

SECTION 07000
WASTEWATER COLLECTION SYSTEMS

TABLE OF CONTENTS

- 07010 GRAVITY SEWERS
 - A. Design
 - B. Materials
 - C. Sewer Main Installation

- 07020 MANHOLES
 - A. Design
 - B. Materials
 - C. Installation

- 07030 SERVICE CONNECTIONS
 - A. Design
 - B. Materials
 - C. Installation

- 07040 TESTING AND INSPECTIONS
 - A. General
 - B. Sewer Main and Service Connection Testing
 - C. Manhole Testing

- 07050 AERIAL CROSSINGS

- 07060 REPAIRS
 - A. Sewer Main Repairs
 - B. Installation

07010 GRAVITY SEWER

A. DESIGN

1. Main Location

- a) All public sanitary sewer mains shall be installed in dedicated street right of way or in dedicated utility easements. Mains installed in Town right of way shall be located in the center of pavement. If the sewer main cannot practically be located in the center of the pavement it shall be located within the south or west side of the street. Mains within easements shall be centered within the easement unless otherwise approved by the Director of Engineering. Mains located within NCDOT right of way shall be placed in accordance with NCDOT standards.
- b) In preparing engineering design plans for sanitary sewer mains, all elevations shall be tied to NC grid system and the benchmark shall be described on the plans.
- c) All private sewer collection mains inside the Cary Utility Service area that will connect or are planning to discharge into the Cary sewer system shall comply with all Town of Cary design, siting and installation criteria outlined herein. The Owner of the private sewer collection system shall meet all State design requirements and obtain a State permit to operate the private system.
- d) Gravity mains shall be installed in dedicated public right of way or in dedicated utility easements as follows:

Standard Easement Width for Sanitary Sewer Mains

<u>Pipe Size</u> (diameter)	<u>Pipe Depth</u> (feet)	<u>Easement Width</u> (feet)
8-inch to 12-inch	10-ft or less	20-ft
8-inch to 12-inch	10-ft – 12.5-ft	25-ft
8-inch to 12-inch	12.5-ft – 15-ft	30-ft
8-inch to 12-inch	15-ft to 17.5-ft	35-ft
8-inch to 12-inch	17.5-ft to 20-ft	40-ft
12-inch to 24-inch	15-ft or less	30-ft
12-inch to 24-inch	15-ft – 17.5-ft	35-ft
12-inch to 24-inch	17.5-ft – 20-ft	40-ft
Greater than 24-inch	Any Depth	Specified by Town Engineer
Any Size	Deeper than 20-ft	Specified by Town Engineer

Dedicated easements for sewer mains and appurtenances shall be recorded as "Town of Cary Utility Easement". Town of Cary sewer easements shall contain only Town of Cary utilities unless otherwise approved by an encroachment agreement.

- e) No permanent structures, equipment, retaining walls, embankments, impoundments, or other elements that would inhibit maintenance operations shall be constructed within a sewer main easement as outlined in Section 2000. Fences may be allowed across easements provided that appropriate access gates have been installed to allow utility maintenance. In all cases, Town of Cary Operations Staff shall have access to secured access gates. Fill or cut slopes are not allowed to extend into easements without full development plan approval or an approved encroachment agreement from the Town of Cary, see Section 2000 for further information. All such pre-existing or planned conditions as noted herein that would impact operations and maintenance within the noted sewer main easement shall be noted and disclosed during the site plan approval process. Pre-existing conditions that are not disclosed during the site plan review may nullify the approval and require relocating the sewer easement where there are no existing conflicts.
- f) Sewer line easements shall be graded smooth, free from rocks, boulders, roots, stumps, and other debris, and seeded and mulched upon the completion of construction. Easements across sloped areas shall be graded uniformly across the slope to no steeper than a 5 to 1 ratio.
- g) Mains paralleling a creek shall be of sufficient depth to allow lateral connections below the stream bed elevation. The top of the sewer main and laterals shall be at least one foot below the stream bed. Concrete encasement and ductile iron pipe shall be required when the cover between the top of the pipe and the stream bed is less than 3 feet.
- h) Mains shall not be installed under any part of water impoundments.
- i) The following minimum horizontal separations shall be maintained:
 - i. 100 feet from any private or public water supply source, including wells, WS-1 waters or Class I or Class II impounded reservoirs used as a source of drinking water (except as noted below)
 - ii. 50 feet from any waters (from normal high water) classified WS-II, WS-III, B, SA, ORW, HQW or SB (except as noted below)
 - iii. 10 feet from any other stream, lake, or impoundment (except as noted below)
 - iv. 25 feet from private wells (with no exceptions)

- v. 50 feet from sources of public water supply (with no exceptions)

Where the required minimum separations cannot be obtained, ductile iron sanitary sewer pipe with joints equivalent to water main standards shall be used.

- j) In accordance with Policy Statement Number 23, sewer mains shall always be extended along natural drainage courses to the adjacent property line.
- k) Gravity sewer mains shall be deep enough to serve the adjoining property and allow for sufficient slope in lateral lines, and shall have the following minimum covers. These requirements may be waived at the direction of the Director of Engineering, in which case ductile iron pipe shall be installed.
 - 4 feet from the top of pipe to finished subgrade in roadways.
 - 3 feet from the top of pipe to finished grade outside roadways.
- l) Sewer mains over 30 feet deep require ductile iron for the entire run between manholes. In all cases where fill material is added above existing sewer mains, the Engineer of Record shall prepare a structural analysis of the existing pipeline and determine if it is capable of supporting additional loading. If the additional fill material exceeds AWWA, DIPRA, UNIBELL and/or manufacturer standards for loading, the pipeline shall either be reinforced to adequately support the additional loading or replaced with a ductile iron pipe rated to support the added loading.
- m) Separation Between Sanitary Sewer and Storm Water Pipes:
 - Sewer mains shall have a minimum vertical separation of 24 inches between storm pipes when the horizontal separation is 3 feet or less. Where sanitary and storm sewers cross with a vertical separation of less than 24 inches, the entire leg of sanitary sewer shall be made of standard ductile iron pipe with joints rated for water main service and the void space between the pipe crossing shall be backfilled with 3000-psi concrete or quick setting, minimum 500-psi, non-excavatable flowable fill that meets or exceeds NCDOT specifications.
- n) Separation Between Sanitary Sewer and Sewer Force Main:
 - There shall be a minimum 7 foot horizontal separation between parallel gravity and/or force mains when the depth of installation is 8-ft or less. Otherwise, the minimum horizontal separation between pipelines shall be 10-ft up to 10-ft depth of installation. Otherwise, a project specific design shall be implemented.
- o) Separation Between Sanitary Sewer and Water Main

- Parallel Installations: 10-ft lateral separation (pipe edge to pipe edge) or minimum 3-ft lateral separation, and water line at least 18-inches above sanitary sewer line measured vertically from top of sewer pipeline to bottom edge of water main. In unique cases where the sanitary sewer and the water main are installed with at least 3-ft of lateral separation but less than 10-ft of horizontal separation, and less than 18-inches of vertical separation, both the water main and sanitary sewer shall be constructed of ductile iron pipe with joints in full compliance with water main standards.

- Crossings (Water Main Over Sewer): All water main crossings of sewer lines shall be constructed over the sewer line in conformance with Town of Cary specifications. At a minimum, 18-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the sewer main. If 18-inches of clearance is not maintained, the water main and sanitary sewer main shall:
 - A) Both lines shall be constructed of ductile iron pipe with joints in conformance with water main construction standards.
 - B) The sanitary sewer pipe shall be ductile iron the entire run from manhole to manhole.
 - C) The void space between the pipes shall be filled with minimum 500-psi, quick setting non-excavatable flowable fill extending 3-ft on both sides of the crossing.
 Regardless of pipe material, at least 12-inches of vertical separation is required for both sanitary sewer crossings of potable water mains.

- Crossings (Water Main Under Sewer Line): Allowed only as approved by Town of Cary, when it is not possible to cross the water main above the sewer line. At a minimum, 18-inches of separation shall be maintained, (measured from pipe edge to pipe edge) and the sanitary sewer shall be constructed of ductile iron in conformance with water main construction standards the entire run from manhole to manhole. If local conditions prevent providing 18-inches of clearance, then at least 12-inches of clearance shall be provided and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

p) Separation Between Sanitary Sewer and Reclaimed Water

- Sanitary sewer and reclaimed water mains shall be laid with at least 10 feet of horizontal separation, measured laterally edge to edge unless the elevation of the bottom of the reclaimed water main is at least 18 inches above the top edge of the sanitary sewer, with a horizontal separation of at least 3 feet.

- Where a reclaimed water main and a sanitary sewer main cross, the crossing shall be constructed at a 90-degree angle and the sanitary sewer main shall cross at least 18-inches below the reclaimed water line. Because all reclaimed water mains in the Cary municipal system are constructed to fully comply with water system testing and integrity standards as described by 15A NCAC 18C, when the minimum separation cannot be met, at least 12-inches of clearance shall be maintained, the sewer main shall be provided in ductile iron pipe in full compliance with water main standards, and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.
- If the sanitary sewer crosses above the reclaimed water line, the clearance shall be at least 18-inches. Because all reclaimed water mains in the Cary municipal system are constructed to fully comply with water system testing and integrity standards as described by 15A NCAC 18C, when the minimum separation cannot be met, at least 12-inches of clearance shall be maintained, the sewer main shall be provided in ductile iron pipe in full compliance with water main standards, and the void space between the pipes shall be filled with minimum 500-psi, quick setting non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

2. Main Size, Slope and Design Criteria

- a) Public gravity mains shall be a minimum of 8 inches in diameter.
- b) Major interceptors shall be sized in accordance with the "Town of Cary Wastewater Collection System Master Plan". In areas not included in the master plan, interceptors shall be designed based on the proposed land use (according to the Town's Comprehensive Growth Plan), using the following flow factors. At a minimum, all gravity sewer mains shall be designed and sized to serve the ultimate tributary buildout of the drainage basin.

Residential flow rates:

Land Use	Flow Factor
Single Family Residential	280 gpd per dwelling unit
Multi-Family Residential	100 gpd per bedroom

Non-residential flow rates:

Use flow factors as required by the North Carolina Department of Environment and Natural Resources (at the time of this specification revision, these flow rates are contained in 15A NCAC 02T .0114).

For all other flow rates not listed in Section ii above, use:

Land Use	Flow Factor
Office and Institutional	0.09 gpd/sq.ft bldg. space
Commercial	0.12 gpd/sq.ft bldg. space
Industrial	0.20 gpd/sq.ft bldg. space

- c) The ratio of peak to average daily flow shall be 3.3.
- d) Sanitary sewers shall be designed to carry the projected peak flow at no more than 2/3 full. The minimum velocity for sanitary sewer lines shall be 3-fps. The minimum velocity may be reduced to 2.5-fps under limited circumstances only by approval of the Director of Engineering.
- e) Sanitary sewers shall be sized based on the Manning's Equation with Manning's roughness coefficient "n" = 0.013 or greater. Pipe diameter sizes used in the calculation of Manning's Equation shall be nominal pipe sizes.
- f) The minimum grades for public sanitary sewers shall be as follows:

Minimum Slopes for Gravity Sewer Mains

Main Size (diameter in inches)	Minimum Slope V=3.0ft/s, depth 2/3 full (feet per 100 feet) {standard required velocity}
8	0.61
10	0.46
12	0.36
14	0.29
15	0.27
16	0.25
18	0.21
21	0.17
24	0.14
27	0.13
30	0.11
36	0.09

Note1: All minimum slopes based on Manning's Equation

Note2: Manning's coefficient n = 0.013 used for all computations

- g) The minimum grade for the uppermost reach of a sanitary sewer line shall be 1% regardless of sewer line size.
- h) The maximum grade for sanitary sewers is 10%. The maximum velocity in sanitary sewers is 15 ft/sec. These limits may only be exceeded with the approval of the Director of Engineering and the incorporation of the following provisions, which apply to all sewers either designed or installed at grades equal to or exceeding 10%:
- i. All sewers with a grade of 10% or higher must have the downstream run of pipe installed with ductile iron pipe.
 - ii. High velocity manholes shall be used on all sewers with a grade of 10% or higher. High velocity lines cannot tie directly to an existing line and must proceed 180° through the invert into the downstream line.
 - iii. Concrete thrust collars shall be installed on all sewers designed at grades of 10% or higher. The anchors shall be installed at the following spacing:
 - Not over 36' center to center on grades from 10% to 25%
 - Not over 24' center to center on grades from 25% to 40%
 - Not over 16' center to center on grades exceeding 40%
 - iv. The Town reserves the right to require all high velocity requirements outlined herein for sewer lines either designed or installed at grades of 10% or greater, regardless of the flow velocity. In cases where the design grade established on the sewer design plan is exceeded during construction and the 10% threshold is exceeded, all high velocity requirements shall apply without waiver.
- i) Sewer extensions shall be designed for projected flows, even when the diameter of the receiving sewer is less than the diameter of the proposed extension.
- j) All pipe diameter changes shall occur only in manholes, with the invert of the larger pipe lowered sufficiently to maintain the same energy gradient. An approximate method of obtaining this result is to place the 0.8 depth point of both sewers at the same elevation. As an alternative, the crown of the incoming pipes may be designed for an elevation at or above the crown of the outgoing pipe.
- k) All transitions of pipe material, pipe separations, grade changes and all angular deflection changes shall occur only at manholes.

- l) Pipe trench excavation and backfilling shall be performed in accordance with Section 05000 of these Specifications.

B. MATERIALS

Materials specified herein are acceptable for sewer service as described herein. See Standard Procedure 120 for instructions on requesting new product approval.

1. DUCTILE IRON PIPE

a) Material Specifications

Ductile Iron Pipe shall be designed and manufactured in accordance with AWWA C150 and C151 and provided in nominal 20-ft lengths. The minimum requirements for ductile iron pipe and required laying conditions are tabulated below. For all other installations other than specified, the laying condition, bedding requirements or the minimum pressure class rating and/or thickness class shall be increased in accordance with AWWA C151. A pipe thickness design shall be submitted for external loading in all cases where the pipe depth exceeds the specified range of depths outlined in the following table.

Pressure Class, Max. Depth and Laying Condition for DI Sewer Mains

Pipe Diameter	AWWA C-150, Laying Condition	Pressure Class	Maximum Depth of Cover
8 -inch	type 1	350 psi	3-16 feet
8 -inch	type 4	350 psi	16-34 feet
10-12 -inch	type 1	350 psi	3-10 feet
10-12 -inch	type 4	350 psi	10-28 feet
10-12 -inch	type 5	350 psi	28-44 feet
14-20 -inch	type 4	250 psi	3-22 feet
14-20 -inch	type 5	250 psi	22-30 feet
14-20 -inch	type 5	350 psi	30-41 feet
24-30 -inch	type 4	250 psi	3-19 feet
24-30 -inch	type 5	300 psi	19-29 feet
24-30 -inch	type 5	350 psi	29-33 feet
36-42 -inch	type 4	300 psi	3-20 feet
36-42 -inch	type 5	350 psi	20-32 feet

Note: For cases not specified, a ductile iron pipe and bedding design certified by a Professional Engineer licensed in the State of North Carolina shall be required in compliance with AWWA C150 and the Ductile Iron Pipe Research Association.

In cases where thickness class designation of ductile iron pipe is specified, the corresponding thickness class designations are as outlined in the following table.

Ductile Iron Pipe Thickness Class

Pipe Diameter	Pressure Class	Nominal Thickness (inches)	Minimum Corresponding Thickness Class
4	350	0.25	51
6	350	0.25	50
8	350	0.25	50
10	350	0.26	50
12	350	0.28	50
14	250	0.28	50
16	250	0.30	50
18	250	0.31	50
20	250	0.33	50
24	250	0.37	50
24	300	0.40	51
30	250	0.42	51
30	300	0.45	52
36	300	0.51	52
36	350	0.56	53
42	300	0.57	52
42	350	0.63	53

Pipe joints shall be of the push-on type as per AWWA C111.

For 10-inch diameter and smaller gravity sewer mains, pipe lining shall be cement mortar with a seal coat of bituminous material, all in accordance with AWWA C104.

For 12-inch diameter and larger gravity sewer mains, all ductile iron pipe and fittings for sewer construction shall receive an interior ceramic epoxy coating, consisting of an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment, such as manufactured by Protecto 401. The interior coating shall be applied at a nominal dry film interior thickness of 40-mils. All DIP bells and spigots shall be lined with 8-mils of joint compound by Protecto 401 or approved equal applied by brush to ensure full coverage. All pipe supplied with Protecto 401 interior lining shall be provided free of holidays. Pipe installed with defects in the lining will be rejected and required to be replaced. Patching of Protecto 401 coating defects after installation shall not be approved.

All buried DIP and fittings shall have bituminous coating on the exterior surface in accordance with AWWA C151. Pipe shall be supplied in minimum 20-ft lengths unless otherwise approved by the Engineering Department.

All ductile iron pipes shall be marked in conformance with ASTM A-746.

2. **SOLID WALL PVC PIPE**

a) **Material Specifications**

PVC Pipe shall be solid wall and made of PVC plastic having a cell classification of 12454 or 12364 (with minimum tensile modulus of 400,000 psi) as defined in Specification D1784. PVC pipe shall have integral wall bell and spigot joints for the conveyance of domestic sewage and shall be supplied in minimum 14 or 20 ft lengths. Fittings shall be made of PVC plastic having a cell classification of 12454-B, as defined in ASTM D1784. All PVC gravity sewer pipe and PVC fittings up to 15-inches in diameter shall be manufactured in accordance with the latest version of ASTM D3034. All solid wall PVC pipe installed at diameters from 18-inches to 27-inches in diameter shall be manufactured in conformance with ASTM F679 and provided at minimum pipe stiffness of 115-psi. Fittings must be manufactured by pipe supplier or approved equal, and have bell and/or spigot configurations compatible with that of the pipe. Compounds with superior properties are also acceptable. PVC pipe shall be installed in accordance with the requirements of this specifications manual and ASTM D2321.

All PVC pipe up to and including 15 inches in diameter shall have a maximum Standard Dimension Ratio (SDR) of 35 for depth of installation no shallower than 4-ft of cover from the pipe crown and no deeper than 14-ft measured from the bottom of the pipe. All solid wall PVC pipe for depth of installation greater than 14-ft shall have a maximum Standard Dimension Ratio (SDR) of 26. Solid wall PVC pipe shall not be approved for depths of installation greater than 30-ft, unless otherwise approved by the Director of Engineering. All solid wall PVC pipe shall be marked and certified in conformance with ASTM D3034 or ASTM F679.

PVC Pipe Sizing and Minimum Wall Thickness

Nominal Pipe Diameter (inches)	Outside Diameter (inches)	Minimum Wall Thickness SDR 35 (inches)	Minimum Wall Thickness SDR 26 (inches)
8	8.400	0.240	0.323
10	10.500	0.300	0.404
12	12.500	0.360	0.481
15	15.300	0.437	0.588
18	18.701	-----	0.720
21	22.047	-----	0.849
24	24.803	-----	0.956
27	27.953	-----	1.077

Note: SDR 35 not approved for pipe diameters greater than 15-inches and for depths greater than 14-ft.

C. SEWER MAIN INSTALLATION

1. General Requirements

- a) Pipe trench excavation and backfilling shall be performed in accordance with Section 05000 of these Specifications.
- b) Transitions of pipe material, pipe separations, grade changes and all angular deflection changes shall occur only at manholes.
- c) All sewer mains installed with less than 4 ft of cover and deeper than 30-ft ft shall be ductile iron pipe.
- d) Pipe and fitting interiors shall be protected from foreign matter and shall be inspected for damage and defects prior to installation. In the event foreign matter is present in pipe and fittings, it shall be removed before installation. Open ends of pipe shall be covered and protected when pipe laying is not in progress to prevent debris from entering the pipe.
- e) All pipes shall be constructed with at least 48 inches of cover below the finished grade. Pipe shall be laid on true lines as directed by the Engineer. Trenches shall be sufficiently wide to adjust the alignment. Bell holes shall be dug at each joint to permit proper joint assembly. The pipe shall be laid and adjusted so that the alignment with the next succeeding joint will be centered in the joint and the entire pipeline will be in continuous alignment both horizontally and vertically. Pipe joints shall be fitted so that a thoroughly watertight joint will result. All joints will be made in conformance with the manufacturer's recommendations for the type of joint selected.

- f) Prior to beginning construction, the Contractor shall contact local utility companies and verify the location of existing utilities. The Contractor shall be completely and solely responsible for locating all existing buried utilities inside the construction zone before beginning excavation. The Contractor shall be solely responsible for scheduling and coordinating the utility location work. When an existing utility is in conflict with construction, it shall be exposed prior to beginning construction to prevent damage to the existing utility.

Bedding and embedment material classifications shall be defined as follows:

- CLASS I - Angular, (1/4 to 1-1/2 inch) graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, crushed gravel, and crushed shells.
- CLASS II - Coarse sands and gravels with maximum particle size of 1-1/2 inch, including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW and SP are included in this class.
- CLASS III - Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures, Soil Types GM, GC, SM, and SC are included in this class.
- CLASS IV - Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH and CL are included in this class. These materials shall not be used for embedment.

Class I foundation material consisting of 1/4-inch to 1 1/2 -inch graded stone shall be required in addition to standard bedding and embedment for all sewer installations, regardless of pipe material, when the trench bottom is unstable due to water, rock, infiltration or soil type.

All bedding, embedment and backfill materials shall be compacted to a minimum of 95% Standard Proctor density regardless of material. In instances where compliance with compaction requirements is questionable as determined by the Inspector, testing shall be provided by the Contractor and a reputable licensed Geotechnical Engineer to verify compliance.

The minimum trench width shall be one pipe diameter plus 9 inches on each side of the pipe as described in Section 5000.

In any area where the pipe will be installed below existing or future ground water levels or where the trench could be subject to inundation, additional Class I material shall be used for bedding.

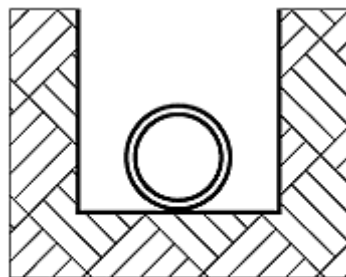
If hydraulic jack shoring is utilized for trench walls, it shall be restricted to the area just above the top of the pipe. This will ensure the embedment materials and pipe will not be disturbed when the shoring is removed.

2. DIP Specific Installation Requirements

Ductile iron pipe shall be installed in accordance with the requirements of AWWA C600 and the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association. Materials at all times shall be handled with mechanical equipment or in such a manner to protect them from damage. At no time shall pipe and fittings be dropped or pushed into ditches.

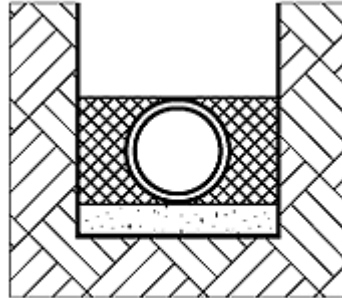
Pipe shall be installed at laying conditions as specified herein and identified by the plan drawings. Laying conditions for ductile iron pipe shall be as described in AWWA C151 and the Ductile Iron Pipe Research Association. Laying conditions shall be defined as follows:

Type 1: Flat Bottom Trench with Pipe Resting on Stable Undisturbed Earth. Unstable conditions such as wet trench bottoms, intermediate rock layering, partially weathered rock, and other unsuitable soil conditions shall require utilizing more stringent laying conditions. At a minimum, Type 4 laying condition shall be utilized with a minimum of 4-inches of bedding to overcome unstable conditions. For severe unstable soil conditions, undercut excavation and an engineer designed foundation plan shall be provided prior to pipeline installation.



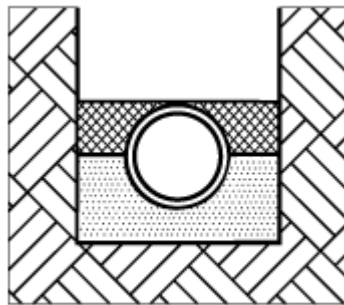
Type 1*

Type 4: Pipe bedded in Class 1 material, No. 67 or No. 78 crushed stone to a depth of 1/8 pipe diameter or a minimum of 4-inches. Embedment material consisting of Class 1, Class 2 or Class 3 materials shall be compacted to the top of the pipe greater than 95% Proctor. Careful attention must be allocated to compacting embedment material under the bottom edges of the pipe.



Type 4

Type 5: Pipe bedded in Class 1 material, No. 67 or No. 78 crushed stone to the center of the pipe and extending a minimum of 4-inches under the pipe. Granular or select embedment, consisting of Class 1 or Class 2 materials, compacted to greater than 95% Proctor installed to the top of the pipe.



Type 5

3. PVC Specific Installation Requirements

- a) The installation of PVC Pipe shall satisfy the requirements of the manufacturer, and/or the following, whichever is more stringent:
- b) For PVC pipe, the pipe shall be produced with bell and spigot end construction. Joining shall be accomplished by rubber gasket in accordance with manufacturer's recommendation, unless otherwise directed or approved by the Director of Engineering. Flexible watertight elastomeric seals in accordance with ASTM D3212-1 may also be used. Each pipe length shall be clearly marked with information including pipe size, profile number and class number.

c) Installation of PVC pipe shall follow the recommendations of ASTM D-2321 "Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications". For PVC pipe installation, bedding and embedment material shall be Class I, typically No. 67 or No. 78 washed stone. Bedding and embedment materials for PVC gravity sewers other than No. 67 or No. 78 washed stone shall be approved by the Town of Cary prior to use.

d) Typical Bedding and Embedment for SDR35 PVC Gravity Sewers, 4-ft to 14-ft in Depth.

Bedding shall consist of minimum 4-inches of No. 67 or No. 78 stone installed under the pipe extending up to the springline. Bedding and embedment shall be compacted to 95% standard proctor density. Careful attention shall be placed on compacting embedment under the haunches of the pipe to prevent any potential voids.

e) Typical Bedding and Embedment for SDR26 PVC Gravity Sewers, 14-ft to 30-ft in Depth.

Bedding shall consist of minimum 6-inches of No. 67 or No. 78 stone installed under the pipe extending 6-inches above the crown of the pipe. Bedding and embedment shall be compacted to 95% standard proctor density. Careful attention shall be placed on compacting embedment under the haunches to prevent any potential voids.

f) The bedding and embedment materials shall be in accordance with ASTM D-2321. The embedment materials shall be installed from trench wall to trench wall.

g) The maximum allowable deflection after installation shall BE LESS THAN 5% for PVC pipe.

h) All PVC pipe shall be stored properly to prevent UV damage prior to installation. Any PVC pipe with visible fading caused by UV radiation from sunlight shall be rejected.

i) All PVC pipe shall be free from nicks, scratches and gouges at the time of installation. Such defects can impact the strength of PVC pipe and all pipes with visible gouges shall be rejected.

07020 MANHOLES

A. DESIGN

1. Manhole Location, Siting and Design

- a) Manholes shall be spaced at a maximum distance of 400 feet for lines 12 inches in diameter or less, and 500 feet for lines greater than 12 inches in diameter.
- b) Manholes shall be installed at each deflection of line and/or grade. The flow channel through manholes shall have a uniform and smooth finish free of irregularities or obstructions. The invert channel shall conform to the shape and slope of the entering/exiting sewer line. Either pre-cast or brick and mortar inverts may be used.
- c) When sewers of uniform slope pass through a manhole, the slope shall be maintained and the invert at the center of the manhole shall be provided. When sewers change slope at a manhole, the incoming and outgoing invert elevations will be given on the plan drawings.
- d) The maximum flow deflection angle in a manhole shall be dependent upon pipe size as shown in the following table. Sufficient drop shall be provided in the manhole to compensate for energy loss caused by the change of alignment. A minimum drop of 0.1-ft is required for a change of alignment greater than 30-degrees.

Maximum Allowable Flow Deflection

Pipe Size (largest pipe controls)	Maximum Deflection Angle per Manhole
8-10 inch diameter	90 degrees
12-20 inch diameter	75 degrees
>20-inch diameter	60 degrees

- e) Free falls of wastewater flow into the manhole invert from incoming sewer mains shall not be allowed, except under limited circumstances.
- f) In certain isolated circumstances standard free drops may be allowed, not exceeding 20-inches, when pipe diameter changes occur at a manhole. In these cases, the smaller diameter pipe crown shall be positioned no higher than the larger diameter pipe crown to limit the drop. When free drops are necessary due to pipe size changes, the Contractor shall take preventive measures to prevent free drops into the manhole invert, such as building a flume or trough up to the incoming invert, or piping the flow to the primary invert flow channel.

- g) Drop manholes are not allowed without the written approval of the Engineering Department. While certain physical constraints may dictate the need for drop manholes, they may not be used merely to decrease trenching depth. Upstream slope changes shall be used to avoid the need for drop manholes.
- h) In the event that drop manholes are required, they shall be constructed with an outside drop connection. The entire incoming sewer main leading to the drop shall be made of ductile iron pipe. Drops shall be concrete encased and constructed in accordance with the Standard Details.
- i) Inside drop manholes shall only be allowed in unique circumstances on a limited basis and can only be approved by the Director of Engineering.
- j) Manholes shall not be obstructed from view or access. It is illegal to bury or obstruct access to manholes.
- k) Manhole covers shall be elevated as follows:
- Roadways: Manholes installed in roadways and road shoulders shall be installed with the cover flush with the top of pavement.
 - Outside of Roadways: Manholes installed outside of roadways shall be elevated at least 1-ft above the surface grade unless otherwise noted.
 - Wooded Outfalls: All manholes installed in wooded, forested or brushy areas shall be elevated at least 2-ft above the surface elevation.
 - 100-Year Flood Zone: All manholes located within the 100-year flood elevation shall be elevated at least 24 inches above the 100-year flood elevation or specify watertight covers and vents that extend at least 24 inches above the 100-year flood elevation.
 - Well Maintained Areas: All manholes installed in well maintained areas, such as yards, sidewalks or otherwise inside an improved right-of-way shall be installed flush with the finished surface.
- l) Manholes higher than 30 inches above finished grade shall be constructed with a flat top and outside steps.
- m) When connecting a new sewer main to an existing main, the connection shall be established with a "Doghouse" type of manhole inserted over the existing main.

2. Manhole Sizing

- a) Manholes shall be sized as shown in the following table. The next larger size shall be required if the pipe size, depth, drop connection or number of main line connections warrants a larger size. In consideration of main line connections, all will be considered regardless of type, whether inside drop, outside drop, force main or standard connection.

Manhole Sizing Guide

Manhole Size	Maximum Allowable Pipe Size	Maximum Depth of Cover	Maximum Depth with Extended Base	Frame and Cover Size (outside of paved areas)	Maximum Sewer Main Connections
<i>(diameter)</i>	<i>(diameter)</i>	<i>(invert to surface)</i>	<i>(invert to surface)</i>	<i>(diameter)</i>	<i>(quantity)</i>
4-ft	8-12 inches	12-ft	25-ft	24-inches	3*
5-ft	14-24 inches	12-ft	35-ft	24-inches	2**
6-ft	27-42 inches	12-ft	35-ft	36-inches	2**

* *Four connections may be permitted in a 4-ft diameter manhole when the separation between each incoming connection is at least 85°.*

** *Additional smaller diameter connections that meet the spacing requirements of Section C, Installation, may be approved by the Director of Engineering.*

All manholes 5-ft in diameter shall be extended to surface elevation with no further reduction in diameter until the eccentric cone section.

Manhole transitions for 6-ft and larger diameter manholes are only allowed in the top 5-ft of the manhole. In no case shall the smallest barrel size be less than 5-ft diameter. At least 5-ft of vertical clearance shall be maintained above the pipe crown before transitioning to a smaller diameter riser, or transition shall not be utilized. An eccentric flat slab reducer from 6-ft diameter or larger manhole base sections to 5-ft diameter risers (non-paved areas) or eccentric cones (paved areas) shall be used to make any transition.

Manholes outside of paved areas that are 6-ft in diameter and greater and are too shallow to maintain 5-ft of vertical clearance above the crown of the pipe shall maintain the full manhole diameter up to the design surface elevation and be provided with a flat top slab cover with eccentric hole.

Manholes inside of paved areas that are 6-ft in diameter and greater shall be constructed with an eccentric, flat top reducer to 5-ft diameter and provided with a 5-ft diameter eccentric, tapered cone at the finished grade. When the depth of the manhole is too shallow to maintain 5-ft of vertical clearance above the crown of the pipe a 3-ft tall eccentric, tapered cone shall be used without any additional 5-ft diameter risers.

B. MATERIALS

1. Concrete Manholes

Manholes shall be precast concrete with a minimum compressive strength of 4000-psi and utilize minimum grade 60 rebar in compliance with ASTM C478. All 4-ft and 5-ft diameter manholes and all 6-ft diameter manholes in paved areas shall be provided with eccentric cone sections. Flat top manholes are required in outfall areas for 6-ft and larger diameter manholes.

Precast concrete manholes shall meet all design and manufacturing requirements of ASTM C478 and all H-20 loading requirements.– Minimum wall thickness shall be 5-inches and shall increase with depth and diameter in accordance with ASTM standards. The standard joint shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant. All lift holes must be plugged with non-shrinking grout after installation.

All manholes shall have minimum 8-inch, 4,000 -psi concrete bottoms resting on a minimum of 12 inches of # 57 stone. Sewer mains shall enter and exit radially through the manhole. Inverts shall be constructed with a width and height equal to 1/2 that of the effluent pipe and shall be so finished with sufficient drop across the manhole to compensate for all resulting energy loss across the invert. Flat invert channels shall not be allowed. At each inlet and outlet of 8 inches or greater resilient connectors or manhole boots shall be provided in conformance with ASTM C923. Rings and clamps are to meet standards of ASTM A167 and/or ASTM C923.

Manhole flat slab, eccentric reducers provided for 6-ft diameter and larger manholes shall be provided with minimum slab thickness of 12-inches. Flat slab, eccentric reducers shall not be allowed for manhole diameters less than 6-ft.

Manhole flat top slab covers for outfall manholes 6-ft diameter and greater shall be designed and manufactured for H-20 loading and provided in minimum slab thickness of 8-inches. Manhole flat top covers shall be provided with a minimum clear opening of 36-inches when utilized with a 36-inch clear span manhole frame and cover.

Manhole benches shall slope upwards from the spring line of the pipe to the projected level of the pipe crown at the manhole wall, or at least 8-inches

above the spring line, whichever is less. Bowl type inverts recessed inside of precast benches shall not be accepted.

2. Manhole Frame and Cover Materials

- a) Manhole Frames and Covers shall be Class 35 gray iron with "Sanitary Sewer" and the Town symbol forged into the cover as indicated in the details. Ring and cover shall be stamped with make and model. All manhole frames and covers shall be domestically made and manufactured in the USA from domestic iron. Manhole frames and covers shall be provided in typical height of 8-inches unless low profile assemblies are otherwise approved.
- b) Manhole Frames and Covers in Paved Areas: For all installations in roadways, use Type 1 ring and cover, and place sufficient depth of concrete below the pavement around the ring to ensure contact with manhole. Type 1 covers shall be provided with 1 vent hole. Type 1 covers shall be designed for a proof load of 40,000 lbs. and provided in Class 35B gray iron in conformance with ASTM A48. At a minimum, type 1 manhole rings shall weigh 190 lbs. and the cover shall weigh 120 lbs.
- c) Manhole Frames and Covers for Outfalls: For installation in unpaved areas, with 4-ft and 5-ft diameter manholes use Type 2 ring and cover. Type 2 covers shall not be installed in areas subject to traffic loading. Type 2 covers shall be provided with an integrated frame and cover assembly in which the cover rotates away from the frame for access. The rotating assembly shall be provided with a cast in stainless steel rod assembly. Type 2 covers shall be provided with a minimum 24-inch clear span opening along the axis with the stainless steel rod assembly. Security shall be provided by 3 exterior cast lugs at $\frac{3}{4}$ -inch thickness that allow padlock installation or bolting with 3 stainless steel bolts with stainless steel zinc plated nuts. Type 2 covers shall be made of Class 35B iron in conformance with ASTM A48 and designed for a proof load of 12,000 lbs. The frame and cover weight shall not be less than 60-lbs for the cover and 80-lbs for the ring. The Type 2A frame and cover assembly shall be provided with a gasket that makes the cover assembly watertight when bolted at all three lugs. Type 2 covers shall be provided in the watertight installation inside the 100-year flood elevation or other areas subject to flooding.

Manhole Frames and Covers for Large Diameter Outfall Manholes: Type 3 ring and cover assemblies shall be provided with a minimum 36-inch clear span opening and utilized for 6-ft diameter or larger manhole installations with eccentric flat top manholes outside of paved areas. Within paved areas, use standard Type 1 cover on 5-ft diameter eccentric cone. The type 3 frame and cover shall be provided with a 36-inch cover with an inset cover of 26-inches in diameter. The smaller inset cover shall be readily

accessible for routine inspections. The larger cover shall be more permanently secured and will only be utilized for larger diameter pipeline cleaning and camera inspections. The frame and cover assembly shall be provided in the watertight configuration in areas within the 100-year flood elevation or other areas subject to flooding.

- d) All castings shall be machined to give even and continuous bearing on the full length of the frame. Castings shall be free of porosity and blow holes. All manhole frames shall be bolted to the manhole, except in paved streets.
- e) All manhole rings in roadways shall be encased in a concrete collar of 3000-psi concrete beneath the asphalt, with the cover flush with the top of pavement.

3. Manhole Step Materials

Manhole steps shall be furnished with the precast manhole sections. Steps shall be of polypropylene material reinforced with a 1/2 inch diameter reinforcing rod. Manhole steps shall meet the requirements of ASTM C478 and be designed for a horizontal pull out load of 1000 pounds. Steps shall be set 16 inches on center. Holes for the installation of manhole steps shall not project through the manhole wall, but shall stop a minimum of one inch from the outside wall. Steps shall be at least 11 3/8 inches clear width and shall project at least 5 inches from the wall into which they are embedded. Steps shall be located along the effluent side of the manhole. The eccentric cone shall be oriented so that the steps are vertical over the downstream invert of the primary flow path to allow ease of access for maintenance, camera or cleaning operations.

C. INSTALLATION

1. General Requirements

- a) The upstream side of the last manhole(s) of a sanitary sewer line extension under construction shall be plugged by constructing a brick/block wall to prevent the passage of groundwater, runoff and sediment into the sanitary sewer system. All water upstream of the wall shall be pumped out of the sanitary sewer line and all sediment and solids shall be removed and properly disposed of by the Contractor. The wall shall not be removed until the line has been inspected by the Town to ensure that all possible points of inflow or infiltration have been eliminated. Failure to meet these requirements will be deemed a violation of the Sewer Use Ordinance with fines up to \$1,000.00 per day.
- b) Manholes shall not be buried or hidden, which is a violation of the sewer use ordinance and subject to penalty by fines.

- c) All manhole penetrations, whether sewer main or service lateral, shall be cored with a concrete coring machine. All pipe connections must be made with flexible watertight couplings or boots.

For new manholes, there shall be a minimum of 9-inches or $\frac{1}{2}$ the pipe outside diameter (OD), whichever is greater, between the pipe hole openings. (Pipe hole opening is typically 4" greater than the pipe OD.) When the adjacent pipes are different sizes, the OD of the smaller pipe shall be used to determine the spacing requirement, but shall never be less than 9-inches.

For connections to existing manholes, there shall be a minimum of 9-inches or 3.5-inches plus $\frac{1}{2}$ the OD of the existing pipe, whichever is greater, between the pipe hole openings.

- d) All external manhole joints shall be wrapped with an approved joint seal material.

2. Manholes Subject to Inundation

- a) Manholes subject to flooding shall be watertight and vented 24 inches above the 100-YR flood elevation. In flood prone areas, the manholes shall be vented at least every 1000-ft or every other manhole, whichever is greater.
- b) The exterior of all manholes within the 100-year flood elevation and in wetland areas shall receive an exterior coating of an approved bitumastic coal tar epoxy or an approved epoxy coating at 40-mils to prevent weepage or attack by acidic soils.
- c) Anti-flotation design measures shall be implemented as required in flood prone areas.

3. Manholes Located on Large Collection Mains

The Town reserves the right to require all manholes located on interceptor or outfall mains 24-inches in diameter and larger to have the manhole interior, and bench coated with an approved epoxy coating at 80-mils thickness. The preferred method of application is field application after the manholes are installed for a monolithic holiday free coating. Factory application will be allowed contingent upon the joints receiving a field application.

4. Force Main Discharge Manholes

07000-23

- a) All manholes located on gravity mains that serve as discharge points for sanitary sewer force mains shall receive an interior epoxy coating at 80-mils thickness. In addition to the receiver manhole, the Town reserves the right to require epoxy coating of the next 2 consecutive manholes downstream of the receiver manhole or all downstream manholes within 1500-lf of the receiver manhole,—See Section 7200 for further information on force main discharge manholes.

07030 SERVICE CONNECTIONS

A. DESIGN

1. General Requirements

- a) Direct sewer service taps shall not be allowed on sewer interceptor or outfall mains 15-inches in diameter or larger, except by manhole connection.
- b) All residential subdivision lots shall be served by gravity unless otherwise approved by the Town Engineer. If a pump is approved, it shall be privately maintained, must pump into a service connection placed on the lot, and must have a note on the recorded plat indicating that a private pump is required to serve the lot.
- c) Service connections to the main lines shall be perpendicular to the main line and shall extend to the edge of the right of way or easement line.
- d) Cleanouts are required on all services with a maximum spacing of 75 feet on 4 inch services and 100 feet on 6 inch services, and at the right of way line or edge of easement. All cleanouts shall extend a minimum of 6 inches above finished grade with brass caps or meet the optional cleanout method requirements in accordance with the Standard Details.
- e) Sewer cleanouts located in paved areas, which bear vehicle loading, must have ductile iron risers, ductile iron fittings and traffic rated cast iron cover assembly.
- f) All 6 inch service connections shall be into a manhole unless otherwise approved by the Director of Engineering.
- g) Service lines connected to manholes shall not be through the cone section or manhole joints. Service lines shall be installed 6" above, but no more than 30 inches above the invert or shall be installed with a standard drop. Multiple service connections shall not be maintained by the Town. For 6-ft

diameter and larger manholes no service is allowed in the reduced diameter riser sections of the manhole.

- h) The use of in-line wyes for service connections shall be required for all new construction unless otherwise approved by the Engineering Department. When connecting to existing sewer mains, service saddle taps will be allowable. Taps shall be at the 10 or 2 position, and shall not be top taps.

B. MATERIALS

1. Pipe Materials

- a) PVC Pipe shall be schedule 40 or greater supplied in minimum 18-ft lengths. Schedule 40 PVC pipe shall be manufactured with a cell classification of 12454 in conformance with ASTM D1784. Schedule 40 pipes shall be manufactured to dimensional tolerances as specified in ASTM D1785 and rated for service conditions up to temperatures of 140-degrees Fahrenheit. The pipe may be joined by solvent weld in conformance with ASTM D2564.

Schedule 40 PVC Service Pipe Sizing

Nominal Pipe Diameter (inches)	Outside Diameter (inches)	Inside Diameter (inches)	Thickness (inches)
4	4.50	4.02	0.24
6	6.62	6.03	0.28

PVC pipe for sewer services shall require bedding based upon depth as follows:

- 3-14-ft Depth – 4-inches of stone bedding extended to springline
- 8-20-ft Depth – 6-inches of stone bedding extended 6-inches above pipe crown

- b) Ductile Iron Pipe shall be used for sanitary sewer services with less than 4 feet of cover or in excess of 20 feet of cover. Ductile iron services shall also be used in all cases where a well is located within 100-ft of the sewer service line. Ductile iron service piping shall be provided in conformance with the ductile iron piping standards outlined herein including cement mortar lining.

DIP Service Pipe Sizing

Nominal Pipe Diameter (inches)	Outside Diameter (inches)	Inside Diameter (inches)	Thickness (inches)
4	4.80	4.30	0.25
6	6.90	6.40	0.25

2. Sewer Service Fittings, New Construction

All sewer service connections for new construction shall be provided with in-line wye fittings unless otherwise approved by the Engineering Department.

DIP Main with DIP Service

In-line wye fittings for ductile iron main lines joined with ductile iron service lines shall be typical DI fittings as specified herein. In this case all fitting sizes shall conform to AWWA C153. Wye fittings through 10-inches in diameter shall be provided with cement mortar lining in accordance with AWWA C104 and provided with exterior asphaltic coating per AWWA C151. Wye fittings for lines larger than 10-inches in diameter shall be provided with Protecto 401 lining as specified herein for ductile iron pipe of the same sizing.

DIP Main with PVC Service

For ductile iron sewer mains to be joined with PVC service lines, the in-line wye fittings shall be slip joint ductile iron with an IPS sized branch for PVC schedule 40 service lines. Ductile iron fittings for connecting PVC service lines shall be deep bell, gasketed joint and air test rated. Gasket grooves shall be machined. Bell depths shall meet the minimum socket depth requirements of ASTM D3034 and ASTM F1336. Wall thickness shall meet the requirements of AWWA C153. DI wye fittings through 10-inches in diameter with IPS connections shall be provided with cement mortar lining in accordance with AWWA C104 and provided with exterior asphaltic coating per AWWA C151. DI wye fittings for PVC lines larger than 10-inches in diameter shall be provided with Protecto 401 lining as specified herein.

PVC Main with PVC Service

For PVC sewer mains to be joined with PVC service lines, PVC in-line wye fittings shall be provided. Typical Schedule 40 PVC fittings shall be provided at the cleanout wye and stack.

3. Service Saddle Connections, Existing Sewer Mains

- a) PVC service saddles shall be of the same material as the main, and shall be solvent welded and fastened with double stainless steel bands.
- b) For existing DIP main lines, ductile iron service saddles shall be "ROMAC CB" type consisting of a virgin SBR gasket compounded for sewer service, a ductile iron saddle casting, a 304 stainless steel adjustable strap for fastening the gasket and the saddle casting to the sewer main and a 304 stainless steel adjustable circle clamp for securing the service line into the SBR gasket.

C. **INSTALLATION**

1. **General Requirements**

- a) Sewer laterals shall not be located in easements when gravity service can be provided to the property frontage at the street.
- b) Each separately owned structure requires a separate tap to a public sewer.
- c) All service lines with less than 3-ft of cover or deeper than 20-ft shall be made of ductile iron pipe.
- d) Four inch lines shall have a minimum slope of 1.0 ft./100 feet and 6 inch lines shall have a minimum slope of 0.60 ft/100 feet.
- e) All service connections to existing sanitary sewer mains shall be made by the Town. Service connections to new mains may be made by the Contractor, but shall include the use of wye (not tee) connections. Saddle taps onto new lines shall not be allowed unless otherwise approved by the Engineering Department.
- f) Saddle taps into existing PVC mains shall be made on the top quarter of the main with the wye saddle angled 45-degrees towards the direction of flow in the main. Taps shall only be made by a mechanical circular cutting saw providing a smooth and uniform cut for the saddle installation.
- g) Service connections made using a "ROMAC CB" sewer saddle shall be made when the line 8", 10", or 12" diameter, ductile iron pipe. This service connection shall not be used when the sewer main material is truss sewer pipe. The opening in the sewer main for the "ROMAC CB" sewer saddle shall be cut with a hydraulically or pneumatically driven circular tapping saw of the same nominal diameter as the sewer service line.

07040 TESTING AND INSPECTIONS

A. **GENERAL**

The Contractor shall furnish all materials, labor, and equipment to perform all testing. Water for testing purposes may be provided by the Town and arranged for by the Contractor. The Contractor shall reimburse the Town for all water used for construction at current inside utility rates.

B. SEWER MAIN AND SERVICE CONNECTION TESTING

1. Visual Testing and Observation

- a) All materials used must be approved by the Inspector prior to installation. Rejected materials shall be immediately removed from the job.
- b) Gravity sanitary sewer lines shall be clean and free from obstructions, and shall be visually inspected from every manhole. Lines which do not exhibit a true line and grade or which have structural defects shall be corrected. Sanitary sewer service connections shall be visually inspected prior to backfilling.

2. Air Testing

- a) Low-pressure air testing in accordance with ASTM F1417 shall be performed on all sewer mains before the laterals or stubs are installed on the line, and after the trench has been backfilled to finished grade. Plugs shall be installed at each manhole to seal off the test section. The line will be pressurized with a single hose and monitored by a separate hose connection from the plug. Air then shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 psig. The air pressure shall then be allowed to stabilize for a minimum of 2 minutes at no less than 3.5 psig (plus groundwater pressure, if any). When the pressure reaches 3.5, the time required for the pressure to drop 1.0 psi will be observed and recorded. The line shall be "acceptable" if the pressure does not drop more than 1.0 psi in the time prescribed for the test in the Sanitary Sewer Air Test table found in the Details. An abbreviated version of the air test table is shown below.
- b) If the section fails to meet these requirements, the source of leakage shall be repaired and the pipe section re-inspected
- c) The Inspector may require that an infiltration test be performed that shall not exceed 100 GPD/inch/mile.

SPECIFICATION TIME (MIN:SEC) REQUIRED FOR PRESSURE DROP FROM 3-1/2 TO 2-1/2 PSIG

		NOMINAL PIPE DIAMETER (INCHES)										
		8	12	15	16	18	21	24	27	30	36	42
LENGTH OF TEST SECTION	50	7:33	11:20	14:10	15:11	17:00	19:48	22:40	25:30	28:19	34:00	39:40
	10	7:33	11:20	14:10	15:11	17:00	19:48	22:47	28:51	35:37	51:17	69:48
	15	7:33	11:20	14:10	15:12	19:14	26:10	34:11	43:16	53:25	76:55	104:42
	20	7:33	11:24	17:48	20:16	25:39	34:54	45:35	57:42	71:13	102:36	139:36
	25	7:33	14:15	22:16	25:20	32:03	43:37	56:58	72:07	89:02	128:12	174:30
	30	7:35	17:06	26:43	30:23	38:28	52:21	68:22	86:32	106:48	153:54	209:25
	35	8:52	19:57	31:10	35:27	44:52	61:05	79:46	101:00	124:42	179:30	244:19
	40	10:07	22:48	35:37	40:31	51:17	69:48	91:10	115:24	142:30	205:06	279:13
	45	11:23	25:39	40:04	45:35	57:42	78:31	102:36	129:48	160:18	230:48	314:07
	50	12:39	28:30	44:31	50:39	64:06	87:15	114:00	144:12	178:06	256:24	349:02

3. Deflection Testing for PVC Pipe

- a) The mandrel (go/no-go) deflection test shall be performed on each line prior to acceptance and no sooner than 30 days after installation. The pipeline shall be thoroughly clean and free of debris and/or sediment prior to testing. The Contractor shall supply the mandrel used for this performance test. The mandrel device shall be cylindrical in shape having 9 possible contact points with the pipe. The mandrel's length and diameter (ID of proving ring) shall be in accordance with the following tables, and shall be subject to the Inspector's approval.

b) For flexible pipes such as PVC, the following shall apply:

Nominal Diameter (inches)	Pipe Class	Average Inside Pipe Diameter (inches)	5% Deflection Mandrel Diameter (inches)	Length of Mandrel (inches)	Minimum Fins Included with Mandrel
8	SDR 26	7.715	7.329	10	9
8	SDR 35	7.891	7.496	10	9
10	SDR 26	9.644	9.162	10	9
10	SDR 35	9.864	9.371	10	9
12	SDR 26	11.480	10.906	10	9
12	SDR 35	11.737	11.150	10	9
15	SDR 26	14.053	13.350	10	9
15	SDR 35	14.374	13.655	10	9
18	SDR 26	17.261	16.398	24	9
21	SDR 26	20.349	19.332	24	9
24	SDR 26	22.891	21.746	24	9
27	SDR 26	25.799	24.509	24	9

Note: Calculated 5% deflection allowance does not include additional manufacturing tolerances provided by pipe manufacturers. For the purposes of testing, 5% deflection shall be calculated from standard pipe inside diameter as published in ASTM D3034 and ASTM F679.

The mandrel shall be advanced through the pipeline to determine if bedding and embedment has been provided in compliance with ASTM D2321 to assure joint deflection of less than 5%. If the mandrel becomes obstructed for any reason while being pulled through the line with less than 100-lbs of force, the location of the defect shall be noted and the mandrel shall be removed from the pipeline. Under no circumstances shall heavy equipment be utilized to force the mandrel through the pipeline. Deflection testing may be done concurrently with sewer televising inspections, provided the mandrel is kept within visible range of the camera.

4. Video Assessment and Cleaning

- a) As a final measure required for acceptance, the Contractor shall clean and televise all newly installed sewer mains prior to acceptance by the Town. The Contractor shall televise the sewer main and all lateral connections installed from the upstream to downstream manhole with no reverse setups or cutaways. Throughout shooting, the camera shall be panned and tilted for a complete view of the main. Lighting shall be adequate to view the entire sewer main and service connections from beginning to end. The video inspection shall be submitted to the Inspector on a CD and formatted with software compatible and readable by the Town. The Town shall not be responsible for purchasing additional software necessary to view the CD's.
- b) The camera shall be advanced at a uniform rate that allows a full and thorough inspection of the new sewer main. The camera shall be a color,

pan and tilt camera. The picture quality and resolution shall be acceptable and sufficient to allow a complete inspection with no lapses in coverage. The length of the sewer main shall be measured and recorded on the video screen. The distance counter shall be calibrated before shooting the inspection video.

- c) The Contractor shall clean the sewer mains ahead of video inspection with a high-velocity water jet. The video inspection shall take place within 2-hours of cleaning operations as witnessed by the Inspector. All construction debris shall be collected in the downstream manhole and shall not be released into the sewer system.
- d) The Inspector shall be present throughout the cleaning and televising of the sewer mains to verify that the video work complies with the specifications.
- e) Prior to submitting the CD's to the Inspector, the Contractor shall label the CD's with the following information:
 - Name of the Project/Development.
 - Name and contact information of responsible party.
 - Date of televising.
 - Manhole identification as shown on the design plans.

C. MANHOLE TESTING

1. Vacuum Testing

- a) All newly installed manholes shall pass a vacuum test in accordance with ASTM C 1244-02. The Contractor shall supply all equipment and materials necessary to vacuum test the manholes.
- b) Vacuum Testing shall not be initiated until the manholes and all specified coatings and lining materials have been cured in accordance with manufacturer recommendations.
- c) The Inspector shall be present and witness all vacuum testing.
- d) The following vacuum testing criteria shall apply for compliance with the testing procedure.
 - A vacuum of 10-inches of mercury shall be drawn with an approved vacuum testing unit.
 - The testing time shall not be measured until after the vacuum pump has been shut off.

- The time required for the vacuum to drop from 10-inches to 9-inches of mercury shall meet or exceed the values listed in the following table.

Manhole Vacuum Testing Time

Depth (feet)	Manhole Diameter (inches)		
	48	60	72
	Time (seconds)		
8	20	26	33
10	25	33	41
12	30	39	49
14	35	48	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

07050 AERIAL CROSSINGS

A. Design

Aerial crossings shall only be utilized in cases where buried crossings are prohibited due to stream crossings, compliance with riparian buffer standards, minimizing impacts to wetlands, preventing excessive depth of installation, or as otherwise directed by the Town of Cary.

In cases where aerial crossings are utilized to cross streams, the bottom of the pipe shall be installed above the 25-year flood elevation of the stream. Piers shall generally be located at a uniform spacing of 20-ft or 1 pier for every joint of pipe. Piers shall be provided in accordance with the standard details or as otherwise designed by a licensed NC Professional Engineer.

All pier footings shall be designed by a licensed NC Professional Engineer and the assumptions provided in the footing design shall be included on the plans. At a minimum, the footing design shall include: 1) the allowable soil bearing capacity, 2) design concrete compressive strength, 3) plan for reinforcing steel with sizing and location of bars, 4) force diagram including buoyant forces, stream velocity impacts 5) depth of installation to prevent frost heaving, 6) bedding design to prevent differential settlement and 7) factors of safety for unanticipated loads such as trees falling across the aerial crossing.

At a minimum all pier foundations shall be constructed on a base of 12-inches of washed stone. The soil conditions under the pier shall be evaluated by a licensed NC Geotechnical Engineer to determine if the allowable soil bearing capacity meets or exceeds the design assumptions included in the structural design. If the soil conditions fail to meet the specified bearing capacity requirements, a pile foundation shall be provided or the soils shall be undercut and replaced in conformance with the recommendations of the geotechnical engineer of record.

Piers installed in stream beds shall be avoided in lieu of spanned crossings. Spanned pipe crossings greater than 20-ft shall be provided in accordance with manufacturer's specifications and shall not exceed 40-ft for ductile iron pipe. Spanned pipe crossings shall be designed such that all flanges and exterior pipe connections are located above the 25-year flood elevation.

Spanned crossings greater than 40-ft without piers shall be provided in a steel encasement pipe and the entire crossing including piers, foundation, truss and/or beam supports and pipe thickness design shall be provided by a licensed NC Structural Engineer.

B. Pipe Materials

Ductile iron pipe for aerial crossings shall be interior lined with Protecto 401 at 40-mils regardless of pipe diameter. All joints for ductile iron pipe utilized in aerial crossings shall be restrained with a bolt lock joint. Ductile iron pipe utilized for spanned crossings greater than 20-ft without a pier shall be provided with flanged connections. All bolts and fasteners for flanged or bolt locking restraining systems shall be provided in stainless steel and installed in a manner to prevent seizing.

PVC pipe shall not be approved for aerial crossings.

Steel pipe

Steel pipe provided for aerial crossings shall be fabricated with grade B steel that has minimum yield strength of 35 KSI in accordance with ASTM A139. Steel pipe for aerial crossings shall be provided with minimum wall thickness consistent with a pressure class of 200-psi or greater. Steel pipe for aerial sewer crossings shall be provided with 40-mils of interior ceramic coating, such as Ceramaline and provided with an exterior tape wrap approved by the manufacturer. All steel pipe joints shall be welded in conformance with manufacturers' specifications.

C. Installation

Aerial crossings are often utilized to span sensitive environmental areas and installation shall be consistent with plans to preserve the sensitive areas.

Joints of bolt lock restrained pipe shall be located within 2-ft of each pier as outlined by the detail drawings.

Pipe shall be secured to each pier with 1/4-inch by 2-inch width steel straps fastened to 4; 1/2-inch stainless steel lugs anchored and adhered with epoxy to the concrete pier. The steel straps shall receive a weather resistant painted finish to prevent long term corrosion.

Precast piers may be submitted for approval provided the footing and foundation designs are completed by licensed structural and geotechnical engineers.

In cases where soil conditions cannot be sufficiently stabilized to provide an adequate foundation for concrete piers, a pile foundation designed by a licensed NC structural engineer and approved by the Town shall be provided.

Reinforcing steel for concrete piers shall be grade 40 and shall be constructed in conformance with the latest edition of the "Recommended Practice for Placing Reinforcing Bars" or other documentation as published by the Concrete Reinforcing Steel Institute.

In cases where rock exists at the foundation elevation, the footing shall be drilled and connected with dowels into the rock layer.

07060 REPAIRS

A. SEWER MAIN REPAIRS

1. V.C. Pipe - replace damaged section with D.I.P. and install a Fernco coupling at each end encased in concrete.
2. PVC Pipe - replace damaged section with PVC Pipe and install a Fernco coupling at each end encased in concrete.
3. ABS/PVC Truss Pipe - replace damaged section with D.I.P. and install a Fernco coupling at each end encased in concrete.
4. A.C. Pipe - Replace damaged section with DIP and couplings encased in concrete.

B. INSTALLATION

1. All repairs to damaged sanitary sewer lines in paved areas shall be backfilled with ABC stone (crusher run) to a density of 95 percent Standard Proctor.
2. All repairs to damaged sanitary sewer lines shall be bedded with 6-inches of washed stone and compacted to a minimum of 95% Standard Proctor density before installing the new joint of ductile iron or PVC pipe.

END OF SECTION 07000