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701 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 20 feet from any other stream, lake, or impoundment.

If a deviation from these separations is proposed and approved by the *Water Resources Department*, 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 *Water Resources 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 *Water Resources 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:

Sewer Main Depth (D, ft)	Easement Width (ft)
8 < D ≤ 12	30
12 < D ≤ 14	40
>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.

Where concentrated sources of runoff (e.g., SCM discharge, FES discharge outlets, natural drainage ways, etc.) convey across existing or proposed Town of Apex Sanitary Sewer Easements, the applicant must design a rip rap lined channel across the full width of the easement in accordance with the design criteria presented in Standard Detail 400.15.

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 *Water Resources 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 3 feet 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.

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.

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 100 of these Specifications and to the guidelines established by the NC Department of Environment and Natural Resources, Division of Water Quality (NCDENR DWQ).

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 flowing half full at the average daily flow. The PROJECT ENGINEER shall furnish complete calculations to establish the basis for pipe sizing. The minimum velocity for gravity sanitary sewer mains is 3 fps. Minimum velocities less than 3 fps must receive approval from the ENGINEER.

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.

F. Slope

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

Sewer Size (in)	Minimum Slope (ft/100ft)
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.

G. 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 24 inches in elevation. All manholes shall have a maximum chimney height of 8 inches, including mortar joints. The total thickness of grade rings shall not exceed 6 inches. 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.

H. 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. 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 and businesses shall have individual connections to public sewer main.

Multiple service connections located outside public right of way or public easement are for private use only and will not be maintained by the Town of Apex. A sewer permit from NCDENR DWQ will be required on all private collection systems before construction plan approval. A clean-out and/or a manhole shall be installed within 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 1/4 inch per foot for 4-inch pipe and 1/8 inch per foot for 6-inch pipe.

All 4-inch 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. All 6-inch service laterals shall connect directly into a manhole. No 4-inch 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 or PVC C900 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 clean-out be located in a sidewalk area without prior written permission of the ENGINEER.

702 Pipe Materials For Gravity Sewers

A. General

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

Diameter (in)	Depth (ft)	Material	Bedding Requirements
8 - 15	≤ 13	PVC SDR 35	6 inches below & up to spring line
8 – 15	13 < D ≤ 16	PVC C900 DR 18 or DIP	6 inches below & up to spring line
8 - 20	16 < D ≤ 20	PVC C900 DR 18 or DIP	6 inches below to 6 inches above (full encasement)
any	> 20	DIP	6 inches below to 6 inches above (full encasement)

Transition of sewer main materials shall only occur at manholes.

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. Ductile iron sewer pipe shall not be designed for use within residential streets with service connections unless approved by the ENGINEER.

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.

Ductile iron pipe used in bored encasements shall be “restrained joint” type.

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

The following table lists approved manufacturers of DIP, DIP fittings, and RJDIP that are allowable for installation within the Town’s system.

Product Category	Approved Manufacturer	Model/Series	Pressure/ Load Rating	Reference Standard	Requirements
Ductile Iron Pipe 8-inch & 10-inch Diameter (& 4-inch & 6-inch services) Cement Mortar Lined	US Pipe	Tyton Joint	350 psi	AWWA C150 & C151	Cement mortar lined with exterior bituminous coating; McWane pipe stamped "McWane by Atlantic States or Clow" only
	American (ACIPCO)	Fastite Joint			
	McWane	Tyton Joint			
Ductile Iron Pipe 12-inch & Larger Diameter Protecto 401 Lined	US Pipe	Tyton Joint	250-350 psi	AWWA & DIPRA Standards	40-mils of Protecto 401 Lining (lining must be less than 1 year old); McWane pipe stamped "McWane by Atlantic States or Clow" only
	American (ACIPCO)	Fastite Joint			
	McWane	Tyton Joint			
Ductile Iron Fittings 8-inch & 10-inch Diameter (& 4-inch & 6-inch services) Cement Mortar Lined	Sigma	Mech. Joint	350 psi	AWWA C110/C111 & AWWA C153	Shall always meet or exceed pipe pressure rating
	Tyler Union	Mech. Joint			
	SIP Industries	Mech. Joint			
	Star	Mech. Joint			
	American	Mech. Joint			
Ductile Iron Fittings 12-inch & Larger Diameter Protecto 401 Lined	Sigma	Mech. Joint	250-350 psi	AWWA & DIPRA Standards	Shall always receive interior Protecto 401 Lining to meet or exceed main line pipe standards (401 lining must be less than 1 year old)
	Tyler Union	Mech. Joint			
	SIP Industries	Mech. Joint			
	Star	Mech. Joint			
	American	Mech. Joint			

C. PVC Sewer Pipe

- 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 C900 DR 18 sewer pipe for gravity flow installations shall meet AWWA standards.
- 3) Fittings for PVC SDR-35 shall conform to the requirements of ASTM D3034 and ASTM F1336. Fittings sizes 4" through 8" shall be molded in one piece with elastomeric joints. Fittings 10" and larger shall be molded or fabricated with manufacturers' standard pipe bells and gaskets. Gaskets shall have a minimum cross sectional area of 0.20 sq. in. and conform to ASTM F477. PVC material shall have a cell classification of 12454 or 13343 as defined in ASTM D1784.
- 4) Fittings for PVC C900 DR 18 using pipe 8" and smaller shall be gasketed joint of one piece and injection molded of PVC compound with a cell class meeting or exceeding 12454 or 13343 per ASTM D1784. Elbows and Tees shall comply with AWWA C907. Wyes shall comply with the dimensional requirements of AWWA C907 except that minimum wall thickness shall be DR 18 of like size AWWA C900 pipe and all other requirements of this specification. Gasketed joints shall be pressure rated 235 psi per ASTM D3139. Gaskets shall be SBR rubber complying with ASTM F477.

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.

703 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.

Manhole Diameter (ft)	Pipe Size (single, in)	Pipe Size (multiple, in)	Depth (ft)
4*	8 - 12		0 to 12
5	16 - 24	8 - 12	>12 - 18
6	30 - 36	16 - 24	>18 - 24
8	≥ 42	30 - 36	> 24
10		≥ 42	

* not allowed in cul-de-sacs

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 eccentric 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 500 of these Specifications for Gray Iron Castings. The cover shall be perforated with two 1-inch 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 700 of these Specifications shall utilize a rotating cover per the Standard Detail.

D. Mortar

Calcium Aluminate (mortar) shall be used in manhole invert construction. 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.

704 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 shop drawings of service material fittings to the *Water Resources Department* for approval. Shop drawings shall include saddles, wyes, clean-out, 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.

PVC C900 DR 18 pipe and fittings shall be gasketed joint of one piece and injection molded of PVC compound with a cell class meeting or exceeding 12454 or 13343 per ASTM D1784.

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, and manufactured by Genco or approved equal. 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 or cast material, 45-degree deflection, conforming to the requirements of ASTM D3034. The saddle shall be equipped with 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.

705 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 INSPECTOR.

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 INSPECTOR, 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 INSPECTOR. 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 200 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 INSPECTOR 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 INSPECTOR 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.

706 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 ½ 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.

707 Pipe Bedding Classes - Definition

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

- A. Class "A" Bedding - Depth \leq 16 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 $>$ 16 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.

708 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.

709 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 INSPECTOR. 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.

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 700.

710 Plugs

The downstream side of the last manhole of a sanitary sewer line extension under construction shall be plugged with a non-pneumatic wing nut plug and secured with a stainless steel cable or wire rope to prevent the passage of ground water, runoff, and sediment into the sanitary sewer system. Each plug shall have a steel tag engraved with the Contractor's name and phone number. The plug installation shall be witnessed, secured to the satisfaction of the INSPECTOR, and documented for location on a Sewer Plug Permit Form. The Contractor shall have a representative present to sign and attest that no additional plugs will be installed throughout the system without prior written approval of the INSPECTOR. All water upstream of the plug shall be pumped out at the discretion of the INSPECTOR or any official from Public Works, and all sediment and solids shall be removed and disposed of by the CONTRACTOR. This maintenance of water removal is required on a 30-day cycle from installation until total acceptance by the Town of the sanitary sewer system. The plug shall not be permanently removed, displaced, or relocated without the written approval. The Town shall reserve the right to assess the Contractor or Developer a fine to cover any remediation costs borne by the Town due to the Contractor's failure to adhere with the requirements of this paragraph.

711 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 700 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 INSPECTOR. Where the sewer pipe is placed in public roads the backfill shall be compacted to at least 95% standard density as measured by AASTHO Method T-99. Where deemed necessary, the INSPECTOR 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.

712 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 and bolted down. The rings with covers shall be set to the final grade indicated on the plans or as may be directed by the INSPECTOR. 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 – 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 INSPECTOR, 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 rotating cover and shall be vented in accordance with the Standard Detail.

713 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. Minimum grade for service laterals shall be 1/4 inch per foot for 4-inch pipe and 1/8 inch per foot for 6-inch pipe.

Where service laterals connect to a manhole, an invert shall be constructed wherever possible to provide a smooth flow line. Where the drop exceeds 24 inches, a service drop connection with clean-out shall be provided in accordance with the Standard Detail.

714 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.

715 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 the Standard Detail.

716 Inspection & Testing of Gravity Sewers

A. Visual Inspection of Pipeline Interior

Upon completion of any designated portion of the sewer lines, the INSPECTOR 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 INSPECTOR.

The INSPECTOR 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.

Normal Pipe Size (in)	Time (t) (Minutes/100 ft)
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 INSPECTOR.

The portion of the sewer line designated by the INSPECTOR 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 INSPECTOR.

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

If PVC Sewer Pipe 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 inch. Contact length shall not be less than 2 inches.

Mandrel Dimensions	
Main Size (in)	PVC Sewer
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 INSPECTOR. 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 INSPECTOR. Upon completion of all work, the INSPECTOR 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 INSPECTOR upon request.

E. Visual Inspection by Camera Prior to Acceptance

- 1) As a final measure required for acceptance, the Contractor shall clean and televise all newly installed sewer mains prior to acceptance by the Town. The Contractor shall televise the sewer main and all lateral connections installed from the upstream to downstream manhole with no reverse setups or cutaways. Throughout shooting, the camera shall be panned and tilted for a complete view of the main including services. 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 Inspector on a CD/DVD and formatted with software compatible and readable by the Town. The Town shall not be responsible for purchasing additional software necessary to view the CD/DVD.
- 2) 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. If distances on the video do not match the distances on record drawings, then the video will not be accepted. The lot number/address of each service inspected shall be documented on the video.
- 3) The Contractor shall clean the sewer mains ahead of video inspection with a high-velocity water jet. All construction debris shall be collected in the downstream manhole and shall not be released into the sewer system.
- 4) The Infrastructure Inspector shall be present throughout the televising of the sewer mains to verify that the video work complies with the Specifications. The camera operator shall stop, reverse, pan and tilt the camera to view any area of interest during the inspection as directed by the Infrastructure Inspector.
- 5) Prior to submitting the CD's/DVD's to the Infrastructure Inspector, the Contractor shall label the CD's/DVD's with the following information:
 - Name of the Project/Development/Phase and Section
 - Name and contact information of responsible party
 - Date of televising
 - Manhole identification as shown on record drawings

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 (ft)	Manhole Diameter (in)		
	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