SECTION 7000
WASTEWATER COLLECTION SYSTEMS

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# 7010 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 Cary 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. Mains located within NCDOT right of way shall be placed in accordance with NCDOT standards.

b) All utility crossings within Cary streets shall be made by trenchless methods. State maintained streets within the Cary ETJ should also be crossed using trenchless methods. In cases where utility conflicts, rock, or other obstructions prevent trenchless crossings, Cary may consider approving other methods.

c) 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.

d) All private sewer collection mains inside Cary's Utility Service area that will connect or are planning to discharge into Cary's sewer system shall comply with all 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.

e) 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

| Pipe Size (diameter) | Pipe Depth (feet) | Easement Width (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 | As Specified by the Utilities Department |
| Any Size | Deeper than 20-ft | |

Dedicated easements for sewer mains and appurtenances shall be recorded as “Cary Utility and Pipeline Easement”. Cary sewer easements shall contain only Cary utilities unless otherwise approved by the development plan or an encroachment agreement.

Access easements to allow sufficient means of gaining entrance to proposed Utility and Pipeline Easements may be required by the Utilities Department where conventional access from the public right-of-way is limited or infeasible.

f) 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, 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 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 development plan approval process. Pre-existing conditions that are not disclosed during the development plan review may nullify the approval and require relocating the sewer easement where there are no existing conflicts.

g) 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.

h) 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. Steel 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.

i) Mains shall not be installed under any part of water impoundments.

j) 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 wetlands and 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. With approval directly from PERCS, the following separations may be acceptable when water main standards are implemented:

a) All appurtenances shall be outside the 100-foot radius of wells.

b) 25 feet from private wells (with no exceptions)

c) 50 feet from public water wells (with no exceptions)

Where the required minimum separations cannot be obtained, the following standards shall be used:

i. Sewer Pipe: Ductile Iron Pipe shall be used with joints equivalent to water main standards.

k) Sewer mains shall be extended to adjacent property lines.

l) Gravity sewer mains shall be deep enough to serve the adjoining property and allow for sufficient slope in lateral lines. Gravity sewer pipe shall have the following minimum covers:

i. 4 feet from the top of pipe to finished subgrade in roadways.

ii. 3 feet from the top of pipe to finished grade outside roadways.

- Material must be DIP if less than 4 feet of cover is provided.

m) Sewer mains over 20 feet deep require ductile iron for the entire run between manholes. Sewer mains 14 feet to 18 feet along or in roadways shall also require ductile iron pipe for the entire run between manholes. The maximum depth of sewer along or in roadways shall be 18 feet.

n) 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 can support 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.

| | Water | Storm water | Sewer (Gravity and Forcemain) | Reclaimed |
|---|---|---|---|---|
| Water | 18-inches vertical | **Parallel Installations**: 10-feet horizontal **Crossings**: 18 inches vertical | **Parallel Installations:** 10 feet horizontally **Crossings:** 18-inches vertical separation water main over sewer | **Parallel Installations**: 10-feet horizontal and water line at least 18-inches above reclaimed **Crossings (water main over reclaimed water pipeline)**: Min. 18-in vertical separation |
| Storm water | **Parallel Installations**: 10-feet horizontal **Crossings**: 18 inches vertical | | 24-inches vertical | Min. 18-inches vertical. |
| Sewer (Gravity & Forcemain) | **Parallel Installations:** 10 feet horizontally **Crossings:** 18-inches vertical separation water main over sewer | 24-inches vertical | 7-feet horizontal separation, increasing with depth | **Parallel Installations:** 10-feet horizontal **Crossings (reclaimed water pipes over sewer pipes**): 18-inches |
| Reclaimed | **Parallel Installations**: 10-feet horizontal and water line at least 18-inches above reclaimed **Crossings (water main over reclaimed water pipeline)**: Min. 18-in vertical separation | Min. 18-inches vertical. | **Parallel Installations:** 10-feet horizontal **Crossings (reclaimed water pipes over sewer pipes**): 18-inches | 18 inches vertical |

o) 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 5 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.

p) 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-feet or less. In cases where the depth of installation is greater than 8-feet, the minimum horizontal separation between pipelines shall be 10-ft up to 10-ft depth of installation or a project specific design shall be implemented.

q) Separation Between Sanitary Sewer and Water Main

i. Parallel Installations: 10-ft lateral separation (pipe edge to pipe edge) unless local conditions or barriers prevent a 10-ft lateral separation, in which case:
   - A minimum 5-ft lateral separation and water line laid in a separate trench, with the elevation at least 18-inches above sanitary or storm sewer line measured vertically from top of sewer pipeline to bottom edge of water main.
   - A minimum 5-ft lateral separation and water line laid in the same trench as the sanitary or storm sewer, with the water main located at one side on a bench of undisturbed earth and with the elevation of the bottom of the water main at least 18-inches above the top of the sanitary or storm sewer.

ii. Crossings (Water Main Over Sewer): All water main crossings of sanitary sewer lines shall be constructed over the sewer or storm line in conformance with 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 sanitary or storm sewer main. If 18-inches of clearance is not maintained, the crossing shall be reviewed and allowed only on a case-by-case basis with justification of deviation provided by the design engineer per section 6010.A.12.c. At a minimum, the water main and

sanitary sewer main shall both be constructed of ductile iron pipe with joints in conformance with water main construction standards for the entire run from manhole to manhole, and the void space between the pipes shall be filled with minimum 500-psi, quick setting, and 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 and/or storm sewer crossings of potable water mains.

iii. Crossings (Water Main Under Sewer Line): Allowed only on a case-by-case basis with justification of deviation provided by the design engineer per section 6010.A.12.c herein. At a minimum, 18-inches of separation shall be maintained, (measured from pipe edge to pipe edge) and both the water main and sanitary sewer shall be constructed of ductile iron in conformance with water main construction standards. The sanitary sewer pipe shall be ductile iron 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, and non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

r) Separation Between Sanitary Sewer and Reclaimed Water

i. 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 5 feet.

ii. 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 Cary's 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 Cary's 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 most current "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 Cary'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 Environmental Quality (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.

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 Utilities 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. Cary 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) Construction Involving Existing Mains**

i. The existing sewer main must remain active and protected during all phases of construction. The contractor must provide a plan for the structural protection of the existing sewer main.

ii. A proposed construction sequence and bypass pumping plan must be submitted for any demolition of a portion of existing sewer main. The plan must be reviewed and approved by Utilities and Public Works.

## B. MATERIALS

Materials specified herein are acceptable for sewer service as described.

See Standard Procedure 120 for instructions on requesting new product approval.

## 1. DUCTILE IRON PIPE

### 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 | 30-38 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 table on the next page.

**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 except a minimum thickness of 1/8" shall be provided (double thickness).

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, from Cary approved manufacturer. 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 approved joint compound listed on Cary's Approved Products List applied by brush to ensure full coverage. All pipe supplied with approved 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 coating defects after installation shall not be approved. Lined pipe must be installed by date required by lining manufacturer.

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.

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

2. SOLID WALL PVC PIPE

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. 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 20-ft. 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.

3. Encasement Pipe

a) Encasement pipe shall be new and manufactured of grade 'B' steel with minimum yield strength of 35,000-psi in accordance with ASTM A139 and A283.

b) All casing pipe shall have machine cut, bevel ends that are perpendicular to the longitudinal axis of the casing.

c) Size and minimum wall thickness of smooth wall or spiral welded steel encasement pipe shall be as shown in the below table. Actual wall thicknesses shall be determined by the casing installer based on their evaluation of the required forces to be exerted on the casing when it is installed.

Minimum Wall Thickness of Steel Encasement Pipe

| Encasement Pipe Outside Diameter *(inches)* | Minimum Wall Thickness *(inches)* |
|---|---|
| 12-$^3/_4$ | 0.188 |
| 14 | 0.250 |
| 16 | 0.250 |
| 18 | 0.250 |
| 20 | 0.250 |
| 24 | 0.250 |
| 26 | 0.312 |
| 28 | 0.312 |
| 30 | 0.312 |
| 36 | 0.375 |

| | |
|---|---|
| 42 | 0.500 |
| 48 | 0.500 |
| 54 | 0.500 |
| 60 | 0.500 |
| 66 | 0.625 |

d) Encasement pipe installed for railroad bores shall meet the requirements of the American Railway Engineering Association (AREA) for boring under railroads.

e) Encasement pipe shall have the following minimum sizes:

Minimum Allowable Steel Encasement Diameter Per Carrier Size

| Carrier Pipe Size Inside Diameter (inches) | Carrier Pipe Outside Bell Diameter Typ. (inches) | Maximum Restraint Outside Diameter (inches) | Steel Encasement Nominal Diameter (inches) |
|---|---|---|---|
| 6 | 9.19 | 11.20 | 16 |
| 8 | 11.33 | 14.70 | 18 |
| 10 | 13.56 | 16.61 | 20 |
| 12 | 15.74 | 19.33 | 24 |
| 14 | 19.31 | 23.26 | 28 |
| 16 | 21.43 | 25.51 | 30 |
| 18 | 23.70 | 27.76 | 36 |
| 20 | 25.82 | 30.01 | 36 |
| 24 | 29.88 | 35.00 | 42 |
| 30 | 36.34 | 42.88 | 48 |
| 36 | 42.86 | 49.76 | 60 |
| 42 | 49.92 | 57.75 | 66 |
| 48 | 56.36 | 61.08 | 66 |

4. Casing Pipe Spacers and End Closures

a) The carrier pipe shall rest on steel pipe alignment spacers. The spacers shall have either a bituminous or epoxy coating. A minimum of 2 steel spacers per joint shall be required on carrier pipe less than 36-inches. Carrier pipe greater than or equal to 36-inches shall have a third spacer. The steel spacers shall be located evenly along the carrier pipe alignment in such a manner that each spacer supports the same unit weight of carrier main. The spacing interval of the steel spacers shall assure the necessary grade, clearance, and support of the carrier main. The spacers shall be manufactured for the specific carrier pipe and casing pipe diameters being used such that the risers do not allow the pipe to float within the casing.

b) In cases where the encasement pipe is installed near facilities with stray current, such as gas lines, high voltage power transmission lines, petroleum lines, railroad tracks, etc., the steel spacers shall be provided with composite contacts on the runners such as an EPDM rubber liner or an ultra-high molecular weight polyethylene plastic skid to prevent transmitting the stray current to the carrier pipe.

c) The carrier pipe bells shall not be allowed to contact the interior of the encasement pipe under any circumstances.

d) No blocks or temporary spacers shall be wedged between the carrier pipe and the top of the encasement pipe.

e) The ends of the encasement pipe shall be sealed using 8-inch bricks and a non-shrink grout.

f) A 2-inch galvanized vent pipe shall be provided on the upper end of the casing on all stream and railroad crossings.

## C. SEWER MAIN INSTALLATION

1. General Requirements

a) Transitions of pipe material, pipe separations, grade changes and all angular deflection changes shall occur only at manholes.

b) All sewer mains installed with less than 4 ft of cover or deeper than 20-ft shall be ductile iron pipe.

c) 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.

d) All sewer cleanouts shall be protected during construction by installation of tree protection fencing or Cary approved material. Material will be adequately maintained throughout the construction period to prevent damage and contamination of the sewer system.

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 conflicts with construction, it shall be exposed prior to beginning construction to prevent damage to the existing utility.

g) Trenching for pipelines (water, sewer, pressure, natural gas and liquid petroleum), communication and power lines and drainage and irrigation pipes shall be excavated to the required depth to permit the installation of the pipe (inclusive of pipes, wires, cables, ducts, and conduit) along the lines and grades shown on the construction drawings.

h) Prior to trenching for the construction of any utility mains or connections, the Contractor shall locate all existing utilities within the construction zone. This may include at a minimum contacting the North Carolina One Call Center at 811 or 1-800-632-4949. Where critical Cary water and sewer utilities cannot be located by traditional means, specialized utility locating, such as vacuum excavation or ground penetrating radar (GPR) may be required to locate existing utilities before excavating.

i) In all cases where trenchless methods are planned to cross an existing utility corridor with water, sewer, force main, reclaimed water and/or other Cary maintained pipelines, an SUE (subsurface utility exploration) services firm shall be contracted to verify the depths of existing utilities prior to boring. Where SUE involves survey work, the survey shall be in accordance with the requirements of Section 10050 of these Standard Specifications.

j) The Contractor shall be responsible for implementing all required safety provisions for trenching in compliance with the Occupational Safety and Health Administration (OSHA) regulations and all other applicable safety requirements and procedures.

k) Trench Dimensions

*i.* The minimum trench width at the top of the pipe shall be at least 24-inches greater than the outside diameter of the pipe. Rock shall be

removed to a depth of at least 6-inches below the bottom of the pipe and the trench backfilled with suitable material.

*ii.* Open trenches shall not exceed 100-feet.

*iii.* All trenches shall be confined to the limits of the right-of-way or utility easement. Trenches in paved areas shall not be sloped.

*iv.* All trenches in or along roadways shall be properly backfilled at the end of each working day.

l) Trench Protection

*i.* Wet trenches shall be stabilized with a base layer of #78 M or #57 stone. The bottom of the trench shall be shaped to provide uniform support along the entire length of the pipeline. Severely unstable trench bottoms requiring undercut excavation shall receive a foundation support system for the pipeline designed by a registered Geotechnical Engineer licensed in the State of NC.

*ii.* A space shall be excavated at each bell to provide ample space to join the pipes with no misalignment.

*iii.* The Contractor shall take all necessary measures to prevent water from entering the trench.

2. Pipe laying and backfilling

a) Open ends of pipe shall be plugged when pipe laying is not in progress to prevent trench water, soil, and debris from entering.

b) All pipe shall be laid in accordance with the manufacturer's recommendations and all applicable Cary Standards, Specifications and Details.

c) Pipe laying shall be accomplished in a manner and with the required resources to provide a properly aligned and sealed pipeline and joints.

d) Pipe deflection limits shall not be exceeded in accordance with manufacturer requirements.

e) All gravity mains shall be installed beginning with the downhill section at the lowest elevation, and advanced upgrade to the terminus of the main. All bell ends shall be oriented facing the uphill direction.

f) Backfill material shall be free from construction material, frozen material, organic material, or unstable material. Backfill with a high clay content or high shrink-swell potential that cannot meet compaction requirements shall be deemed unsuitable and replaced as directed by a professionally licensed Geotechnical engineer.

g) Backfill materials that have been allowed to become saturated or with moisture contents non-conducive to meeting compaction requirements shall be deemed unsuitable and replaced.

h) When original excavated materials have been deemed unsuitable, granular material must be imported to the site to backfill utility trenches and meet compaction requirements. The following materials shall be acceptable forms of granular backfill: aggregate base course, soil type base course, select backfill material, sand or screenings in accordance with NCDOT Specifications.

i) In all open utility trenches, backfill shall be compacted to 95% maximum dry density as measured by AASHTO method T99. The Contractor shall be responsible for verifying that compaction requirements have been met or exceeded by providing soils testing data from an approved Geotechnical Firm. The soil test results shall be certified by a licensed Geotechnical Engineer.

j) Backfill for utility trenches shall be placed in 8-inch lifts or less of uncompacted soil and compacted with a mechanical tamp before placing additional layers.

3. Pavement repairs

a) All pavement cuts shall be repaired within a maximum of three (3) days from the date the cut is made. If conditions do not permit a permanent repair within the given time limit, permission to make a temporary repair must be obtained from the Infrastructure Field Technician.

b) Pavement repairs shall be made in accordance with Cary Standard Details.

c) All asphalt pavement utilized to repair open trenches shall comply with all applicable Cary asphalt pavement material and installation Specifications.

d) All pavement patches shall be provided in such a manner that a uniform and smooth driving surface free of depressions and/or bumps is obtained. Pavement patches not meeting this standard shall be milled and replaced.

4. Trenchless pipe installation

a) The preferred trenchless method shall be auger boring. Alternate trenchless methods including microtunneling, guided boring, conventional tunneling, horizontal directional drilling or hand tunneling may be approved after thorough evaluation by the Utilities Department.

b) In addition to meeting or exceeding all Cary requirements, all trenchless crossings shall be approved by and meet the requirements of all controlling legal authorities, such as NCDOT, Norfolk Southern Railway and CSX Corporation.

c) Direct bores may be made without a casing pipe on pipelines 6-inches in diameter and smaller.

d) Encasement pipe shall be installed with all trenchless construction methods (excluding horizontal directional drilling when it is approved and as noted above). There shall be a minimum cover of 4-ft between the pavement subgrade and the top of the casing pipe. Under no circumstances shall the pavement subgrade be disturbed.

e) Permanent easements (UPE) shall be provided at all trenchless pits to allow for future access to casing pipes.

f) All carrier pipe shall be manufacturer provided restrained joint ductile iron pipe.

g) As the trenchless operation progresses, each new section of encasement pipe shall be joined using full penetration seal welds prior to installation of the casing. Joints shall be electric-fusion welded by operators qualified in accordance with the American Welding Society's standard procedure for arc welds. The welds shall be capable of transmitting all thrust and other loads across the joints.

h) If voids are encountered while installing encasement pipe thirty (30) inches and larger, 2-inch or larger grout holes shall be installed at ten (10) foot centers in the top section of the encasement pipe. The grout holes shall be used to fill the void spaces with 1:3 Portland cement grout at sufficient pressure to prevent settlement of the roadway, unless NCDOT approval stipulates otherwise. Other grout mixtures may be submitted for approval.

i) In the event that an obstruction is encountered during the trenchless operations, the equipment shall be withdrawn. The pipe shall be cut off, capped, and filled with 1:3 Portland cement grout at a sufficient pressure to fill all voids before moving to another boring site.

j) Restrained joint ductile iron carrier pipe shall be pulled into the casing pipe.

k) For all trenchless operations of 100-ft or more, the ground surface elevations shall be recorded prior to beginning work.
    i. At a minimum, survey points shall be identified with a nail or hub located as follows:
        - Road crossings: Centerline and each shoulder/curb
        - Utility and Pipeline Crossings: Directly above and 10-ft each side of the crossing
        - All locations: Points shall not exceed 50-ft spacing.
    ii. Elevations at each point shall be recorded with an accuracy of 0.01-feet.

l) Settlement observations shall be made each day until the pipe/casing is fully installed.

m) Readings shall be reported to the Infrastructure Field Technician.

n) In the case of observed settlement, the monitoring points and observation frequency shall be increased as determined by Cary.

5. External corrosion protection

a) External corrosion can occur at an accelerated rate in metallic pipelines such as steel and ductile iron when they are installed in aggressive soils or when they are installed near other structures or utilities that carry impressed currents. Such facilities that typically utilize impressed current cathodic protection are gas pipelines, such as owned by Colonial Pipeline, Cardinal Pipeline and Dixie Pipeline. Other potential sources that may create stray currents that contribute to accelerated pipeline corrosion are high voltage power transmission lines and railroad crossings.

b) In cases where metallic steel and ductile iron pipelines or encasement pipes are planned for installation in close proximity to any potential sources of stray current or aggressive soils, zinc coated pipe shall be specified and a field analysis consisting of stray current evaluation and soil testing shall be conducted by an experienced technician, as certified by the National Association of Corrosion Engineers, (NACE), to determine the potential for external corrosion and the need for additional protection measures. In cases where stray current conditions and/or aggressive soils are prevalent, a corrosion specialist certified by the NACE or other applicable certification board shall be consulted regarding the design of pipeline protection measures.

c) At a minimum, all stray current protection systems should include bonded joints and sacrificial anodes with a 50-year or longer design life and test facilities in lieu of polyethylene encasement, unless otherwise approved by Cary. The cathodic protection element of the pipeline design package shall be sealed by Professional Engineer licensed in the State of NC.

d) Full impressed current cathodic protection shall only be utilized when extreme corrosion potential has been proven and/or as otherwise directed by the Utilities Department and the certified corrosion engineer of record.

6. Embedment Material

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 Of 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 Of MH, ML, CH and CL are included in this class. These materials shall not be used for embedment.

Class I foundation material consisting of ¼-inch to 1½ -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 Infrastructure Field Technician, testing shall be provided by the Contractor and a reputable licensed Geotechnical Engineer to verify compliance.

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.

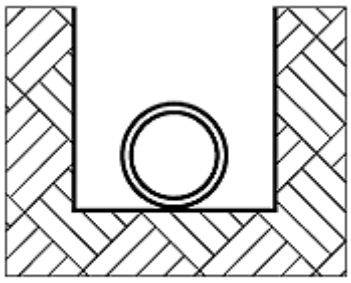
If hydraulic jack shoring is utilized for trench walls, it shall be restricted to the area just above the top of the pipe. This will ensure the embedment materials and pipe will not be disturbed when the shoring is removed.

7. 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.

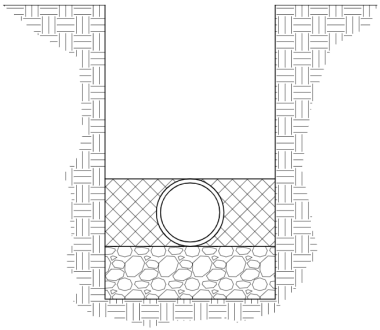
Pipe shall be installed at laying conditions as specified herein and identified by the plan drawings. Laying conditions for ductile iron pipe shall be as described in AWWA C151 and the Ductile Iron Pipe Research Association. Laying conditions shall be defined as follows:

*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.*



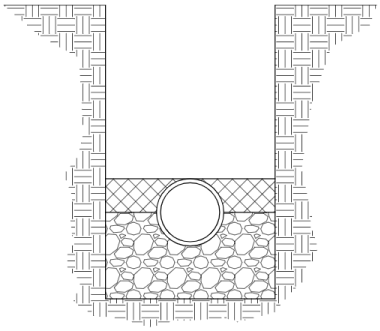
Type 1*

*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

8. 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. 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 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. Embedment shall extend to the top 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 of the pipe to prevent any potential voids.

e) Typical Bedding and Embedment for SDR26 PVC Gravity Sewers, 14-ft to 20-ft in Depth.

   Bedding shall consist of minimum 6-inches of No. 67 or No. 78 stone installed under the pipe. The embedment, consisting of the same material, shall extend 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.

## D. PIPE IDENTIFICATION AND MARKING

2. Marking Tape
   a) Installation: Marking tape shall be installed continuously and longitudinally along all sanitary sewer mains for new construction and for any repair or

retrofit construction using open trench methods. For service connections, the marking tape shall extend from the main line to the cleanout at the right-of-way/easement. Marking tape shall be installed directly above the center of the pipe and at least 24-inches deep from final grade to a maximum depth of 36-inches below final grade.

b) Specifications: The sanitary sewer main marking tape shall be an approved product identified in Cary's Approved Products List. The marking tape shall be made of polyethylene (or approved equivalent) material, 6-inches wide and a minimum of 6 millimeters thick. The marking tape shall have detectable markers embedded in the tape and spaced adequately to provide continuous detection along the tape from above the buried pipe at final grade. The tape shall be green in color and shall be marked with words "CAUTION SEWER LINE BURIED BELOW" (or an approved equivalent wording). The wording shall be repetitive along the full length of the tape.

# 7020 MANHOLES

## A. DESIGN

1. Manhole Location, Siting and Design

a) Manholes shall be spaced at a maximum distance of 400 feet.

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 Utilities 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) If 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 Utilities.

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) Manholes shall be provided with only top and bottom interior steps installed.

n) 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 |
|---|---|---|---|---|---|
| *(diameter)* | *(diameter)* | *(invert to surface)* | *(invert to surface)* | *(diameter)* | *(quantity)* |
| 4-ft | 8-12 inches | 12-ft | 25-ft[1] | 24-inches | 3[2] |
| 5-ft[4] | 14-24 inches | 12-ft | 35-ft | 24-inches | 2[3] |
| 6-ft[4] | 27-42 inches | 12-ft | 35-ft | 36-inches | 2[3] |
| 8-ft[4] | 48 inches | 12-ft | 35-ft | 36-inches | 2[3] |
| 10-ft[4] | 54 inches | 12-ft | 35-ft | 36-inches | 2[3] |

*[1]Depths beyond 14-ft in roadways shall require a 5-ft diameter manhole with extended base.*
*[2]Four connections may be permitted in a 4-ft diameter manhole when the separation between each incoming connection is at least 85°.*
*[3]Additional smaller diameter connections that meet the spacing requirements of Section C, Installation, may be approved by the Utilities Department.*
*[4]Due to the limited manhole wall area that could exist between the invert in and out, some manholes may require upsizing as directed by the Utilities Department.*

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 greater than 5-ft diameter shall have minimum 8-inch (6-inch for 4-ft diameter manholes), 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 equal to the effluent pipe and a height equal to 1/2 that of the effluent pipe. Inverts 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.

Precast manhole components shall not be installed, transported, or removed from the casting yard prior to reaching the minimum compressive strength of 4,000-psi and at least 7 days have elapsed since casting.

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

2. Polymer Concrete Manholes

Polymer concrete manhole sections, monolithic base sections and related components shall meet the requirements of ASTM C 478. ASTM C 478 material and manufacturing is allowed compositional and dimensional differences required by a polymer concrete product. Polymer Concrete Manholes shall be domestically manufactured.

Base riser section shall be provided with monolithic floors, unless shown otherwise. Riser sections shall be provided joined with bell and spigot / ship-lap design seamed with butyl mastic and or rubber gaskets (ASTM C

990) so that on assembly, manhole base, riser and top section make a continuous and uniform manhole structure. Riser sections for polymer concrete manholes shall be constructed from standard polymer concrete manhole sections of the diameter indicated on drawings. Use various lengths of polymer concrete manhole sections in combination to provide correct height with the fewest joints.

Wall sections shall be designed for depth and loading conditions with wall thickness as designed by polymer concrete manufacturer.

Manhole tops shall support AASHTO HS-20 loading or loads as required and receiving cast iron frame covers or hatches, as indicated on drawings. Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet the intent of ASTM C 478 with allowable compositional and sizing differences as designed by the polymer concrete manufacturer.

Covers shall be designed to meet AASHTO HS-20 design or as required by drawings, shall be domestically manufactured, and listed on Cary's Approved Products List. Polymer manholes shall be designed based upon live and dead load criteria in ASTM C 857 and ACI 350-06.

Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet loading requirements of ASTM C 478, ASTM C 857 and ACI 350-06 as modified for polymer concrete manhole design as follows:

Polymer Concrete Mix Design shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment.

Reinforcement – Shall use acid resistant reinforcement (FRP Bar) in accordance with ACI 440.1R-06 as applicable for polymer concrete design.

The wall thickness of polymer concrete structures shall not be less than that prescribed by the manufacturer's design by less than 95% of stated design thickness.

Thermosetting Resin - The resin shall have a minimum deflection temperature of 158° F when tested at 264 psi (1.820 mPa) following Test Method D 648. The resin content shall not be less than 7% of the weight of the sample as determined by test method D 2584. Resin selection shall be suitable for applications in the corrosive conditions to which the polymer concrete manhole structures will be exposed.

Each polymer concrete manhole component shall be free of all defects, including indentations, cracks, foreign inclusions, and resin starved areas that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part. Cosmetic defect shall not be cause for rejection. The nominal internal diameter of manhole components shall not vary more than 2%. Variations in height of two opposite sides of risers and cones shall not be more the 5/8 inch. The under run-in height of a riser or cone shall not be more than ¼ in/ft of height with a maximum of ½ inch in any one section.

Marking and Identification - Each manhole shall be marked with the following information - Manufacturer's name or trademark, Manufacturer's location, and Production Date.

Manhole joints shall be assembled with a bell/spigot or shiplap butyl mastic and/or gasketed joint so that on assembly, manhole base, riser and top section make a continuous and uniform manhole. Joint sealing surfaces shall be free of dents, gouges and other surface irregularities that would affect joint integrity.

Minimum clearance between wall penetrations and joints shall meet the requirements laid out in Cary's Standard Specifications and Details.

Construct invert channels in accordance with Cary's Standard Details to provide smooth flow transition with minimal disruption of flow at pipe-manhole connections. Invert slope through manhole is as indicated on drawings. All precast base sections to be cast monolithically. Polymer bench and channel are to be constructed with all polymer concrete material. Extended ballast slab requirements for buoyancy concerns can be addressed with cementitious concrete material.

Provide resilient connectors conforming to requirements of ASTM C 923 or other options as available. All connectors shall be watertight. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions.

All materials needed for grouting and patching shall be a polyester mortar compound provided by the manufacturer or an approved equal by the manufacturer.

Manufacturer shall be included on most current edition of Cary's Approved Products List.

3. <u>Manhole Frame and Cover Materials</u>

a) Manhole Frames and Covers shall be Class 35 gray iron with "Sanitary Sewer" and the Cary symbol forged into the cover as indicated in

Standard 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.

b) Types

i. Manhole Frames and Covers in Paved Areas and some Unpaved Areas: For all installations in roadways or within the right of way, 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 be 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.

ii. Manhole Frames and Covers for Outfalls: For installation in outfall areas, with 4-ft and 5-ft diameter manholes use Type 2 ring and covers. 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 ¾-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 2A covers shall be provided inside the 100-year flood elevation or other areas subject to flooding if the manhole lid is less than 24 inches above the 100-year flood elevation. Type 2B covers are not watertight and are not required to have a gasket.

iii. 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 a 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 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 if the manhole lid is less than 24 inches above the 100-year flood elevation.

c) 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.

## 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 Cary 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 ½ 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 ½ 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 at 40-mils to prevent weepage or attack by acidic soils. In lieu of epoxy coated concrete manholes, approved polymer concrete manholes may be installed. Manufacturer of polymer concrete manholes shall be listed on Cary's Approved Products List.

c) Anti-flotation design measures shall be implemented as required in flood prone areas.

3. Manholes Located on Large Collection Mains

Cary 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 epoxy coating shall be field applied and tested as described herein. An approved polymer concrete manhole may be installed in lieu of epoxy coating the manholes.

4. Force Main Discharge Manholes

All manholes located on gravity mains that serve or will 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, Cary reserves the right to require epoxy coating of the next two 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. An approved polymer concrete manhole may be installed in lieu of epoxy coating the manholes.

5. Epoxy Coating

a) Material Providers and Installers: Approved coating manufacturers and corresponding installers are identified in Cary's Approved Product List.

b) Surface Preparation: Concrete manholes must be well cured prior to application of the protective epoxy coating. Generally, 28 days is adequate cure time for standard Portland cement. If earlier application is desired, compressive, or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself. An Elcometer pull test to determine suitability of concrete for coating may be required).

Surface preparation shall be based on the requirements of the manufacturer of the epoxy coating and applicable NACE International standards.

c) Installation: A minimum 80-mils thickness shall be field applied to new manholes (120-mils for existing manholes). During application a wet film thickness gage, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.

Temperature of the surface to be coated should be maintained between 40° F and 120° F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising or in the early morning. The humidity should also be observed to ensure compliance with the epoxy manufacturers' recommendations.

Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective epoxy coating. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.

If necessary, subsequent top coating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

# 7030 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. If a pump is approved, it shall be privately maintained and must pump into either a service connection placed on the lot or through a private force main to a manhole, if approved by Cary Utilities Department. The pump and force main (if needed) must have a note on the recorded plat indicating the following: “Privately maintained sewer pump and force main is required to serve this lot”.

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. In addition, within townhouse developments, sewer service connections shall be located within 4-feet of driveways, or under driveways, to minimize conflicts between service lines and trees.

c) All sewer service lines shall be installed with a minimum distance to adjacent infrastructure of 5-feet on either side of the service.

d) Cleanouts are required on all services with a maximum spacing of 75 feet on 4-inch services and 100 feet on 6-inch or 8-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.

Sewer cleanouts located in or within 24-inches of paved areas, which bear vehicle loading and sidewalks require a traffic rated cast iron or ductile iron cover assembly. Refer to Standard Details for mini manhole for sewer service cleanout assembly in traffic areas.

e) Where 8-inch sewer services are required, the length of service may not exceed 200-ft and cleanouts should be utilized. The NC Plumbing code (708.1.2) requires that a manhole be set no further than 200-ft from the building. At this manhole, the service must transition to either public or private main. If a private main is required due to site constraints, the sewer permit must be obtained from the State and the most current version of the FTSE form should be submitted to Cary staff. For further information, see NC Plumbing Code 708.1.2 Gravity Building Sewers.

f) All 6-inch and 8-inch service connections shall be into a manhole.

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 Cary. 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. When connecting to existing sewer mains, service saddle taps will be allowable. Taps shall be at the 10 or 2 o'clock position and shall not be top taps.

i) Service connections to mains at depths of 14-ft and greater shall utilize ductile iron pipe between the main and the cleanout, including a ductile iron wye for the cleanout stack. Location and angle of fittings shall be as shown in the Standard Detail drawings.

j) Where the flood level rims of plumbing fixtures are below the elevation of the manhole cover of the next upstream manhole in the public sewer, such fixtures shall be protected by a backwater valve installed in the building drain, branch of the building drain or horizontal branch serving such fixtures. Plumbing fixtures having flood level rims above the elevation of the manhole cover of the next upstream manhole in the public sewer shall not discharge through a backwater valve.

## 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. Non mechanical joints shall 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:

- 4-14-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 more than 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.

DIP Main with DIP Service

In-line wye fittings for ductile iron main lines joined with ductile iron service lines shall be typical ductile iron mechanical joint 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 Cary approved 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. Ductile iron 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. Ductile iron wye fittings for

PVC lines larger than 10-inches in diameter shall be provided with Cary approved 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.

PVC Main with DIP Service
A ductile iron tee/wye shall be provided when the service line is required to be ductile iron due to a crossing or other obstruction. The fitting shall be specifically manufactured for ASTM 3034 PVC pipe such that a smooth flow way exists on the main line through the fitting. The branch shall be gasketed to receive the 4-inch DIP service line without additional fittings. The ductile iron tee/wye fitting shall be provided with Cary approved lining.

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.

For existing DIP main lines, ductile iron service saddles shall be used. The saddle assembly shall consist of a virgin SBR or NBR 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 rubber 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 4-ft of cover or deeper than 20-ft shall be made of ductile iron pipe.

d) 4-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 Cary. 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.

f) Saddle taps into existing PVC mains shall be made at the 10 o'clock or 2 o'clock position 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 shall be made using an approved sewer saddle when the existing sewer line is 8", 10", or 12" in diameter. This service connection shall not be used when the sewer main material is truss sewer pipe. The opening in the sewer main for the sewer saddle shall be cut with a hydraulically or pneumatically driven circular tapping saw of the same nominal diameter as the sewer service line.

h) Grease traps shall not be located within the public ROW or within public easements.

# 7040 TESTING AND INSPECTIONS

## A. GENERAL

The Contractor shall furnish all materials, labor, and equipment to perform all testing. The Contractor may arrange to obtain water for testing purposes from Cary. The Contractor shall reimburse Cary 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 Infrastructure Field Technician 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 Standard Details. An abbreviated version of the air test table is shown below.

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

| LENGTH OF TEST SECTION | NOMINAL PIPE DIAMETER (INCHES) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 | 12 | 15 | 16 | 18 | 21 | 24 | 27 | 30 | 36 | 42 |
| 50 | 7:33 | 11:20 | 14:10 | 15:11 | 17:00 | 19:48 | 22:40 | 25:30 | 28:19 | 34:00 | 39:40 |
| 100 | 7:33 | 11:20 | 14:10 | 15:11 | 17:00 | 19:48 | 22:47 | 28:51 | 35:37 | 51:17 | 69:48 |
| 150 | 7:33 | 11:20 | 14:10 | 15:12 | 19:14 | 26:10 | 34:11 | 43:16 | 53:25 | 76:55 | 104:42 |
| 200 | 7:33 | 11:24 | 17:48 | 20:16 | 25:39 | 34:54 | 45:35 | 57:42 | 71:13 | 102:36 | 139:36 |
| 250 | 7:33 | 14:15 | 22:16 | 25:20 | 32:03 | 43:37 | 56:58 | 72:07 | 89:02 | 128:12 | 174:30 |
| 300 | 7:35 | 17:06 | 26:43 | 30:23 | 38:28 | 52:21 | 68:22 | 86:32 | 106:48 | 153:54 | 209:25 |
| 350 | 8:52 | 19:57 | 31:10 | 35:27 | 44:52 | 61:05 | 79:46 | 101:00 | 124:42 | 179:30 | 244:19 |
| 400 | 10:07 | 22:48 | 35:37 | 40:31 | 51:17 | 69:48 | 91:10 | 115:24 | 142:30 | 205:06 | 279:13 |
| 450 | 11:23 | 25:39 | 40:04 | 45:35 | 57:42 | 78:31 | 102:36 | 129:48 | 160:18 | 230:48 | 314:07 |
| 500 | 12:39 | 28:30 | 44:31 | 50:39 | 64:06 | 87:15 | 114:00 | 144:12 | 178:06 | 256:24 | 349:02 |

b) If the section fails to meet these requirements, the source of leakage shall be repaired and the pipe section re-inspected.

The Infrastructure Field Technician may require that an infiltration test be performed that shall not exceed 100 GPD/inch/mile.

3. Deflection Testing for Flexible 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 Infrastructure Field Technician'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 and laterals from the demarcation cleanout to the main and shall be clearly identifiable as to the lot of building serviced prior to acceptance by Cary. 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 and laterals. 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 Infrastructure Field Technician on a Cary approved media type. IT Pipe files shall be included with the submission. Cary shall not be responsible for purchasing additional software necessary to view the submission.

b) The camera shall be advanced at a uniform rate not to exceed 20 feet per minute that allows a full and thorough inspection of the new sewer main. The camera shall be a color, pan and tilt camera capable of producing a five-hundred-line resolution picture. Lighting for the camera shall be sufficient to yield a clear picture of the entire periphery of the pipe. The picture quality 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 and laterals 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 Infrastructure Field Technician. All construction debris shall be collected in the downstream manhole and shall not be released into the sewer system.

d) The Infrastructure Field Technician shall be present throughout the cleaning and televising of the sewer mains and laterals to verify that the video work complies with the Specifications.

e) Prior to providing the inspection media to Cary's Infrastructure Field Technician, the Contractor shall label the submission 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.

5. Marker Tape Testing

Testing of the marker tape shall be performed by the Contractor at the completion of the project to assure it is working properly and completely detectable. It is the Contractor's responsibility to provide the necessary equipment to test the markers. Any defective, missing, or otherwise non-locatable segments shall be replaced at the Contractor's expense.

## C. MANHOLE TESTING

1. Vacuum Testing

a) All newly installed manholes shall pass a vacuum test in accordance with ASTM C 1244. The Contractor shall supply all equipment and materials necessary to vacuum test the manholes.

b) Vacuum Testing shall be completed prior to any specified coating and lining materials being installed.

c) The Infrastructure Field Technician 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 | Manhole Diameter (inches) | | |
|---|---|---|---|
| (feet) | 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 |

2. Holiday Testing of Lined Manholes

All manholes that require an epoxy coating shall undergo discontinuity testing. This shall be a high-voltage spark test conducted in accordance with NACE International Standard Practice 0188. All areas of the manhole coated shall be tested. The spark tester shall be set at a minimum of 100 volts per mil of coating thickness applied. The Contractor shall supply the spark tester and all testing equipment and labor needed to perform this test.

All holidays identified must be repaired. The epoxy coating must be abraded and cleaned prior to re-coating. All touch-up work shall be in accordance with the epoxy manufacturers guidelines.

# 7050 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 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 and designed by a licensed NC Professional Engineer with foundations and structural components, including concrete reinforcements, designed by a licensed Structural Engineer. Aerial crossing with greater than 50 acres of drainage area are subject to Cary floodplain regulations.

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 subbase scour and 7) factors of safety for unanticipated loads such as trees falling across the aerial crossing. At locations inundated by the 100-year design storm shall include foundation anchor design.

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 and subbase stability. If the soil

conditions fail to meet the specified bearing capacity and stability 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 the pipe manufacturer's specifications. The carrier pipe shall be SDR26 PVC with bell joint restraints installed in a casing meeting the requirements of the standard specifications. The carrier pipe shall be SDR26 between the upstream and downstream manholes. The entire crossing including piers, reinforcement, foundation, truss and/or beam supports, pipe anchor straps, and pipe thickness design shall be provided by a licensed NC Structural Engineer. Spanned pipe crossings shall be designed such that all flanges and exterior pipe connections are located above the 25-year flood elevation.

Each pier exposed to the 100-year design storm shall be protected by the appropriately size rip rap and extends 6-feet beyond the pier radially. Stream bank slopes beneath the aerial crossing shall be protected by appropriately sized rip rap and extend a minimum of 6-feet beyond the centerline of the pipe up and downstream. Rip rap shall not be allowed in the stream.

## B. PIPE MATERIALS

1. **Ductile iron pipe** shall not be approved for aerial crossings.

2. **PVC pipe** shall be SDR26 solid wall pipe meeting the requirements of speciation section 7010 above.

3. **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.

Pipe shall be secured to each pier with minimum1/4-inch by 2-inch width steel straps fastened to a minimum 4; ½-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. All pipe securing methods shall be designed by a NC licensed Professional Engineer.

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 Cary 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 or potential scour elevation, the footing shall be drilled and connected with dowels into the rock layer.

# 7060 REPAIRS AND MODIFICATIONS

## A. SEWER MAIN REPAIRS

1. Vitrified Clay 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.

## 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.

## C. ABANDONMENT

Sewer service laterals shall be abandoned by removing and replacing the saddle with a 360-degree stainless steel sleeve. At in-line wyes the service lateral shall be cut within 12” of the wye and a mechanical cap installed on DIP/cast services or glued to PVC services and the abandoned wye encased with 1 cubic foot of concrete.

## D. DRAINING SEWER MAINS

A detailed pumping and emergency plan shall be required for any sewer line draining event.

All sanitary sewer mains and sewer force mains 20-inches and larger, active, inactive, or abandoned shall begin to be drained by tapping the bottom half of the pipe. A corporation stop or other valve shall be provided to control flow. All effluent shall be pumped to a downstream manhole (when available) or other containment tank utilizing continuous piping. The use of a sump pit on lines 20-inches and larger is not allowed.

In sensitive environmental areas and in other various scenarios the Utilities Department may require lines less than 20-inches also be tapped to be drained.

END OF SECTION 7000