

# WASTEWATER GRAVITY SYSTEM

## STANDARDS & SPECIFICATIONS MANUAL



### MOORE COUNTY PUBLIC WORKS

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## Preface

These standards are for design and construction of wastewater distribution facilities which will come under the jurisdiction of Moore County Public Works (MCPW). **These standards alone do not constitute a complete set of construction documents. The owner's or developer's Professional Engineer is responsible for design and computation of complete construction and contract documents.** These standards are set forth as the minimal requirements to achieve a suitable quality level for utilities which will become the property of MCPW.

The standards do not include a complete commentary on methods of installation and detailed information of quality of workmanship in place. The owner's or developer's Professional Engineer must include detailed information on methods of construction and should expand on the testing and any of the special requirements to the engineer's satisfaction, subject to the approval of MCPW.

From time to time, these standards will be amended and/or expanded at the request of the MCPW Engineering Department and with approval of the Director. It will be the responsibility of the owner or developer to contact the MCPW to obtain updated standards.

There may be circumstances whereby the design engineer may wish to propose changes or modifications to these standards, when this occurs permission from the County Engineer shall be obtained prior to submission to NC DENR.

## DISCLAIMER

To the best of their ability, the authors have insured that material presented in this manual is accurate and reliable. The design of engineered facilities, however, requires considerable judgment on the part of designer. It is the responsibility of the design professional to insure that techniques utilized are appropriate for a given situation. Therefore, neither More County Public Works, nor any author or other individual, group, etc., associated with production of this manual, accepts any responsibility for improper design, any loss, damage, or injury as a result of the use of this manual.

## MANUAL 4

### WASTEWATER GRAVITY SYSTEM STANDARDS & SPECIFICATIONS

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# MOORE COUNTY PUBLIC WORKS ENGINEERING DIVISION

## MANUAL 3 – WASTEWATER GRAVITY SYSTEM STANDARDS AND SPECIFICATIONS

### 4.01 DESIGN

#### A. GENERAL

Moore County Public Works (MCPW) wastewater collection system design and construction and non MCPW wastewater collection system design and construction, which connect to the MCPW system, shall be in accordance with the standards and requirements of Title 15A 2T Sect. .0100 -.1600 of the North Carolina Administrative Code, Department of Environment and Natural Resources, “Waste Not Discharged to Surface Waters” (latest revision) and this Manual.

#### B. HYDRAULIC DESIGN AND ROUTE SELECTION

The following procedures and criteria are to be used for sizing and hydraulic design of gravity sanitary sewers. Generally, sewer outfalls and trunk mains shall be sized for the future full development of the natural basin using the following criteria unless more specific data is available. These design and peak flow calculations are not to be used to calculate flows for wastewater permits. Wastewater extensions will be approved on the basis of current actual land use and flow allocations as shown in Table 1.

1. Determine Drainage Basin and Population to be served
  - a. Outline the major basin on topographic maps. Identify and outline all sub basins and identify any other basins or sub basins that will be pumping into the sewer being designed.
  - b. Determine the acres to be served. Include the basins or sub-basins that will be pumped into the sewer. If the area is undeveloped, reduce the area by 20% to account for streets. Further reduce the area by any acreage that is not considered developable (i.e. lakes, wetlands, greenways, recreation areas, etc.). If the area is developed, reduce the area as necessary to allow for existing streets.
  - c. For each basin and sub basin, determine the existing population, land use and zoning. Consideration shall be given to the maximum anticipated capacity of commercial areas, of institutions, industrial parks, inflow/infiltration, etc.

Refer to the appropriate area Land Use Plan to determine trends in land use and zoning and for predictions of population growth rate.

2. Wastewater Flow Rates (Table 1)

Table 1 is intended only as a minimum design standard for the classification listed. The Engineer shall be responsible for insuring that the design discharge utilized in sizing sewer collection facilities are adequate for the area, which the extension is to serve.

TABLE 1  
WASTEWATER FLOW RATES

<u>Type of Establishment</u>	<u>Gallons Per Day</u>
<u>Dwellings</u>	
1 Bedroom	240
2 Bedroom	240
3 Bedroom	360
For each additional bedroom add	120
Barber Shops	50 gal/chair
Beauty Shops	125 gal/booth or bowl
<u>Businesses, Offices &amp; Factories</u>	
General Business & Office facilities	25 gal/employee/shift
Factories, excluding industrial waste	25 gal/employee/shift
Factories or Businesses with showers or food preparation	35 gal/employee/shift
Warehouse	100 gal/employee/shift
Warehouse-self storage	1 gal/unit
<u>Churches</u>	
Without kitchens, day care or camps	3 gal/seat
With kitchen	5 gal/seat
With day care or camps	25 gal/person
<u>Fire, Rescue &amp; Emergency Response Facilities</u>	
Without on site staff	25 gal/person
With on-site staff	50 gal/person/shift
<u>Food &amp; Drink Facilities</u>	
Banquet, Dining Hall	30 gal/seat
Bars, cocktail lounges	20 gal/seat
Caterers	50 gal/100 sq ft floor
Restaurant, full service	40 gal/seat
Restaurant, single service articles	20 gal/seat
Restaurant, drive-in	50 gal/car space

Restaurant, carry out only	50 gal/100 sq ft floor
Institutions, Dining Halls	5 gal/meal
Deli	40 gal/100 sq ft floor
Bakery	10 gal/100 sq ft floor
Meat dept., butcher shop or fish market	75 gal/100 sq ft floor
Special Food Stand or Kiosk	50 gal/100 sq ft floor
<b>HOTELS AND MOTELS</b>	
Without in-room cooking facilities	120 gal/room
With in-room cooking facilities	175 gal/room
Resort Hotels	200 gal/room
Cottage, Cabins	200 gal/unit
Self Service Laundry Facilities	500 gal/machine
<b>Medical, Dental, and Veterinary Facilities</b>	
Medical or Dental Offices	250 gal/practitioner/shift
Veterinary Offices (not including boarding)	250 gal/practitioner/shift
Veterinary Hospital, Kennels, Animal Boarding	20 gal/pen, cage or stall
Hospitals, Medical	300 gal/bed
Hospitals, Mental	150 gal/bed
Convalescent, Nursing, Rest Homes without Laundry	60 gal/bed
Convalescent, Nursing, Rest Homes with Laundry	120 gal/bed
Residential Care Facilities	60 gal/person
<b>Parks, Recreation, Camp Grounds, R-V Parks, etc.</b>	
Campgrounds with Comfort Station, no water or sewer hookup	75 gal/campsite
Campgrounds with water and sewer hookups	100 gal/campsite
Campground with Dump Station Facility	50 gal/space
Construction, Hunting or Work Camps with flush toilets	60 gal/person
Construction, Hunting or Work Camps with chemical or portable toilets	40 gal/person
Parks with Restrooms Facilities	250 gal/plumbing fixture
Summer Camps without Food Preparation or Laundry Facilities	30 gal/person
Summer Camps with Food Preparation and Laundry Facilities	60 gal/ person
<b>Public Access Restrooms</b>	
Schools, Preschools and Day Care	
Day Care and Preschool Facilities	25 gal/person (child & employee)
Schools with Cafeteria, Gym and Showers	15 gal/student
Schools with Cafeteria	12 gal/student
Schools without cafeteria, gym or showers	10 gal/student
Boarding Schools	60 gal/person (student & employee)
Service Stations, Car Wash Facilities	
Service Stations, Gas Stations	250 gal/plumbing fixture

Car Wash Facility (if recycling water see rule .0235)	1200 gal/bay
<b>SPORT CENTERS</b>	
Bowling Center	50 gal/lane
Fitness, Exercise, Karate or Dance Center	50 gal/100 sq.ft.
Tennis, Racquet Ball	50 gal/court
Gymnasium	50 gal/sq ft.
Golf Course with only minimal Food Service	250 gal/ plumbing fixture
Country Clubs	60 gal/member or Patron
Mini Golf, Putt-Putt	250 gal/plumbing fixture
Go-Kart, Motorcross	250 gal/plumbing fixture
Batting Cages, Driving Ranges	250 gal/Fixture
Marinas without Bathhouse	10 gal/slip
Marinas with Bathhouse	30 gal/slip
Video Game Arcades, Pool Halls	250 gal/plumbing fixture
Stadiums, Auditoriums, Theaters, Community Centers	5 gal/seat
Stores, Shopping Centers, Malls, and Flea Markets	
Auto, Boat, Recreational Vehicle Dealerships/Showrooms with Restrooms	125 gal/plumbing fixture
Convenience Stores, with food preparation	60 gal/100 sq. ft
Convenience Stores without food preparation	250 gal/plumbing fixture
Flea Markets	30 gal/ stall
Shopping Centers and Malls with Food Service	130 gal/1000 sq. ft.
Stores and Shopping Centers without Food Service	100 gal/1000 sq. ft.
Transportation Terminals-air, Bus, Train, Port and Dock	5gal/passenger

The latest Wastewater Flow Rates Standards by the NC Department of Environment Natural Resources, Water Quality Section shall be used. At the discretion of the County, additional support documentation may be submitted for review and consideration. Support documentation might include actual flow data, the installation of flow restriction devices and Engineers' reports.

### C. FLOW DETERMINATION

1. Determine the average daily flow (design flow) for residential areas.
2. Determine average daily flow (design flow) for industrial or commercial areas. Add additional flow based on research of specific zoning and any known large water users.
3. Determine, peak daily flow by multiplying the average daily flow by the appropriate peaking factor. The minimum peaking factor permitted is 2.5 and this factor should be used in the absence of specific design or flow data supporting a higher peaking factor.
4. Determine the allowable infiltration flow based upon 25 gal per 24 hrs. per inch of sewer pipe diameter, per mile (for gravity sewers).

#### D. SANITARY SEWER MINIMUM SLOPE

1. From topographic maps and any vertical survey control in the area, determine the average slope of the natural drainage in the area to be serviced. Determine whether any sections are significantly flatter than the average.
2. Determine whether there are obstructions (e.g. existing utilities) or natural terrain features that will limit the pipe slopes such as creek crossings, proper cover under railways, etc.
3. Based on (1) and (2), establish the minimum slope for the pipeline. This should be used as the design slope.
4. All public sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second, based on Manning's formula using as "n" value of 0.013. The following are the minimum slopes, which shall be provided. However, slopes greater than these are recommended, particularly for mains and services serving few residences, to effect flushing solids.

**Table 2. Minimum Slopes**

<u>Diameter of Pipe (Inches)</u>	<u>Minimum Slope (Feet per 100 feet)</u>
4 (laterals)	1.00
6 (laterals)	1.00
6 (private)	0.60
8	0.40
10	0.28
12	0.22
14	0.17
16	0.14
18	0.12
21	0.10
24	0.08
27	0.07
30	0.06
36	0.05

5. Note: Sewer lines shall be laid on straight lines between manholes and at a constant grade or uniform slope. Sewer collection mains shall be laid no less than the minimum slope as identified in Table 2. The straight alignment shall be checked by using a laser, lamping and/or mirrors.

#### E. PIPE SIZE

1. Sewers shall be designed so as to carry the total peak tributary flow at one-half of full depth (50% capacity) for sewers 16-inch and smaller, and two-thirds of full depth (66% capacity) for sewers 18-inch and larger.
2. Pipe diameter changes shall occur only in a manhole with the pipe crowns matched as long as a minimum drop of approximately 0.20 feet is maintained between inverts.
3. For pipe with less than 3-foot of cover, aerial or outside drop, the County Engineer will determine if pipe diameter can be changed.

#### F. MAXIMUM VELOCITY

In general, average flow velocities greater than 10 feet per second shall not be permitted. Drop manholes shall be provided where required to eliminate steep slopes and to reduce high velocities to a limit of eight feet per second or less. Where it is impractical to limit velocities below eight feet per second, reasonable effort must be made not to exceed ten feet per second. Where velocities are anticipated to exceed eight feet per second, restrained joint pipe (Mega-Lugs, Grip-Rings or equal) and fittings may be required and the pipe shall conform to appropriate ASTM or AWWA specifications, which provide protection against internal erosion.

#### G. DEPTH & PIPE TYPES

The depth of sewer mains shall be great enough to serve adjoining property, sufficient to meet the minimum standard depth and to allow for sufficient grade on the service line. Service connections are to be into manholes or into the top quarter of sewer mains. No service connections may be made in any portion of the manhole from the cone section to the manhole frame. All services connection larger than 4 inches shall be made at a manhole.

- a. Lines with less than 3 feet of cover shall be ductile iron pipe.
- b. Lines with greater than 12 feet of cover shall be ductile iron pipe.

## **4.02 LOCATION WITH UTILITIES**

### **A. EASEMENTS**

1. A minimum 20 foot wide easement, centered over the sewer, shall be conveyed to the County when facilities of the County are to be placed on private property of NC DOT, Railroad, Towns, Private Property Owners, Electrical Transmission Lines and other Utilities (this width may be changed by the County Engineer). No building or permanent structure shall be constructed within these easements. No trees, large shrubs, or obstacles shall be placed within an easement, which would render the easement inaccessible, by equipment. Temporary construction easements, of varying widths, shall be acquired when necessary to facilitate wastewater system construction.
2. All easements shall be accessible from public roadways, with a 30 ft. turn around easement at needed locations. A gate, for maintenance access, shall be provided if any fence constructed is permitted crossing the easements. With the exception of Piers, End Walls, and small shrubs or flowers, no construction is permitted within the sewer easement. These and any other encroachments are subject to destruction by MCPW during maintenance or construction. Replacement and/or repair of said obstruction shall be the responsibility of the encroaching property owner.

### **B. WATER SUPPLY SEPARATION**

A distance of 100 feet shall be maintained between any private or public water supply source, including any WS-I waters or Class I or Class II impounded reservoirs used as a source of drinking water. A distance of 50 feet shall be maintained from normal high water for areas classified as WS-II, WS-III, B, SA, ORW, HQW, or SB. If this minimum separation cannot be maintained, ferrous sewer pipe with joints equivalent to public water supply design standards and pressure tested to 200 psi to assure water tightness, shall be used. The minimum separation shall, however, not be less than 25 feet from a private potable well or 100 feet from a public water supply well.

### **C. WATER MAIN SEPARATION**

Horizontal sewers shall be laid at least 10 feet, from existing or proposed water mains. Should local conditions prevent a horizontal separation of ten feet, a sewer may be laid closer than ten feet to a water main if it is laid in a separate trench and the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main, with a horizontal separation of at least 3 feet.

Vertical crossings of a water main and a sanitary sewer cross, where the vertical separation is less than 18 inches, or the water line passes under the sewer, both the water main and 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 sewer shall be ductile iron pipe for the entire segment from manhole to manhole.

#### D. STORM SEWER AND GAS MAINS SEPARATION

##### Sanitary Sewer under Storm Sewer/Gas Line

1. >2' clearance use 10 ft. of stone bedding
2. < 2' clearance use 10 ft. DIP and stone bedding

##### Sanitary Sewer over Storm Sewer/Gas Line

1. If storm drain/sewer clearance > 12" use PVC
2. If storm drain/sewer clearance < 12" use 10' DIP

Sanitary Sewer parallel to Storm Sewer/Gas Line to be separated by 24 inches.

#### E. BUILDING SEPARATION

Any building foundation	5 feet
Any basement	10 feet
Drainage systems	5 feet
Any swimming pool	10 feet

Note: For utilities not listed 24 inch separation is required.

#### F. NC DOT RIGHT-OF-WAY

1. All collection systems within NC DOT right-of-way shall be designed as outlined in NC DOT manual "Policies and Procedures for Accommodating Utilities on Highway Right-of-Ways".
2. Crossings under ditch to be 30-inch below bottom of ditch to top of pipe.  
Crossing under a roadway to be 3 feet below top of roadway to top of pipe.
3. Utilities to be constructed within NC DOT right-of-way will require a NC DOT encroachment agreement.

#### G. RAILROAD RIGHT-of-WAY

1. Railroad crossings shall be perpendicular, ductile iron pipe and encased.
2. Crossing to be 5 feet 6 inches minimum depth from top of rail to top of encasement pipe.
3. Utilities to be constructed within railroad right-of-way will require a railroad encroachment agreement.

## H. STREETS & DEAD ENDS

1. Dead end sewers are defined as those which cannot be further extended upstream due to topographical constraints. The sewer main shall extend to a point where the terminal manhole is contiguous to the most upstream lot being served. In streets, the terminal manhole shall be within the street frontage of the lot being served.
2. When located in the street, the main shall be located as near as possible to the center of the pavement so that manhole covers are not located in vehicle wheel paths.
3. Extensions needed to serve a wastewater flow request shall be extended beyond the requested point to the next planned manhole as directed by the County Engineer.

### **4.03 PIPE SIZING**

1. Use the peak daily flow for design calculations with the pipe flowing half full.
2. Using Manning's Equation or Charts, to determine the pipe size:

$$Q = \frac{1.486}{n} A R^{(2/3)} S^{(1/2)}$$

Where:

Q = cubic feet per second

N = coefficient of roughness (typically, n=0.013)

S = energy grade line in. ft/ft

R = hydraulic radius =  $\frac{\text{cross sectional area ft. sq.}}{\text{wetted perimeter ft.}}$

A = cross sectional area of pipe in square feet

Solve for A and then pipe radii to get the design pipe size.

3. Using Manning's Equation, check the velocity of the gravity sewer:

$$V = \frac{1.486}{n} R^{(2/3)} S^{(1/2)}$$

Where:

V=mean velocity in feet/second

N=coefficient of roughness (typically n = 0.013)

S=slope of energy grade line, ft/ft

R=hydraulic radius =  $\frac{\text{cross-section area ft.sq.}}{\text{wetted perimeter ft.}}$

4. Check the pipe size and slope and adjust the pipe size as needed to meet the minimum design slope and velocity as required.

#### **4.04 PIPE LAYING**

##### **A. GENERAL**

In all instances, pipe shall be installed in a workmanlike manner and true to line and grade. The various pipe specified shall be handled and installed in accordance with the manufacture's recommendations and good engineering practices. 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 herein shall conform to the allowable soil classifications as defined in Manual 2 – General Construction. (for pipe bedding see SS-1)

##### **B. BACKFILLING**

The pipe shall be backfilled with suitable materials. The initial backfill is to a point 12 inches above top of the pipe and shall be placed in shallow 6 inch layers, individually compacted, with emphases on the “haunching” area (up to the spring-line of the pipe).

##### **C. FINAL BACKFILLING**

The remaining or final backfill shall be suitable material. No rocks, boulders, or stone shall be included in the backfill material for at least 2 feet above the top of the pipe. In not-traffic areas, the backfill shall be placed in lifts not exceeding 12 inches and compacted to 90% of optimum moisture density per AASHTO T-99. In traffic areas the final backfill shall be placed and compacted in 6 inch layers, and compacted to 95% of optimum moisture density per AASHTO T-99 to a point 12 inches below sub-grade. The top 12 inches shall be compacted to 100% of optimum moisture density (AASHTO T-99).

Where deemed necessary, the County Engineer may require compaction test on any or all lifts of backfill placed in trenches under roadways. The cost for such test shall be born by the contractor.

#### **4.05 DETAIL OF DESIGN**

##### **A. MINIMUM SIZE**

Public sanitary sewer collection system, graving piping, shall be a minimum of eight (8) inches in diameter. Private gravity piping collection systems, conveying wastewater, shall be a minimum of four (4) inches in diameter.

## B. DEPTH

1. A minimum of three (3) feet of cover, as measured from the crown of the pipe to the finished grade, shall be provided for all sewers. Ductile iron pipe is required for lines with less than 3 feet of cover. Proper bedding shall be provided where sewers are subject to traffic bearing loads to develop design-supporting strength. Additional protection shall be provided for sewers that cannot be placed at a depth sufficient to prevent damage. The County Engineer shall determine the acceptability of such installations.
2. Typically, the depth of gravity sewer mains shall be sufficient enough to serve adjoining property or the first floor of existing homes if possible. In isolated cases, the lot owner may be required to provide a Low Pressure Sewer System to transport sewage to the collection system.
3. Where unstable soil conditions are known to exist in the pipe zone, structural design shall be based on a careful evaluation of the soil conditions and depth of cover. Special structural designs (e.g. pilings with pipe support cradles, etc.) shall be used where appropriate, and shall be detailed by the Engineer. A North Carolina Professional Engineer shall design trench excavation and pipe support/protection systems.

## C. CHANGE IN PIPE SIZE & MATERIAL

1. Where a smaller pipe joins a larger one within a manhole, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. Generally, aligning the crowns of the different size pipes is acceptable.
2. Sewer extensions shall be designed for projected flows, even when the diameter of the receiving sewer is less than the diameter of the proposed extension at a manhole, with special consideration of an appropriate flow channel to minimize turbulence when there is a change in sewer size. Justification shall be provided with the certification of completion and the construction plans, indicating that the capacity of the downstream sewer will not be overloaded by the proposed upstream installation. The County Engineer may require a schedule for construction of future downstream sewer hydraulic conditions.
3. Pipe material should remain constant between manholes, unless the pipe is DIP and SDR-26 and the County Engineer approves. For connection of DIP and SDR-26 pipe see STD. NO. SS-2.
4. At drop manholes, where invert separation exceeds 2.5 feet, the pipe material shall be Ductile Iron for outside drop and PVC for interior drop. Pipe size between manholes shall remain the same.

#### **4.06 SERVICE CONNECTIONS**

1. A 4-inch service lateral may be tapped directly into the top quarter of 8, 10, and 12-inch mains or manholes. All service connections 6-inch and larger shall be made into manholes. Connections to sewer mains 16-inch and larger shall only be made at manholes. All individually owned structures shall require only one sewer tap unless otherwise approved by the Engineer. See STD. NO. SS-3, SS-4, SS-5 for details.
2. For a multiple family dwelling owned by a single individual or organization, the number and location of service connections is to be approved by the County Engineer with standard fees to be paid for each individual dwelling.
3. A maximum of three service connections may be installed into one manhole. When the service connection is to be installed into an existing manhole, a boot connector must be used. When joining ductile iron to other pipe materials, a rigid connection designed specifically for transition of the two types of material is required. When more than one service connection is installed in a manhole, the connections shall be staggered vertically. See STD. NO. SS-3 for detail.
4. Plans for projects, which propose the creation of lots (subdivision) shall include individual sewer taps to each parcel, including any residual parcels reserved for future lots.
5. The size and locations of the service laterals shall be based on the anticipated use of the lot, for which, County Engineer approval shall be required. The minimum lateral size shall be 4-inch laid on a minimum 1% grade. 6-inch lateral grades shall be a minimum of 0.6%.
6. Service not terminated at manholes shall be installed at right angles to the gravity sewer main using in-line wyes, or tapping service saddles on existing mains. The wyes, saddles or taps shall be separated horizontally at least five (5) feet, measured along the pipe. See STD. NO. SS-4 for detail.
7. The lateral length shall not exceed 75 feet for 4-inch or 100 feet for 6-inch, without additional cleanouts. Up-sizing the lateral size to increase lengths is not acceptable.
8. The service cleanout shall be placed at the edge of the right-of-way or permanent easement and in no case shall be placed within a temporary easement. See STD. NO. SS-5 for detail.
9. Cleanouts on service lines shall be at 50 foot intervals.

10. Lateral taps in manholes:

- a. If a service is proposed in an existing manhole at a height of 2.5 feet or greater above the invert, an inside drop shall be required for the service. For a new manhole an inside drop is required. See STD. NO. SS-3 for detail.
- b. The sewer lateral invert shall be a minimum of one (1) inch above the shelf, or sufficiently high enough to allow the installation of a flexible connector and core into existing manholes.

**4.07 SERVICE LATERAL MATERIALS**

**A. GENERAL REQUIREMENTS**

All sewer service laterals shall be constructed of PVC Schedule 40, or ductile iron pipe, as specified herein, shall be used for all service laterals crossing beneath creeks or drainage ways.

**B. PVC SERVICE PIPE & FITTINGS**

PVC pipe and fittings for sewer laterals shall be Schedule 40 with slip joints. Laying lengths shall be 20 feet.

All cement shall be PVC Cement, all weather and have a trace color to allow for visual indication of uniform application. The cement shall be preceded with a primer.

**C. SERVICE SADDLES ON DUCTILE IRON PIPE**

Service saddles for connection of laterals to ductile iron sewer pipe 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. A pipe cutter shall be used for tapping ductile iron pipe. In lieu of service saddles, wye branches may be used on ductile iron sewers. SEE STD. NO. SS-4 for detail.

**D. SADDLES FOR PVC SEWER PIPE (UP TO 12" DIAMETER SEWERS ONLY)**

Saddles for PVC shall conform to the requirements of ASTM D3034. The saddle shall be equipped with two one stainless steel clamps that are bolted to the saddle. The saddle service branch shall stub slightly into the sewer main so that when installed, the saddle shall not slip or rotate. The saddle shall be bedded and haunched with at least 6" of #78-M stone. Saddles shall be by Romac Industries, Inc. or equal. SEE STD. NO. SS-4 for detail.

#### E. SERVICE CLEANOUT PROTECTOR BOXES

Each service cleanout installed within any travel way area such as a driveway, alley, or sidewalk shall be equipped with a cast iron protector box. The protector box shall have a 9-5/8 inch diameter lid with the letter "S" cast into the lid. See STD. NO. SS-6 for detail.

### **4.08 SEWER BACKWATER VALVE**

Any structure having a first floor elevation or basement floor elevation (if the basement is sewer) which is lower than the elevation of manhole rim immediately upstream of the site is considered to be susceptible to sewage backup. In such cases, the sewer service lateral for the affected building shall be equipped with a suitable sewage backwater valve as per the NC Plumbing Code. The backwater valve shall be located on private property in an accessible location for maintenance. Any lots or structures where such backwater preventers are required shall be indicated on the construction drawings.

The operation and maintenance of these devices shall be the responsibility of the property owner. It is recommended that all connections have a Sewer Backwater Valve.

### **4.09 GREASE TRAPS**

All commercial and institutional establishments engaged in the preparation of food shall install a grease trap in accordance with State and MCPW Ordinances.

The operation and maintenance of these devices shall be the responsibility of the property owner.

#### Grease/Oil/Sediment Traps

All washing facilities, such as vehicle washes, car wash areas, etc. shall be equipped with a grease/oil/sediment trap and trash basket. Sizing calculations shall be submitted with the initial site/construction.

### **4.10 MANHOLES**

#### A. GENERAL FEATURES

1. Manholes installed in pavement shall have their cover set flush with finished grade, and shall be located outside of designated parking spaces, where possible. Whenever practical, manholes located in streets shall be located in the center of the street.
2. Manholes installed in yards and landscaped areas shall have the top elevation set six (6) inches above existing grade.

3. Manholes installed in outfalls or in natural areas shall have tops located 18-inches above grade, or 2-foot above the 100 year flood elevation, whichever is greater.
4. Manholes should not be located in ditches, roadside swales, or gutter lines.
5. The minimum elevation difference between the centerline “invert in” and the centerline “invert out” of manholes shall be 0.10 feet. Exceptions are: 1) when there is a change in flow direction of greater than 90 degrees, the minimum difference shall be 0.20 feet; 2) when pipes of different sizes converge in a manhole, the inside tops of the pipes shall be set at the same elevation; and 3) when grade is critical. Exceptions must be approved by the County Engineer.
6. Hydrostatic uplift restraint shall be provided for manholes installed in areas that are subject to floating/uplift.
7. The flow channel straight through a manhole shall be made to conform as closely as possible in shape, and slope to the connecting sewer pipe. The channel walls shall be formed or shaped to three quarters (3/4) of the height of the crown of the outlet sewer in such a manner to not obstruct maintenance, inspection or flow in the sewer. See STD NO. SS-7 for detail.
8. Vent Pipes shall have their opening at 2 feet above the 100 Year Flood Level or 5 feet above the Manhole, whichever is greater. See STD NO. SS-8 for detail.
9. “Doghouse” manholes shall be installed over existing sewer lines if an additional main line connection is needed. See STD NO. SS-9 and SS-10 for detail.
10. For manholes 2 foot in height or less use a flat top with a standard frame and cover. See STD NO. SS-11 for detail.
11. All manholes, outside pavement and yards, shall have a 66 inch tall Manhole Warning Post. See STD NO. SS-12 for detail.

#### B. LOCATION

1. The maximum distance between manholes, measured horizontal along the centerline of the gravity sewer, shall be 425 feet.
2. Manholes shall be installed:
  - a. At the end of each main
  - b. At all changes in pipe grade
  - c. At all changes in nominal pipe size
  - d. At all horizontal changes in pipe alignment
  - e. At all intersections, unless otherwise approved by County Engineer

#### C. DIAMETER

The minimum interior diameter of gravity sewer manholes shall be specified dependent upon the size of sewer main and depth on installation,

MH Diameter	Main Size	Depth of Installation
4 Ft.	8" – 12"	1' – 12'
5 Ft.	15" – 30"	12' – 20'
6 Ft.	36" – 54"	20' - plus

#### D. DROP TYPE

1. Vertical elevation drops through manholes should be limited to prevent turbulent conditions. If the vertical elevation difference between the “invert in” and “invert out” is: 1) greater than 6 inches, but less than 24 inches, a pipe slide is required to prevent solids depositing; or 2) 24 inches and greater, a drop structure is required. See STD NO. SS-13 for detail.
2. Inside drops will be permitted for new lines using a 5 foot (5') inside diameter manhole. For existing 4 foot (4') manholes, an inside drop may be permitted, as approved by Engineer. Drop manholes shall be constructed with inside drops, secured to the inside of the wall, and shall be positioned, in such a manner to allow for cleaning. All Ductile Iron Pipe Fittings to be #401 coated. See STD. NO. SS-14 for detail.
3. Outside drops are not preferred. Inside drops shall be used unless approved by the County Engineer. See STD. NO. SS-15 for detail.

#### E. BENCH/SHELF

A bench/shelf shall be provided on each side of any manhole channel, when the pipe diameter(s) are less than the manhole diameter. The bench/shelf shall be sloped not less than 1 inch per foot and not greater than 2 inches per foot. The invert elevation of any lateral sewer, service connection, or drop manhole pipe, shall be above the bench/shelf surface elevation. Invert shall be located a minimum of 1 inch (1") above the bench/shelf.

#### F. WATER TIGHTNESS

1. Lift holes and grade adjustment rings shall be sealed with non-shrinking mortar or other material approved by County Engineer.
2. Inlet and outlet pipes shall be joined to the manhole with a Neoprene Rubber Boot with Stainless Steel Jack (boot) or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place. Connections of new sewers to existing manholes shall be accomplished by machine coring and the installation of a flexible connector (boot). The boot, if used, shall be equal to Flexible Manhole Sleeve as manufactured by the Interpace Corporation. See STD. NO. SS-16 for detail.

The sealing system shall be furnished by the manhole manufacturer.

3. Watertight manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water. Locked manhole covers may be desirable in isolated easement locations, where vandalism may be a potential or where lids are subject to be flooded off. See Manhole Frame and Cover section for more information. See STD. NO. SS-17 for detail.

Where a series of watertight manhole covers are used on a main line sewer for a distance of 1,000 feet or more, vent pipes are required.

4. Joints – Manhole sections shall have a standard tongue and groove joint with a Rubber O-ring Gasket or Rope Mastic Seal, conforming to ASTM Standard C-443. Conseal, Rub- R-Nek or equal may be used.

#### G. PRECAST MANHOLES

1. All new manholes shall be of precast concrete construction, unless approved by the Engineer. See STD. NO. SS-18 for detail.
2. 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 penetrations.

#### H. MANHOLE FRAME and COVER

Manhole ring and cover shall meet the requirements of ASTM Specifications for Gray Iron Castings, latest edition for Class 30. Minimum weight for the frame and cover shall be 190 lbs. and 120 lbs. respectively. The cover shall have the words "SANITARY SEWER" cast in and be perforated with 2 - 1" diameter holes unless otherwise noted on plans. Standard frame & covers shall be equivalent to Vulcan V-1384, US Foundry 669-KL or Southern Foundry SF-101. Watertight manholes shall be Vulcan V-2384, US Foundry 361-CJ-BWT or Southern Foundry SF-138. 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. Flush type rings shall be used and cast into flat top manholes. See STD NO. SS-17 and SS-19 for details.

Mortar used in manhole invert construction shall consist of one part Portland Cement and two parts sand. Portland Cement shall meet the requirements of the latest ASTM Specifications C-150, Type I. Sand used for mortar shall meet the requirements of ASTM Specifications 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.

I. STONE for STABILIZATION of TRENCH FOUNDATION

Stone used for pipe bedding and trench stabilization shall meet the gradation requirements of Table 905-1 for standard aggregate size number 67 as contained in Section 905 of the *Standard Specifications for Roads & Structures* as published by the NC Department of Transportation - latest edition. In all areas of unsuitable soil and/or organics, the pipe shall be bedded in at least 12" of No. 67 stone with an additional 12" of stone above the crown of the pipe, except for ferrous pipe.

J. SPECIAL COATING REQUIREMENTS

Sewer Tie-Ins - Manholes located at the terminus of any gravity or sewer force main (other than from an individual residential grinder pump force main) shall have an interior coating thickness of 100 mils of 100% solids epoxy, such as Raven 405, Cor-Cote SC, PerpetuCoat or approved equal. All epoxy coatings shall be installed per manufacturer's recommendations, following all surface preparation steps required. The MCPW reserves the right to require interior coating of additional manholes downstream of the receiving manhole of up to 1,000 feet as recommended by the County Engineer.

**4.11 STREAMS AND OTHER WATER BODIES**

A. STREAM CROSSING

Crossing of streams shall be minimized and as nearly perpendicular to the stream as possible. Streams shall be protected in accordance with erosion control plans and specifications and shall be stabilized immediately after construction is completed on the segment of crossing line. Depending on actual cover, stream width, flow conditions and soil conditions, the sewer pipe may require special anchorage to prevent flotation and/or washout. Each crossing must be evaluated individually. Pipe for submerged stream crossings shall be restrained by means approved by the County Engineer.

1. Cover Depth

- a. Sewer paralleling streams/creeks shall be designed to be below the streambed elevation, such that lateral connections will be protected as described herein.
- b. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the streambed to protect the sewer line and meet all regulations of permitting agencies.

One foot (1') of cover where the sewer is located in rock:

Three feet (3') of cover in other material unless ductile iron pipe is specified; in which case, a minimum of one foot (1') of cover will be required.

In major streams, more than three feet (3') of cover may be required;

In paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement.

## 2. Horizontal Location

- a. Sewers located along streams, lakes or impoundments, shall be located outside of the stream and/or creek bank or sufficiently removed to provide for future possible stream widening, to prevent siltation of the stream during construction and to meet all regulations by permitting agencies.
- b. Sewers shall not be installed under any part of an impoundment and/or earthen dam, without specific MCPW approval. Plans shall require review, and approval by NC DWQ Dam Safety Section.
- c. Sewers crossing streams shall be perpendicular (90 degrees) as practical to the streambed and in no case at an angle less than 75 degrees or greater than 105 degrees to the stream unless approved by County Engineer.
- d. Edge of the construction corridor shall not be closer than 10 feet to a stream.
- e. Intermittent or permanent stream crossing shall not have joints connected within the stream channel or within two feet (2') of banks, unless approved by County Engineer.
- f. Construction corridor limited to 40 feet in width in wetlands and across stream channels. Wetland delineation shall be clearly shown on the plans.

## 3. Structures

The sewer outfalls, headwalls, manholes, gate boxes, or other structures shall be located so they do not interfere with the free discharge of flood flows of the stream.

## 4. Materials

- a. Sewer entering or crossing streams shall be constructed of ductile iron material pipe with mechanical joints, and shall be constructed to remain watertight, free from changes in alignment or grade and tested with water to 200 psi. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage to pipe during placement, or corrode the pipe.
- b. Measures shall be taken to prevent fresh concrete from coming in contact with waters of the state.
- c. Placement of rip-rap is restricted to the stream bottom, and cannot be above normal stream bottom; banks directly impacted and only below normal high water level.
- d. No fertilizer shall be placed within 10 feet of a stream.

## B. AERIAL CROSSINGS

1. Proper joint technology, such as flanged or restrained, adequate supports prevent excessive flexion, or a combination of both, shall be provided for all aerial pipe crossing. Supports shall be designed to prevent frost heave, overturning, and settlement.
2. Supports shall be designed to withstand the hydrodynamic effects of the stream flow pressure using the following formula:

$$P=1.5K(VxV)$$

Where:

1.5-safety factor against overturning

P=pressure, psf

V=velocity of water, fps

K=4/3 for square ends, 1/2 for angle ends when angle is 30 degrees or less and 2/3 for circular piers. (Dimensionless)

If it is probable that the aerial pipe could be submerged by the stream flow, the effects of the flow pressure on the pipe shall also be taken into account when computing pier-overturning moments. For aerial stream crossings, the impact of flow waters, and debris shall be considered.

3. H-Piles shall be driven to resistance by an approved hammer developing not less than 7,500 ft-lbs of energy per blow. The load capacity of each pile shall be determined by the following formula:

$$Ra=2E/(S+0.3)$$

Where:

Ra=Safe load (lbs)

E=Energy per blow (ft-lbs)

S=Final penetration per blow (inches); (average of last 6 blows)

4. Protection against freezing, such as, insulation and increased slope, shall be provided. Expansion jointing shall be provided. Expansion jointing shall be provided between above ground and below ground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize heaving.
5. The bottom of the pipe should be placed no lower than the elevation of the 100-year flood.
6. Small streams or ditches that can be spanned with a single joint of ductile iron pipe may be anchored with concrete collars provided the collars are below grade.
7. Sewer Pipe to be encased within 35,000 psi, Steel Pipe.
8. See STD NO. SS-20 and SS-21 for detail examples.

C. ANTI-SEEPAGE COLLARS

In areas where the sewer trench is located in jurisdictional wetlands and has the potential to drain wetlands, anti-seepage collars shall be installed. A water quality and wetlands (401/404) permit shall be required. An anti-seep collar shall be placed at the downstream wetland boundary and every 150 feet until the utility exits the wetland. Wetland crossings that are open cut and less than 150 feet long do not require anti-seep collars unless specifically required by County Engineer.

**4.12 PIPE MATERIALS**

A. PIPE SIZE AND TYPES

<u>Pipe Type</u>	<u>Pipe Size</u>
DIP (Depths 12 ft & greater)	all sizes
DIP Ductile Iron Pipe, Class 350	12" & smaller
DIP Ductile Iron Pipe, Class 250	16" & larger
PVC C-905, PC200, DR21	14" to 36"
PVC Polyvinyl Chloride SDR-26	8" to 16"
PVC Schedule 40 (Service) Not Foam Core	4" & 6"
SP Steel Pipe, 35,000 psi (Encasement)	all sizes

- No encasement for taps under Secondary Roads
- Encasement under Secondary Roads & Town Streets if noted
- Encasement under Primary roads
- Encasement under Railroads

B. DUCTILE IRON SEWER PIPE

All ductile iron pipes shall be designed as per ANSI/AWWA C-151/A21.50-02. Pipe up to and including 12 inch diameter shall be Pressure Class 350, with pipe greater than 12 inch diameter to be at least Pressure Class 250. The County Engineer may require heavier class pipe on a case-by case bases.

Pipe joints shall be of the push-on type with rubber gaskets as per ANSI/AWWA C-111/A21.11-07. Pipe lining shall be cement-mortar, on the interior, with an external coat of bituminous material, all in accordance with ANSI/AWWA C-104/A21.4-03.

The class or nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, Country where cast, year in which the pipe was produced and the letters "DI" or "Ductile" shall be cast or stamped on the pipe.

Ductile iron pipe shall be manufactured by U.S. Pipe, American, or McWane and shall be furnished in 20 foot or 18 foot lengths.

#### C. PVC GRAVITY SEWER PIPE

PVC pipe shall be rigid polyvinyl chloride with integrally formed, factory fabricated ball with “slip” joints rubber gaskets conforming to AWWA C-111. It shall be suitable for all conditions imposed by plan locations and for a maximum working pressure of 200 psi. Pipe shall be type 1, Grade 1, made from clear virgin material and shall conform to the requirements of ASTM D-1784. All pipe shall bear the manufacturer’s name, pipe class, and date produced. Pipe to conform with ANSI/AWWA C-900. Where restrained joints are indicated Mega-Lugs or Grip rings shall be used.

#### D. STEEL (CASING) PIPE

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. For pipe thickness, see Manual 2, General Construction.

### **4.13 INSPECTION & TESTING OF GRAVITY SEWERS**

#### A. VISUAL INSPECTION OF PIPELINE INTERIOR AND MANHOLES

Upon completion of any designated portion of the sewer lines, a visual inspection of the manholes and pipeline interior shall be conducted by the Engineer and/or the Inspector in the presence of the Contractor. 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 inflow, ponding, 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. If any such failures are noted, they shall be promptly repaired by the Contractor and re-inspected by the Engineer during the 12 month Warranty Period.

#### B. LOW PRESSURE AIR TESTS

All newly constructed Sewer Lines shall be air tested in the presence of the Engineer or representative.

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 for (5) minutes and hold.

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

The Contractor shall furnish all plugs, compressors, hose, gauges, etc., as required to conduct the low-pressure air test. All testing equipment shall be approved by the Engineer.

#### C. INFILTRATION TESTS

Portions of the sewer lines installed in areas that exhibit a higher ground water table (in the trench) 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 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 25 gallons per 24 hours per inch of sewer pipe diameter per mile of pipe.

Weirs and other equipment required for infiltration tests shall be furnished by the Contractor 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

If PVC Sewer Pipe is used for gravity sewers, a deflection test shall be conducted on all such pipe installed. These pipes shall be mandreled 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 pipe.

The mandrel (Go/No-Go) device shall be cylindrical in shape and constructed with nine or ten evenly spaced arms or prongs. Mandrels with less arms will be (in odd or even numbers) rejected as not sufficiently accurate. Mandrels exhibiting significant wear will be rejected for use. The mandrel diameter shall have a tolerance of + or - 0.01".

## MANDREL DIMENSIONS

### For PVC Pipe

<u>Main Size</u>	<u>Mandrel Dimension</u>
8"	7.36"
10"	9.26"
12"	11.16"
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 shall not be deducted from the 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 allowed maximum deflection allowance.

The mandrel shall be approved by the Engineer. Deflection test must be completed in the presence of the Engineer or representative.

#### E. EXFILTRATION TESTS

In addition to infiltration test the Engineer may require an exfiltration test for all sewers and manholes that are exposed (i.e. aerial). Each segment of pipe and manholes shall be plugged and filled with water to a depth no less than the rim of the downstream manhole for a period of 1 hour. **No leakage shall be allowed.** This work shall be carried out beginning at the high end of the aerial segment in order to minimize the amount of water necessary for testing.

F. VACUUM TESTING - MANHOLES

All Manholes shall be subjected to vacuum testing in accordance with the following table. Any manhole that fails to meet the testing criteria shall be uncovered, properly repaired to the satisfaction of the Engineer utilizing non-shrink grout or other approved materials/methods and retested.

All compressors, hoses, gages, plugs, and other equipment necessary to conduct the vacuum testing shall be supplied by the Contractor. All testing equipment shall be approved by the Engineer.

Manhole Depth	Diameter of Manhole		
	<u>4' Diameter</u>	<u>5' Diameter</u>	<u>6' Diameter</u>
10 feet or less	60 sec.	75 sec.	90 sec.
>10 feet but less than 15 feet	75 sec.	90 sec.	105 sec.
> 15 feet	90 sec.	105 sec.	120 sec.

Times shown are the minimum elapsed time for maintaining initial vacuum draw of 10 inches mercury with no greater than one inch (1”) of mercury drop in vacuum.

Vacuum testing may be required before backfilling by the County Engineer and must be completed in the presence of the Engineer or representative.

G. SPARK (HOLIDAY) TEST

Spark Test for epoxy coated manholes shall conform to ASTM G62-07 and NACE SP0188-2006. After epoxy coating has been installed and has sufficiently cured, it shall be inspected with high-voltage detection equipment to locate pinholes, voids, metal particles protruding through the coating and any gross faults. This spark test is used by providing a 100V per mil that penetrates the coating. If defects are found they shall be repaired per manufacturer’s recommendations and the Spark Test repeated. Spark Testing shall be performed in the presence of the Engineer or representative and is the responsibility of the Contractor.

END OF SPECIFICATIONS