

150 WASTEWATER COLLECTION SYSTEMS

150.01 GENERAL

150.01.01 All public wastewater sewer extensions shall be designed by a Design Professional and shall be approved by the Pretreatment, Emergency Response, and Collection Systems Unit of NCDEQ/DWQ. All designs shall comply with these Standard Specifications, the State of North Carolina Administrative Code Section 15A NCAC 2H .0200, the "Gravity Sewer Minimum Design Criteria" as provided by NCDEQ/DWQ, or any other State or Federal regulations that govern, whichever of them are more stringent.

150.01.02 All private sewer collection mains that will connect or are planning to discharge into the Town sewer system shall comply with all Town design, siting and installation criteria outlined herein. The Owner/Developer of the private sewer collection system shall meet all State design requirements and obtain a State permit to operate the private system.

150.01.03 Materials: shall be as specified in Section 100.

150.02 DESIGN AND INSTALLATION

150.02.01 All public sanitary sewer mains shall be installed in dedicated street ROW or in dedicated utility easements. Please see Section 100 for more information on easements.

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

150.02.03 Public gravity mains shall be a minimum of 8 inches in diameter. Major interceptors shall be sized in accordance with the "Town of Fuquay-Varina Master Utility Plan". Interceptors not listed in the Master Utility Plan shall be designed based on the proposed land use (according to the Town's Current Land Use Plan), using the flow factors indicated in Table 150.01. At a minimum, all gravity sewer mains shall be designed and sized to serve the ultimate tributary buildout of the drainage basin.

150.02.04 The ratio of peak to average daily flow shall be based on line size as shown in Table 150.02.

150.02.05 The minimum grades for public sanitary sewers shall be based on line size as shown in Table 150.03. The minimum grade for the uppermost reach of an 8" sanitary sewer line shall be 1%.

150.02.06 Outfalls shall require accessibility with a maximum cross slope of 6:1.

150.02.07 The minimum velocity for sanitary sewer lines shall be 2.5 feet per second at projected peak flow. The minimum velocity may be reduced to 2.0 feet per second under limited circumstances only by approval of the Director of Engineering.

150.02.08 Sanitary sewers shall be designed to carry the projected peak flow at no more than 80% full at the minimum slope for that pipe, regardless of the actual slope of the pipe. If there is a force main discharged anywhere upstream of the gravity sewer line, the peak

pumping rate of that pump station shall be added to the projected peak flow of the gravity drainage basin.

150.02.09 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.

150.02.10 Mains shall be deep enough to serve all property within the natural drainage basin while allowing for sufficient slope in all lines and meeting the minimum cover requirements. Mains paralleling a creek shall be of sufficient depth to allow connections from across the creek below the stream bed elevation.

150.02.11 All deep sewer mains greater than 12' in depth shall be C-900 or Ductile Iron Pipe. Pipe materials shall be as specified in Section 100.

150.02.12 Sanitary sewers shall not be installed under any part of an existing impoundment or beneath any areas 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.

150.02.13 The following minimum cover requirements shall be met.

150.02.13.01 4 feet from the top of pipe to finished subgrade in roadways.

150.02.13.02 4 feet from the top of pipe to finished grade outside roadways.

150.02.13.03 1 foot from the top of the pipe to the bottom of the stream bed in creek crossings. Concrete encasement and ductile iron pipe shall be required when the cover between the top of the pipe and the stream bed is less than 3 feet.

150.02.14 The maximum grade for sanitary sewers is 10%. The maximum velocity in sanitary sewers is 15 feet per second. These limits may be exceeded with the approval of the Director of Engineering and the incorporation of the following provisions, which apply to all sewers either designed or installed at grades equal to or exceeding 10%.

150.02.14.01 All sewers with a grade of 10% or higher shall have the downstream run of pipe installed with DIP.

150.02.14.02 High velocity manholes shall be used on all sewers with a grade of 10% or higher. Vitrified clay pipe of the same diameter as the largest pipeline connecting to the manhole shall line the grout flow channel in high velocity manholes. High velocity lines cannot tie directly to an existing line and shall proceed 180 degrees through the invert into the downstream line.

150.02.14.03 Concrete anchors shall be installed on all sewers designed at grades of 10% or higher. The anchors shall be installed at the following spacing:

150.02.14.03.01 36' or less center to center on grades from 10% to 25%

150.02.14.03.02 24' or less center to center on grades from 25% to 40%

150.02.14.03.03 16' or less center to center on grades exceeding 40%

150.02.14.04 The Town reserves the right to require all high velocity requirements outlined herein for sewer lines either designed or installed at grades of 10% or greater, regardless of the flow velocity. In cases where the design grade established on the sewer design plan is exceeded during construction and the 10% threshold is exceeded, all high velocity requirements shall apply without waiver.

150.02.15 Sewer extensions shall be designed for projected flows, even when the diameter of the existing receiving sewer is less than the diameter of the proposed extension.

150.02.16 There shall be a minimum 5-foot horizontal separation between parallel gravity and/or force mains.

150.02.17 Pipe diameter changes shall occur 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.

150.02.18 All residential subdivision lots shall be served by public gravity sanitary sewer unless otherwise approved by the Director of Engineering. If a pump is approved, it shall be privately maintained, must pump into a gravity service connection placed on the lot, and must have a note on the construction plans and recorded plat indicating a private pump may be required to serve the lot with sanitary sewer service. In instances where private pump stations are approved, the gravity service that received the force main shall be required to extend into private property so that the required private force main vent is located a minimum of 20' from public right of way.

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

150.03 MANHOLES

150.03.01 Manholes shall be spaced at a maximum distance of 400 feet for lines 12 inches in diameter or less, and 500 feet for lines greater than 12 inches in diameter, unless otherwise approved by the Public Utilities Director.

150.03.02 Manholes shall have extended bases for stability.

150.03.03 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 and exiting sewer line. Hand-troweled grout, pre-cast, or brick and mortar inverts may be used.

150.03.04 The maximum flow deflection angle in a manhole shall be dependent upon pipe size as shown in Table 150.04.

150.03.05 Free falls of wastewater flow into the manhole invert from incoming sewer mains shall not be allowed without prior approval from the Director of Engineering. 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.

150.03.06 Drop manholes are not allowed without the written approval of the Director of Engineering. While certain physical constraints may dictate the need for drop manholes, they shall not be used merely to decrease trenching depth. In the event that drop manholes are allowed, they shall be constructed with an inside 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.

150.03.07 Drop manholes shall have the entire interior coated with an approved corrosion resistant lining. See Section 100 for more information on manhole coatings.

150.03.08 Manholes shall not be obstructed from view or access. It is illegal to bury or obstruct access to manholes.

150.03.09 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. In designing a manhole connection with a doghouse manhole, the angular separation between any incoming or outgoing mains shall be greater than 35 degrees and in accordance with manufacturer's recommendations.

150.03.10 The upstream side of the lowest manhole(s) of a sanitary sewer line extension under construction shall be plugged during construction to prevent the passage of groundwater, 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 by the Town to ensure that all possible points of inflow or infiltration have been eliminated. Failure to meet these requirements can result in fines.

150.03.11 Manholes not located in roadways shall have a top elevation a minimum of 12 inches above finished grade. Manholes located along outfalls shall have a top elevation a minimum of 24 inches above finished grade or 100 year flood plain, or 12 inches above the 500 year flood plain, whichever is higher.

150.03.12 Manholes higher than 30 inches above finished grade shall be constructed with a flat top and outside steps.

150.03.13 Manholes ring and cover vertical adjustments shall be by pre-cast concrete rings. Adjustments using bricks and mortar are not allowed.

150.03.14 Manholes located in NCDOT highways or roads with greater than 35 mile per hour speed limit shall have lockable lids.

150.04 SERVICE CONNECTIONS

150.04.01 Design

150.04.01.01 All residential subdivision lots shall be served by gravity unless otherwise approved by the Director of Engineering. If a pump is approved, it shall be privately maintained, shall pump into a service connection placed on the lot, and shall have a note on the recorded plat indicating that a private pump is required to serve the lot.

150.04.01.02 Service connections to the main lines shall be perpendicular to the main line and shall extend to the edge of the ROW or easement line. Sewer laterals shall not be located in easements when gravity service can be provided to the property frontage at the street.

150.04.01.03 Each separately owned structure requires a separate service connection to a public sewer.

150.04.01.04 Service connections on new sewer lines shall include the use of wye (not tee) connections. Service connections to existing lines shall use service saddles.

150.04.01.05 Cleanouts are required on all services with a maximum spacing of 75 feet on 4-inch services and 100 feet on 6-inch services, and at the ROW line or edge of easement. All cleanouts shall be flush with finished grade with an inverted brass cap.

150.04.01.06 Sewer cleanouts located in paved areas shall conform to Detail 150.13.

150.04.01.07 All 6 inch and larger service connections shall be into a manhole.

150.04.01.08 Direct sewer service taps shall not be allowed on sewer interceptor or outfall mains 18 inches in diameter or larger, except by manhole connection.

150.04.01.09 Sewer cleanouts located in paved areas, which bear vehicle loading, must have ductile iron risers, ductile iron fittings and traffic rated cast iron cover assembly.

150.04.01.10 Sewer services on mains that are 12' deep or greater shall follow the maximum allowable slope until it reaches the normal sewer service depth matching the private service per Detail 150.02.

150.04.01.11 All service lines which are connected into manholes shall not be through the cone section or manhole joints. Service lines shall be installed a minimum of 6 inches, but no more than 30 inches, above the invert, or they shall be installed with a standard outside drop, unless otherwise approved by the Public Utilities Director. Multiple service connections shall not be maintained by the Town.

150.04.01.12 All shallow service connections shall match the sewer line main. All deep sewer connections greater than 12' in depth shall be ductile iron pipe or C-900 up to the right-of-way.

150.04.02 Materials: shall be as specified in Section 100.

150.04.03 Installation

150.04.03.01 Residential service connections to existing sanitary sewer mains for existing residential homes (not for remodels/redevelopment for profit) may be made by the Town. Service connections for commercial properties or for profit residential remodels/redevelopment on existing mains and all service connections to new mains shall be made by the Contractor.

150.04.03.02 Service taps into mains shall be made on the top quarter of the main with the wye saddle angled towards the direction of flow in the main.

150.04.03.03 Ductile Iron Pipe shall be used for sanitary sewer services with less than 4 feet from finished grade or in excess of 20 feet of cover. If DIP sewer service is in excess of 15-feet of cover, the service shall be epoxy lined the same as the main line. Ductile iron services shall also be used in all cases where a well is located within 100 feet of the sewer service line.

150.04.03.04 Service lines between 3 and 8 feet in depth do not require special bedding. PVC service lines between 8 and 20 feet in depth shall require Class I bedding from 4 inches below the service line to 4 inches above the service line.

150.04.03.05 Four inch lines shall have a minimum slope of 1.0 foot/100 feet and 6 inch lines shall have a minimum slope of 0.60 feet/100 feet.

150.04.03.06 Service connections made using a ductile iron service saddle shall be made only when the service line is iron pipe and only when the sewer main is 8", 10", or 12" diameter concrete, ductile iron, or PVC sewer pipe. This service connection shall not be used when the sewer main material is truss sewer pipe. The opening in the sewer main for a ductile iron service saddle shall be cut with a hydraulically or pneumatically driven circular tapping saw of the same nominal diameter as the sewer service line.

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

150.04.03.07.01 The bedding shall be designed per manufacturer's recommendations; however, bedding shall be minimum of 1 foot below invert and 1 foot above crown of 78M or No. 5 stone.

150.04.03.07.02 PVC pipe shall also be wrapped in minimum of 6-inches of stone above and below to the cleanout at ROW.

150.04.03.07.03 The entire sewer service shall be left exposed for visual inspection the Town Construction inspector before backfill, with special attention at service taps.

150.05 GREASE TRAPS

150.05.01 All Owner/Developers involved in the preparation of food for commercial purposes shall provide oil/grease separators.

150.05.02 All Owner/Developers whose wastewater stream is associated with unusually large quantities of grit, sand or gravel shall be required to install a sand separator. All car/truck wash systems shall be required to install sand separators. The requirements of this section shall not apply to private living quarters or dwelling units.

150.05.03 All sand and oil/grease separators used in conjunction with facilities other than eating establishments shall have a capacity of 24 minutes retention time at the peak 8-hour flow rate. Flow-through velocities shall not exceed 1.0 foot per second at the peak 8-hour flow rate.

150.05.04 All sand and oil/grease separators shall be sized, located and constructed in accordance with the provisions of the duly adopted North Carolina State Code where such parameters have not been otherwise set forth in this Section.

150.05.05 Where automobiles are serviced, greased, repaired, or washed or where gasoline is dispensed, oil/water separators shall have a minimum capacity of 6 cubic feet for the first 100 square feet of area to be drained, plus 1 cubic foot for each additional 100 square feet of area to be drained into the oil/water separator. The minimum size is 1,000 gallons.

150.05.06 Food service establishments discharging to the Town wastewater system shall install, operate, clean and maintain a sufficiently sized oil/grease separator necessary to achieve compliance with requirements set forth under this Section.

150.05.07 All oil/grease separators required in this Section shall have a capacity and design in compliance with the most updated *GREASE INTERCEPTOR SIZING WORKSHEET PROCEDURE FOR KITCHEN FIXTURES* provided on the Town website.

150.05.08 No oil/grease separators shall be smaller than 750 gallons, no single separator shall be larger than 3,000 gallons and where requirements exceed 3,000 gallons multiple units shall be used. In cases of certain fast food restaurants or establishments with potential to discharge large quantities of grease and oil, capacity requirements greater than 25 gallons per seat may be required. Prepackaged or manufactured oil/grease separators may be approved by the Town with proper engineering and application review.

150.05.09 The use of any additives, such as enzymes, chemicals or bacteria, as a substitute for oil/grease separators or oil/grease separator maintenance is prohibited. The use of additives as a supplement to oil/grease separators or oil/grease separator maintenance may be authorized by the Town after proper documentation and efficiency review.

150.05.10 All oil/grease separators shall be maintained by the Owner/Developer at the Owner/Developer's expense. Maintenance shall include the complete removal of all the contents, including floating materials, wastewater and bottom sludges and solids. Decanting or discharging of removed waste back into the trap from which the waste was removed or to

any other oil/grease separator or sanitary sewer connection for the purpose of reducing the volume to be hauled is prohibited.

150.05.11 All oil/grease separators shall be maintained in proper working order. The Town may require maintenance by the Owner/Developer when the Town determines a problem exists affecting the Town's system. At a minimum, the oil/grease separator shall be emptied every thirty calendar days unless otherwise approved by the Public Utilities Director.

150.05.12 When required by the Town, the Owner/Developer shall install a suitable manhole on the discharge sewer to allow observation, sampling, and measurement of the wastewater. This manhole shall be installed so as to be safe and accessible at all times.

150.05.13 Any authorized representative of the Town bearing proper credentials and identification shall be permitted to enter and inspect all properties without prior notification. This right of inspection shall include the right to measure, observe, sample, test, record, review and make copies of all pertinent documents, in accordance with this section.

150.05.14 All pumpage from oil/grease separators shall be disposed in accordance with State regulations.

150.05.15 Maintenance, Reporting & Record Keeping

150.05.15.01 Maintenance records shall be maintained onsite where the grease interceptor or oil/water separator is located for a period of three years.

150.05.15.02 Grease interceptor maintenance records must include the following information:

- FSE name and physical location
- Date and time of grease interceptor service
- Name of grease interceptor service company
- Name and signature of person doing said service
- Established service frequency and type of service (Example Full pump out, partial pump out, on site treatment, etc.)
- Number and size of each grease interceptor serviced
- Approximated amount, per best professional judgment, of grease and solids removed from each grease interceptor
- Total volume of waste removed from each grease interceptor
- Destination of removed wastes, food solids, and wastewater Disposal

150.05.15.03 Maintenance records that do not include all the above information will be considered incomplete. Incomplete records are considered a violation of the Town Sanitary Sewer Use Ordinance and may subject the facility to penalty assessments and/or service termination.

150.05.15.04 Facilities for which a specific pretreatment permit has been issued will follow the requirements for maintenance and record keeping as stated in the permit.

150.06 TESTING AND INSPECTIONS

150.06.01 General

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

150.06.02 Sewer Main and Service Connection Testing

150.06.02.01 Visual Testing and Observation

150.06.02.01.01 All materials used shall be approved by the Construction Inspector prior to installation. Rejected materials shall be immediately removed from the job.

150.06.02.01.02 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.

150.06.02.02 Air Testing

150.06.02.02.01 Low-pressure air testing shall be performed on all sewer mains in accordance with ASTM F1417 after the Town maintained portion of the laterals are installed on the line, and after the trench has been backfilled to finished grade.

150.06.02.02.02 Please reference Uni-Bell publication "UNI-B-6-98" for additional information on low-pressure air testing of PVC pipes. See Table I of that publication for testing times of any pipe sizes not included in Table 150.05.

150.06.02.02.03 Plugs shall be installed at each manhole to seal off the test section. The line shall be pressurized with a single hose and monitored by a separate hose connection from the plug. A single hose, gauge, and valve arrangement may be used with approval of the Construction Inspector. Air shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 PSI. The air pressure shall then be allowed to stabilize for a minimum of 2 minutes at no less than 3.5 PSI (plus groundwater pressure, if any). When the pressure reaches 3.5, the time required for the pressure to drop 1.0 PSI shall be observed and recorded.

150.06.02.02.04 The minimum time during which the pressure shall not drop more than 1.0 PSI shall be calculated using the information in Table 150.05.

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

150.06.02.02.06 The Construction Inspector may require that an infiltration test be performed that shall not exceed 100 GPD/inch/mile.

150.06.02.03 Deflection Testing for Flexible and Semi-Rigid Pipe

150.06.02.03.01 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 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 Table 150.06, and shall be subject to the Construction Inspector's approval.

150.06.02.04 Video Assessment and Cleaning

150.06.02.04.01 As a final measure required for acceptance, the Contractor shall clean and televise all newly installed sewer mains prior to acceptance by the Town.

150.06.02.04.02 The Contractor shall clean the sewer mains ahead of video inspection with a high-velocity water jet. The video inspection shall take place within 2 hours of cleaning operations as witnessed by the Construction Inspector. All construction debris shall be collected in the downstream manhole and shall not be released into the sewer system.

150.06.02.04.03 The camera shall be advanced at a uniform rate, from the upstream to downstream manhole, allowing a full and thorough inspection of the new sewer main, with no reverse setups or cutaway. The camera shall be a color, pan and tilt camera. Throughout shooting, the camera shall be panned and tilted for a complete view of the main and all lateral connections. The picture quality and resolution shall be acceptable and sufficient to allow a complete inspection with no lapses in coverage. The length of the sewer main shall be measured and recorded on the video screen. The distance counter shall be calibrated before shooting the inspection video.

150.06.02.04.04 The Construction Inspector shall be present throughout the cleaning and televising of the sewer mains to verify that the video work complies with the specifications.

150.06.02.04.05 The video inspection shall be submitted to the Construction Inspector on a CD with mpeg2 .AVI formatting. The Town shall not be responsible for purchasing additional software necessary to view the CD's. Prior to submitting the CD's to the Construction Inspector, the Contractor shall label the CD's with the following information:

- 150.06.02.04.05.01 Name of the Project/Development.
- 150.06.02.04.05.02 Name and contact information of responsible party.
- 150.06.02.04.05.03 Date of televising.
- 150.06.02.04.05.04 Manhole identification as shown on the design plans.

150.06.03 Manhole Testing

150.06.03.01 Vacuum Testing

150.06.03.01.01 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.

150.06.03.01.02 Vacuum Testing shall not be initiated until the manholes and all specified coatings and lining materials have been cured in accordance with manufacturer recommendations.

150.06.03.01.03 The Construction Inspector shall be present and witness all vacuum testing.

150.06.03.01.04 The following vacuum testing criteria shall apply for compliance with the testing procedure.

150.06.03.01.04.01 A vacuum of 10 inches of mercury shall be drawn with an approved vacuum testing unit.

150.06.03.01.04.02 The testing time shall not be measured until after the vacuum pump has been shut off.

150.06.03.01.04.03 The time required for the vacuum to drop from 10 inches to 9 inches of mercury shall meet or exceed the values listed in Table 150.07.

150.07 REPAIR AND REHABILITATION

150.07.01 For vitrified clay (VC) Pipe, replace damaged section with DIP and install a Fernco coupling at each end encased in concrete.

150.07.02 For PVC Pipe, replace damaged section with PVC Pipe and install a Fernco coupling at each end encased in concrete.

150.07.03 For ABS/PVC Truss Pipe, replace damaged section with DIP and install a Fernco coupling at each end encased in concrete.

150.07.04 For asbestos cement (AC) Pipe, use a full circle repair clamp for the damaged section or replace damaged section with DIP and couplings encased in concrete.

150.07.05 All repairs to damaged sanitary sewer lines shall be bedded with 6 inches of washed stone compacted to a minimum of 95% Standard Proctor density before installing the new pipe. If the repair is located in a paved area, it shall be backfilled with ABC stone to a density of 95% Standard Proctor.

Table 150.01 – Flow Factors	
Land Use	Flow Factor
Single Family Residential*	75 GPD per bedroom (225 GPD per unit min.)
Multi-Family Residential*	75 GPD per bedroom (150 GPD per unit min.)
Office and Institutional	3000 GPD/acre
Commercial	2500 GPD/acre
Industrial	5000 GPD/acre
* Use the average of the range of dwelling units per acre for the various zoning densities.	
Note: Flow factors not listed shall be as recommended by the North Carolina Department of Environmental Quality (NCDEQ).	

Table 150.02 – Peaking Factors	
Line Diameter (inches)	Peaking Factor
8	3.66
10	3.53
12	3.38
15	3.25
16	3.21
18	3.12
21	2.86
24	2.83
27	2.81
30	2.61
36	2.44

Table 150.03 – Minimum Slope	
Line Diameter (inches)	Minimum Slope (feet per 100 feet)
8	0.50
10	0.30
12	0.24
15	0.18
16	0.16
18	0.14
21	0.11
24	0.10
27	0.08
30	0.07
36	0.06

Table 150.04 – Maximum Allowable Flow Deflection	
Pipe Diameter (inches)	Deflection Angle
8-10	90 degrees
12-20	75 degrees
>20	60 degrees

Table 150.05 – Low Pressure Air Test Times									
Minimum time (min:sec) required for pressure drop from 3½ to 2½ PSI									
Length of Line (feet)	Pipe Diameter (inches)								
	4	6	8	10	12	15	18	21	24
25	3:46	5:40	7:34	9:26	11:20	14:10	17:00	19:50	22:40
50	3:46	5:40	7:34	9:26	11:20	14:10	17:00	19:50	22:40
75	3:46	5:40	7:34	9:26	11:20	14:10	17:00	19:50	22:40
100	3:46	5:40	7:34	9:26	11:20	14:10	17:00	19:50	22:47
125	3:46	5:40	7:34	9:26	11:20	14:10	17:00	21:49	28:29
150	3:46	5:40	7:34	9:26	11:20	14:10	19:13	26:10	34:11
175	3:46	5:40	7:34	9:26	11:20	15:35	22:26	30:32	39:53
200	3:46	5:40	7:34	9:26	11:24	17:48	25:38	34:54	45:34
225	3:46	5:40	7:34	9:26	12:49	20:02	28:51	39:16	51:17
250	3:46	5:40	7:34	9:53	14:15	22:15	32:03	43:37	56:58
275	3:46	5:40	7:34	10:53	15:40	24:29	35:15	47:59	62:40
300	3:46	5:40	7:36	11:52	17:05	26:42	38:27	52:21	68:22
325	3:46	5:40	8:14	12:52	18:31	28:56	41:40	56:43	74:04
350	3:46	5:40	8:52	13:51	19:56	31:09	44:52	61:00	79:46
375	3:46	5:40	9:30	14:50	21:22	33:23	48:05	65:26	85:28
400	3:46	5:42	10:08	15:49	22:47	35:36	51:16	69:48	91:10
425	3:46	6:03	10:46	16:49	24:13	37:50	54:29	74:10	96:51
450	3:46	6:24	11:24	17:48	25:38	40:04	57:41	78:31	102:33
475	3:46	6:46	12:02	18:48	27:07	42:17	60:54	82:53	108:15
500	3:46	7:07	12:40	19:47	28:29	44:31	64:06	87:15	113:57

Table 150.06 – Mandrel Criteria		
Pipe Diameter (inches)	Mandrel Length (inches)	Mandrel Diameter (inches)
6	6	5.65
8	8	7.40
10	10	9.31
12	10	11.22
15	12	14.09

Table 150.07 – Manhole Vacuum Testing			
Minimum time (seconds) for pressure drop from 10 to 9 inches of mercury			
Manhole Depth (feet)	Manhole Diameter (feet)		
	4	5	6
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