compactive effort.
- 2. Impact type compactors are suitable. Rubber tired rollers and track type equipment are not suitable and are not allowed for Class II or III backfill.

S. **SETTLEMENT POLICY**

1. Any subsequent settlement of the finished surfacing during the warranty period shall be considered to be a result of improper or insufficient compaction and shall be promptly repaired at no cost to the Department.
5. Foundation Stabilization
 - a. When the existing material in the bottom of the trench is unsuitable for supporting the pipe, provide foundation stabilization as described here. Excavate below the pipe zone and backfill to specified grade with crushed stone or Class II backfill. Place the crushed stone or Class II backfill over the full width of the trench and compact to the required grade.

T. HYDROSTATIC TESTING

1. Conduct hydrostatic testing in accordance with AWWA C600.
 - a. Conduct tests on each line or valved section of line.
 - b. Clean and flush line of dirt and foreign material.
 - c. Do not perform hydrostatic tests until at least five days after installation of concrete thrust blocking.
 - d. Test pressures shall be 150 psi based on the elevation of the lowest point of the section under test and corrected to the elevation of the test gauge.
 - e. Slowly fill main in order to expel air from the main through the air release valves or other appurtenances.
 - f. Tests are to be conducted in the presence of a representative of the Department and the Design Engineer.
2. Pressure tests:
 - a. Pressure leakage test must be conducted in accordance with AWWA C600. Each section of the pipeline shall be subjected to and successfully meet a pressure test of 150% of its working pressure, but not less than 150 psi. The line shall be slowly filled with water and all air expelled through the air valves or other means.
 - b. A suitable test pump, furnished by the Contractor, shall be connected to the line by means of a tap in the line, and the proper test pressure slowly applied to the line. The test pressure shall be maintained for at least two (2) hours. Leaks, if found shall be immediately repaired.

The Department representatives must be on site to witness the test.
No leaks will be allowed.

- c. Open and close each valve within the section being tested several times during the test period.
- d. Replace cracked pipe, defective pipe, and cracked or defective joints, fittings and valves with new material and repeat the test until results are satisfactory.

3. Leakage test:

- a. Conduct leakage test after the pressure has been satisfactorily completed.
- b. Duration of each leakage test: minimum of two (2) hours.
- c. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

- 1) No piping installation will be accepted until the leakage is less than the number of gallons per hour as determined by the appropriate formula below:

Ductile Iron Piping:

$L = 0.000007 SD \times \text{sq. root of } P$; where

L = allowable leakage in gallons per hour;

S = length of pipe tested in feet;

D = nominal diameter of pipe in inches; and

P = average test pressure psi gauge.

PVC Piping:

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

L = allowable leakage (gals./hr.)

N = # of joints in pipeline being tested

D = diameter of pipe (inches)

P = average test pressure (psig)

- 2) When testing against closed metal seated valves, an additional leakage per closed valve of 0.0078 gallons per hour per inch of nominal valve size may be allowed.

- 3) Should any test of pipe disclose leakage greater than that specified above, locate and repair the defective joint or joints until the leakage is within the specified allowance.
- 4) **DCWS reserves the right to require that no measureable leakage be allowed during the pressure test.**

U. DISINFECTION

1. Conduct disinfection in accordance with AWWA C651 before being placed in service.
 - a. Upon completion of testing, disinfect all water lines to meet requirements of the South Carolina Department of Health and Environmental Control.
 - b. Newly laid valves or other appurtenances shall be operated several times while line is filled with chlorinating agent.
 - c. Should initial treatment fail to meet results specified, repeat procedures until satisfactory results are obtained.
2. Procedure:
 - a. Flush line to extent possible with available pressure and outlets, prior to disinfection.
 - 1) Hydrant openings required to produce proper flushing velocity at 40 psi are:

Pipe Size (Inches)	Hydrant Openings
6 through 12	one 2 ½"
14 through 18	two 2 ½"
20	one 4 ½"

- b. Apply chlorine as liquid chlorine and chlorine compound such as calcium hypochlorite with known chlorine content. Water from the existing distribution system or other source of supply should be controlled so as to flow slowly into the newly laid pipeline during the application of chlorine.
- c. Apply through corporation cock in top of main, at beginning of section being sterilized.
- d. Use proper feeder and flow regulator to introduce chlorinating agent.

- e. Application rate shall be not less than 50 ppm.
- f. Retain chlorinated water in main not less than 24 hours.
- g. At end of retention period, at least 10 ppm of chlorine shall remain in the water at the extreme end of section.
- h. Flush the system with potable water and the sampling program begins.

3. Acceptance:

- a. Provide two (2) separate samples for each sample location, taken at 24 hour intervals, free of coliform bacteria. The Contractor working with the developer shall pull the water samples to SCDHEC specifications and provide the Department and Engineer with copies of the water sample reports with chain of custody.
 - 1) Prior to sampling, the chlorine residual must be reduced to normal system residual levels or be non-detectable in those systems not chlorinating.
 - 2) If the non-coliform growth is greater than eighty (80) colonies per one hundred (100) milliliters, the sample result is invalid and must be repeated.
 - 3) Contractor to take first and second samples, deliver to South Carolina Department of Health and Environmental Control (SCDHEC) approved laboratory for testing with the registered professional engineer's letter of certification. The Contractor shall furnish all necessary pipe or hose extension or transportation to the point of use and shall exercise care in the use of water.
 - 4) The first and second sample results shall include the free chlorine residual at the time the samples were collected.
 - 5) Notify the Department/SCDHEC to take a third sample.
 - 6) If the membrane filter method of coliform analysis is used, non-coliform growth must also be reported.
- b. At a minimum, sample locations shall be as required by SCDHEC and the following:
 - 1) The tie-in location of new and existing water lines.

- 2) The end of all dead end lines.
 - 3) At intervals of no more than 1,200 feet for all new lines longer than 1,200 feet in length.
- c. All sample locations are to be given an identifying label and a corresponding identification label is to be included on the record drawings indicting each sample location.

V. DECHLORINATION OF CHLORINATED DISINFECTION WATER

1. Dechlorinate the chlorinated water used for disinfected water lines to meet requirements of the South Carolina Department of Health and Environmental Control.

W. OPERATION OF DEPARTMENT VALVES AND HYDRANTS

1. No Department valve or hydrant shall be opened by the contractor without prior approval of the Department.
2. All hydrant and blowoff operations shall be done in a manner so that there is no impact to private property and there is no flooding of streets or roadways or any other traffic problems created.
3. The Contractor shall monitor pressure on the existing main to insure operating pressure is maintained.

X. ASPHALT PAVEMENT

1. Applicable Standards
 - a. All construction, repair, and resurfacing of asphalt pavement shall be conducted in accordance with South Carolina Department of Transportation Standard Specification for Highway Construction.
2. Guarantee
 - a. The Developer and Contractor shall guarantee all pavement work and repair completed incidental to the installation of the water distribution system for a period of two (2) years following acceptance by the Department, and shall repair or replace, at no cost to the Department, any pavement or pavement repair which crumbles, cracks, settles, or is otherwise unsound or unacceptable during this two (2) year period.

SECTION 8

WATER DISTRIBUTION SYSTEM FIRE HYDRANTS

SECTION 8

WATER DISTRIBUTION SYSTEM

FIRE HYDRANTS

A. GENERAL

1. Comply with the local Fire Code.
2. Fire hydrant spacing:
 - a. The Department reserves the right to require additional fire hydrants to provide the maximum and most efficient emergency fire protection response time to customers.
3. Fire hydrant leads to be a minimum of 6" diameter DIP. Larger size mains will be required as necessary to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure. A hydrant control valve shall be installed on all hydrant leads.
4. Fire hydrants must be provided with a gravel pocket or dry well. Hydrant drains must not be connected to or located within ten (10) feet of sanitary sewers [R.61-58.4(D)(9)(ii)].
5. No privately owned fire hydrants will be permitted.
6. Conform to Section C of the AWWA Standards.

B. CONSTRUCTION

1. Compression type, opening against pressure and closing with pressure, comply with ANSI/AWWA C502 dry-barrel fire hydrants, existing national standards and ANSI B26.
2. Waterway valve opening, 5 ¼" with EPDM main valve. Minimum 200 psi working pressure.
3. Six inch (6") bell connection, two (2) 2 ½" hose connections, one (1) 4 ½" pumper nozzle with mechanical removal feature, set screw, lock ring, etc., and shall conform to existing national standard specifications and ANSI B26, but will not have chains attaching the hydrant clip to the upper barrel.
4. National Standard screw threads on outlet nozzles.

5. Open by turning counter clockwise, with arrow cast in top indicating direction of opening.
6. Two part breakable safety flange shall be an integral part of barrel casting at least 2" above bury line.
7. Barrel lengths shall generally be for 3'6" bury.
8. Interior shall be two (2) part thermosetting, or fusion bonded, coated holiday free to a minimum thickness of 4 mil conforming to AWWA C550 protective interior coatings for valves and hydrants.
9. Exterior coating shall be as follows:
 - a. Hydrant barrel, operating nut and nozzle caps will be painted Industrial Safety Red enamel or epoxy coated.
 - b. Weather cap (bonnet) and arm caps will be painted white.
 - c. The ring of the weather cap (bonnet) will be painted in accordance with the level of service color code as shown below:

Color	Level of Service
Light Blue	1,500 GPM or greater
Green	1,000 to 1,499 GPM
Orange	500 to 999 GPM
Red	Less than 500 GPM
Black	For drafting use only
White Cross on top	For filling tankers only

When the level of service is near a dividing point, the lower level of service shall be marked unless otherwise approved by the Department.

- c. Exterior hydrant parts below ground will be asphaltic or epoxy coated.
10. Provide one (1) hydrant wrench for each ten (10) hydrants. Provide at least one hydrant wrench.
11. An all bronze seat ring shall thread directly into an all bronze drain ring or heavy bronze bushing located between the lower hydrant barrel and shoe securely retained in this position, or it may be threaded into a heavy bronze bushing in the hydrant shoe. Drain rings cast into iron body are not acceptable.

12. All bronze or brass internal working parts in contact with service water are to be maximum 16% in zinc content and 79% minimum in copper.
13. Acceptable product: Mueller Company (Super Centurion A-423), American AVK Model 2780, or American Darling (B-84-B).

C. FIRE HYDRANT REFLECTOR

1. Provide industry standard blue hydrant reflector for paved roadway - South Carolina Department of Transportation approved.

D. FIRE HYDRANT OFFSET FITTING

1. Locate between the shut-off valve and each hydrant where required to match finished grade.
2. Provide a 12" offset.
3. Provide Grade Lok as manufactured by Assured Flow Sales, Inc., or approved equal.

E. INSTALLATION OF HYDRANTS

1. General:
 - a. Inspect carefully, insuring that all foreign material is removed from the barrel. Inspect materials upon receipt for damaged or missing items. Store rubber gaskets under cover out of direct sunlight. Do not store nuts, bolts, glands, and other appurtenances directly on the ground. Keep interiors free of dirt and debris.
 - b. Hydrants shall be carefully handled, cleaned and checked for operation prior to backfilling. Care shall be taken to insure that no dirt, rock and other obstacles that would interfere with the operation are left in the hydrant. The Contractor will provide proper anchorage to fire hydrant installations by means of retainer glands.
 - c. Rotate Grade Lok fitting so hydrant is plumb and at the elevation detailed, or install extension kit as necessary to position the bury line at grade.
 - d. Install stone drainage bed and thrust blocking. Insure the weepholes in hydrant boot are not obstructed.
 - e. Fully open and close each hydrant to assure that all parts are in working condition.

- f. Install blue hydrant reflector on centerline of paved roadway marking the perpendicular location of hydrant with reference to the road centerline.
- g. Paint fire hydrant according to the Department's current standards.
- h. Install with breakaway flange at a minimum of 2" above finished grade.

F. QUALITY ASSURANCE

- 1. Reference Standards of the American National Standards Institute (ANSI).
 - a. A21.11 Rubber gasket joints for cast iron and ductile iron pressure pipe and fittings (AWWA C111).
 - b. B16.1 Cast iron pipe flanges and flanged fittings, Class 25, 125, 250, and 800.
- 2. Reference Standards of the American Water Works Association (AWWA).
 - a. C600 Installation of Ductile Iron Water Mains and Appurtenances
 - b. C601 Disinfecting Water Mains
 - c. C502 Dry-Barrel Hydrants
 - d. C509 Resilient Seated Gate Valves
- 3. Acceptable Manufacturers
 - a. Joint Material
 - 1) Connections between the hydrant and the water main shall be mechanical joint with retainer glands and conforming to ANSI/AWWA Rubber Gasket Joints for Grey-Iron and Ductile and C111/A21.11 Iron Pressure Pipe and Fittings.
 - b. Other Requirements
 - 1) Hydrants shall have a 6" mechanical joint connection with a 53" main valve. EPDM rubber will be specified on all hydrants and hydrant replacement parts to guard against chloramine deterioration.

- 2) Hydrants shall have a 1 ½" pentagon shaped operating stem nut and shall open "Left" (counter clockwise) unless otherwise specified.
- 3) Hydrants shall have a 250 psi minimum working pressure, factory tested to a minimum of 500 psi.
- 4) Hydrants shall have a traffic breakaway feature.
- 5) Retaining bolts of shoe to lower barrel shall be 316 stainless steel.
- 6) Upper assembly shall be provided with a grease or oil reservoir that automatically lubricates all operating stem threads and bearing surfaces each time of operation. The system shall be completely sealed from waterway and external contaminants. The reservoir is to have an external filler point that does not require dismantling any portion of the hydrant during regular maintenance and all hydrants are to be completely lubricated with food grade product prior to leaving the factory.
- 7) Exterior casting shall indicate type, design, date, and location of manufacture.

- 8) All fire hydrants shall be tested to 500 psi test pressure before shipping.
- 9) Upper and lower main stem rods shall be stainless steel.
- 10) The Department shall perform a post-construction fire flow test on all newly installed fire hydrants and report static, residual, and Q_{20} data prior to issuing a letter accepting operation and maintenance of the system.

SECTION 9

WATER DISTRIBUTION SYSTEM BACKFLOW PREVENTION

SECTION 9

WATER DISTRIBUTION SYSTEM

BACKFLOW PREVENTION

A. REDUCED PRESSURE PRINCIPLE (RP) BACKFLOW PREVENTER

1. General:
 - a. $\frac{3}{4}$ " through 2": Use Febco Model 825Y reduced pressure backflow preventer, or approved equal.
 - b. $2\frac{1}{2}$ " through 10" On services other than unmetered fire services, use Febco Model 825YD reduced pressure backflow preventer, or approved equal. On unmetered fire services, use Febco Model 826YD or approved equal. Backflow preventers on unmetered fire services must have a detector check.
 - c. Must be on the approved list published by SCDHEC and tested by a certified tester before placing into service. Provide two (2) copies of the test results to the Owner and one (1) copy to the Department.
 - d. Bypasses not allowed unless equipped with an equal backflow protection.
 - e. High hazard category cross connections, as defined by SCDHEC, shall require an air gap separation or an approved reduced pressure backflow preventor.
 - f. All piping must be AWWA and ANSI/NSF standard 61 approved.
2. $\frac{3}{4}$ " through 2" reduced pressure backflow preventers to consist of the following:
 - a. Two (2) independently operating, spring-loaded, "Y" pattern check valves and one (1) hydraulically dependent differential relief valve.
 - b. Designed to automatically reduce the pressure in the zone between check valves to at least 5 psi lower than inlet pressure.
 - c. The differential relief valve will open and maintain proper differential should differential between upstream and the zone drop to 2 psi.

- d. Mainline valve body and caps including relief valve body and cover to be Bronze, ASTM B584-78.
 - e. Center stem guided check valve moving member.
 - f. All springs to be stainless steel, 300 series.
 - g. Internally locate all hydraulic sensing passages within mainline relief valve bodies and relief valve cover.
 - h. Diaphragm to seal area ratio to be 10:1 minimum, nitrile, fabric reinforced.
 - i. Removable seat ring on relief valve.
 - j. Construct check valve and relief valve components so they may be serviced without removing the valve body from the line.
 - k. Reversible, nitrile ASTM D-2000 seats.
 - l. Full ported ball valves for shut-off valves and test locks.
 - m. Rate assembly to 175 psi water working pressure and water temperature range from 32°F to 180°F
 - n. Assemblies to meet requirements of ASSE Standard 1013; AWWA Standard Code C511-92, or latest revision; and USC Foundation of Cross Connection Control and Hydraulic Research, latest edition.
3. 2 ½" through 10" reduced pressure backflow preventers to consist of the following:
- a. Two (2) independent "Y" configured check valves and one (1) differential relief valve.
 - b. To automatically reduce pressure in zone between check valves. Should differential between zone and upstream pressure drop to 2 psi, differential relief valve will open, maintaining proper zone differential.
 - c. Series 300 stainless steel internal parts containing no dissimilar metals.

- d. Reversible elastomeric seat discs on check valves and relief valves. Seat rings to be B-61 Bronze or Series 300 stainless steel.
 - e. Check assembly to be center stem guided at seat ring with replaceable non-corrosive bushings at the cover.
 - f. Series 300 stainless steel relief valve spring.
 - g. Design with ductile iron ASTM A-536, Grade 65-45-12 valve bodies and cover to withstand a 10:1 safety factor over rated cold water working pressure.
 - h. Flanged ductile iron bodies, ANSI B16-1, Class 125, epoxy coated internally 10-20 mils.
 - i. Locate all orifices of the pressure sensing passages out of the normal debris flow path or settling areas.
 - j. Copper, ASTM B-280 external sensing tubing.
 - k. Assemblies must be flanged, full port resilient wedge shut-off valves and four vandal resistant ball valve test cocks, integral to assemblies.
 - l. Factory-assemble and backflow test all assemblies.
 - m. Construct assemblies so all internal parts, including seat rings, can be serviced from the top or side removed while assemblies are in line.
 - n. Assemblies to be rated 175 MWWP (32°-140°F).
4. Other RP backflow preventers may be considered by the Department if they are approved by the USC-Foundation for Cross-Connection Control and Hydraulic Research and SCDHEC and they can be tested.

B. DOUBLE-CHECK BACKFLOW PREVENTER

- 1. General:
 - a. 2 ½" through 10": On services other than unmetered fire services, use Febco Model 805YD double-check backflow preventer, or approved equal. On unmetered fire services, use Febco Model 806YD or approved equal. Backflow preventers on unmetered fire services must have a detector check.

- b. Must be on the approved list published by SCDHEC and tested by a certified tester before placing into service. Provide two (2) copies of the test results to the Owner and one (1) copy to the Department.
 - c. Bypasses not allowed unless equipped with an equal backflow protection.
 - d. All piping must be AWWA and ANSI/NSF standard 61 approved.
2. 2 ½" through 10" double-check backflow preventers to consist of the following:
- a. Two independent "Y" configured check valves.
 - b. Must be spring-loaded, center stem guided type.
 - c. Series 300 stainless steel internal parts.
 - d. Elastomeric seat disc must be reversible.
 - e. Bronze, ASTM B-61 or series 300 stainless steel seat rings bolted to valve bodies incorporating an o-ring to facilitate field removal and replacement.
 - f. Guide double-check assemblies at the seat ring and at the cover by replaceable non-corrosive bushings to assure positive check seating.
 - g. Head loss through assemblies not to exceed 5.5 psi at velocities from 0, up to and including 7.5 fps.
 - h. Document flow curves by independent laboratory testing.
 - i. Design ductile iron ASTM A536, Grade 65-45-12 valve bodies and cover to withstand 10:1 safety factor over rated cold water working pressure.
 - j. Ductile iron bodies flanged, ANSI B16-1, Class 125, epoxy coated internally 10-20 mils. and prime coated externally.
 - k. Assemblies to include flanged, full port resilient wedge shut-off valves and four vandal-resistant full port ball valve test cocks, considered integral to assemblies.
 - l. Factory-assemble and backflow test all assemblies.

- m. Construct double-check assemblies so all internal parts, including seat rings, can be serviced while in line.
 - n. Assemblies to be rated 175 MWWP (32°-140°F).
 - o. Assemblies to meet requirements of ASSE Standard 1015; AWWA Standard Code C510-92, or latest revision; and USC Foundation of Cross Connection Control and Hydraulic Research, latest edition.
3. Other double check valve backflow preventers may be considered by the Department if they are approved by the USC-Foundation for Cross-Connection Control and Hydraulic Research and SCDHEC and they can be tested.

C. INSTALLATION OF REDUCE PRESSURE PRINCIPLE BACKFLOW PREVENTER

1. General:
- a. Minimum clearance of 12" and a maximum clearance of 30" between port and floor or grade.
 - b. Install where no discharge is objectionable and can be positively drained away.
 - c. Must be easily accessible for testing and maintenance and protected from freezing.
 - d. Eliminate excessive pressure situations to avoid possible damage to system and assemblies.

D. INSTALLATION OF DOUBLE-CHECK BACKFLOW PREVENTER

1. Maintain adequate clearance and easy accessibility for testing and maintenance.

SECTION 10

GRAVITY SANITARY SEWER SYSTEM DESIGN GUIDELINES

SECTION 10

GRAVITY SANITARY SEWER SYSTEM

DESIGN GUIDELINES

A. GENERAL

1. The following sanitary sewer system design guidelines are based on Federal, State and local health requirements and the Department engineering design criteria.
2. These design guidelines are applicable to all developments including but not limited to residential, commercial and industrial developments, subdivisions and/or parks requiring sanitary sewer service from the Department.

B. GRAVITY SEWER SYSTEM DESIGN CRITERIA

1. Minimum main line size: 8".
2. Service lines:
 - a. Minimum size: 6".
 - b. A 6" service line may serve up to two residential units or one non-residential building.
 - c. 8" or larger service lines shall connect to a manhole.
3. Minimum pipe slope:
 - a. Minimum main line design slope:
 - 1) 8-inch: 0.40%
 - 2) 10-inch: 0.30%
 - 3) 12-inch: 0.22%
 - 4) 15-inch: 0.15%
 - 5) 18-inch: 0.12%
 - 6) 21-inch: 0.10%
 - 7) 24-inch: 0.08%
 - b. Main line slope in as-constructed conditions shall meet minimum SCDHEC requirements.
 - c. Service lines:
 - 1) 6-inch: 0.5%

2) 8-inch: 0.4%

- h. Main line runs through a residential lot or is to be in close proximity to an existing or proposed building.

C. CAPACITY DESIGN

- 1. Comply with the unit contributory loading criteria, Appendix A of the South Carolina Department of Health and Environmental Control Standards for Wastewater Facility Construction: R.61-67 to determine average daily flow except that residential units shall not be greater than 250 gallons per day (GPD).
- 2. Minimum peak factor shall be 2.5.

D. INFILTRATION

- 1. Maximum infiltration: 100 gallons per inch of pipe diameter per mile per day.

E. SEWER PIPES

- 1. Straight alignment.
- 2. Depth adequate to receive wastewater from the lowest service and prevent freezing.
- 3. Sewers on 20% slopes or grater shall be anchored securely with concrete anchors or approved equal spaced per DHEC standard.
- 4. Where a smaller sewer joins a larger one, match the crowns of each.
- 5. Service laterals: Locate one (1) foot from property pin from opposite corner of water service lateral.
- 6. Locate sewer mains and manholes outside of paved roadway where possible. If manholes must be in paved areas, manholes are to be located and the cones rotated so that the lids are in a parking area or centered in a driving lane.

F. SEPARATION OF WATER MAINS AND SEWERS

- 1. Where possible, locate sewer pipe at least ten (10) feet away, horizontally, from water lines.
- 2. Should ten (10) feet separation not be practical, then the sewer pipe may be located closer provided:

- a. It is laid in a separate trench.
 - b. It is laid in the same trench with the water main located at one side on a bench of undisturbed earth.
 - c. In either of the above cases, crown elevation of the sewer pipe shall be at least 18" below invert elevation of water line.
3. Where sewer pipes cross over or under water lines, maintain 18" minimum clearance between outside edges of the two pipes.

G. COVER

1. Provide suitable cover on all lines. Minimal cover depth as follows:
 - a. Less than 8" diameter: 30".
 - b. 8" and above: 36".
 - c. All piping located within the right-of-way of the South Carolina Department of Transportation and Dorchester County shall have a cover of 48" below the crown of the road when installed within the limits of the paved roadway, 36" cover when installed in the shoulder of right-of-way and a minimum of 18" separation under the design invert of drainage structures. The greater dimension of the above shall dictate minimum depth where applicable. Any other requirements of SCDOT or Dorchester County shall be met.
 - d. Special conditions other than those listed above may be approved if requested in writing from the Department.

H. DUCTILE IRON PIPE LOCATIONS

1. Use ductile iron pipe as follows:
 - a. Where sewer lines cross over water mains, the sewer main shall transition to ductile iron pipe. A full length of ductile iron pipe shall be installed in the sewer main centered so that each joint is equidistant from the water main. Joint of ductile iron pipe water main shall also be installed so that each joint is equidistant from the ductile iron pipe section of the sewer main.
 - b. Crosses beneath storm drainage pipe with less than three (3) feet of clearance.
 - c. Crosses above a storm drainage or other pipe with less than 18" of clearance.
 - d. Crosses creeks, rivers and other water bodies.
 - e. Cover is less than minimum as in Part G above.
 - f. Cover is greater than 16'.
 - g. Main line is under pavement.

- h. Main line runs through a residential lot or is to be in close proximity to an existing or proposed building.
- i. The Department reserves the right to require ductile iron pipe in specific locations.
- j. The Department may allow C900 PVC in lieu of DIP in c, d, f, g, and h above and where a sewer line crosses under a stormdrain with more than 18 inches of cover.

I. MANHOLES

- 1. Maximum manhole spacing: 400 feet.
- 2. Minimal angle between sewer mains intersecting at manhole: 90°.
- 3. Manhole top elevations:
 - a. One (1) foot above the fifty year flood elevation where possible.
 - b. If located lower than fifty year flood elevation, use water tight ring and cover.
- 4. Use outside drop manholes where the difference in incoming and outgoing pipe elevation is two (2) feet or greater. Inside drops may be considered on a case by case basis.

SECTION 11

GRAVITY SANITARY SEWER MATERIALS FOR CONSTRUCTION

SECTION 11

GRAVITY SANITARY SEWER

MATERIALS FOR CONSTRUCTION

A. GENERAL

1. Unless otherwise noted or approved by the Department all materials shall be manufactured in the United States.

B. PIPE AND FITTINGS

1. Pipe Size and Type Selections
 - a. On depths of 1' to 3' use DIP.
 - b. On depths of 3' to 16' use PVC SDR-26 minimum.
 - c. On depths of 16' and greater use DIP or C900 PVC.
2. Ductile-iron pipe and fittings (DIP):
 - a. Ductile iron pipe and fittings shall be not less than the thickness Class 50; and for fittings, shall be pressure Class 150, meeting the requirements of ANSI A21.50 (AWWA C150) and of ANSI A21.51 (AWWA C151) with a standard outside coating of coal tar or asphalt base material and inside lining of an approved material. Pipe shall have push-on-joints, mechanical joints, flanged joints, or restrained joints as required. Pipe joints including gaskets shall meet the requirement of ANSI A21.11 (AWWA C111). Fittings shall meet the requirements of ANSI A21.10 (AWWA C110).
 - b. Use wall thickness in accordance with Section 12 for depth and bedding conditions.
 - c. Use fittings with pressure rating of 150 psi: ANSI/AWWA C110/A21.10.
 - d. Lining:
 - 1) Amine cured Novalac Epoxy polymeric lining, 40 mils nominal thickness.
 - 2) Acceptable products:

- a) Protecto 401 by Vulcan Painters, Birmingham, Alabama. 40 mils nominal thickness.
 - e. When transition is required from PVC sewer main to ductile iron pipe sewer main, mechanical joints will be used. No Fernco will be allowed.
 - f. All DIP gravity line installations shall also include the installation of an electronically or magnetically detectable safety tape buried directly over the pipe 12" below the ground surface continuously. The tape shall be at least 2" wide, be green on top, and be boldly labeled every 18" to 32" as follows "CAUTION SEWER LINE BURIED BELOW". The tape shall have a tensile strength of not less than 4000 psi, a dart impact strength of not less than 120 grams per 1.5 mils, be not less than 0.0055" thick, and include sufficient metal to allow easy detection at the above stated depths. The tape shall be designed to last as long as the pipe it is installed over, even in adverse soils.
3. Polyvinyl chloride pipe and fittings (PVC):
- a. PVC gravity sewer pipe and fittings shall conform to the requirements of ASTM specifications D3034. Wall thickness shall be SDR26. Saddle type fittings shall not be used.
 - b. All PVC gravity line installations shall also include the installation of an electronically or magnetically detectable safety tape buried directly over the pipe 12" below the ground surface continuously. The tape shall be at least 2" wide, be green on top, and be boldly labeled every 18" to 32" as follows "CAUTION SEWER LINE BURIED BELOW". The tape shall have a tensile strength of not less than 4000 psi, a dart impact strength of not less than 120 grams per 1.5 mils, be not less than 0.0055" thick, and include sufficient metal to allow easy detection at the above stated depths. The tape shall be designed to last as long as the pipe it is installed over, even in adverse soils.
4. General Information
- a. All materials used in the construction of sewers shall be new and unused when delivered on-site and shall be suitable for installation and operation under the conditions for which they are to be used.
 - b. Casing pipes shall be installed at:
 - 1) Railroad crossings, as directed by the railroad;
 - 2) highway crossings, as directed by SCDOT, or;

3) as designated by the Department.

- c. No sewer line of any type shall be allowed to pass through any storm drainage structure.

C. MANHOLES

1. Use precast manholes:

- a. Comply with ASTM C478.
- b. Portland cement: ASTM C150, Type II, 4,000 psi and absorption shall not exceed 6%.

c. The minimum wall thickness of the manhole riser sections shall be:

4' Diameter	5"
5' Diameter	5"
6' Diameter	6"

Cone sections shall have a minimum wall thickness of 8" at their top.

- d. Monolithic base slab with walls. Bottoms cast with invert and bench are acceptable.

Minimum thickness of bottom:

4' diameter	6"
5' and 6' diameter	8"

- e. Flat slab top sections: HS-20 traffic loadings.
- f. Suitable openings for inlet and outlet sewer pipe shall be cast into the base sections and into riser sections for drop connections. These openings shall be circular, accurately made, and located as required for each manhole. Base riser sections shall be set on compacted #57 stone, 12" in thickness.
- g. Provide flexible pipe boot conforming to ASTM C923m. Attach boot to piping with dual stainless steel straps.

- h. The manhole sections may be jointed with either O-ring seals or butyl rubber type sealer. If O-rings are used, they shall conform to ASTM C443 and shall be set in a rectangular groove cast into the tongue section of each manhole. O-rings shall be installed as recommended by the manhole manufacturer. If butyl rubber sealer is used it shall be "Ram-Nek" joint sealer or equal. "Ram-Nek" shall be set on only clean and dry surfaces and placed as recommended by the manufacturer.

In both cases, after manhole sections are joined, the inside of the joint shall be covered with a smooth tapered coat of premixed non-shrink grout to a thickness of ½" at the joint.

- i. Manhole inverts shall be constructed of cement grout 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 to flow through the sewer shall be made to a true curve with as large a radius as the size of the manhole will permit. Concrete brick will be used only to form the invert channel walls. All other annular space shall be filled with non-shrink concrete grout. No fillers such as broken block, gravel, sand, or excavated material, is allowed in the construction of fillets (benches). Inverts shall be "U" design with top of "U" even with b the diameter of pipe. Invert piping shall not extend inside manhole any further than 2". The slope of the invert benches shall provide a minimum of 2" higher than the crown of the pipe. When dissimilar pipe size occur, the elevation of the crown of the pipes must be the same.
- j. Manhole sections shall be free from large honeycomb, cracks, spalds, large chips, exposed reinforcing, and broken bells or spigots. Allowable deviation in form joints shall be ¼". Edges of bells and spigots shall be even and straight.
- k. Size lift holes and inserts for a precision fit with the lift devices.
 - 1) Do not penetrate through the manhole wall.
 - 2) Comply with OSHA Standard 1926.704.
- l. Provide flat slab tops where manhole depth is less than 4'-0".

m.

<i>Standard Manholes Schedule of Governing Dimensions</i>	
Pipe Size	Manhole Diameter
8" to 15"	4' - 0"
16" to 30"	5' - 0"
36" to 42"	6' - 0"

2. Exterior joint collar:

- a. Install an exterior joint collar on all manhole joints.
- b. Provide a 12" wide band.
- c. Acceptable product: Seal Wrap Exterior Joint Sealer by Mar-Mac Manufacturing Company.

3. Frames and covers:

- a. Manhole cover and frame shall be PAMREX or approved equal. Cover and frame shall be manufactured from Ductile Iron in a foundry fully certified under the requirements ISO 9000:2000. Product design will require that covers are hinged and incorporate a 90-degree blocking system to prevent accidental closure. Cover will allow automatic release of back pressure. Frame shall come complete with an open hinge box and a hinge infiltration plug. Covers shall be one-man operable using standard tools and shall be capable of withstanding a test load of 120,000 lbs. Covers shall be capable of receiving a retrofit badge through use of a punchout design. Frames shall be circular and shall incorporate a seating ring capable of withstanding surface water inflow and absorbing shock from routine traffic. Product will be available in a 24-inch clear opening. The frame depth shall not exceed 4 inches, and the flange shall incorporate bedding slots and bolt holes. All components shall be black coated. Frame weight: 73 lbs. Cover weight: 122 lbs. Total weight: 195 lbs. All product shall meet the requirements of EN124:1994.
- b. Leveling and final grading of manhole frames and covers shall be accomplished by using a maximum of two (2) 4" concrete grade rings or one (1) 6" grade ring. Use cement brick for adjustments less than

4". The total number of grade rings shall not exceed 8" in thickness. Grade rings and cement brick shall be laid in a full bed of non-shrink grout and covered after laying with a smooth coating of non-shrink grout or hydraulic cement a minimum of ½" thick.

- c. After the manhole has been set in its final position, the ductile iron frame for the cover shall be carefully set above finished grade and properly bonded to the masonry with non-shrinking cement grout or hydraulic cement. Where manholes are constructed in paved areas, sidewalks, etc., 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.
- d. Locking kits will be required unless approved otherwise by the Department.

5. General

- a. All manholes over 12' deep shall be reviewed during design with the Department.
- b. Where the difference in the invert elevation between an intersecting sewer and a manhole is 2' or more, a drop manhole shall be constructed. 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. Inside drop can be considered on a case by case basis.
- c. Where the work requires special stream or railroad crossings or other extraordinary conditions, or where alternate types of construction that are not covered by these specifications, the materials and construction methods shall be submitted for approval to the Department.

D. PIPE AND MANHOLE FOUNDATION AND BACKFILL MATERIALS

1. Pipe Bedding Materials

- a. Crushed stone shall be granite, or well graded approved slag rock. Crushed stone shall be No. 57.

2. Backfill Materials

- a. Reuse of existing excavated materials will be allowed provided the materials are compactable, dried or dampened to their optimum

moisture content, are free from roots, large clods of clay, and are granular and non-cohesive in nature.

- b. Select fill shall be sand-clay, fine sand or sand gravel mixes with a maximum of 25% passing a wash #200 sieve.

3. Manhole Bedding Materials

- a. Shall be crushed stone as noted in Section D.1.a.

E. CASING, SPACERS AND END SEALS FOR UTILITIES

1. General

- a. Provide bore and jack with casing for pipes larger than 2".
- b. Casing pipe to be 2" larger in diameter than the bell of the carrier pipe based on the following:
 - 1) Casing pipe to be a minimum of 2" larger than the largest outside diameter of the carrier pipe (joints and couplings) if the carrier pipe is less than 6" in diameter. If the diameter of the carrier pipe is 6" or larger, the diameter of the casing pipe shall be a minimum of 4" larger than the largest outside diameter of the carrier pipe (joints and couplings).
 - 2) The end of casing pipe to extend a minimum of six (6) feet from the edge of pavement/back of curb.
 - 3) The top of the casing pipe shall be a minimum of four (4) feet below the crown of the finished asphalt roadway.
 - 4) The top of the casing pipe shall be a minimum of two (2) feet below the design invert of roadside drainage ditches and pipes.

2. Casing pipe for dry bores

- a. Steel complying with ASTM A139 for Grade B with minimum yield strength of 35,000 psi.
- b. Provide ends suitable for field welding.
- c. Minimum wall thickness as follows:

<u>Diameter of Casing</u> (Inches)	<u>Minimum Wall Thickness</u> (Inches)
6 thru 14	1/4
16 and 18	5/16
20 and 22	3/8
24 and 26	7/16
28 thru 32	1/2
34 thru 42	9/16
44 thru 48	5/8
50 thru 54	3/4

3. Pipeline casing spacers

- a. Provide pipeline casing spacers for piping installed in casing.
- b. Provide a minimum of one spacer per ten linear feet of pipe for ductile iron pipe and a minimum of one spacer per six linear feet for PVC pipe.
- c. Provide spacer with shell of 14 gauge Type 316 stainless steel.
- d. Provide shell liner of .090" thick PVC, 85-90 durometer.
- e. Provide 5/16" stainless steel connecting bolts and lock nuts, minimum three (3) per flange.
- f. Runners from 2" wide ultra high molecular weight polymer with a high resistance to abrasion and a coefficient of friction of 0.11-0.13 in accordance with ASTM D-1894.
- g. Support runners on 14 gauge reinforced Type 316 stainless steel risers welded to shell.
- h. All metal surfaces to be fully passivated.
- i. The diameter as measured over the runners shall exceed the pipeline bell or coupling outside diameter.
- j. Acceptable product: Cascade Manufacturing or approved equal.

4. End seals

- a. Seal each end with brick and mortar to prevent the entrance of foreign material.

SECTION 12

GRAVITY SANITARY SEWER SYSTEM CONSTRUCTION PROCEDURES

SECTION 12

GRAVITY SANITARY SEWER SYSTEM

CONSTRUCTION PROCEDURES

This section covers construction procedures normally required for work. It does not cover any special construction procedures which may be encountered for abnormal conditions.

Special construction procedures are to be presented to the Department by the Developer's Design Engineer.

A. HANDLING OF MATERIALS

1. Storage and handling shall be in accordance with manufacturers recommendation.
2. Storage of PVC pipe:
 - a. Store in unit packages as received from manufacturer until just prior to use.
 - b. Stack units to prevent deformation to pipe barrel and bells.
 - c. Protect from direct sunlight by covering with opaque material.
3. Avoid severe impact blows, gouging or cutting by metal surfaces or rocks.
4. Handle pipe so as to ensure delivery to the trench in sound, undamaged condition.
 - a. Carry pipe into position - do not drag.
 - b. Use pinch bars or tongs for aligning or turning the pipe only on the bare end of the pipe.
 - c. Use care not to injure pipe linings.
5. Thoroughly clean interior of pipe and accessories before lowering pipe into trench. Keep clean during layout operations by plugging or other approved method.
6. Before installation, inspect each piece of pipe and each fitting for defects:
 - a. Replace material found to be defective before or after laying with sound material meeting the specified requirements.

7. Rubber gaskets: Store in a cool dark place until just prior to time of installation.

B. PIPE CUTTING

1. Cut pipe neatly and without damage to the pipe. Bevel pipe to ensure final homing of pipe without damage to gasket.
2. Unless otherwise recommended by the pipe manufacturer, cut pipe with mechanical cutter only.
 - a. Use wheel cutters when practical.
 - b. Cut plastic pipe square and remove all burrs.

C. LOCATING

1. Sewer lines in relation to water lines must conform to "Ten State Standards".
2. Where possible, locate sewer pipe at least ten (10) feet away, horizontally, from water lines.
3. Should ten (10) foot separation not be practical, then the sewer pipe may be located closer provided:
 - a. It is laid in a separate trench.
 - b. It is laid in the same trench with the water main located at one side on a bench of undisturbed earth.
 - c. In either of the above cases, crown elevation of the sewer shall be at least 18" below invert elevation of water line.
4. Where water lines cross over, maintain 18" minimum clearance between crown of sewer and invert of water lines.
5. Where sewer lines cross over water mains, the sewer main shall transition to ductile iron pipe. A full length of ductile iron pipe shall be installed in the sewer main centered so that each joint is equidistant from the water main. Joint of ductile iron pipe water main shall also be installed so that each joint is equidistant from the ductile iron pipe section of the sewer main.
6. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pressure pipe, and shall be pressure tested to assure water tightness prior to backfilling.

7. Water Supply Interconnections

There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenances thereto which would permit the passage of any sewage or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

8. Relation to Water Works Structures

While no general statement can be made to cover all conditions, it is generally recognized that sewers shall meet the requirements of the appropriate reviewing agency with respect to minimum distances from public water supply wells or other water supply sources and structures.

D. INSTALLATION

1. Trench, backfill and compact for the work of this Section in strict accordance with pertinent provisions of these specifications, and the following requirement:
 - a. Maximum trench widths, depths and bedding methods.
 - 1) Install all sewers complying with tables for depths of cut and class of bedding included hereinafter.

b. Ductile-iron pipe:

MAXIMUM DEPTHS IN FEET			
			Class of Bedding
			B
PIPE SIZE	MAX. TRENCH WIDTH	CLASS OF PIPE	TYPE 1 OR TYPE 2
8"	2'2"	50	32
10"	2'4"	50	32
10"	2'4"	51	35
12"	2'6"	50	32
12"	2'6"	51	35
12"	2'6"	52	35
14"	2'9"	50	32
14"	2'9"	51	35
14"	2'9"	52	35
16"	3'0"	50	32
16"	3'0"	51	35
16"	3'0"	52	35
18"	3'2"	50	32
18"	3'2"	51	35
18"	3'2"	52	35
20"	3'6"	50	32
20"	3'6"	51	35
20"	3'6"	52	35
24"	3'10"	50	30
24"	3'10"	51	34
24"	3'10"	52	35
30"	4'7"	50	26
30"	4'7"	51	30
30"	4'7"	52	34
36"	5'5"	50	27
36"	5'5"	51	31
36"	5'5"	52	35
36"	5'5"	53	35
42"	6'1"	50	27.5
42"	6'1"	51	27.5
42"	6'1"	52	31.5

c. Polyvinyl chloride pipe (SDR35):

MAXIMUM DEPTHS IN FEET		
		Class of Bedding
		B
PIPE SIZE	MAX. TRENCH WIDTH	TYPE 2* ONLY
4"	2'0"	30
8"	2'2"	30
10"	2'4"	30
12"	2'6"	30
15"	2'10"	30
18"	3'2"	30
21"	3'6"	30

* Class B Bedding (Type 2) shall extend to the top of the pipe.

d. Bedding and tamping:

- 1) Class B (Type 1) Bedding (Ductile iron pipe only):
 - a) Shape bottom of trench to a level 2" below bottom of pipe; bring bed to proper level by spreading and thoroughly tamping fine granulated moist earth and sand to conform accurately to one-fourth circumference of pipe barrel; provide suitable material if not available from trench excavation; lay pipe, backfill and hand tamp in thin layers to height three-fourths of pipe diameter, using material same as bedding material; complete trench backfill as specified in the guidelines.
 - b) In lieu of Class B (Type 1) bedding for ductile iron pipe, Class B (Type 2) bedding may be used.

- 1) Class B (Type 2) Bedding:
 - a) Undercut 6" below pipe barrel, full width of trench; bring to grade with compacted No. 57, stone, or slag. Place stone or slag in 6-inch lifts to top of pipe. In special conditions with pipe other than PVC, No. 5 stone may be allowed.
 - b) In lieu of Class B (Type 2) bedding, fine granulated material may be used from the excavation provided that the trench is dewatered prior to excavation and a dry trench is maintained until the pipeline is completely backfilled.
 - c) Trench backfill complying with the requirements contained in the guidelines.

2. Pipe laying:

a. General:

- 1) Protect pipe during handling against shocks and free fall. Remove extraneous material from the pipe interior.
- 2) Gravity sewer pipe installation must comply with ANSI/ASTM D2321-74 as the minimum acceptable standard as well as any additional requirements as stated herein.
- 3) Before sewer pipe is placed in position in the trench the bottom and sides to the trench shall be carefully prepared as per manufacturer's specifications. Each pipe shall be accurately placed to the exact line and grade called for on the

plans. Laser equipment shall be used in setting pipe in lieu of the batter board method.

- 4) Pipe shall be laid in a full bed of crushed stone (ASTM C33, Gradation 67). Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. Pipe shall be straight when placed in the trench. Trench bottoms found to be at incorrect grade after pipe laying operations have begun shall be corrected and brought to exact line and grade.
- 5) After each line of pipe has been laid, it shall be carefully inspected and all earth, trash, rags, and other foreign matter removed from the interior.
- 6) Each joint shall be laid so that it will form a close concentric joint with adjoining pipe and so as to avoid sudden offsets.
- 7) All jointing of pipe and fittings shall be in accordance with the pipe manufacturer's recommendations.
- 8) Any leaks or defects discovered at any time after completion of the work shall be repaired immediately. All pipe in place shall be carefully protected from damage until the backfilling operations have been completed.
- 9) Water shall not be allowed to run through the pipe or stand in the trench.

b. Polyvinyl chloride pipe:

- 1) Use proper bedding as specified above.
- 2) Comply with ASTM D2321, except as otherwise specified herein.

c. Ductile-iron pipe:

- 1) Use proper bedding as specified above.
- 2) Comply with ANSI/AWWA C600, except as otherwise specified herein.

E. MANHOLES

1. Set bases level so that walls will be plumb.
2. Clean bells and spigots.

3. Apply joint sealer, or ring gasket to wall section(s), set firmly in place to assure watertight joints.
4. Connect pipe boot to piping with dual stainless steel straps.
5. Grout lift holes from the outside using non-shrink grout.
6. Install exterior joint collar.
 - a. Follow manufacturer's recommendations.
 - b. Clean the surface.
 - c. Remove the protective paper and place the band around the manhole, mastic side to the manhole and spanning the joint.
7. Form the invert channels directly in the concrete of the manhole base, with mortar and brick. Smooth the floor of the manhole outside the channels, and slope toward the channels at not less than 1" per foot nor more than 2" per foot.
 - a. Shape the invert channels to be smooth and semi-circular, conforming to the inside of the adjacent sewer section. Inverts shall be to crown of pipe.
 - b. Make changes in direction of flow with a smooth curve of as large a radius as the size of the manhole will permit.
 - c. Make changes in size and grade of channels smoothly and evenly.
 - d. Slope invert uniformly from invert of inlet to invert of outlet.
8. Match manhole top to grade utilizing concrete grade rings or cement brick as specified, maximum height 8".

F. MANHOLE COATINGS

1. Provide in manholes (new or existing) where a force main enters and in the next manhole down stream. The Department reserves the right to require coatings in additional down stream manholes.
 - a. Acceptable product for coating:
 - 1) 125 mills Raven 405 Epoxy.
 - 2) 240 mills Neopoxy NPL 5300.
 - 3) Others as approved by the Department.

b. Surface preparation:

- 1) Follow all manufacturers' recommendations for surface preparation for new or existing manholes.

G. CONNECTIONS TO EXISTING SYSTEM

1. Connections to existing manholes shall be made in the presence of the Department. The Contractor shall notify the Department 48 hours before starting a connection. All new holes in existing manholes shall be core drilled.
2. Construct new manhole over existing gravity main breaking upper half of existing pipe after base of manhole is completed so as not to obstruct flow of the existing pipe.
3. At existing manhole tie-ins, temporarily block and/or divert sewage flows, perform other miscellaneous work.
 - a) Use high-early strength cement for mortar, forming proper channels with minimum interruption to service of the existing sewer.

H. SERVICE LATERALS

1. Service laterals shall be installed where required to provide a connection from the sanitary sewer to all lots. For a single residence, the elder valve shall not be placed in a driveway or sidewalk.
2. Service laterals shall consist of 6" diameter DIP or PVC and conform to the requirements of these guidelines. A service wye shall be installed at the end of each service lateral and plugged in a manner to allow for air testing. The depth of a service shall be a minimum of 36" below finished grade, and a maximum of 60". Service laterals will not exceed 75' in length, however, laterals that are less than 20' in length on single family dwellings may be 4" in diameter with approval by the Department.
3. All sewer services shall have elder valves installed during construction and the cleanout pipe for the elder valve shall rise at least three (3') feet above grade and be capped.
4. All services that are in an area where new curb and gutter will be provided shall be marked with an "X" on the curb and gutter to mark the location of the service lateral.

5. Service laterals shall be connected at manholes whenever possible and installed so the crown of main sewer line and service lateral are the same elevation.
6. Connect to street sewers using wye branches and ells.
7. Do not stack service lines vertically over the sewer main.
8. Comply with details in the Details Section.
9. Locate service lateral within one (1) foot from property corner on opposite corner of water lateral.
10. Minimum cover required by SCDOT and the Department of service lateral is 24". SCDOT and the Department may require concrete encasement under drainage ditch on an individual review.

I. INSPECTIONS AND TESTING

1. General:

- a. The Department will require that all sanitary sewer systems pass the following test prior to acceptance: (Department shall be notified 72 hours before inspections).

2. Air Testing:

The Contractor shall conduct low pressure air tests on all completed sections of gravity sewer. The air test results will be used to evaluate construction methods on the sewer line sections.

The Contractor shall furnish an air compressor which will provide at least 300 cubic feet of air per minute at 100 psi, air hose, connection and other equipment necessary to conduct the air tests. Plugs in sewers 18" in size and larger shall be connected by cable for thrust reaction. The following provisions will be adhered to when conducting low pressure air tests:

3. Equipment

a. Plug Design

Either mechanical or pneumatic plugs may be used. All plugs shall be designed to resist internal testing pressures without the aid of 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.

b. Singular Control

To facilitate test verification by the inspecting Engineer, all air used shall pass through a single, above ground control panel.

c. Equipment Controls

The above ground air control equipment shall include a shut-off valve, pressure regulating valve, input pressure gauge, and a continuous monitoring pressure gauge having a pressure range from 0 to at least 10 psi. The continuous monitoring gauge shall be no less than 4" in diameter with minimum divisions of 0.10 psi and an accuracy of ± 0.04 psi.

d. Separate Hoses

Two separate hoses shall be used to: (1) connect the control panel to the sealed line for introducing low pressure air, and (2) a separate hose connection for constant monitoring of air pressure build-up in the line. This requirement greatly diminishes any chance for over-pressurizing the line.

e. Pneumatic Plugs

If pneumatic plugs are utilized, a separate hose shall also be required to inflate the pneumatic plugs from the above ground control panel.

4. Line Preparation

a. Laterals, Stubs, and Fittings

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. It may be necessary and is always advisable to restrain gasketed caps, plugs, or short pipe lengths with bracing stakes, clamps and tie-rods, or wire harnesses over the pipe bells.

5. Test Procedure

a. Plug Installation and Testing

After a manhole to manhole reach of pipe has been backfilled to final grade, prepared for testing, and the specified waiting period has elapsed, the plugs shall be placed in the line at each manhole and secured.

It is advisable to seal test all plugs before use. Seal testing may be accomplished by laying one length of pipe on the ground and sealing

it at both ends with the plugs to be checked. The sealed pipe should be pressurized to 9 psig. The plugs should hold against this pressure without bracing and without any movement of the plugs out of the pipe. No persons shall be allowed in the alignment of the pipe during plug testing.

It is advisable to plug the upstream end of the line first to prevent any upstream water from collecting in the test line. This is particularly important in high groundwater situations.

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. A probable point of leakage is at the junction of the manhole and the pipe, and this fault may be covered by the pipe plug, and thus not revealed by the air test.

b. Line Pressurization

Low pressure air shall be slowly introduced into the 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. Immediately before testing, if groundwater is present, the groundwater elevation must be determined by appropriate means.

c. Pressure Stabilization

After a constant pressure of 4.0 psig (greater than the average groundwater back pressures), is reached, the air supply shall be throttled to maintain that internal pressure for at least 2 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe walls.

d. Timing Pressure Loss

When temperatures have been equalized and the pressure stabilized at 4.0 psig (greater than the average groundwater back pressure), the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than 3.5 psig (greater than the average back pressure of any groundwater over the pipe). At a reading of 3.5 psig, or any convenient observed pressure reading between 3.5 psig and 4.0 psig (greater than the average groundwater back pressure), timing shall commence with a stop watch or other timing device that is at least 99.8% accurate.

A predetermined required time for a specified pressure drop shall be used to determine the lines acceptability. Traditionally, a pressure

drop of 1.0 psig has been specified. However, other pressure drop values may be specified, provided that the required holding times are adjusted accordingly. If the specified pressure drop is 0.5 psig rather than the more traditional 1.0 psig, then the required test times for a 1.0 psig pressure must be halved. Specifying a 0.5 psig pressure drop is desirable in that it can reduce the time needed to accomplish the air test without sacrificing test integrity. Therefore, the following subsections contain provisions for both the traditional 1.0 psig pressure drop and the more efficient 0.5 psig pressure drop. All requirements for a specified 0.5 psig drop are given in parentheses.

e. Determination of Line Failure

If the time shown in Table I (or Table II), for the designated pipe size and length, elapses before the air pressure drops 1.0 psig (or 0.5 psig); the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued once the prescribed time has elapsed even though the 1.0 psig (or 0.5 psig) drop has not occurred.

f. Determination of Line Failure

If the pressure drops 1.0 psig (or 0.5 psig) before the appropriate time shown in Table I (or Table II) has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.

g. Line Repair or Replacement

If the section fails to meet these requirements, the Contractor shall determine at his own expense the source, or sources of leakage, and he shall repair or replace all defective materials and/or workmanship to the satisfaction of the Department. The extent and type of repair which may be allowed, as well as results, shall be subject to the approval of Department. The completed pipe installation shall then be retested and required to meet the requirements of the test.

h. Specified Time Tables

To facilitate the proper use of this recommended practice for air testing, the following tables are provided. Table I contains the specified minimum times required for a 1.0 psig pressure drop from a starting pressure of at least 3.5 psig greater than the average back pressure of any groundwater above the pipe's invert. Table II contains specified minimum times required for a 0.5 psig pressure drop from a starting pressure of at least 3.5 psig greater than the average back pressure of any groundwater above the pipe's invert. Both Tables also include easy to use formulas for calculating required

test times for various pipe sizes and odd lengths. A series of examples are provided in the Appendix to this recommended practice that demonstrate proper use of the Tables.

6. Pipe Deflection

All PVC gravity sewer pipe, 8" diameter and larger, shall be tested after installation and backfill by the Contractor. Testing shall be performed at the Contractor's expense using a 5% mandrel acceptable to the Department to insure that initial deflection of pipe does not exceed 5%. The Mandrel pull shall be as described in the Ten State Standards. The Contractor shall not use any mechanical device in the Mandrel pull. All deflection testing shall be performed in the presence of the Engineer and Department. Contractor shall notify the Engineer and the Department in sufficient time to insure that the both will be present during deflection tests. Deflection test records shall identify the location and deflection amount at all points where deflection exceeds the specified limit. Such records shall be certified by the Contractor, and shall be furnished to the Engineer prior to acceptance and payment. Pipe with initial deflection exceeding the specified limit will be unacceptable, and shall be re-bedded to the correct deflection and retested for deflection, at the Contractor's expense.

7. Visual Inspection

All gravity sewer manholes and pipelines shall be visually inspected by the Department's Inspector prior to acceptance. Gravity sewer manholes shall be to final grade, have no visible infiltration, contain properly formed and sloped inverts, and be properly coated as outlined in previous sections. Gravity sewer pipelines shall be of uniform slope with no portion holding water. Repairs to gravity sewer pipelines shall be performed in manner equivalent to new construction. Fernco style couplings or repair bands shall not be used.

8. Camera Inspection

a. Standard

Gravity sewer mains shall be inspected using the Pipeline Assessment Certification Program (PACP) inspection standards and closed-circuit television techniques.

b. Scope of work

1. The video shall include all mainline sections from manhole to manhole from the right-of-way boundary to the mainline connection or manhole connection.

2. Video inspection shall be performed after the pipe has been laid and passed the air pressure and Mandrel tests.
3. Prior to the performing the CCTV inspection, the Contractor shall thoroughly clean the sewer mains and laterals to be inspected. After cleaning, all equipment will be removed from thesewer line(s). Just prior to performing the inspection, water is to be sent into the nearest upstream manhole until it is observed at the nearest downstream manhole. This will insure that any pipe segments with bellies are easily identified during the CCTV inspection.

c. CCTV and Equipment

1. Television inspection equipment shall have an accurate footage counter that will display on the monitor and record the camera distance from the manhole and pipe connection. Prior to the beginning of each CCTV inspection, manhole identification numbers as shown on the record drawing will be displayed in the title.
2. The camera shall be of the remotely operated pan and tilt type. The rotating camera and light head configuration shall have the capability of panning 360 degrees with tilt capability of providing a full view of the pipe to ensure complete inspection of the main line and laterals.
3. The camera, television monitor and other components shall be color. To ensure peak picture quality throughout all conditions encountered, the color camera shall be equipped with the necessary circuitry to allow for the remote adjustment of the optical focus iris from the power control unit at the viewing station. A variable intensity control of the camera lights shall also be located at the viewing station.
4. All fog shall be evacuated from the pipeline and the pipeline kept clear of any fog during the CCTV inspection process.
5. Lighting and camera quality shall be suitable to allow a clear, in-focus picture inside the pipelines extending at least ten (10) feet in front of the camera. In High Density Polyethylene (HDPE) or ductile iron pipe (DIP), lighting should be sufficient enough to provide a clear view at least two (2) feet in front of the camera. The replay of the recorded video information shall be free of electrical interference and shall provide a clear stable image.

d. Execution

1. The CCTV inspection may be performed by a contractor or Department Personnel. Inspections performed by a contractor must be observed by a Department Inspector. The Developer's Engineer may observe the inspection as well.
2. The Contractor shall provide the personnel performing the CCTV inspection a copy of the record drawing.
3. Line segment inspection shall be made manhole to manhole.
4. The pipe must be clear and free of any dirt and/or debris. The travel speed of the camera shall be variable but uniform and shall not exceed 30 feet per minute. Any means of propelling the camera through the sewer line which would produce nonuniform or jerky movement of the camera will not be acceptable.
5. The camera shall be propelled through the camera at a uniform rate that will allow for a clear view of the pipe.
6. The camera shall be stopped to view and study potentially deficient areas when directed by the Department's Inspector or the Developer's Engineer's representative.
6. The interior of the pipe shall be carefully inspected to determine the location and extent of all deficiencies. Pipe conditions that result in a question of proper installation procedures shall be noted so that these conditions can be reviewed and, if necessary, corrected before actual acceptance of the sewer system.
7. CCTV inspection will take place as soon as possible after testing.
9. The camera shall be stopped to get a clear view of each defect and service connection. At each service lateral, the camera shall be panned to view up each lateral or point of connection.
10. The CCTV technician shall record the inspection in a PACP format, and the video shall be recorded in an extra-high CD/DVD format. The title block shall include the following information:
 - a. Date

- b. Television operator's name
- c. Sewer segment number
- d. Upstream manhole number
- e. Downstream manhole number
- f. Size of sewer pipe
- g. Pipe material
- h. Direction of movement of camera and direction of normal flow.
- i. Location of service connections indicated by clock position and with counter distance in feet from beginning of pipe.
- k. Distance from beginning of pipe and description of obstructions, structural defects, longitudinal and/or circumferential cracking, faulty joints including open and offset joints, ovality, leakage or evidence thereof, break in connections, protruding connections, mineral deposits, roots, previous repairs, deposits on pipe walls, sags, and other abnormalities in the sewer.

The CCTV technician's log shall include the same information.

- 11. The CD/DVD shall visually display, at a minimum, the CCTV technician's name project name, date of inspection, pipe segment number, manhole numbers and, if applicable, lateral lot numbers.
 - 12. The CD/DVD shall be maintained and delivered to the Department in a hard case along with a copy of the field logs. The disk or case shall be labeled with the project name, Department project number, date of inspection, manhole segment number(s) inspected, and CCTV technician's identification.
 - 13. If during video operations the camera cannot pass safely through the entire sewer segment being inspected, the CCTV technician shall set up the equipment in reverse and perform the inspection from the other manhole. The forward distance traveled shall be entered into the log and noted on the video. If the video cannot pass the entire length safely in reverse, the inspection of the segment shall stop.
 - 14. All services shall be inspected with a push camera.
- e. Acceptance

1. A section of sewer shall be recleaned and reinspected if the video is not clear, does not show the entire internal surface of the pipe or is not accompanied by a complete inspection log.
 2. Any of the following shall be considered defects:
 - a. Bellies
 - b. Joint separations
 - c. Offset joints
 - d. Chips in pipe ends
 - e. Cracked or damaged pipe
 - f. Evidence of the presence of an external object bearing upon the pipe
 - g. Infiltration
 - h. Roots
 - i. Debris or other objects
 - j. Other inconsistencies with the approved plans and specifications
 3. Any deficient sections of sewer pipe must be repaired by the contractor. The section of pipe must be fully reinspected and retested including CCTV inspection, air test and Mandrel test.
2. At the discretion of the Department, and in addition to air testing, pipe deflection test, and visual inspection and CCTV inspection, the Department may require the following:
- a. Leaking and Infiltration Test

All pipe joints shall be watertight. Infiltration of groundwater or other leakage into the sewer (including manholes) shall not exceed 50 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 3,000 gallons per mile per 24 hours. The infiltration rate into each section of the sewer shall be measured by the temporary installation of suitable metal or wooden weirs as authorized by the Department. These weirs shall be furnished, installed, and removed by the Contractor. Any leaks into the sewer shall be located, repaired and corrected.
 - b. Soil Compaction Test

All trenches suspected of not meeting the compaction requirements stated previously shall be tested for conformance by a Department approved testing lab and at the locations and depths requested by the Department.

Table I

Specification time required for a 1.0 psig pressure drop for size and length of pipe indicated for $Q=0.0015$

1 Pipe Diameter (in)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	4:00	597	0.380L	4:00	4:00	4:00	4:00	4:00	4:00	4:00	4:00
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	59:48	78:31
24	22:40	99	13.674L	22:47	34:11	45:34	56:58	68:32	79:46	91:10	102:33
27	25:30	88	17.306L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

Table II

Specification time required for a 0.5 psig pressure drop for size and length of pipe indicated for Q=0.0015

1 Pipe Diameter (in)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)								
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	
4	4:00	597	0.190L	4:00	4:00	4:00	4:00	4:00	4:00	4:00	4:00	4:00
6	4:00	398	0.427L	4:00	4:00	4:00	4:00	4:00	4:00	4:00	4:00	4:00
8	4:00	298	0.760L	4:00	4:00	4:00	4:00	4:00	4:26	5:04	5:42	
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54	
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50	
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02	
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51	
21	9:55	114	5.235L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16	
24	11:20	99	6.837L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17	
27	12:45	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:43	46:54	
30	14:10	80	10.683L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07	
33	15:35	72	12.926L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57	
36	17:00	66	15.384L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23	

J. GENERAL

1. Wyes and Tees

- a. Wye and tee branches shall be installed in sanitary sewer lines as required. If such branches are not to be used immediately they shall be capped as specified by manufacturer for the sewer pipe.
- 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 by a method approved by the Department prior to construction.
- c. Wyes and tees 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 Department. The exact location of each connection shall be determined by the Engineer before backfilling.

- d. Wyes and tees shall be of the same material and strength as the sewers on which they are installed.

2. Service Laterals

- a. Service laterals shall be installed where required to provide a connection from the sanitary sewer to all lots.
- b. Service laterals shall consist of 6" diameter DIP or PVC and conform to the requirements of these guidelines. A service wye shall be installed at the end of each service lateral and plugged in a manner to allow for air testing. The depth of a service shall be a minimum of 36" below finished grade, and a maximum of 60". Service laterals will not exceed 76' in length. However, laterals that are less than 20' in length on single family dwellings may be 4" in diameter with approval by the Department.

3. Connections to Existing Sewers

- a. Connections to existing manholes shall be made in the presence of the Department Inspector. The Contractor shall notify the Department 48 hours before starting a connection. All new holes in existing manholes shall be core drilled.

4. Pipe Protection

- a. Sewer pipe which, when completed, will have less than 3' of cover shall be constructed of ductile iron pipe.
- b. Where foundation conditions are not satisfactory as determined by the soil conditions, sewer pipe shall be either laid on a Class B concrete cradle, pipe foundation material, or constructed of ductile iron pipe, as approved in advance by Department.
- c. Where sewer pipe is laid under storm drainage pipe, there must be a minimum of 18" of separation or more. If unable to obtain 18" of clearance, use one joint of DIP centered under the drainage line.

- 5. Pipe storage and handling shall be in accordance with the pipe manufacturer's recommendations. Pipe shall be stored on a smooth surface to avoid point loadings. Pipe shall be handled with care so as to prevent damage. Correct equipment should be used to load or unload pipe so as to eliminate dropping, etc.

- 6. All excavated areas, backfills, embankments, trenches and access roads, grading and ditches shall be maintained by the Contractor in good condition

at all times until final acceptance by the Department. Where trench backfill has settled, trenches shall be brought back to grade.

K. TRENCH EXCAVATION

This section of the guidelines is provided to outline most types of laying conditions, but is not intended to cover all special laying conditions or the Engineer's special requirements.

1. Trench excavation shall be made in open cut and true to the lines and grades shown on the plans, unless boring is necessary or required. Banks of the trenches shall be cut in vertical, parallel planes equidistant from the pipe center line. The horizontal distance between such planes, or the overall width of trench, shall vary with the size of the pipe to be installed. The overall width of trench shall be as recommended by the manufacturer. 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. 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 12" above the top of the pipeline. The bottom of the trench shall be level in cross section and shall be cut true to the required grade of the pipe and pipe embedment materials.
2. Bell holes for bell-and-spigot pipe shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of joints in the pipe.
3. When muck, quicksand, soft clay, swampy or other material unsuitable for foundations or sub-grade are encountered, such material shall be removed and replaced with crushed stone.
4. After excavation, the area between the final pipe grade and the trench soil bottom shall be filled with crushed stone materials as required, compacted to proper grade, and made ready for pipe laying.
5. Debris encountered in trench excavation for sewers and other pipelines shall be removed for the overall width of trench which shall be as shown on the plans. It shall be removed to a depth of 6" below the bottom of the pipe for pipes smaller than 24" in size; 8" below the bottom of the pipe for pipes 24" to 36" in size; and 12" below the bottom of the pipe for pipes larger than 36" in size, if debris extends to such depth.
6. In all cases, materials deposited shall be placed so that in the event of rain, no damage will result to the work.

7. The sides of all excavations shall be sufficiently sheeted, shored and braced whenever necessary to prevent slides, cave-ins, settlements or movement of the banks and to maintain the excavation clear of obstructions. Wood or steel sheet piling of ample design and type 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 or damage. Sheeting, shoring or bracing materials shall not be left in place unless as shown by the plans or permitted by the Department. All trench sheeting and bracing shall be left in place until the trench has been backfilled one foot above the top of the pipe.
3. Comply with all OSHA guidelines.

L. TRENCH BACKFILL

1. The backfilling of pipeline trenches shall be started immediately after the pipe work has been inspected. The initial backfill material, placed to a height of one (1) foot above the top of the pipe, shall consist of approved backfill material free from organic matter and deleterious substances, containing no rocks or lumps over 2" in any dimension.

It shall be carefully placed and compacted through compaction of the entire area backfilled.

Backfill shall be deposited in 6" layers (before compaction) and thoroughly compacted with power tools to 95% of theoretical maximum density, modified Proctor ASTM-D-1557.

2. Where trenches are not under pavement, sidewalks, or in alleys, the backfill material above pipe zone shall be compacted to a sufficient density to prevent settlement. Any deficiency in backfilling the trenches, or depressions caused by settlement, shall be repaired.
3. Where pipe trenches are cut across or along pavement, trenches shall be backfilled with select fill material placed and compacted in 6" lifts. Replacement of road base and asphalt shall be in accordance with South Carolina Department of Transportation (SCDOT) regulations.
4. Backfilling around structures shall be done in the manner specified above for pipe trenches by power tamping for the full depth of cut from the bottom of the finished grade.
5. All backfilling shall be done in such a manner as will not disturb or injure the pipe or structure over or against which it is being placed. Any pipe or structure injured, damaged or moved from its proper line or grade during backfilling operations shall be uncovered, repaired, and then re-backfilled as herein specified.

M. INSTALLATION OF CASING, SPACERS, AND END SEALS

1. Locate to avoid interference with traffic, adjacent structures, etc. to such extent possible.
2. Excavate to required depth, providing sheeting and shoring necessary for protection of the work and for safety of personnel.
3. Maintain entry pits in dry condition by use of pumps, drains or other approved method.
4. Install casings by dry-boring through the casing while simultaneously jacking the casing.
5. Any proposed alternate method shall be approved in writing by Department.
6. Weld joints to provide a watertight joint.
7. Install casings for gravity sanitary sewer to grade, not varying more than 3/32" per foot of length from the indicated grade.
8. Installing pipe in casing:
 - a. Inspect carefully, insuring that all foreign material is removed from the casing and the casing meets alignment criteria for the type of carrier pipe being used.
 - b. Install casing spacers on the carrier pipe per the manufacturer's instructions.
 - c. For sanitary sewer provide spacer sizing and length necessary to obtain the pipe slope and elevations as shown on the plans.
 - d. Provide restrained configuration.
 - e. Install the carrier pipe in the casing insuring each joint is pushed "home" before the joint is installed into the casing.

9. Seal each end with brick and mortar to prevent the entrance of foreign material.

SECTION 13

PRESSURE SEWER (FORCE MAIN) DESIGN GUIDELINES

SECTION 13

PRESSURE SEWER (FORCE MAIN)

DESIGN GUIDELINES

A. GENERAL

1. The following pressure sewer system design guidelines are based on Federal, State and local health requirements and the Department engineering design criteria.
2. These design guidelines are applicable to all developments including, but not limited to, residential, commercial and industrial developments, subdivisions and/or parks requiring sewer service from the Department.

B. PRESSURE SEWER DESIGN CRITERIA

1. Minimum pipe size: 4".
2. Design velocity.
 - a. Minimum: 2 feet per second.
3. Maximum pipe size:
 - a. Provide so as to maintain the minimum 2 feet per second velocity and minimize pump head.

C. AIR RELEASE VALVES

1. Provide at high points in the force main.
2. Design force main to minimize the number of air release valves.
3. Maintain a minimum 54-inch cover over the force main at air release valves.

D. PLUG VALVES

1. Provide a plug valve at the half way point, or approximately every 1,000 feet.

E. FORCE MAINS ENTERING MANHOLES

1. No more than two (2) feet, vertically, above the receiving manhole's flowline.
4. Coat manholes per Section 12.
3. The Department reserves the right to require a manhole vent where force mains are entering manholes.

F. FORCE MAINS CONNECTING TO EXISTING FORCE MAINS

1. Force mains will not be allowed to manifold into existing force mains unless no other option is deemed practical by the Department. Cost shall not be a consideration in determining if another option is practical.
2. Where a manifold to an existing force main is allowed:
 - a. The engineer shall prepare a hydraulic model of all manifolded force mains affected by the new force main to determine if all stations will continue to function within acceptable limits.
 - b. At a minimum, a plug valve shall be installed at the tie-in point.
 - c. The Department may require a check valve with plug valves immediately upstream and downstream of the check valve.

G. SEPARATION OF PRESSURE SEWER AND WATER MAINS

1. Where possible, locate pressure sewer at least ten (10) feet away, horizontally, from water mains.
2. Should ten (10) foot separation not be practical, then the pressure sewer may be located closer provided:
 - a. It is laid in a separate trench.
 - b. It is laid in the same trench with the water main located at one side on a bench of undisturbed earth.
 - c. In either of the above cases, crown elevation of the pressure sewer shall be at least 18" below invert elevation of water line.
3. Where pressure sewers cross over or under water lines, maintain 18" minimum clearance between outside edges of the two pipes.
 - a. Use full length of pressure sewer pipe located so that the joints will be equal distance from the water main.

H. COVER

1. Provide suitable cover on all pressure sewers. Minimal cover depth as follows:
 - a. Typical for 4" and larger: 36".
 - b. At air release valves: 54"
2. All piping located within the right-of-way of the South Carolina Department of Transportation and the Department shall have a minimum cover of 48" below the crown of the road when installed within the limits of the paved roadway, 36" cover when installed in the shoulder of right-of-way and a minimum of 18" separation under the design invert of drainage structures. The greater dimension of the above shall dictate minimum depth where applicable.
3. Special conditions other than those listed above may be approved if requested in writing from the Department.

I. DUCTILE IRON PIPE LOCATIONS

1. Use ductile iron pipe for the following:
 - a. Where sewer mains cross over water mains, the sewer main shall transition to ductile iron pipe. A full length of ductile iron pipe shall be installed in the sewer main centered so that each joint is equidistant from the water main. Joint of ductile iron pipe water main shall also be installed so that each joint is equidistant from the ductile iron pipe section of the sewer main.
 - b. Crosses beneath storm drainage pipe with less than three (3) feet of clearance.
 - c. Crosses above storm drainage pipe with less than 18" of clearance.
 - d. Crosses creeks, rivers and other water bodies. The Department may allow Fusible Polyvinyl chloride (FPVC) or High Density Polyethylene (HDPE) on a case by case basis.
 - e. Cover is less than the depth prescribed in Part G above.

SECTION 14

PRESSURE SEWER (FORCE MAIN) MATERIALS FOR CONSTRUCTION

SECTION 14

PRESSURE SEWER (FORCE MAIN)

MATERIALS FOR CONSTRUCTION

A. GENERAL

1. Unless otherwise noted or approved by the Department all materials shall be manufactured in the United States.

B. PIPE AND FITTINGS

1. Ductile-iron pipe and fittings (DIP):
 - a. 4" - 12" class 52
 - b. 14" - 64" pressure class 250
 - c. Flanged pipe shall be class 53 (minimum)
 - d. Underwater pipe shall be a minimum of class 52.
 - e. Use mechanical or push-on joints: ANSI/AWWA C111/A21.11 as modified by ANSI/AWWA C151/A21.51.
 - f. Use rubber gaskets and lubricant: ANSI/AWWA C111/A21.11.
 - g. Use fittings with pressure rating of 150 psi: ANSI/AWWA C110/A21.10.
 - h. Lining:
 - 1) Amine cured Novalac Epoxy polymeric lining, 40 mils nominal thickness. Protecto 401 by Vulcan Painters, Birmingham, Alabama 40 mils nominal thickness.
 - i. All DIP force main and house sewer installations shall also include the installation of an electronically or magnetically detectable safety tape buried directly over the pipe 12" below the ground surface continuously. The tape shall be at least 2" wide, be green on top, and be boldly labeled every 18" to 32" as follows "CAUTION SEWER LINE BURIED BELOW". The tape shall have a tensile strength of not less than 4000 psi, a dart impact strength of not less than 120 grams per 1.5 mils, be not less than 0.0055" thick, and include sufficient metal to allow easy detection at the above stated depths. The tape

shall be designed to last as long as the pipe it is installed over, even in adverse soils.

- j. All DIP force main and house sewer installations shall also include the installation of metallic tracer wire laid 6" above the pipe.

2. Polyvinyl chloride pipe and fittings (PVC):

- a. 1) Gaskets to comply with ASTM F477.
 - a) Natural rubber gaskets are not acceptable.
- b. 4" - 12":
 - 1) Comply with ANSI/AWWA C900, Table 2, Pressure Class 150.
- c. 14" and larger:
 - 2) Comply with ANSI/AWWA C905 Table 2, pressure class 165.
- d. Plastic pipe 3" and smaller:
 - 1) Comply with ASTM D2241 for PVC 1120, SDR 26.
- e. Use integral bell or coupling type with elastomeric gaskets.
- f. Factory-install gaskets integral with the pipe.
- g. Use ductile iron fittings with pressure rating of 150 psi: ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53.88.
 - 1) Lining per Part B.1.h. above.
- h. Provide adaptor glands, gaskets, etc. as required to accommodate any differences in pipe and fitting dimensions.
- i. Couplings:
 - 1) Ductile iron, minimum Class 52, full length.
- j. All PVC force main installations shall also include the installation of an electronically or magnetically detectable safety tape buried directly over the pipe 12" below the ground surface continuously. The tape shall be at least 2" wide, be green on top, and be boldly labeled every 18" to 32" as follows "CAUTION SEWER LINE BURIED BELOW". The tape shall have a tensile strength of not less than 4000 psi, a dart impact strength of not less than 120 grams per 1.5 mils, be not less

than 0.0055" thick, and include sufficient metal to allow easy detection at the above stated depths. The tape shall be designed to last as long as the pipe it is installed over, even in adverse soils.

- k. All PVC force main installations shall also include the installation of metallic tracer wire laid 6" above the pipe.

5. High Density Polyethylene (HDPE) Pipe

- a. High Density Polyethylene (HDPE) pipe shall be used only for directional drilling under creeks or marsh crossings unless approved otherwise by the Department.
- b. Comply with AWWA C-906, SDR 11 and working pressure of 160 psi minimum.
- c. The pipe supplied shall be SDR high performance, high molecular weight, high density polyethylene pipe, and shall conform to ASTM D 1248 (Type III C, Category 5, P34). Minimum cell classifications values shall be 345434C as referenced in ASTM D-3350 - latest edition. All pipe resin shall be manufactured by the same company that manufactures the pipe itself in accordance with these specifications to insure complete resin compatibility and total product accountability. The fittings supplied in this specification shall be molded or manufactured from a polyethylene compound having a cell classification equal to or exceeding the compound used in the pipe. To insure compatibility of polyethylene resins, all fittings supplied under this specification shall be of the same manufacture as the pipe being supplied.

4. Physical properties:

- a. The pipe shall conform to the physical properties as described herein.
- b. Typical pipe physical properties:

<u>Property</u>	<u>Test Method</u>	<u>Unit</u>	<u>Value</u>
Density	ASTM Method	gms/cc	0.955
Melt Index	ASTM D-1238 (190/2.16)	gms/10 min	

Environmental Stress Cracking Resistance:

Condition A, B, & C, F-0	ASTM D-1693	hrs	>5000**
Compressed Ring, F-60	ASTM F-1248	hrs	>1500
Tensile Strength, Yield	ASTM D-638	psi	3200
Type IV Specimen	(2"/min)		
Elongation at Break	ASTM D-638	%	>750
Type IV Specimen	(2"/min)		
Victate Softening Temp	ASTM D-1525	°F	257
Brittleness Temp	ASTM D-746	°F	<-180
Flexural Modulus	ASTM D-790	psi	135,000
			0
Modulus of Elasticity	ASTM D-638	psi	130,000
Hardness	ASTM D-2240	Shore D	65
Linear Thermal			
Expansion Coef.	ASTM D-696	in./in./°F	1.2x10-4
Thermal Conductivity	Dynatech-Colora BTU, In./Thermoconductor ft./2hrs/°F		2.7

Long Term Strength:

73°F	ASTM D-2837	psi	1600
UV Stabilizer	ASTM D-1603	%C	2.5
Material Cell Classification	ASTM D-1248		345434C
Material Description	PPI Recommendation		PE 3408

5. Quality control:

- a. The resin used for manufacture of the pipe shall be manufactured by the pipe manufacturer, thus maintaining complete control of the pipe quality. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogenous throughout and free of visible cracks, holes, foreign inclusions, or other deleterious defects and shall be identical in color, density, melt index, and other physical properties.

The polyethylene resin used shall have all ingredients pre-compound prior to extrusion of pipe, in plant blending is not acceptable. Owner may request, as part of the quality control records submittal, certification that the pipe produced is represented by the quality assurance testing. Additionally, test results from manufacturer's testing or random sampling by the Engineer that do not meet appropriate ASTM standards or manufacturer's representation, may be cause for rejection of pipe represented by the testing. These tests may include density and flow rate measurements from samples taken

at selected locations within the pipe wall and thermal stability determinations according to ASTM D 3350, 10.1.9. Certified lab data may be requested to verify the physical properties of the materials supplied under this specification or may take random samples and have them tested by an independent laboratory.

6. Rejection:
 - a) The Department reserves the right to reject any polyethylene pipe and fittings failing to meet any of the requirements of this specification.

C. RESTRAINED JOINT PIPE AND FITTINGS

1. Provide restrained joint pipe and fittings on all piping at each fitting, valve, and on the pipe joints to a minimum distance of 18' on each side of the fitting or valve for 12" piping and smaller and to a minimum distance of 36' on each side of the fitting for piping over 12" as a minimum. Use the ductile iron pipe research association (DIPRA) procedure for calculating restrained joint lengths.
2. Provide for use with mechanical joint pipe and fittings.
3. Acceptable products: Megalug as manufactures by EBAA Iron Sales, Inc.
4. Concrete thrust blocking can be used on a case-by-case basis as approved by Department.
5. Restrained joint pipe will be indicated clearly on plans. The location and length of restrained joint pipe will be clearly marked on the drawings at all points where the direction or cross-sectional area of the pipe changes as well as at all bends, reducers, offsets, tees, wyes and valves.

D. AIR RELEASE AND VACUUM VALVES

1. Single body universal type with compound lever system.
2. Internal linkage and float of stainless steel.
3. Capacity: At 10 lbs. working pressure, vent not less than 25 cfm of free air.
4. Provide the following:
 - a. 2" inlet.
 - b. 2" stainless steel T-handle ball valve.
 - c. 1" blowoff stainless steel T-handle ball valve.

- d. Quick disconnect couplings.
 - e. Back flushing hose.
 - f. "Protectop" cover.
 - g. Piping, nipples, plugs, etc.: Schedule 40, type 316 stainless steel.
5. 6. Acceptable product: H-TEC Model #986 or approved equal.
7. Valve manhole:
- a. Use manhole wall sections.
 - b. Provide manhole frame and cover in accordance with Section 11.C.

E. CASING, SPACERS AND END SEALS FOR UTILITIES

1. General
- a. Provide bore and jack with casing for pipes larger than 2".
 - b. Casing pipe to be 2" larger in diameter than the bell of the carrier pipe.
 - 1) Casing pipe to be a minimum of 2" larger than the largest outside diameter of the carrier pipe (joints and couplings) if the carrier pipe is less than 6" in diameter. If the diameter of the carrier pipe is 6" or larger, the diameter of the casing pipe shall be a minimum of 4" larger than the largest outside diameter of the carrier pipe (joints and couplings).
 - 2) The end of casing pipe to extend a minimum of six (6) feet from the edge of pavement/back of curb.
 - 3) The top of the casing pipe shall be a minimum of four (4) feet below the crown of the finished asphalt roadway.
 - 4) The top of the casing pipe shall be a minimum of two (2) feet below the design invert of roadside drainage ditches and pipes.
2. Casing pipe for dry bores
- a. Steel complying with ASTM A139 for Grade B with minimum yield strength of 35,000 psi.

- b. Provide ends suitable for field welding.
- c. Minimum wall thickness as follows:

<u>Diameter of Casing</u> (Inches)	<u>Minimum Wall Thickness</u> (Inches)
6 thru 14	1/4
16 and 18	5/16
20 and 22	3/8
24 and 26	7/16
28 thru 32	1/2
34 thru 42	9/16
44 thru 48	5/8
50 thru 54	3/4

3. Pipeline casing spacers

- a. Provide pipeline casing spacers for piping installed in casing.
- b. Provide a minimum of one spacer per ten linear feet of pipe for DIP pipe and one spacer per six linear feet of pipe for PVC pipe.
- c. Provide spacer with shell of 14 gauge Type 316 stainless steel.
- d. Provide shell liner of .090" thick PVC, 85-90 durometer.
- e. Provide 5/16" stainless steel connecting bolts and lock nuts, minimum three (3) per flange.

- f. Runners from 2" wide ultra high molecular weight polymer with a high resistance to abrasion and a coefficient of friction of 0.11-0.13 in accordance with ASTM D-1894.
 - g. Support runners on 14 gauge reinforced Type 316 stainless steel risers welded to shell.
 - h. All metal surfaces to be fully passivated.
 - i. The diameter as measured over the runners shall exceed the pipeline bell or coupling outside diameter.
 - j. Acceptable product: Cascade Manufacturing or approved equal.
4. End seals:
- a. Seal each end with brick and mortar to prevent the entrance of foreign material.

SECTION 15

PRESSURE SEWER (FORCE MAIN) CONSTRUCTION PROCEDURES

SECTION 15

PRESSURE SEWER (FORCE MAIN)

CONSTRUCTION PROCEDURES

This section covers construction procedures normally required for work. It does not cover any special construction procedures which may be encountered for abnormal conditions.

Special construction procedures are to be presented to the Department by the Developer's Design Engineer.

A. HANDLING OF MATERIALS

1. Handle pipe so as to ensure delivery to the trench in sound, undamaged condition:
 - a. Carry pipe into position - do not drag.
 - b. Use pinch bars or tongs for aligning or turning the pipe only on the bare end of the pipe.
 - c. Use care not to injure pipe linings.
2. Thoroughly clean interior of pipe and accessories before lowering pipe into trench. Keep clean during layout operations by plugging or other approved method.
3. Before installation, inspect each piece of pipe and each fitting for defects:
 - a. Replace material found to be defective before or after laying with sound material meeting the specified requirements.
4. Rubber gaskets: Store in a cool dark place until just prior to time of installation.

B. PIPE CUTTING

1. Cut pipe neatly and bevel pipe end without damage to the pipe.
2. Unless otherwise recommended by the pipe manufacturer, cut pipe with mechanical cutter only.

- a. Use wheel cutters when practicable.
- b. Cut plastic pipe square and remove all burrs.

C. LOCATING

1. Where possible, locate pressure sewer at least ten (10) feet away, horizontally, from water mains.
2. Should ten (10) foot separation not be practical, then the pressure sewer may be located closer provided:
 - a. It is laid in a separate trench.
 - b. It is laid in the same trench with the water main located at one side on a bench of undisturbed earth.
 - c. In either of the above cases, crown elevation of the pressure sewer shall be at least 18" below invert elevation of water line.
3. Where pressure sewers cross over or under water lines, maintain 18" minimum clearance between outside edges of the two pipes.
 - a. Use full length of pressure sewer pipe located so that the joints will be equal distance from the water main.

D. ALIGNMENT OF PIPE

1. Pipe lines intended to be straight shall be so laid.
2. Where vertical or horizontal alignment requires deflection from straight lines or grade, do not exceed 75% of maximum deflection recommended by the pipe manufacturer.
3. If alignment requires deflection exceeding recommended limits, furnish bends to provide angular deflections within the allowable limits.

E. PLACING AND LAYING

1. General:
 - a. Lower pipe and accessories into trench by means of derrick, ropes, belt slings, or other equipment approved by the manufacturer.

- b. Do not dump or drop any of the materials into the trench.
 - c. Except where necessary in making connections to other lines, lay pipe with the bells facing in the direction of laying.
 - d. Rest the full length of each section of pipe solidly on the pipe bed, with recesses excavated to accommodate bells, couplings, and joints.
 - e. Take up and relay pipe that has the grade or joint disturbed after laying.
 - f. Do not lay pipe in water, or when trench conditions are unsuitable for the work; keep water out of the trench until jointing is completed.
 - g. Securely close open ends of pipe, fittings, and valves when work is not in progress.
 - h. Replace pipe where any part of lining is damaged.
 - i. Lay pipe to the grades indicated on the plans. Avoid excessive high points in the force main.
 - j. After each line of pipe has been laid, it shall be carefully inspected and all earth, trash, rags, and other foreign matter removed from the interior.
 - k. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe and so as to avoid sudden offsets.
 - l. All jointing of pipe and fittings shall be in accordance with the pipe manufacturer's recommendations.
2. Ductile iron pipe:
- a. Mechanical and push on joints, install in accordance with ANSI/AWWA C600.
 - b. Gaskets: Handle, lubricate where necessary and install in strict accordance with manufacturer's recommendations.
3. Plastic pipe:
- a. Install in accordance with ASTM D-2321, latest revision.

- b. Clean gasket, bell or coupling interior, especially groove area.
 - c. Lubricate gasket as recommended by manufacturer.
 - d. Align spigot to bell, insert spigot into bell until it contacts gasket uniformly.
 - e. Use manufactures approved leverage bar to bell pipe.
 - 1) Home line is to be clearly visible when pipe is joined.
4. Restrained joints:
- a. Install in accordance with manufacturer's instructions.
 - b. Tighten set screws to the manufacturer's rated torque using a torque wrench.
 - 1) If twist-off nuts are provided, tighten screws until nut breaks loose.

F. INSTALLATION OF AIR RELEASE VALVES

- 1. Compact backfill thoroughly over pressure sewer.
- 2. Install gravel drainage bed.
- 3. Set valve plumb, use a 316 stainless steel nipple between pressure sewer and valve.
- 4. Install manhole wall sections plumb and level.

G. INSPECTIONS AND TESTING

- 1. General:
 - a. The Department will require that all sanitary sewer systems pass the following test prior to acceptance: (the Department shall be notified 72 hours before inspections).
 - b. Soil Compaction Test
- All trenches suspected of not meeting the compaction requirements stated previously shall be tested for conformance by a Department

approved testing lab and at the locations and depths requested by the Department.

c. Pressure Test

All force mains shall successfully pass a pressure test of one and one half times working pressure, but in no case less than 100 psi. The pressure test is to hold for two (2) hours.

Typically, no measureable leakage will be allowed for wastewater force mains. The force main will be unacceptable if the leakage exceeds the following AWWA formula of allowable leakage:

$$L = SD \frac{\sqrt{P}}{133200}$$

where,

L = Allowable Leakage in gal/hr
S = Length of Pipe Tested in feet
D = Nominal Diameter in inches
P = Average Test Pressure in psig

H. INSTALLATION OF CASING, SPACERS, AND END SEALS

1. Locate to avoid interference with traffic, adjacent structures, etc. to such extent possible.
2. Excavate to required depth, providing sheeting and shoring necessary for protection of the work and for safety of personnel.
3. Maintain entry pits in dry condition by use of pumps, drains or other approved method.
4. Install casings by dry-boring through the casing while simultaneously jacking the casing.
5. Any proposed alternate method shall be approved in writing by the Department.
6. Weld joints to provide a watertight joint.
7. Installing pipe in casing:

- a. Inspect carefully, insuring that all foreign material is removed from the casing and the casing meets alignment criteria for the type of carrier pipe being used.
 - b. For pressure systems, the casing deflection shall not exceed the maximum deflection recommended by the carrier pipe.
 - c. Install casing spacers on the carrier pipe per the manufacturer's instructions.
 - d. Provide centered or restrained configuration.
 - e. Install the carrier pipe in the casing insuring each joint is pushed "home" before the joint is installed into the casing.
8. Seal each end with brick and mortar to prevent the entrance of foreign material.

I. TRENCH EXCAVATION

This section of the guidelines is provided to outline most types of laying conditions, but is not intended to cover all special laying conditions or the Engineer's special requirements.

1. Trench excavation shall be made in open cut and true to the lines and grades shown on the plans, unless boring is necessary or required. Banks of the trenches shall be cut in vertical, parallel planes equidistant from the pipe center line. The horizontal distance between such planes, or the overall width of trench, shall vary with the size of the pipe to be installed. The overall width of trench shall be as recommended by the manufacturer. 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. 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 12" above the top of the pipeline. The bottom of the trench shall be level in cross section and shall be cut true to the required grade of the pipe and pipe embedment materials.
2. Bell holes for bell-and-spigot pipe shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of joints in the pipe.

3. When muck, quicksand, soft clay, swampy or other material unsuitable for foundations or sub-grade are encountered such material shall be removed and replaced with crushed stone.
4. After excavation, the area between the final pipe grade and the trench soil bottom shall be filled with crushed stone materials as required, compacted to proper grade, and made ready for pipe laying.
5. Debris encountered in trench excavation for sewers and other pipelines shall be removed for the overall width of trench which shall be as shown on the plans. It shall be removed to a depth of 6" below the bottom of the pipe for pipes smaller than 24" in size; 8" below the bottom of the pipe for pipes 24" to 36" in size; and 12" below the bottom of the pipe for pipes larger than 36" in size, if debris extends to such depth.
6. In all cases, materials deposited shall be placed so that in the event of rain, no damage will result to the work.
7. The sides of all excavations shall be sufficiently sheeted, shored and braced whenever necessary to prevent slides, cave-ins, settlements or movement of the banks and to maintain the excavation clear of obstructions. Wood or steel sheet piling of ample design and type 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 or damage. Sheeting, shoring or bracing materials shall not be left in place unless as shown by the plans or permitted by the Department. All trench sheeting and bracing shall be left in place until the trench has been backfilled one foot above the top of the pipe.
3. Comply with OSHA guidelines.

J. TRENCH BACKFILL

1. The backfilling of pipeline trenches shall be started immediately after the pipe work has been inspected. The initial backfill material, placed to a height of one (1) foot above the top of the pipe, shall consist of approved backfill material free from organic matter and deleterious substances, containing no rocks or lumps over 2" in any dimension.

It shall be carefully placed and compacted through compaction of entire area backfilled.

Backfill shall be deposited in 6" layers (before compaction) and thoroughly compacted with power tools to 95% of theoretical maximum density, modified Proctor ASTM-D-1557.

2. Where trenches are not under pavement, sidewalks, or in alleys, the backfill material above pipe zone shall be compacted to a sufficient density to prevent settlement. Any deficiency in backfilling the trenches, or depressions caused by settlement, shall be repaired.
3. Where pipe trenches are cut across or along pavement, trenches shall be backfilled with select fill material placed and compacted in 6" lifts. Replacement of road base and asphalt shall be in accordance with South Carolina Department of Transportation (SCDOT) regulations.
4. Backfilling around structures shall be done in the manner specified above for pipe trenches by power tamping for the full depth of cut from the bottom of the finished grade.
5. All backfilling shall be done in such a manner as will not disturb or injure the pipe or structure over or against which it is being placed. Any pipe or structure injured, damaged or moved from its proper line or grade during backfilling operations shall be uncovered, repaired, and then re-backfilled as herein specified.

SECTION 16

SANITARY SEWER PUMP STATION DESIGN GUIDELINES

SECTION 16

SANITARY SEWER PUMP STATION

DESIGN GUIDELINES

A. GENERAL

1. The following sanitary sewer pump station design guidelines are based on Federal, State and local health requirements and the Department's engineering design criteria.
2. These design guidelines are applicable to all developments including but not limited to residential, commercial and industrial developments, subdivisions and/or parks requiring sewer service from the Department.
3. Design criteria for other than normal circumstances are to be presented to the Department for approval prior to preparation of plans and specifications.
4. The Engineer should submit the following design calculations:
 - a. Station service area ultimate loading.
 - b. Flotation calculation (weight of station without pumps vs. uplift).
 - c. Cycle time calculation maximum of six (6) cycles/hour at the average daily flow rate.
 - d. Provide certification that motor and control circuit will permit twelve (12) cycles/hour.

B. GENERAL PUMP STATION DESIGN

1. Minimum of two (2) pumps of equal capacity, each capable of handling the design peak flow.
2. Capable of passing 3" diameter spherical solids, minimum.
3. Discharge piping: 4" diameter, minimum.
4. Peaking factor:
 - a. Based on the following population based equation:

$$PF = \frac{18 + (P)^{0.5}}{4 + (P)^{0.5}}$$

Where P = 20-year sewer population in thousands

- b. Minimum, 2.5.
 - c. Based on the source of the wastewater and the distance of the pump station from the source.
6. Wetwell level settings:
- a. Distance between pump "OFF" and lead pump "ON": Based on cycle time.
 - b. Distance between lead pump "ON" and lag pump "ON" and alarm "ON": 1'-0", minimum.
 - c. Distance between lag pump "ON" and alarm "ON": 1'-0", minimum.
 - d. Distance between alarm elevation and inlet pipe: 6", minimum.
7. Provide a check valve and gate valve on each pump discharge line. A surge relief valve may be required by the Department on larger pump stations.
8. Pumps shall have an operating point at or near peak efficiency.
9. Pumps shall be non-overloading for all duty points.
2. Provide by-pass connection per detail section.
3. Provide receiving manhole on influent line within pump station fence for by-pass pumping.
4. Provide a gate valve on the influent line between the receiving manhole and wetwell.

C. SUBMERSIBLE PUMP STATION

1. Opposite opening, dual access covers with safety hatch.
2. Provide components of the pump station per detail section.

D. PUMPS AND MOTORS

1. Acceptable pump manufacturers for submersible pumps are:
 - a. Flygt

- b. Fairbanks Morse
- c. ABS

No other manufacturers shall be used.

2. Pumps shall be equipped as follows:

- a. Pumps shall be designed to handle peak flow with largest pump out of service.
- b. Motors shall be non-overloading over entire pumping range.
- c. Motors shall have Class F (155°C) insulation and withstand Class B (130°C) temperature rise with a service factor of 1.0 at the efficient point of the curve.
- d. Motor rpm shall not exceed 1800 rpms. Wire to water efficiency curves shall be submitted for approval.
- e. Three (3) phase power shall be required on all motors.
- f. Unbalanced voltage on motors under load shall not exceed 1.0% when measured at the motor terminals. Voltage shall be read with an accurate digital voltmeter; and recorded as part of the final inspection; calculation shall be NEMA Standard MG1-1972 (See Vol. Ia-11, No. 1, Jan/Feb 1974 IEEE Transaction Industrial Application).
- g. Power factor correction shall be required to 85%.
- h. Lightning arresters are required for all services.
- i. Pump and motor shall have a minimum of 400 series stainless steel shaft on motors under 10 Hp, above 10 Hp motors can have a chrome plated steel shaft.
- j. Impeller shall be keyed to shaft and be single vane.
- k. Pump volute shall have replaceable wear rings.
- l. Lower seals shall be silicone carbide to silicone carbide.
- m. B-10 bearing lift shall be a minimum of 50,000 hours.
- n. Pump and motors shall have adequately sized 316 stainless steel lifting chain; length shall reach top of station plus an additional 6'. Chain shall be ¼" welded 316 stainless steel link chain.

- o. Adequate designed lift chain hooks shall be imbedded into the side of the top slab and situated to facilitate easy removal of units.
- p. All piping shall be Class 53 DIP and all fittings shall be Class 150 DIP. All pipe and fittings shall be lined in accordance with Section 14.
- q. Motor shall be equipped with moisture detection probe and have moisture detection indication lamp mounted on control panel. Moisture detection shall cause motor shut down.
- r. Motor shall be equipped with overheat sensor and shall shut down the motor. Control panel shall have separate indicator lamp for overheat shut down.
- s. Motor shall be wired for lead-lag operation and shall be equipped for alternate cycle operation.
- t. Each motor shall have a separate run time totalizer and H-O-A switch.
- u. Pump and motor shall be shipped with non-wicking electrical power cable, overheat cable and seal failure cable, factory installed. Cut ends are to be sealed and tagged at the factory for shipping.
- v. The Department may require VFD's at their discretion.
- w. Large pump stations shall have variable speed pumps with soft starts where practical.

E. PUMP STATION PIPING

- 1. All piping shall be arranged as shown in the detail section.
- 2. Each pump discharge line shall have a weighted arm cushioned swing check valve and a gate valve. All fittings to be flanged.
- 3. Provide ½" tap with pressure gauge connection after the true wye.
- 4. Provide air release valve as shown in the detail section.
- 5. All bolts, nuts and washers shall be 316 stainless steel.

F. WETWELL DESIGN CRITERIA

- 1. Size the wetwell based on the following:

- a. Flow from proposed development and any associated future development.
- b. Capability to receive flows from surrounding areas as determined by Department.
- c. Formula:

$$V = \frac{T}{\left(\frac{1}{Q-S} + \frac{1}{S}\right)}$$

Where: V = Effective volume of wetwell (in gallons)
 T = Time for one pump cycle (in minutes)
 Q = Pumping rate (GPM)
 S = Flow into wetwell (GPM)

- d. Minimum allowable wetwell diameter shall be 8'-0".
2. Normal operating volume shall prevent any one pump from starting more than three (3) times per hour (maximum six (6) cycles per hour with alternating pumps after each cycle).
 3. Interior components:
 - a. Type 316 stainless steel hardware including, but not limited to, the following:
 - 1) Lifting chains
 - 2) Anchor bolts
 - 3) Bolts, nuts, and washers
 - 4) Guide rails - to be compatible with Flygt Guide Rail System.
 - 5) Rail guides
 - 6) Cable holder
 4. Level controls are to be floats and/or ultrasonic level transmitter.
 5. Locate floats where flow from the inlet pipe will not interfere with the floats at all operating levels.

6. Provide a stainless steel hanger for the float cables and/or ultrasonic level transmitter.
7. Line interior of wetwell and all piping located within wetwell with 125 mills of Raven 405 Epoxy, 240 mills of NEOPOXY NPR 5300 or other approved by the Department.
8. Where an increase in main size is required, provide a reducing elbow at the horizontal/vertical transition inside the wetwell.
9. Locate to allow access with vacuum truck and boom truck.
10. Minimum slope of one to one and half (1 to 1.5) on the floor to the hopper bottom.
11. Horizontal area of hopper bottom shall be no larger than necessary for proper installation and operation of the pump or pump inlet.
12. Provide 4" DIP with vent cap for venting the wetwell.
13. The bottom slab of the wetwell shall be set on a minimum of 12" of gravel. All over-excavated areas 12" below the wetwell bottom shall be filled with gravel.
14. Top of slab shall be 1' above the 100-year flood elevation.
15. Steps should NOT be used in wetwells.
16. Influent line shall terminate a minimum of ½" inside the wetwell.
17. All hatches shall be aluminum with stainless steel hasp, hinge and safety hatch.

G. ELECTRICAL

1. Electrical design of pump station shall conform to current editions of NFPA 70 (National Electric Code) and NFPA 820 (Standard for Fire Protection in Wastewater Treatment and Collection Facilities).
2. All areas designated as hazardous as defined by NFPA 820 shall be so delineated on the contract documents.
3. Electrical service shall be designated to accommodate the ultimate capacity of the pump station. Coordinate three phase service with utility company prior to ordering pumps. Add a phase shall not be accepted without prior written approval from the Department.

4. Coordinate location of meter pole with local utility and the Department. Install main breaker with lightning arrestor on meter pole. Main breaker shall be NEMA 12 stainless steel, gasketed with drip shield.
5. Provide adequately sized emergency generator and automatic transfer unit on all stations. Contact the Department for specifications on this equipment.
6. All electrical cables from the motors and float switches shall be terminated in a NEMA 3/7 explosion-proof junction box located adjacent to or directly below the pump control panel. The junction box shall contain power distribution blocks (Square D Type LB or equal) for the termination of the power cables and terminal blocks (Square D Type G or equal) for the termination of the float cables and sensor cables. The conduits entering the box from the wetwell shall be sealed with duct seal.
7. The conduits from the junction box to the pump control panel shall be sealed with Condulet type seals or Type ES sealing hubs. All seals shall be made with Chico brand sealing compound poured to a thickness of no less than the trade size of the sealing fitting end, in no case less than 5/8".
8. All electrical equipment shall be located outside of the hazardous areas, but the conduit seals shall be located within 10' of the classification boundary.
9. All conduit shall be full weight, hot dipped galvanized rigid conduit.
10. Provide support for electrical equipment in accordance with details.
11. Provide 70-watt high pressure sodium floodlight with weatherproof switch at each site. Mount on top of control panel support structure to light wetwell and valve vault area.
12. Wetwell float switch and/or ultrasonic level transmitter hangers shall be located at the edge of the hatch.
13. Provide concrete pad for pump control panel only, when supported on legs to extend out 3' from the face control panel.
14. Provide a complete addition to the Department's Supervisory Control and Data Acquisition System (SCADA).

H. PUMP STATION SITE

1. Minimum property size: 50' x 50'. A 20' landscape buffer in front of the station to be deeded to the Department may be required.

2. Site shall be serviced by an all weather road with top of road above the 25-year flood elevation. Road and site drainage shall be included and approved by appropriate agency.
3. Access road:
 - a. Minimum 20 foot wide.
 - b. Asphalt paving.
4. Area within pump station site:
 - a. Asphalt paving.
5. Fencing of Lift Station Site
 - a. Pump stations located in a residential development may be wooden per the detail in the detail section unless otherwise approved by the Department.
 - b. Pump stations located in commercial and/or industrial areas shall be chain link.
 - c. Chain Link Fence Materials. (All materials Class I Galvanized Coated.)
 - 1) Fabric shall be 6' high, ends twisted and barbed, commercial grade 9 gauge. 2" mesh with galvanized coating.
 - 2) End, cover and pull posts to be 2 ½" O.D. galvanized coated.
 - 3) Top and line posts to be 2" O.D. galvanized coated.
 - 4) Bottom tension wire shall be 7 gauge spring coil wire with galvanized coating.
 - 5) Barb wire shall be 12 ½ gauge galvanized twisted line wires with four point, 14 gauge barbs spaced 5" on centers, three (3) rows of outward facing barbed wire shall be used.
 - 6) Gate posts shall be 3" O.D. galvanized coated.

- 7) Gate shall be a pair of 10' long 6' high sections constructed of 2" O.D. pipe. Gate shall be equipped with a prop post center latch and hasp assembly. A ground anchor cast in concrete shall be provided. Gates shall be factory fabricated and equipped with gate hold backs. Panel shall have a horizontal brace center of fabric height.
6. Design gate to allow entrance of service trucks and vacuum truck without blocking the main roadway.
7. Design site layout to allow access of service trucks and vacuum truck to the wetwell.
8. Power pole should be located within the fence area and should be located in such a manner so the electric meter can be easily read from outside the fenced area.
9. All power lines within the site shall be underground. No overhead power line will be allowed to cross the site.

I. SPARE PARTS FOR SUBMERSIBLE PUMP STATION

1. Contractor shall furnish on or before final inspection spare parts identified in Section 17.

SECTION 17

SANITARY SEWER PUMP STATION MATERIALS FOR CONSTRUCTION

SECTION 17

SANITARY SEWER PUMP STATION

MATERIALS FOR CONSTRUCTION

A. WETWELLS

1. Use manhole sections complying with Section 11.
2. Wetwell structure.
 - a. Comply with pump station details.
3. Wetwell vent:
 - a. Cast iron vent cap.
 - 1) Josam Model 26704.
 - 2) Smith Model 1744.
 - b. 4" ductile iron connection pipe.
 - c. Finish:
 - 1) Primer - one (1) coat of Tnemec Polyuraprime.
 - 2) Paint - two (2) coats of Tnemec Epoxy Polyurethane Series 66 or 69 high build epoxoline at 5 mil's thickness.
4. Cable holders:
 - a. Use six (6) hook, 316L stainless steel
 - b. Acceptable manufacturer: Halliday Metals.
5. Interior piping and wetwell coating:
 - a. Provide 125 mills of Raven 405 Epoxy.
6. Other pump station appurtenances.
 - a. Comply with pump station details.

B. SUBMERSIBLE PUMP STATION

1. Acceptable pump manufacturer: Flygt, Fairbanks Morse, and ABS.
2. Provide a service engineer for the following periods of time for each pump station.
 - a. Start-up and performance testing: One day - One trip.
3. Spare parts:
 - a. Provide the following minimum spare parts:
 - 1) One of each seal assemblies.
 - 2) One complete set of bearings.
 - 3) One set of wear rings.
 - 4) One of each type relay.
 - 5) One pump starter.
 - 6) One pump alternator.
 - 7) One float switch with cable.
 - 8) One of each type pilot light.
 - 9) One box of each type lamp.
 - b. Two (2) complete sets of record drawings for wetwell, electrical, electronic schematics (and six (6) copies of O&M Manuals, with factory pump curves for pumps installed), copies of all certified test and inspection data, and a completed start-up report by the pump manufacturer.
 - c. Package in one container all spare parts and clearly identify on the outside what the unit is for.
 - 1) Seal tightly, properly protect for long term storage, and deliver to the Department.
4. Warranty:

- a. The pump manufacturer shall warrant the units being supplied against defects in workmanship and material for a period of five (5) years or 10,000 hours under the Municipal Wastewater Permanent Installation Warranty Policy under normal use, operating and service. The warranty shall be in printed form and apply to all similar units.

5. Pumps:

- a. General:

- 1) ANSI 125 lb standard cast iron flange fitting or cast with volute.
- 2) Pump components: cast iron, ASTM A48, Class 30.
- 3) All exposed fasteners and washers: Type 316L stainless steel.
- 4) Pump lift handle:
 - a) Type 316 stainless steel.
- 5) Coating:
 - a) All components coming into contact with sewage, except stainless steel, with a sewage resistant coating.
 - b) Pump exterior: PVC epoxy primer and a chlorine rubber paint finish.

- b. Impeller:

- 1) Double shrouded non-clog type.
- 2) Gray cast iron, Class 30, balanced dynamically to 0.5".
- 3) Paint with one coat of alkyd resin primer.
- 4) Provide wear ring consisting of a replaceable stationary ring made of brass, drive fitted to the volute inlet.
- 5) Sliding fit between the impeller and the shaft with one key.

- c. Volute:

- 1) Single piece, non-concentric design.

- d. Shaft:

- 1) Less than 10 Hp ANSI Type 420 stainless steel.
- 4) 2) 10 Hp and above chrome plated steel.

e. Bearings:

- 1) Two (2) permanently lubricated bearings.
- 2) B-10 bearing life of 50,000 hours.
- 3) Upper bearing: single deep groove ball bearing.
- 4) Lower bearing: two row angular contact ball bearing.

f. Watertight seals:

- 1) Nitrile rubber o-rings.
- 2) Fittings:
 - a) Accomplished sealing by metal-to-metal contact between machined surfaces.
- 3) Gaskets, elliptical o-rings, grease or other devices are not acceptable.

g. Mechanical seals:

- 1) Tandem mechanical shaft seal system.
- 2) Operate the upper of the tandem set of seals in an oil chamber.
- 3) Upper seal set: one stationary tungsten carbide ring soldered to a holder of stainless steel and one positively driven rotating carbon ring to function as an independent secondary barrier between the pumped liquid and the stator bearings.
- 4) Lower seal set: a stationary ring soldered to a holder of stainless steel and a positively driven rotating ring, both of tungsten carbide.
 - a) Hold each interface in contact by its own spring system.

- 5) Require neither maintenance nor adjustment, easily inspected and replaced.
 - 6) Provide all seal hardware of stainless steel.
6. Pump motor:
- a. General:
 - 1) Submersible, explosion proof type, designed for continuous duty, capable of sustaining a minimum of fifteen (15) starts per hour.
 - 2) Integral motor and pump.
 - 3) Air filled, squirrel cage induction, shell type design, Class F insulation system, Class F materials rated for continuous duty in 40°C (104°F) liquids.
 - 4) Cast iron motor frame and end shields.
 - 5) Stainless steel hardware and shaft.
 - 6) Service factor: 1.15.
 - 7) Stator:
 - a) Heat-shrink fitted to shaft.
 - b) Dip and bake in Class F varnish.
 - c) Do not use bolts, pins or other fastening devices requiring penetration of the stator housing.
 - 8) Aluminum rotor bars and short circuit rings.
 - b. Cable entry water seal system.
 - 1) Single cylindrical elastomer grommet, flanked by stainless steel washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable.
 - 2) Bear assembly against a shoulder in the pump top.

- 3) Separate the cable entry junction chamber and motor by a stator lead sealing gland or terminal board to isolate the motor interior from foreign material gaining access through the pump top.
 - a) Do not use epoxies, silicones, or other secondary sealing systems.
- c. Provide pre-lubricated bearings:
 - 1) Minimum B-10 life of 50,000 hours.
- d. Thermal protection:
 - 1) Motor rated thermally to NEMA MG1-12.42.
 - 2) Three (3) thermostatic switches (one in each phase) in the stator windings.
- e. Junction chamber:
 - 1) Seal from the motor by elastomer compression seal (o-ring).
 - 2) Connect between the cable conductors and stator leads with threaded compressed type binding, post permanently affixed to a terminal board.
7. Discharge connection:
 - a. Permanently installed discharge connection system.
 - b. Pump(s) automatically connected to the discharge connection elbow when lowered into place.
 - 1) Easily removed for inspection or service.
 - c. Accomplish sealing of the pump unit to the discharge connection elbow by a simple linear downward motion of the pump.
 - d. Stainless steel sliding guide bracket to be an integral part of the pump unit.
 - e. Guide the entire weight of the pumping unit by no less than two guide bars and press tightly against the discharge connection elbow with metal-to-metal contact.

- f. A diaphragm, o-ring or other devices to interface sealing of the discharge are not acceptable.
 - g. No portion of the pump to bear directly on the floor of the sump.
8. Discharge elbow:
- a. Gray cast iron: ASTM A48, Class 30.
 - b. Vertical leg:
 - 1) ANSI Class 125 lb. flange.
 - c. Provide integral cast iron base.
 - d. If necessary, size elbow with a reducer to match discharge piping.
 - e. Provide a discharge elbow capable of accepting a Flygt pump with no modifications.
9. Guide rails (per pump):
- a. Provide two lengths of Schedule 40, Type 316 stainless steel pipe, with diameter as specified by manufacturer.
 - b. 316 stainless steel bottom and top pilots.
 - 1) Acceptable manufacturer: Halliday Metals.
10. Pump guides:
- a. Attach to pump volute with stainless steel hex head cap screws.
11. Lift chain:
- a. Provide each pump and motor with adequately sized Type 316 stainless steel lifting chain.
 - 1) Minimum ¼" welded stainless steel link chain.
 - b. Length to reach top of station plus an additional 6'.
 - c. Attach upper end of chain to wetwell access frame with Type 316 stainless steel clip and stainless steel eye nut.

- d. Connect chain to pump using Type 316 stainless steel screw pin and shackle.
12. Hardware:
- a. All bolts, machine screws, nuts, washers, and lockwashers for complete assembly of wetwell access cover, guide rails, and discharge elbow to be Type 316 stainless steel.
13. Wetwell access:
- a. Fabricate from welded aluminum sections.
 - b. Provide dual hinged door of 1/4" aluminum treadplate for each pump.
 - c. Flush upper surface.
 - d. Fit door with recessed latch.
 - e. Provide safety hatch.
 - f. All hardware: Stainless steel.
 - g. Type 316 stainless steel support bracing with a self-locking hinge mechanism.
 - h. Acceptable: Halliday Metals, Bilco, or Flygt.
14. Pump control panel:
- a. Enclosure:
 - 1) Code gauge stainless steel: NEMA 12, gasketed with drip shield.
 - a) Provide for rack mounting with exterior flanges.
 - b) Provide leg stand kit for enclosures with a height greater than 48".
 - 2) Single 3-point locking latch.
 - a) Attach with stainless steel screws.
 - 3) Removable aluminum inner swing panel.

- a) Minimum thickness of 0.125".
 - b) Continuous stainless steel piano type hinge.
 - c) Minimum horizontal swing of 90°.
- 4) Use removable aluminum back panel.
 - a) 0.125" minimum thickness.
 - b) Attach to enclosure on collar studs.
 - c) Do not use self-tapping screws.
 - 5) Engraved nameplates on door mounted hardware.
 - a) Attach with stainless steel screws.
- b. Motor starting components:
- 1) NEMA rated magnetic motor starters.
 - a) Acceptable products: Square D (Class 8606), or General Electric.
 - b) Use motor starter contacts easily replaceable without removing the motor's starter from its mounted position.
 - c) Provide phase failure, undervoltage release and overload protection on all three phases.
 - i) Acceptable product: Allen Bradley 813S or Diversified SLA-230-ASA.
 - d) For motors 20 hp or less in size provide open frame, across the line, type.
 - e) For motors larger than 20 Hp in size provide open frame, reduced voltage, closed transition type.
 - f) The Department may require the use of VFD's in a climate controlled panel. Acceptable manufacture shall be Allen Bradley.
 - 2) Circuit breaker and operating mechanism:

- a) Provide thermal magnetic air circuit breaker having a minimum symmetrical RMS interrupting rating of 10,000 amperes at 240V or 14,000 amperes at 480V.
 - b) Provide padlockable operating mechanism on each motor circuit breaker.
 - c) Locate mechanism operator handles on exterior of the inner swing panel with interlocks which permit the panel to be opened only when circuit breakers are in the OFF position.
 - d) Provide Square D or General Electric.
- c. Components:
- 1) Provide "H-O-A" switches for each motor.
 - a) UL rated, heavy duty, 600 VAC, NEMA 4X, oil-tight switches.
 - b) Acceptable products: Allen Bradley 800H or Square D Class 9001 SK.
 - c) "Hand" position not to override motor overload shutdown.
 - 2) Provide the following components with the panel:
 - a) Pilot run light for each motor.
 - b) Lockable enclosure.
 - c) Condensation heater.
 - d) High level alarm indication light.
 - e) Alarm bell silence.
 - f) GFI 20A duplex receptacle with stainless steel cover.
 - g) Weatherproof switch for flood lights.
 - h) Control relays.
 - i) Remote alarm terminals.

- j) “Seal failure” indicator lamp.
 - k) “High temperature” indicator lamp.
 - l) “Power on” indicating lamp.
 - m) Temperature failure test push-button.
 - n) Seal failure test push-button.
 - o) Temperature and seal failure resets.
- 3) Provide spring-loaded test switches.
- a) Return to normal position when released.
 - b) Arrange float switches from left to right as follows:
 - i) A “Momentarily On” switch for the pumps off float.
 - ii) A “Momentarily Off” switch for the pumps off float.
 - iii) A “Momentarily On” switch for the lead pump float.
 - iv) A “Momentarily On” switch for the lag pump float.
 - v) A “Momentarily On” switch for the high level alarm float.
- d. Pump alternator relay:
- 1) Provide electrical/mechanical industrial design, Class 47.
 - a) Acceptable product: Model 47AB10AF by Furnas Electric.
 - 2) Provide pump sequence selector switch.
 - a) Provide manual selection of either Pump No. 1 or No. 2 as the “LEAD” pump.

- b) Acceptable products: Allen Bradley Series 800H or Square D Class 9001SK.
- e. High temperature shutdown:
 - 1) Provide high temperature shutdown for each motor utilizing the temperature switches embedded in the motor windings.
 - a) Under high temperature conditions the switch shall open, de-energize the motor starter and stop the pump motor.
 - b) Automatic reset type.
- f. Moisture detector control (seal failure):
 - 1) Provide for each pump a float switch sensor to detect moisture in the stator chamber.
 - 2) Detection of moisture by the sensor shall disrupt the motor starting circuit of the pump.
 - 3) Motor shall remain inoperative until problem is corrected and the control circuit is manually reset.
- g. Provide overload reset device:
 - 1) Operable without opening the inner swing panel.
- h. Provide the following components mounted on the back plate:
 - 1) 120V control circuit transformer (open core and coil type) with primary circuit breaker and secondary circuit breakers for (for 240V installations no control transformer is required):
 - a) Control.
 - b) Duplex receptacle.
 - c) Condensation heater.
 - d) Flood light (100 watts).
 - e) Remote telemetry unit (1200 watts minimum).
 - f) Gas alarm panel (300 watts).

- g) High Level alarm light and bell.
 - h) Generator auxiliaries.
 - 2) Lightning arrestor.
 - a) Acceptable product: Delta Type "LA".
 - 3) Provide power terminals and control terminals.
- i. Design control sequence so that panel is functioning automatically again after a power failure and manual reset is not necessary.
 - 1) Provide a time delay relay to prevent both pumps from starting simultaneously after power failure.
- j. Provide a terminal board for connection of line, pump leads, level sensors and remote power and alarms.
- k. Provide elapsed time meter wired to each motor starter at the bottom of the heater block.
 - 1) Six digit, non-resettable.
 - 2) Indicate total run time in hours and tenths.
- l. Provide high water alarm activated by mercury float switch.
 - 1) Front panel mounted silence switch.
 - 2) 120V AC.
 - 3) Utilize standard 40 watt incandescent bulb, vapor tight, alarm light with red globe, guard and mounting hardware.
 - a) Mount on side of panel.
 - b) Provide threaded type globe.
 - 4) 120V AC alarm bell
 - a) Weatherproof housing
 - b) Mounting lugs
 - c) Conduit tap

- d) Acceptable product: Edwards No. 340-4N5/348
- 5) Bell and light
 - a) Operate simultaneously under alarm conditions.
 - b) On at high level.
- m. Provide a motor ammeter:
 - 1) Panel mounted.
 - a) Scale range greater than pump rating.
 - b) Provide an "Off-L1-L2-L3" selector switch.
 - c) Provide a "Pump 1 - Pump 2" selector switch.
 - d) Acceptable manufacturer: General Electric.
- n. Control relays:
 - 1) Heavy-duty industrial grade, tube base, plug-in type.
 - 2) Silver cadmium oxide contacts and LED indicating light.
 - 3) Acceptable products:
 - a) Allen Bradley, Bulletin 700, Type H.
 - b) Square D, Class 8501, Type K
- o. Electrical schematic:
 - 1) Provide a number indexed, laminated electrical schematic diagram of the pump controls including terminal board connections.
 - 2) Permanently mount on the inside of the enclosure door.
- p. Attachment screws.
 - 1) 316 stainless steel.
- q. Wiring:

- 1) Factory wired completely, except for power supply, motor, temperature switches and moisture sensor, connections, and mercury float switches. Provide terminal strip for all exterior connections.
 - a) Comply with applicable standards of National Electric Code.
 - b) Color code and number as indicated on factory wiring diagram.
 - c) Control wire: MTW 90°C #14 AWG.
 - 2) Electrically ground all components to a common ground screw mounted on the removable back panel.
 - 3) Group all wiring in plastic wire troughs except wiring from the 14 gauge backplate to the door shall be done in separate bundled harnesses for control circuits.
 - 4) Provide sufficient motor lead wiring and float control wiring to make connections in the junction box.
- r. Level control and motor power cable:
- 1) Provide cable of adequate length to terminate in control panel junction box without splicing.
- s. Acceptable manufacturer:
- 1) Control panel: Sta Con, Control Interface, or as approved by the Department.
 - 2) Switches, push-buttons and indicator lamps:
 - a) Allen Bradley Series 800H or Square D Class 9001 SK.
- t. Remote alarm contacts and terminals to RTU:
- 1) Provide contacts for the following:
 - a) Motor overload (all pumps).
 - b) Over temperature (all pumps).

- c) Moisture (seal failure) - (all pumps).
- d) Power off.
- e) High level.
- f) Pump on (all pumps).
- g) Phase failure.

15. Pressure gauges:

- a. Provide on the discharge side of the gate valves after the true wye.
- b. Range - nearest available upper range above pump shut off head.
- c. Provide rounded type, stainless steel case, 4 ½" nominal diameter with phosphor-bronze bourdon tubes, glycerin filled, ½" NPT bottom male threaded connections, stainless steel rack and pinion movement, black micro-adjusted corners and black figures with white plastic dials, and a threaded ring.
 - 1) Acceptable product: Ashcroft Model No. 1279SSL (specify Range).
- d. Gauge accuracy:
 - 1) Within ½ % of the total scale range.
- e. Provide diaphragm isolators on all gauges.
 - 1) Provide diaphragm material resistant to chemicals in the process line being measured.
 - a) Acceptable product: Ashcroft Diaphragm Isolator/Seal Flushing Type – Model No. 50-101SS-04T-CG.
- f. Gauge connections to consist of the following:
 - 1) ½" Type 316 stainless steel shutoff valve with Viton seals.
 - a) Acceptable product: Whitey ball valve.
 - 2) ½" stainless steel piping connections.

16. Gas detection system.

- a. Provide combustible gas sensor module suitable for installation in wetwell. (SMC Model 201 from J.H. Instruments, Charlotte, NC (704)527-6920).
- b. Provide dual channel gas alarm panel for local alarm. (SMC Model 2102 from J.C. Instruments, Charlotte, NC (704)527-6920).

C. GRINDER STATIONS

It is not the policy of Department to allow grinder pump stations. However, under unusual conditions that arise, where normal installation of the standard pump station cannot be implemented, Department will consider such installations after all other possibilities have been exhausted. When it has been approved, the following criteria will be used.

1. Duplex station only - with guide rails.
2. No motors larger than 3 Hp.
3. Only ABS Piranha S-Series will be allowed.
4. A 4' diameter precast concrete wetwell may be used.
5. All discharge piping shall be arranged same as standard pump stations. No valve vaults will be accepted.
6. Furnish control panel as specified in Part B.14 of this Section.
7. All piping shall be 304SS.

D. LEVEL CONTROL SYSTEM

1. Use four (4) mercury ultrasonic float switches for pump stations less than 5 Hp. For pump stations 5 Hp and larger use two (2) float switches and an ultrasonic level transmitter.
2. Floats
 - a. Single action design.
 - b. Capable of withstanding water penetration under 25' of water.
 - c. 3 to 1 safety factor, minimum.
 - d. Use integrally weighted floats, do not use float switches that require pole mounting.

3. Ultrasonic level transmitter:
 - a. Provide a microprocessor based echo-time measuring type consisting of a transmitter and transducer.
 - b. Transducer:
 - 1) Internal temperature sensor.
 - 2) Range of the transducer: 1' to 50'.
 - 3) KYNAR transducer housing.
 - 4) 1" NPT conduit connection.
 - 5) Operating ambient temperature shall be -40°F to 203°F.
 - 6) 6-degree beam angle.
 - 7) Adequate cable to run to transmitter location.
 - 8) Acceptable product: Milltronics Echomax XPS-15.
 - c. Transmitter:
 - 1) Mount inside pump station control panel.
 - 2) Suitable for operation from a 100-230 VAC $\pm 15\%$ @ 50-60 Hz power supply or a 12-30 VDC power supply, depending on application.
 - 3) NEMA 4X polycarbonate enclosure.
 - 4) Operating ambient temperature shall be -58° to 302°F.
 - 5) Outputs:
 - a) 4-20mA into 750 ohms (isolated).
 - b) 1 form C, SPDT multi-purpose relay rated at 5A/250 VAC non-inductive.
 - 6) Programming: Enter all parameters and commands via a hand-held infrared keypad.

- 7) Multi-field backlit LCD indicator, with parameters displayed during setup and with eight digits for totalizer.
 - 8) Range: 1 to 50', depending on transducer.
 - 9) Acceptable product: Milltronics Hydro-Ranger 200.
 - d. Ultrasonic level transmitter shall not be used as an alternating method of pump control.
4. Provide for duplex operation:
 - a. Utilize "LEAD/LAG" principal using four (4) float switches.
 - 1) One for "LEAD" pump start.
 - 2) One for "LAG" pump start.
 - 3) One for a common "OFF" level.
 - 4) One in high level.
 - b. Design circuitry so that operation of the "LAG" pump start circuit is not contingent on proper operation of the "LEAD" pump start circuit.
5. Switches:
 - a. Mercury type.
 - b. Seal in a polypropylene housing.
 - c. No less than 40' of cable.
 - d. Polypropylene cord grips and mounting hardware.
6. Cable holder:
 - a. 316L stainless steel, six hook design.
 - b. Mount with 316 stainless steel anchors.
 - c. Acceptable manufacturer: Halliday Metals.
7. For pumps stations 5 Hp and larger, configure the control panel to allow the floats to control the pumps in the event the ultrasonic level fails.

E. CUSHIONED SWING CHECK VALVES

1. Cast iron body with bronze seating ring and stainless steel shaft for attachment of weight and lever with non-corrosive adjustable air cushioned shock chamber.
2. Mount the cushioned chamber to the side of the valve body with piston operating in the chamber which will prevent valve closing without any hammering action.
3. Shock absorption by air:

- a. Adjustable closing speed.
4. Approved manufacturer: G. A. Industries, Inc. Figure 250-D.

F. PLUG VALVES

1. One on each discharge pipe to permit either or both pumps to be isolated from the header.
2. Plug valves shall comply with AWWA Standard C517

G. Addition to Existing Supervisory Control and Data Acquisition System (SCADA)

1. Provide remote telemetry unit (RTU) located at the pump station complete with radio modem that will provide communications medium between the Department's master station and the RTU.
2. System shall be configured using Allen Bradley PLC and Electronic Systems Technology (EST) hardware.
3. Radio modem shall operate on a frequency compatible with the Department's existing equipment (verify).
4. Add the RTU to the appropriate screen on the Department's existing RSView32 software at the master station.
5. The RTU shall consist of, but not be limited to, the following:
 - a) An Allen-Bradley Micrologix PLC controller.
 - b) An Electronic Systems Technology Esteem radio modem of frequency to match existing system.
 - c) Wall or rack mounted NEMA 4 white fiberglass enclosure having 3-point locking handle and latch and necessary backplate (40"x32"x12").
 - d) Miscellaneous associated electrical components and hardware.
 - e) Surge arrestors.
 - f) Unit shall contain 12 digital inputs and 6 outputs (connect pump station alarms and control as directed by Owner).

- g) A 5 element Yagi antenna and 25 feet (minimum) of RG-8 coax cable.
 - h) Necessary wiring, labels and mounting hardware.
 - i) A 60-foot tall Class 3 pressure treated pole may be required to support the antenna. Contact the Department to determine if this will be a requirement for each pump station site.
6. The RTU shall monitor the following:
- a) Motor overload (all pumps).
 - b) Over temperature (all pumps).
 - c) Moisture (seal failure) - (all pumps).
 - d) Power off.
 - e) High level.
 - f) Pump on (all pumps).
 - g) Phase failure.
 - h) Transfer switch position.
 - i) Generator running.
 - j) Generator alarm.
 - k) Low fuel alarm.
7. Acceptable system supplier: RCI Enterprises, Inc.

SECTION 18

SANITARY SEWER PUMP STATION CONSTRUCTION PROCEDURES

SECTION 18

SANITARY SEWER PUMP STATION

CONSTRUCTION PROCEDURES

This section covers construction procedures normally required for work. It does not cover any special construction procedures which may be encountered for abnormal conditions.

Special construction procedures are to be presented to the Department by the Developer's Design Engineer.

A. GENERAL

1. An inspection of the rebar and electrical conduit by the Department will be required prior to the pouring of any concrete.
2. Contact the Department to schedule an inspection.

B. SUBMERSIBLE SEWAGE PUMPS

1. Use base plate as a template for drilling individual hole patterns.
 - a. Mount base plates using $\frac{3}{4}$ " Type 316 stainless steel expansion anchors.
2. Set up 60° slope on both sides of wetwell using portland cement grout.
3. Assemble guide rails to access frame and plumb the assembly.
4. Install float switch cable holder and/or ultrasonic level transmitter hanger to precast top:
 - a. Use Type 316 stainless steel anchors.
5. Install pumps and piping, plumbing assembly for proper alignment and fit.
6. Seal around inlet and discharge piping with non-shrink grout.
7. Install power cables using cable strain reliefs and cord grips (stainless steel).

8. Field wiring:

- a. Extend grounding wire from control panel main ground screw to external ground as shown in details.
 - 1) Comply with NEC and local electrical codes.
- b. Make motor lead, mercury float switch, temperature sensor, moisture sensor, and power supply connections.
- c. Seal all conduits between junction box and control panel as shown in details.
 - 1) Comply with all pertinent National Electric Code requirements.
- d. Seal conduit terminations in control panel with duct seal.
- e. Use licensed personnel.

3. Pump testing:

- a. Provide the following inspections and tests on each pump before shipment from factory by the manufacturer:
 - 1) Check impeller, motor rating and electrical connections for compliance to the customer's purchase order.
 - 2) Make a motor and cable insulation test for:
 - a) Moisture content.
 - b) Insulation defects.
 - 3) Prior to submergence, run the pump dry to establish correct rotation and mechanical integrity.
 - 4) Run the pump for 30 minutes submerged, at a minimum of 6' underwater.
 - 5) After operational test No. 4, perform the insulation test (No. 2) again.
 - 6) Supply a written report stating the foregoing steps have been done with each pump at the time of shipment.

- b. Provide the following tests after installation:
- 1) In presence of the Developer's Engineer and the Department:
 - a) Remove pump from structure.
 - b) Replace, demonstrating proper alignment and operation of mating parts.
 - 2) Operate pumps utilizing manual and automatic modes.
 - 3) Demonstrate proper operational sequences, including alarm conditions.
 - 4) Measure amperage, voltage, pumping rate and discharge pressure for:
 - a) Each pump operating separately.
 - b) Both pumps operating simultaneously.
 - 5) The design engineer shall conduct testing of pump station pumps and controls to verify operating parameters are met per design criteria. The design engineer shall be responsible for coordinating the pump manufacturers, the Department representative, and the contractor for draw down testing.
 - 6) The design engineer shall submit six (6) copies of final test report to the Department.

C. REMOTE TELEMETRY UNIT (RTU)

1. Install in strict accordance with the details and the manufacturer's recommended installation procedures.
2. Upon completion of the installation a joint inspection shall be conducted of the installed equipment by a Tegron representative and a Department Inspector.
3. The Department shall be responsible for placing the RTU in operation.

SECTION 19

SAND, OIL, AND GREASE INTERCEPTOR

SAND, OIL AND GREASE INTERCEPTOR

This section includes guidelines for design and installing a sand, oil and grease interceptor.

A. GENERAL

1. Grease, oil, and sand interceptors or traps shall be provided when, in the opinion of the Department, they are necessary for the proper handling of liquid wastes containing grease in excessive amounts, any flammable wastes, sand, grit, or other harmful ingredients. All interceptors or traps shall be of a type and capacity approved by the Department and shall be located so as to be readily and easily accessible for cleaning and inspection. All interceptors shall be supplied and properly maintained continuously in satisfactory and effective operation by the Owner at his expense.
2. It is the intent of the Department to provide for specific standards for grease trap location, design, installation, construction, operation and maintenance so as to comply with the above requirements. It should be noted that failure to comply shall be considered violation subject to applicable penalties and/or denial or discontinuance of water and/or sewer service.

B. DEFINITIONS

1. Food Service Establishment

Any commercial facility discharging kitchen or food preparation wastewaters including restaurants, motels, hotels, cafeterias, hospitals, schools, bars, etc. and any other facility which, in the Department's opinion, would require a grease trap installation by virtue of its operation. Such definition normally includes any establishment which is required to have a South Carolina Department of Health and Environmental Control (SCDHEC) food service license.

2. Grease Trap/Grease Interceptor

The device which is utilized to effect the separation of grease and oils in wastewater effluents from food service establishments. Such traps or interceptors may be of the "outdoor" or "underground" type normally referred to as large grease interceptors. However, for the purposes of this Standard, the words "trap" and "interceptor" are generally used interchangeably.

C. GENERAL REQUIREMENTS

The following administrative, operational, and other general requirements are applicable to all food service establishments, new or existing. Particular requirements for grease trap/interceptor construction, specifically pertaining to both new and existing food service establishments, can be found in Section D of this Standard.

1. All food service establishments in the Department's sewer service area shall have grease handling facilities approved by the Department. Establishments whose grease handling facilities are not in accordance with this Standard shall be given a compliance schedule with a deadline not to exceed three (3) months from initial notification date.
2. All food service establishment grease handling facilities/operations shall be subject to periodic review, evaluations, and inspections by the Department representatives at any time.
3. Violations of the Department's Grease Trap and Grease Interceptor Standard will be considered grounds for discontinuance of water and/or sewer service.
4. In the maintaining of the grease interceptors, the Owner(s) shall be responsible for the proper removal and disposal by appropriate means of the captured material by the Department's Wastewater Collection Department. Any removal and hauling of the collected materials not performed by Owner(s) personnel must be performed by currently licensed waste disposal firms.
5. All grease traps/interceptors shall be designed, installed and located in accordance with this Standard to allow for complete access to inspection, maintenance, etc.
6. All grease traps/interceptors must be installed by properly licensed plumbing contractors.

D. CONSTRUCTION STANDARDS

1. New Facilities
 - a. All newly constructed (or newly located) food service establishments shall be required to install a grease interceptor, approved by the Department. Grease interceptors shall be sized at 20 gallons per food service seat, with no interceptor less than 1,000 gallons total capacity, unless such interceptors are not feasible to install.
 - b. All grease trap/interceptor plans and specifications must be reviewed and approved by the Department prior to installation. An approval

letter for each new trap will be issued by the Department prior to construction and/or installation.

- c. The construction and location criteria for grease interceptors shall be in accordance with Environmental Protection Agency (EPA) Guidance Document, "On site Wastewater Treatment and Disposal Systems," Chapter 8. Typical construction detail drawings for acceptable grease traps are attached to this Standard.
- d. All grease interceptors, whether singular or in series, must be directly accessible from the surface and must be fitted with an extended outlet sanitary tee that terminates 6" to 12" above the tank floor. The minimum access opening dimensions shall be 18" x 18" or a minimum of 24" in diameter. Two (2) access openings (inlet and outlet) to underground traps are required and should be removable with ease by one person.

See typical detail for 1,000 gallon capacity trap in detail section.

- e. All below ground grease interceptors must either be two-chambered or individual tanks in series. If two-chambered, the dividing wall must be equipped with an extended elbow or sanitary tee terminating 6" to 12" above the tank floor. An extended outlet sanitary tee must also be provided at the outlet of the second chamber. Both chambers must be directly accessible from the surface. See drawings included in the detail section for underground type grease traps.
- f. Maintenance of grease traps/interceptors must include thorough pump-out and/or cleaning as needed, with a minimum frequency of four (4) times per year. The Owner is ultimately responsible for the proper maintenance of the grease trap facility(ies).
- g. No new food service facility will be allowed to initiate operations until grease handling facilities are installed and approved by the Department.

2. Existing Facilities

- a. All existing food service establishments (or renovated or expanded establishments) shall have grease handling facilities approved by the Department. Food service establishments without any grease handling facilities will be given a compliance deadline not to exceed three (3) months from date of notification to have approved and installed grease handling equipment in compliance with this Standard. Failure to do so will be considered a violation and will subject the establishment to penalties regarding water and/or sewer service discontinuance.

- b. Exclusive use of enzymes or other grease solvents, emulsifiers, etc. in lieu of physical cleaning is not considered acceptable grease trap maintenance practice.
- 3. New Food Service Establishments in Existing Buildings
 - a. Where practical, new food service establishments locating in existing buildings will be required to comply with the Grease Trap Standards applicable to new facilities, i.e., outdoor type grease trap units (minimum size 1,000 gallons) shall be installed.

E. SAND, OIL AND GREASE INTERCEPTOR

- 1. Provide precast concrete vault.
 - a. 4000 psi concrete.
- 2. See detail in Section 20.

F. LOCATING

- 1. Easily accessible for cleaning and solids removal.
 - a. Remove solids when approximately 75% of the interceptors capacity is reached.

G. MANHOLE FRAMES AND COVER

- 1. Provide grey iron castings, ASTM A48, Class 30 iron.
- 2. Machine all bearing surfaces.
- 3. Provide watertight covers, where below the 50-year flood elevation.
- 4. Acceptable manufacturers: Pamrex.