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**7.01 Design**

a. **Location:**

All public sanitary sewer mains shall be within dedicated street rights-of-way or dedicated sanitary sewer easements. When sanitary sewer mains are installed in street rights-of-way they shall be located in the center of the pavement or right-of-way, where practical, or the south or west side of the pavement. When sanitary sewer mains are installed outside street rights-of-way, they shall be located in the center of an easement.

In natural drainage ways, sewers shall be extended to the property lines to readily enable future connection to adjoining property. Sewer design shall account for future upstream development based on the current land use plan, and shall include evaluation of existing downstream sewer capacity.

Sanitary sewers shall not be installed under any part of an existing impoundment or beneath any area to be impounded. Sanitary sewers shall not be installed through, above, or below any retained earth structure. Sewer profile shall follow natural topography and road grade.

A 100-foot minimum separation must be maintained from any private or public water supply source, including any wells, WS-I waters, or Class I or Class II impounded reservoirs used as a source of drinking water. A fifty (50) foot minimum separation from normal high water for waters classified WS (except WS-I or WS-V), B, SA, ORW, HQW, or SB, and wetlands, and 10 feet from any other stream, lake, or impoundment.

If a deviation from these separations is proposed and approved by the DPW, DIP sewer main with joints equivalent to water main standards must be used. But in no case shall minimum separations be less than 50 feet from a private well or 50 feet from a public water supply.

Sanitary sewers shall be designed at least 10 feet laterally from the existing or proposed water mains unless the elevation of the top of the sewer is at least 18 inches below the bottom of the water main.

Where public sanitary sewer mains are installed within easements crossing private property, the Town's Public Works Department shall have the right to enter upon the easement for purposes of inspecting, repairing, or replacing the sewer main and appurtenances. Where paved private streets, driveways, parking lots, etc. have been installed over public sewer mains, the Town of Apex shall not be responsible for the repair or replacement of pavement, curbing, landscaping, etc. which must be removed to facilitate repairs. The Public Works Department shall excavate as necessary to make the repair, and shall backfill the disturbed area to approximately the original grade. Replacement of privately owned pavement, curbing, walkways, etc. shall be the responsibility of the property owner and/or Homeowner's Association.

**b. Easements:**

Minimum width of permanent sanitary sewer easements for public sewer mains shall be 20 feet. Where sewer mains are installed at a depth in excess of 8 feet nominal, the easement widths shall be increased in accordance with the following table:

<b>Sewer Main Depth (D)</b>	<b>Easement Width Increase</b>
8' < D ≤ 12'	10 FT
12' < D ≤ 14'	20 FT
>14'	Determined by Engineer

Sewer mains shall be centered in the easement. Under special conditions, temporary construction easements may be required upon approval of the ENGINEER.

The minimum permanent combination easement width for sanitary sewer and storm sewer is 30 feet. There must be a separation of 10 feet between outside diameters of pipes and 10 feet from the centerline of the sanitary sewer to the easement line.

All sanitary sewer lines shall have an easement width during construction of not less than 40 feet.

All off-site easements shall be acquired by the developer. These off-site shall be recorded by and by deed of easement prior to construction approval. These easements shall be dedicated to the Town of Apex and labeled 'Town of Apex Sanitary Sewer Easement'.

No person shall place any part of a structure, any permanent equipment, or impoundment of sanitary sewer easements or mains. Prohibited structures include, but are not limited to: buildings, houses, air conditioning units, heat pump units, decks, garages, storage/tool sheds, swimming pools, walls, retaining wall mechanisms/appurtenances, and fences. Upon prior written approval by the Public Works Department, fences may be permitted across easements, provided that an access gate is installed with a minimum width of 14 feet for residential and the full width of the easement for commercial.

No plantings or structures are allowed within sewer easements.

**c. Depth of Cover:**

All sanitary sewer mains in non-traffic areas shall be installed with a minimum cover of 3 feet measured from the finish grade to the top of the pipe. In traffic areas, the minimum depth of cover shall be 4 feet measured from finish subgrade to the top of the pipe. DIP shall be used when the minimum 3 feet of cover in a non-traffic area or the minimum 4 feet of cover in a traffic area cannot be maintained.

The depth of sewer mains shall be great enough to serve adjoining property, allowing for sufficient grade on the service line. Lateral connections are to be into manholes or into the top quarter of sewer mains, avoiding angles that go against the flow of the main.

Proposed sewers paralleling a creek shall be designed to a proper depth to allow lateral connections, such that all creek crossings will be below the stream bottom elevation. The top of the sewer pipe should be at least 1 foot below the streambed elevation.

No bells or connections shall be within the waterway crossing area.

Where a sanitary sewer and a water main cross, and the vertical separation is less than 18 inches or the water line passes under the sewer, the sewer shall be ductile iron pipe equivalent to water main standards for a distance of 10 feet on each side at the point of crossing. The water line pipe section shall be centered at the point of crossing.

Transition of sewer main materials shall only occur at manholes.

Sanitary sewers shall have the top of pipe at least 24 inches below the bottom of storm sewer pipe when the horizontal separation is 3 feet or less from existing or proposed storm sewer. Where a sanitary sewer and a storm sewer cross, and the vertical separation is less than 24 inches, the sanitary sewer shall be ductile iron pipe equivalent to water main standards for a distance of 10 feet on each side at the point of crossing. The sanitary sewer pipe section shall be centered at the point of crossing.

**d. Construction Drawing:**

Construction drawings for sanitary sewer collection systems shall be prepared by or under the direct supervision of a professional engineer licensed to practice in North Carolina. Drawings shall conform to the applicable requirements outlined in Section 1.03 of these Specifications and to the guidelines established by the NC Department of Environmental Health and Natural Resources.

Plans shall indicate the deflection angles at all manholes. Profile elevations shall be on NCGS datum and benchmarks shall be shown and described on the Drawings.

**e. Size:**

Gravity sewer mains shall be designed to serve the total natural drainage basin. Total off-site drainage area in acres must be shown on the plans. An 8-inch main shall be the minimum size permitted.

Sewers shall be designed so as to carry the total peak tributary flow at one-half of full depth (50% capacity) for sewers 15-inch and smaller, and two-thirds of full depth (approximately 66% of full capacity) for sewers 18-inch and larger.

The minimum velocity for gravity sanitary sewer mains is 3 fps. Minimum velocities less than 3 fps must receive approval from the ENGINEER.

Sewer size shall be based on an average daily flow based on the current capacity fee schedule and a peak/average ratio of 2.5, which includes an allowance for infiltration. Where average daily flows are less than 10,000 gpd, the peak/average ratio shall be increased to 3.0. The PROJECT ENGINEER shall furnish complete calculations to establish the basis for pipe sizing.

Pipe diameter changes shall occur in a manhole with the pipe crowns matched as long as a minimum drop of approximately 0.20 feet is maintained between inverts.

The minimum gradient for sanitary sewer shall not be less than the following:

<b>Sewer Size (in)</b>	<b>Minimum Slope (ft/100ft)</b>
8	0.52
10	0.39
12	0.30
14	0.25
15	0.23
16	0.21
18	0.18
24	0.12
30	0.09
36	0.07
42	0.06
48	0.05

The maximum gradient for sanitary sewers shall be 10 percent, or such lesser gradient as may result in a maximum velocity of 15 fps.

**f. Manholes:**

Manholes shall be spaced a maximum distance of 400 feet apart. Manholes shall be installed at each deflection of line and/or grade with a minimum drop in the invert of 0.2 feet. Drop manholes shall be required where the difference in pipe inverts exceeds 18 inches in elevation. All manholes shall have a maximum chimney height of 22 inches. No more than 2 courses of grade rings with 1-inch mortar joints shall be permitted on any manhole. All frames shall be sealed and bolted to the manhole.

Flat top manholes shall be used in outfalls and other non-traffic bearing areas. Concentric

manholes shall be used in road rights-of-way. Manholes located in cul-de-sacs shall be 5-foot diameter.

**g. Service Laterals:**

Service laterals may be tapped directly into the top quarter of mains or manholes. Connections 6-inch and larger shall be made into manholes. All dwellings and businesses shall require at least 1 sewer tap, except multi-story apartments, condominiums, and businesses. Clean-outs for sewer services shall be located at intervals no greater than 50 feet for 4-inch pipe and 100 feet apart for 6-inch pipe. All single family residences shall have individual connections to public sewer main.

Multiple service connections are to be for private use only and will not be maintained by the Town of Apex. A clean-out (or manhole) shall be installed of each serviced lot's right-of-way or easement for the Town's use, and shall extend a minimum of 6 inches above the finish grade. Minimum grade for service laterals shall be 1/8 inch per foot for 4-inch and 0.6 percent for 6-inch.

All service laterals shall connect directly into an 8-inch (minimum) sewer main in the fronting street or into an easement which is contiguous to the lot, or which traverses through the lot. No service lateral may cross another adjacent lot to gain access to a sewer main. Private service easements will not be permitted.

All service laterals between 13 and 20 feet deep shall be DIP and use Class A bedding. Any sewer service lateral deeper than 20 feet shall be pre-approved by the ENGINEER.

Service laterals to be maintained by the TOWN shall not be located beneath a driveway or curb, nor shall a cleanout be located in a sidewalk area without prior written permission of the ENGINEER.

**7.02 Pipe Materials For Gravity Sewers**

**a. General:**

Sanitary sewer collection lines, trunk sewers, and interceptors shall conform to the following depth criteria:

<b>Diameter (inches)</b>	<b>Depth (feet)</b>	<b>Material</b>
8 - 15	≤ 13	polyvinyl chloride pipe (PVC)
> 15	any	ductile iron pipe (DIP)
any	> 13	ductile iron pipe (DIP)

**b. Ductile Iron Sewer Pipe:**

Ductile iron pipe shall be designed in accordance with ANSI Standard A21.50, latest revision. Unless noted otherwise on the drawings, the pipe thickness class may be Class 50 and shall be designed for an 8-foot minimum cover and a "Type 1" laying condition as denoted in Figure 1 of ANSI A21 .50.

The ductile iron pipe shall be manufactured in accordance with ANSI A21.51, latest revision. Pipe shall have cement mortar lining and seal coat in accordance with ANSI A21.4. The seal coat shall be the coat tar epoxy lining and shall be Indurall coating, Inc. "Ruff-Stuff," Kopper's Company, Inc. "Bitumastic No. 300-M," or equal. Joints for ductile iron pipe shall be mechanical or of the "push-on" type conforming to the requirements of ANSI A21.11.

Gravity sewer which runs from a connection point with force main shall be lined with 401-type ceramic epoxy for 1200 feet.

**c. PVC Sewer Pipe - SDR (Standard Dimension Ratio) 35:**

- 1) PVC sewer pipe for gravity flow installations shall be manufactured in accordance with all requirements of ASTM Standard D-3034 for SDR 35, "Type PSM Polyvinyl Chloride Sewer Pipe and Fittings." PVC gravity sewer pipe shall be furnished in nominal laying lengths of 12.5 feet.
- 2) PVC sewer pipe (SDR-35) and fittings shall be of cell classification of 12454-B, as defined in ASTM D-1784. PVC of other cell classifications will not be accepted. This pipe shall be appropriately marked.
- 3) Pipe Joints - Pipe joints for PVC Sewer Pipe shall be of the bell and spigot type with rubber gasket conforming to ASTM F-477.
- 4) Manufacturer's Certification - The manufacturer of non-pressure PVC Sewer Pipe shall furnish a notarized affidavit certifying as to compliance with the foregoing ASTM Specifications and with the PVC cell classification as specified.

**d. Steel Pipe:**

- 1) For Aerial Crossings & Miscellaneous Special Uses Where Approved by the ENGINEER - Steel pipe shall be high strength steel, welded or seamless manufactured in accordance with ASTM A139 and consisting of grade "B" steel with a minimum yield strength of 35,000 psi.

The outside of the pipe shall have 1 shop coat of epoxy primer. The pipe shall receive a field touch up primer and 2 field coats of black coal tar epoxy.

Pipe ends shall be square so as to receive a Dresser style "62" - Type I or approved equal mechanical transition coupling.

- 2) For Bored Casings - Steel encasement pipe shall be welded or seamless, consisting of grade "B" steel with a minimum yield strength of 35,000 psi and manufactured in accordance with ASTM A139.

The pipe thickness shall be as specified on the encroachment agreement or approved plans, and the ends shall be beveled and prepared for field welding of the circumferential joints.

Metal fabricated "spiders" with poly feet shall be used for support of the carrier pipe within the bored casing. Spiders with poly feet shall be placed at 8-feet O.C. maximum for the entire length of the casing.

### 7.03 Manholes & Accessory Materials

#### a. General Requirements:

All new manholes shall be of precast concrete construction, flat bottom type. Doghouse manholes shall be used where required for tie-ins to existing sewers. The following minimum diameter manholes shall be utilized dependent upon the size of the mains and depth of installation.

<i>Manhole Diameter</i>	<i>Pipe Size</i>	<i>OR</i>	<i>Depth</i>
4'-0"	8" - 12"		0' to 12'
5'-0"	16" - 24"		>12' - 18'
6'-0"	30" - 36"		>18' - 24'
8'-0"	≥ 42"		> 24'

Variance from this specification must be approved by the ENGINEER prior to construction. Each manhole shall be of consistent diameter throughout its entire height.

Inside drop manholes shall be a minimum 5-foot diameter. If more than 1 inside drop occurs within the same manhole, a 6-foot diameter manhole is required.

#### b. Precast Manholes:

- 1) Design - Precast concrete manholes shall be designed and manufactured in accordance with ASTM C478. The manhole walls shall be a minimum of 5 inches

thick and the base slab shall have a minimum thickness of 6 inches. The minimum compressive strength of the concrete shall be 4,000 psi. The manhole sections shall have reinforcement as required to provide resistance to the hydrostatic and passive earth pressures to which they will be subjected, and to provide adequate resistance to temperature and shrinkage cracking.

All manholes shall be equipped with a flexible watertight connection and sealing system for all pipe penetration 6-inches and larger.

- 2) Joints - Manhole sections shall have a standard tongue and groove joint with a rubber "O"-ring, conforming to ASTM Standard C-443 or butyl rope sealant such as Ram-Nek.
- 3) Cone Sections - The upper precast cone sections shall be of the concentric type with a minimum height of 24 inches. Flat top slabs shall be used in all non-traffic areas.

**c. Manhole Ring and Cover:**

Manhole ring and cover shall meet the requirements of Section 5.03e of these Specifications for Gray Iron Castings. The cover shall be perforated with 2 - 1" diameter holes unless otherwise noted on plans. Manholes shall have rings and covers made by East Jordan Iron Works, Neenah Foundry Company, or equal and should facilitate raising of manhole for future paving. Where deemed necessary in low areas of streets, solid manhole covers may be required by the ENGINEER to prevent surface water inflow into the sewer.

Manholes located along outfalls within the 100-year flood plain per Section 7.14c of these Specifications or where deemed appropriate by the ENGINEER, shall utilize a locking ring and cover per Detail 7.05.

**d. Mortar:**

Mortar used in manhole invert construction shall consist of 1 part Portland Cement and 2 parts sand. Portland Cement shall meet the requirements of the latest ASTM Specification C-150, Type I. Sand used for mortar shall meet the requirements of ASTM Specification C-144, latest edition. Mortar shall be mixed in a clean, tight mortar box or in an approved mechanical mixer and shall be used within 45 minutes after mixing.

**e. Flexible Sealing System for Joining Pipes to Precast Manholes:**

Each connection to a manhole shall be sealed watertight by means of a flexible sleeve or gasket type sealing system. The flexible sleeve type system, if used, shall be equal to Flexible Manhole Sleeve as manufactured by the Interpace Corporation. The gasket type system, if used, shall be equal to the

PSX system as manufactured by the Press Seal Gasket Corporation. The sealing system shall be furnished by the manhole manufacturer.

**f. Stone for Stabilization of Trench Foundation:**

Stone used for pipe bedding and trench stabilization shall meet the gradation requirements for standard aggregate size No. 57 or 67 as contained in the Standard Specifications for Roads and Structures as published by the NCDOT.

**7.04 Service Lateral Materials**

**a. General Requirements:**

All sewer service laterals shall be constructed of either of the two types of materials indicated herein. Materials shall be consistent throughout the service. Transition of material between the horizontal service line and the clean-out will not be permitted. Prior to beginning work, the CONTRACTOR shall furnish samples of service material fittings to the DPW for approval. Samples shall include saddles, wyes, cleanout, adapters, couplings, etc.

**b. PVC Service Pipe & Fittings:**

PVC pipe and fittings for sewer laterals shall conform to ASTM D2665 "PVC" Plastic Drain, Waste & Vent Piping" and shall be Schedule 40 and NSF approved. Laying lengths may be 10 or 20 feet. Joints shall be of the solvent weld type.

**c. Service Saddles on DIP Sewers:**

Service saddles for connection of laterals to DIP sewers shall be cast iron, 45-degree deflection, equipped with a single stainless steel clamp. The saddle shall be furnished with adapters as required to properly receive the service pipe to be used.

**d. Saddles for PVC Sewer Pipe:**

Saddles for PVC sewer pipe shall be of PVC material, 45-degree deflection, conforming to the requirements of ASTM D3034. The saddle shall be equipped with 2 stainless steel clamps and bell adapters as required to properly receive the service pipe to be used. The saddle service branch shall stub slightly into the sewer main so that when installed, the saddle shall not slip or rotate.

**7.05 Trench Excavation and Preparation**

**a. General Requirements:**

The pipeline trench shall be excavated to the line and gradient shown on the approved

drawings. Trench width shall be a minimum of 16 inches plus the outside diameter of the pipe and a maximum of 24 inches plus the outside diameter of the pipe.

The length of trench which may be open ahead of pipe laying operations shall be no more than 100 feet and no less than 20 feet unless warranted by special circumstances, and then only upon approval of the ENGINEER.

The trench bank shall be vertical from the bottom to a point not less than 1 foot above the top of the pipe. The CONTRACTOR shall do all bracing, sheeting, sloping of bank, shoring, pumping, etc., as required to prevent caving of the banks, all in strict accordance with applicable OSHA regulations. Trench sheeting shall be cut off and left in place where its removal might adversely affect the sewer pipe installation.

During trench excavation operations, the CONTRACTOR shall endeavor to separate the excavated materials by soil types, so that the better materials (if any) may be used in the bedding, haunching, and initial backfill zones.

**b. Dewatering:**

The ground adjacent to the excavation shall be graded to prevent surface water from entering the trench. The CONTRACTOR will, at his expense, remove by pumping or other means approved by the DPW, any water accumulated in the trench and shall keep the trench dewatered until bedding and pipe laying are complete. When water is pumped from the trench, the discharge shall follow natural drainage channels. Proper erosion control measures shall be employed. Direct discharge into stream is not permissible.

In trenches where water is present or where dewatering is required, the trench bottom shall be undercut and stabilized with No. 57 or No. 67 stone, having a minimum depth of 8-inches.

**c. Rock Excavation:**

Where rock is encountered, the trench shall be excavated to a depth of not less than 6 inches beneath the bottom of the pipe and then refilled with No. 57 or No. 67 stone. For ductile iron sewer pipe, the bedding may be other native granular soil as may be approved by the ENGINEER. The trench width in rock excavation shall be as previously specified.

**d. Blasting Procedures:**

Blasting for trench rock may be initiated only after the permitting requirements prescribed in Section 2.03(c) of these Specifications have been met. The CONTRACTOR is also reminded of the work hour limitations for blasting.

Blasting procedures shall conform to all applicable local, state, and Federal laws and ordinances. The CONTRACTOR shall take all necessary precautions to protect life and

property, including the use of an approved blasting mat where there exists the danger of throwing rock or overburden. The CONTRACTOR shall keep explosive materials that are needed on the job site in specially constructed boxes provided with locks. These boxes shall be painted red and plainly identified as to their contents. After working hours, the boxes containing explosive materials shall be removed from the job site.

Failure to comply with this specification shall be grounds for suspension of blasting operations until full compliance is made. No blasting shall be allowed unless a galvanometer is employed to check cap circuits. Where blasting takes place within 500-feet of a utility, structure, or property which could be damaged by vibration, concussion, or falling rock, the CONTRACTOR shall be required to keep a blasting log containing the following information for each and every shot:

1. Date of shot
2. Time of shot
3. Foreman's name
4. Number and depth of holes
5. Approximate depth of overburden
6. Amount and type of explosive used in each hole
7. Type of caps used (instant or delay)
8. The weather

This blasting log shall be made available to the ENGINEER upon request and shall be kept in an orderly manner. Compliance by the CONTRACTOR with these specifications does in no way relieve him/her of legal liabilities relative to blasting operations.

The ENGINEER reserves the right to require removal of rock by means other than blasting where any utility, residence, structure, etc. is either too close to, or so situated with respect to the blasting as to make blasting hazardous.

#### **7.06 Soils Classifications - for Bedding and Backfill**

Soils for pipe bedding and backfill are described in the ASTM D2487 Figure 1 soils classification chart and for purposes of these specifications are grouped in (5) categories as follows, according to their suitability for this application:

a. **Class I Soil:**

Angular, 6 to 40 mm (1/4 to 1 1/2 in.), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

b. **Class II Soil:**

Course sands and gravels with maximum particle size of 40 mm (1.5 in.), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types OW, OP, SW, and SP are included in this class.

c. **Class III Soil:**

Includes fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil types GM, OC, SM, and SC are included in this class.

d. **Class IV Soil:**

Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil types MH, ML, CH, and CL are included in this class. These materials are not recommended for bedding, haunching, or initial backfill on PVC sewer pipes.

e. **Class V Soil:**

Include the organic soils - types OL, OH, and PT, as well as soils containing frozen earth, debris, rocks larger than 1.5-inch diameter, and other foreign materials. These materials are not recommended for bedding, haunching, or initial backfill for any of the accepted sewer pipe materials.

### **7.07 Pipe Bedding Classes - Definition**

For these specifications, pipe-bedding classes shall be those classes as defined below:

a. **Class "A" Bedding - Depth ≤ 20 feet:** is that condition existing when the trench bottom is undercut a minimum of 6 inches below the pipe and filled to pipe spring line with No. 57 or No. 67 stone.

b. **Class "B" Bedding - Depth > 20 feet:** is that condition existing when the trench bottom is undercut a minimum of 6 inches below the pipe and filled to 6 inches above the pipe with No. 57 or No. 67 stone.

### **7.11 Unloading and Storage of Pipe Materials**

The unloading and loading of all pipe, fittings, and other accessories shall be in accordance

with the manufacturer's recommended practices and shall at all times be performed with care to avoid any damage to the material.

Once on the job site, all materials shall be stored in accordance with the manufacturer's recommended practices, and within the limits of the project site.

### **7.12 Pipe Laying**

After the trench bedding has been prepared and properly shaped and bell holes excavated as required, the gravity sewer pipe, including service laterals, shall be installed so as to have a full and uniform bearing throughout its entire length. Sewer pipe shall be installed in strict accordance with the manufacturer's recommendations and the requirements of these Specifications. Pipe shall be carefully handled and in no case shall pipe be dumped or dropped into the trench. Any damaged pipe shall be rejected and replaced.

All gravity sewer lines and manholes shall be laid to the line and grade shown on the approved drawings with no deviations whatsoever unless approved by the ENGINEER. Laser equipment shall be used by the CONTRACTOR for maintaining proper alignment. The installation shall begin at the downstream end of a sewer segment and progress upstream.

The pipe interior shall be kept clean throughout the pipe laying operation. **Pipe ends shall be plugged at the end of each workday.** Plugs shall be watertight to prevent the entrance of foreign matter into the pipe.

The downstream side of the last manhole(s) of a sanitary sewer line extension under construction shall be plugged with a non-pneumatic plug and secured with a stainless steel chain or wire rope to prevent the passage of ground water, runoff and sediment into the sanitary sewer system. All water upstream of the plug 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 plug shall not be removed until the line has been inspected, in accordance with Section 7.18 hereof, by the Town to insure that all possible points of inflow or infiltration have been eliminated. The Director of Public Works shall reserve the right to assess the Contractor or Developer a fine, to cover any remediation costs borne by the Town, for the Contractor's failure to adhere with the requirements of this paragraph.

Where a sewer line crosses an existing or proposed water line or water service line, the sewer shall always be installed beneath the water line, with a minimum separation of 18 inches. The CONTRACTOR shall locate the conflicting water main or service sufficiently far in advance to ensure that the sewer can be laid at the proper gradient and meet the eighteen-inch separation requirement. If this separation cannot be attained, then both the water line and the sewer line shall be constructed in accordance with Section 7.01(c).

### **7.13 Backfilling**

Backfilling shall be completed as soon as possible, so as to minimize the length of time that the trench or any part thereof is left open. Material classification for backfill materials as may be noted hereinafter shall conform to the allowable soil classifications as defined in Section 7.06 hereof.

The material shall be compacted in 6-inch lifts (loose measurement) to the top of the pipe and compacted to 95% of maximum dry density (Standard Proctor). The backfilling shall be done on both sides of the pipe simultaneously to prevent displacement of the pipe. If the pipe is within an area to be paved or where the trench is immediately behind the curb, the backfill material shall be placed on top of the pipe with an initial lift of 12 inches followed by 6 inch lifts to the top of the trench. If the pipe is outside of the paved area and is not located directly behind the curb, the backfill material shall be placed on top of the pipe in 12 inch lifts to the top of the trench. The backfill materials shall be moistened when necessary in the opinion of the INSPECTOR to obtain maximum compaction. Water setting or puddling shall not be permitted. For PVC sewer pipe, if there is a question as to soils classification, the CONTRACTOR shall have representative samples of the soil(s) classified by an approved testing laboratory to ensure that Class IV materials have been excluded from the initial backfill zone. See last paragraph of this section for the final backfill requirements.

The remaining or final backfill for all pipe materials shall be suitable native material placed and compacted in layers not to exceed 6 inches. No rocks, boulders, stones, or debris shall be included in the backfill material for at least 2 feet above the top of the pipe. In traffic areas the final backfill shall be placed and compacted in 6 inch layers. Backfill shall be of such density as to ensure no settlement of the trench. Should any sewer trench exhibit settlement, the CONTRACTOR shall correct the deficiency to the complete satisfaction of the ENGINEER. Where the sewer pipe is placed in public roads the backfill shall be compacted to at least 95% standard density as measured by AASHTO Method T-99. Where deemed necessary, the ENGINEER may require compaction tests on backfill placed under State roads or other public roads. The cost for such tests shall be borne by the CONTRACTOR or DEVELOPER.

### **7.14 Manhole Construction**

#### **a. General:**

Precast concrete manholes shall be set true to the alignment and elevations indicated on the plans. Grade ring adjustments shall not exceed 12 inches. The monolithic base section shall be set on an eight-inch thick, No. 57 or No. 67 stone base. Inlet and outlet piping shall be connected using the gasket seal system as previously specified, in strict accordance with the manufacturer's recommendation. Any manhole that is within 1200 feet of force main connection shall be coated with a protective epoxy, such as Sherwin Williams Sewer-Cote.

Backfill around manholes shall be placed uniformly in shallow layers and thoroughly compacted with mechanical tampers and with care taken to ensure against displacement of the structure.

Inverts shall be constructed in all manholes and shall be of concrete or other approved masonry construction. The inverts shall be shaped to form a smooth and regular surface free from sharp and jagged edges. The benches shall be sloped so as to prevent sedimentation. The inverts from intercepted cross lines shall be tied into the main flow line wherever possible, so as to provide a smooth transition. Wherever such cross lines tie-in at a substantially higher elevation than that of the downstream invert, the connecting line shall extend into the manhole a sufficient distance to enable the flow to spill into the flow line rather than onto the invert bench.

**NOTE - DEAD END MANHOLE:** On dead end manholes receiving service connections, the invert must be constructed and the invert flow line shall extend through the manhole so that all flow entering the manhole shall be readily conveyed downstream.

The manhole rings shall be set in full mortar beds. The rings with covers shall be set to the final grade indicated on the plans or as may be directed by the ENGINEER. Any rings and covers not conforming to the correct grade shall be adjusted by the CONTRACTOR as required. The exterior surface of all manholes shall be thoroughly cleaned of all grease, dirt, etc. All lifting lugs shall be removed and holes patched thoroughly with non-shrink mortar, color to match that of the manhole where such patches are exposed.

**b. Special Provisions - Drop Manholes:**

Where drop manholes are noted on the Drawings, they shall be constructed in accordance with the Detail 7.08. Drop pipe and fittings shall be ductile iron. The sewer pipe entering the drop tee shall consist of 1 joint of ductile iron pipe.

**c. Special Provisions – Manholes Within the 100-Year Flood Plain:**

Manholes located within the 100-year flood plain or in areas of high ground water shall be waterproofed by wrapping the individual joints with Conwrap, Conseal, or approved equal. Waterproofing measures shall be approved by the INSPECTOR prior to backfill. Manholes showing signs of infiltration shall be excavated and repaired, to the satisfaction of the ENGINEER, prior to acceptance by the Town.

Manholes located within the 100-year flood plain shall be installed with rim elevations not less than 2 feet above the flood plain at that location. All manholes located within the 100-year flood plain shall be equipped with a locking ring and cover per Detail 7.05 and shall be vented in accordance with Detail 7.13.

### **7.15 Construction of Sewer Service Laterals - Additional Provisions**

Lateral connections to new sewer mains shall be made with an in-line wye of the same material as the main. Connections to existing sewer mains shall be made by means of a special saddle and 1/8 bend as previously specified and shown on the detail and specifically designed to fit the sewer pipe selected. The inlet connection shall include any required adapters to accommodate the selected service pipe material.

The saddle shall be installed in strict accordance with the manufacturer's recommendations and shall be properly bedded and backfilled so as to prevent slippage or rotation on the sewer main.

The service lateral shall terminate with a combination wye and 1/8 bend. A vertical riser shall extend and project slightly above grade (6 inches nominal). The riser shall terminate with a female pipe adapter and threaded cap.

All specifications previously presented relative to bedding and backfill shall apply. Four-inch service pipe shall be laid on a gradient of not less than 1/8 inch per foot. Minimum gradient for 6-inch pipe shall be 0.6 percent.

Where service laterals connect to a manhole, an invert shall be constructed wherever possible to provide a smooth flow line. Where the drop exceeds 18 inches, a service drop connection with cleanout shall be provided in accordance with the standard detail.

### **7.16 Installation of Steel Casing Pipes by Boring & Jacking**

Steel casing pipe to be installed by simultaneous boring and jacking shall be constructed to the required standards of the NCDOT. For railroad crossings, the construction requirements shall conform to the requirements of the affected railway company.

The project drawings shall show a plan and profile for each casing pipe to be installed. The plan shall clearly note the casing pipe wall thickness and length. For railroad crossings, the CONTRACTOR shall be certain that a proper license agreement has been obtained and that any special insurance requirements are complied with.

### **7.17 Cutting & Replacement of Existing Pavements**

The open cutting of existing pavements may be permitted for sewer line installations across designated Town streets. The cutting and replacement of such pavements shall conform to Detail 3.13.

## 7.18 Inspection & Testing of Gravity Sewers

### a. Visual Inspection of Pipeline Interior:

Upon completion of any designated portion of the sewer lines, the ENGINEER in the presence of the CONTRACTOR shall conduct a visual inspection of the pipeline interior. The test shall be conducted by flashing a light between manholes, by use of mirrors, or by such other devices as will allow an adequate inspection of the line to detect misalignment or structural defects. Any portion of the line which does not exhibit a true alignment and uniform grade, or which shows any defect shall be corrected to the complete satisfaction of the ENGINEER.

The ENGINEER may re-inspect the line at any time prior to final acceptance if any damage or displacement is suspected to have occurred subsequent to the initial inspection.

### b. Low Pressure Air Tests:

The low pressure air testing shall be conducted in accordance with ASTM C-828. Prior to testing, the sewer line shall be clear of debris and flushed with water as necessary. The line shall be plugged and the plugs shall be securely braced to prevent slippage. The line shall be pressurized with air to 5 psi and allowed to stabilize for a period of 2 minutes. To simplify the ASTM procedure, the following table shall be used to determine the test time. If there are multiple sizes, add the various times together.

<b><i>Normal Pipe Size (inches)</i></b>	<b><i>Time (t) (Minutes/100 ft.)</i></b>
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0
42	7.3

If the pressure stays at 5 psi for the required test time length as noted above, the pipe is acceptable.

Should the section of pipe being tested fail to meet these requirements, the source of leakage shall be determined and repaired to the satisfaction of the TOWN. The section shall then be retested until it is deemed to be acceptable by the TOWN.

The CONTRACTOR shall furnish all plugs, compressors, hose, gauges, etc., as required to conduct the low-pressure air test.

**c. Infiltration Tests:**

Portions of the sewer lines, which exhibit a higher ground water table during construction, shall be tested for infiltration. The portions of the line to be infiltration tested shall be determined by the ENGINEER.

The portion of the sewer line designated by the ENGINEER shall be tested for infiltration by installing a V-notch measuring weir or other suitable measuring device in the downstream end of the pipe to be tested. When a steady flow occurs over the weir, the rate of flow (infiltration) shall be measured. The rate thus measured shall not exceed 100 gallons per 24 hours per inch of sewer pipe diameter per mile of pipe. The CONTRACTOR shall furnish weirs and other equipment required for infiltration tests and the tests shall be performed in the presence of the ENGINEER.

Should the infiltration tests reveal leakage in excess of the allowable, the leaking joints shall be re-laid if necessary or other remedial construction shall be performed by and at the expense of the CONTRACTOR. The section of sewer thus repaired shall then be retested to determine compliance with the Specifications.

**d. Deflection Testing of PVC Sewer Pipe (SDR-35):**

If PVC Sewer Pipe (SDR-35) is used for gravity sewer, a deflection test shall be conducted on all such pipe installed. These pipes shall be mandrelled with a rigid device sized to ensure that the final long term deflection or deformation of the pipe barrel has not exceeded 5 percent for PVC sewer pipes.

The mandrel (Go/No-Go) device shall be cylindrical in shape and constructed with 9 or 10 evenly spaced arms or prongs. Mandrels with fewer arms (in odd or even numbers) will be rejected as not sufficiently accurate.

The outside diameter of the 9-arm mandrel shall be as shown below for 8-inch PVC Pipe. The mandrel diameter shall have a tolerance of +/- 0.01". Contact length shall not be less than 2 inches.

<b>Mandrel Dimensions</b>	
<b>Main Size</b>	<b>PVC Sewer</b>
8"	7.28
10"	9.08
12"	10.79
15"	13.20

Any lines not meeting this test shall be corrected by the CONTRACTOR and the test repeated.

Allowances for pipe wall thickness tolerances or ovality shall not be deducted from the "D" dimension but shall be counted in as a part of the deflection allowance.

The mandrel shall be hand pulled by the CONTRACTOR through all PVC sewer lines. Any sections of sewer not passing the mandrel shall be uncovered and the CONTRACTOR shall re-round or replace the sewer to the satisfaction of the ENGINEER. These repaired sections shall be retested.

The initial inspection shall be conducted no earlier than thirty (30) days after reaching final trench backfill grade. Deflection testing shall be accomplished at such times as may be directed by the ENGINEER. Upon completion of all work, the ENGINEER may require such final deflection testing as may be deemed necessary to ensure that the long-term deflection has not exceeded the maximum allowed deflection.

An INSPECTOR shall approve the mandrel. The CONTRACTOR shall furnish drawings of the mandrel with complete dimensions to the ENGINEER upon request.

**e. Visual Inspection by Camera Prior to Acceptance:**

Prior to acceptance of any development with a gravity sewer extension, the INSPECTOR shall arrange with the Public Works Department, a camera inspection of all gravity sewer lines. Any discrepancies found in violation of these Specifications shall be repaired to the satisfaction of the Public Works Department prior to acceptance. No sewer line shall receive or transmit active flow prior to acceptance by the Town.

**f. Vacuum Testing of Manholes**

Prior to making sewer systems active, all manholes shall pass a vacuum test in accordance with ASTM C 1244-93. The Contractor shall supply all equipment and materials necessary

to vacuum test the manholes. Vacuum Testing shall not be initiated until the manholes and all specified coatings and lining materials have been cured in accordance with manufacturer recommendations. The Inspector shall be present and witness all vacuum testing. The following vacuum testing criteria shall apply for compliance with the testing procedure.

1. A vacuum of 10-inches of mercury shall be drawn with an approved vacuum testing unit.
2. The testing time shall not be measured until after the vacuum pump has been shut off.
3. 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 (seconds)**

Depth (feet)	Manhole Diameter (inches)		
	48	60	72
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