WASTEWATER GRAVITY SYSTEM

STANDARDS & SPECIFICATIONS MANUAL

MOORE COUNTY PUBLIC WORKS DEPARTMENT

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PREFACE

This Manual is for the Moore County Public Utilities and the East Moore Water District water and sewer systems, all of which are under the Moore County Public Works Department (MCPW).

These standards are for design and construction of wastewater distribution facilities which will come under the jurisdiction of 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 the North Carolina Department of Environmental Quality (NCDEQ).

Disclaimer

To the best of its ability, the County has ensured that the material presented in this manual is accurate and reliable. However, the design of engineered facilities requires considerable judgment on the part of the designer. It is the responsibility of the design professional to ensure that techniques utilized are appropriate for a given situation. Therefore, neither the County of Moore nor any officer, employee or agent of the County accepts any responsibility for improper design, loss, damage, or injury as a result of the use of this manual.

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STANDARD & SPECIFICATIONS MANUAL - WASTEWATER GRAVITY SYSTEM

1.0 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 Section .0100 -.1600 of the North Carolina Administrative Code, Department of Environmental Quality, "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 required by NCDEQ standards and regulations.

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, 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

   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 and meets NCDEQ standards and regulations.

The latest Wastewater Flow Rates Standards by the NC Department of Environmental Quality 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.

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.

Minimum Slopes

Diameter of Pipe (Inches)	Minimum Slope (Feet per 100 feet)
4 (laterals)	1.00
6 (laterals)	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. Sewer mains 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 1. 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 1/2 of full depth (50% capacity) for sewers 16 inch and smaller, and 2/3 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.

F. Maximum Velocity

In general, average flow velocities greater than 10 feet per second shall not be permitted. Inside drop manholes shall be provided where required to eliminate steep slopes and to reduce high velocities to a limit of 8 feet per second or less. Where velocities are anticipated to exceed 8 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 and 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.

2.0 UTILITIES LOCATION

A. Easements

See the County's Water and Wastewater Systems Development Policy, Section III.E.

B. Water Supply Separation

A distance of 100 feet shall be maintained between any 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, ductile iron 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 be 25 feet from a single family private potable well and 50 feet for all other private potable wells.

C. Water Main Separation

(1) Parallel Installation: Water mains shall be installed at least 10 feet laterally from existing or proposed sewers, unless local conditions or barriers prevent a 10 feet lateral separation, in which case:
   a. The water main is installed in a separate trench, with the elevation of the bottom of the water main at least 18 inches above the top of the sewer; or
   b. The water main is laid in the same trench as the sewer with the water main located at one side of a bench of undisturbed earth, and with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.

(2) Water Main over a Sewer: The water main shall be laid at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer, unless local conditions or barriers prevent an 18 inch vertical separation—in which case both the water main and sewer shall be constructed of ferrous materials and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing.

(3) Water Main under a Sewer: This type of installation must be approved by the County Engineer prior to installation. The water main shall be laid at such an elevation that the top of the water main is at least 18 inches below the bottom of the sewer. Both the water main and the sewer shall be constructed of ductile iron pipe and with joints equivalent to water main standards for a distance of 10 feet each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing.

D. Storm Sewer and Gas Main Separation

Sanitary Sewer under Storm Sewer and Gas Main

1. > 2 feet clearance use select backfill
2. < 2 feet clearance use 10 feet DIP on each side and select backfill

Sanitary Sewer over Storm Sewer and Gas Main

1. If storm drain/sewer clearance < 12 inches use 10 feet DIP on each side

Sanitary Sewer parallel to Storm Sewer and Gas Main to be separated by 24 inches. (See STD. NO. SS-1)

E. NCDOT Right-Of-Way

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

F. **Railroad Right-Of-Way**

Railroad crossings shall be perpendicular, ductile iron pipe and encased.

1. Crossing to be 5 feet and 6 inches minimum depth from top of rail to top of encasement pipe.
2. 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.

3.0 PIPE SIZING

1. Use the peak daily flow for design calculations with the pipe flowing half full.

2. Using Manning's Equation or Charts, determine the pipe size:

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

Q = flow, cubic feet per second
N = coefficient of roughness (typically, n=0.013)
S = energy grade line, ft/ft
R = hydraulic radius = $\frac{\text{cross sectional area, sq. ft.}}{\text{wetted perimeter, ft.}}$
A = cross sectional area of pipe in, square feet

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

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

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

V=mean velocity, 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.

4.0 PIPE INSTALLATION

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 manufacturer'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. (See STD. NO. SS-2)

B. Bedding and Initial Backfilling

The pipe shall have a minimum bedding depth to the spring line of the pipe. Then 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 and individually compacted.).

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 non-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 responsibility of the contractor.

5.0 DETAIL OF DESIGN

A. Minimum Size

Public sanitary sewer collection system, gravity piping, shall be a minimum of 8 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 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 the 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-3).

4. At drop manholes, where invert separation exceeds 2 1/2 feet, the pipe material shall be Ductile Iron or C900 PVC for interior drop. Pipe size between manholes shall remain the same.

6.0 SERVICE LATERALS

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 be allowed only one sewer tap unless otherwise approved by the County Engineer. (See STD. NO. SS-4, SS-5 and SS-6 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.

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, the 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 5 feet, measured along the pipe. See STD. NO. SS-5 for detail.

7. The lateral length shall not exceed 50 feet without additional cleanouts.

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-6 for detail.

9. Lateral taps in manholes:
   a. If a service is proposed in an existing manhole at a height of 2 1/2 feet or greater above the invert, an inside drop shall be required for the service. See STD. NO. SS-4 for detail.

   b. The sewer lateral invert shall be a minimum of 1 inch above the shelf, or sufficiently high enough to allow the installation of a flexible connector and core into existing manhole.

10. **Services Across Roads Wider Than Two (2) Lanes:** Services across roads wider than two (2) lanes shall have a 6" encasement pipe (casing) installed by the customer, in addition to the Tap Fee, in order for Moore County to install a 4" gravity service pipe inside the casing. The casing shall be installed by Bore & Jack or Directional Bore and shall meet the standards in the General Construction section of these specifications and extend from R/W to R/W.

7.0 SERVICE LATERAL MATERIALS

A. General Requirements

All sewer service laterals shall be constructed of PVC Schedule 40, or ductile iron pipe, as specified herein, 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 cemented 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 ductile 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-5 for detail.

D. Saddles for PVC Sewer Pipe (4-12 Inch Diameter Only)

Saddles for PVC shall conform to the requirements of ASTM D3034. The saddle shall be equipped with two 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 inch of select fill. Saddles shall be by Romac Industries, Inc. or equal. SEE STD. NO. SS-5 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" diameter lid with the letter "S" cast into the lid. See STD. NO. SS-7 for detail.

8.0 SEWER BACKWATER PREVENTION DEVICES

A. Backwater Relief Valve

All services shall have a Backwater Relief Valve and shall meet the following requirements.

1. Automatic pop-up release to release sewage overflows outside the building
2. Vandal and tamper resistant center
3. Threaded for minimum 4" riser pipe
4. Constructed of PVC
5. Conforms to ASTM Standard D-2665
6. Safe in yard or high traffic areas

B. Backwater Check Valve

It is recommended that all connections have a Sewer Backwater Valve.

Any structure having a first floor elevation or basement floor elevation (if the basement is connected to the 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 current 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 valves are required shall

be indicated on the construction drawings. The operation and maintenance of these devices shall be the responsibility of the property owner.

9.0 GREASE TRAPS

All establishments, except private living quarters or dwelling units, engaged in the preparation and/or serving of food shall install a grease trap in accordance with the State and MCPW Ordinances.

All traps must be sized using approved formulas and calculations and must be submitted to MCPW for approval.

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.

10.0 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 6 inches above existing grade.

3. Manholes installed in outfalls or in natural areas shall have tops located 18 inches above grade, or 2 feet 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 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-8 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-9 for detail.

9. "Doghouse" manholes shall be installed over existing sewer lines if an additional main line connection is needed. See STD NO. SS-10 for detail.

10. For manholes 2 feet 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 or depth of installation,

MH Diameter (feet)	Main Size (inches)	Depth of Installation (feet)
4	8 – 12	1 – 12
5	15 – 30	12 – 20
6	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 are required for new lines using a 5 feet inside diameter manhole. For existing 4 feet 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.

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 above the bench/shelf.

Mortar used in manhole invert construction shall consist of one part Non-Shrink Portland Cement and two parts sand. Portland Cement shall meet the requirements of the latest ASTM Specifications C150, Type I. Sand used for mortar shall meet the requirements of ASTM Specifications C144, 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.

F. Water Tightness

1. Lift holes shall be sealed with non-shrinking mortar.

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-15 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-16 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. See STD. NO. SS-9 for detail.

4. 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-17 for detail.

2. 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.

3. 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 inch diameter vent/pick holes. Standard frame & covers shall be equivalent to Vulcan V-1384, US Foundry 669-KL or approved equal. Watertight manholes shall be Vulcan V-2384, US Foundry 361-CJ-BWT or approved equal. Where deemed necessary in low areas of streets, solid manhole covers may be required by the County 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-16 and SS-18 for details.

I. Stone for Stabilization of Trench Foundation

In all areas of unsuitable soil and/or organics, the pipe shall be bedded in at least 12 inches of No. 57 stone with an additional 12 inches of stone above the crown of the pipe, except for ferrous pipe.

J. Special Coating Requirements

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. 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.

K. Grade Adjustment Rings

Where deemed necessary in low areas, precast concrete rings may be required by the County Engineer to prevent surface water inflow into the sewer. Grade adjustment rings shall be made of reinforced concrete, comply with ASTM C 478 and be free from cracks, voids, and other defects. Set concrete rings with bituminous jointing material in trowelable or rope form. Tapered adjusting ring thickness ranges from 1/2 inch to 3 inches. Install grade adjustment rings on clean, flat surfaces according to the manufacturer's recommendations with the proper bituminous jointing material. Ensure the inside diameter of the adjustment ring is not be less than the inside diameter of the manhole frame. Construct manholes with at least one adjustment ring, totaling 4 inches minimum and 12 inches maximum for new manholes and 4 inches minimum and 16 inches maximum for existing manholes

11.0 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.

      i. 1 foot of cover where the sewer is located in rock
      ii. 3 feet of cover in other material unless ductile iron pipe is specified; in which case, a minimum of 1 foot of cover
      iii. In major streams, a minimum of 3 feet of cover
      iv. 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 NCDWQ 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 2 feet 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. 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.. 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-19 and SS-20 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.

12.0 PIPE MATERIALS

A. Pipe Size and Types

Pipe Type	Pipe Size (inches
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, Class 200, 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. All Ductile Iron Pipe Fittings to be #401 coated

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 diameter, 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 bell with "slip" joints and 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 shall conform to the requirements of ASTM D-1784 and green in color. All pipes shall bear the manufacturer's name, diameter, pipe class and date produced. Pipe to conform to SDR 26. 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 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.

Spacers – Steel, epoxy coated "spiders" shall be provided. Provide one spacer in the center of pipe and one spacer on each end of the same pipe stick.

Carrier pipe shall be Ductile Iron Pipe with 401 Liner. PVC can be an option for installation if approved by the County Engineer. Carrier pipe shall be installed using boltless restraining gaskets. Boltless restraining gaskets shall be "Field-Lok", "Fast-Grip", "Gripper Gasket" or approved equal.

13.0 INSPECTION AND TESTING OF GRAVITY SEWERS

A. CCTV Inspection of Pipeline Interior, Manholes and Lift Stations

All pipelines interior, manholes and lift stations shall be inspected after installation. See CCTV INSPECTION OF GRAVITY SEWERS section.

B. Low Pressure Air Tests

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

The low pressure air testing shall be conducted in accordance with ASTM C828. 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 County 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 County Engineer.

The portion of the sewer line designated by the County 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 100 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 County 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% 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 fewer 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 inch.

MANDREL DIMENSIONS (PVC)

Main Size (inches)	Mandrel Dimension (inches)
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 County Engineer. These repaired sections shall be retested.

The Deflection Test shall be conducted after the final backfill has been in place at least 30 days to permit stabilization of the soil-pipe system. As an alternative to waiting 30 days to permit stabilization of the soil-pipe system, the County Engineer will accept certification from a soil testing firm verifying that the backfill of the trench has been compacted to at least 95% maximum density.

The mandrel shall be approved by the County Engineer. Deflection test must be completed in the presence of the County 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. Testing may be required before backfilling by the County Engineer and must be completed in the presence of the Engineer or representative.

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

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

Manhole Depth	**4 feet Dia.**	**5 feet Dia.**	**6 feet Dia.**
10 feet or less	60 sec.	75 sec.	90 sec.
10 feet to 15 feet	75 sec.	90 sec.	105 sec.
> 15 feet	90 sec.	105 sec.	120 sec.

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.

14.0 CCTV INSPECTION OF GRAVITY SEWERS

A. Qualifications

All CCTV operator(s) responsible for direct reporting of sewer condition shall be certified by National Association of Sewer Service Companies (NASSCO) and Pipeline Assessment and Certification Program (PACP) and have previous experience in surveying, processing, and interpretation of data associated with CCTV surveys/inspections.

B. Submittals

The Owner's designated representative on site shall certify receipt of the daily record. The Contractor shall submit a copy of the CCTV DVD's and a copy of Inspection Report incorporating a summary statistical breakdown of defects and main findings

C. Equipment

The television equipment used for the survey shall be one specifically designed and constructed for such a survey, including all-terrain conditions. The surveying/inspecting equipment shall be capable of surveying/inspecting a length of sewer up to at least 1,000 ft. when entry into the sewer may be obtained at each end and up to 750 ft. where a self-propelled unit is used, where entry is possible at one end only.

The CCTV camera lens head shall be positioned centrally (i.e. in prime position) within the sewer along the axis of the sewer. A positioning tolerance of ± 10% of the vertical sewer dimension shall be allowed when the camera is in prime position.

The camera shall have suitable illumination capable of providing an accurate, uniform and clear record of the sewer's internal condition of the entire periphery of the pipe. In-sewer lighting shall produce a minimum of 1.0 LUX illumination. The camera shall be able to operate in 100% humidity. The camera, television monitor and other components of the video system shall be capable of producing a minimum 700 line resolution color video picture. The contractor shall maintain the camera in clear focus at all times. The video camera shall include a titler.

D. Digital Video

DVD or Thumb Drive shall be supplied for all television surveys. All DVDs or Thumb Drives shall be submitted to the Owner and will become the property of the Owner. Digital video logs shall also be provided with the DVDs or Thumb Drives.

E. Execution

The camera shall be moved through the line at a moderate rate, stopping whenever necessary to permit proper documentation of any defects or infiltration and inflow. In no instances shall the camera move at more than 30 linear feet per minute.

When performing television inspection, depth of flow shall not exceed that shown below for the respective pipe sizes, as measured in the downstream manhole.

Pipe Size (in)	Maximum Depth of Flow for Pipe Diameter (in)
6	1.20
8	1.60
10	2.00
12	3.00
15	3.75
18	4.50
21	5.25
24	6.00
27	8.10
30	9.00
> 30	30%

F. Acceptance

Acceptance of internal sewer main television inspection shall be made upon the successful completion of the survey and shall be to the satisfaction of the Owner.

15.0 ABANDONMENT OF SEWER MAINS AND SEVICES

All sewer mains and services shall be abandoned as per below.

A. Sewer Services: All sewer services shall be demolished and disposed of that are within the R/W back to the discharging sewer main and the sewer service capped at the discharging sewer main.

B. Sewer Mains: All sewer mains shall be demolished and disposed of that are within the R/W back to the discharging manhole and the abandoned sewer main hole in the discharging manhole shall be plugged and grouted per Moore County standards and approval.