

TOWN OF MOORESVILLE LAND DEVELOPMENT DESIGN STANDARDS

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TOWN OF MOORESVILLE, NC
ENGINEERING DIVISION

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Section 1. Introduction

This document is intended to establish minimum design and construction requirements for the preparation and submittal of plans for all land development projects within the Town of Mooresville and its Extraterritorial Jurisdiction (ETJ). The Town of Mooresville Engineering Department will use these standards, as well as sound engineering principles, to review the detailed engineering drawings. All Engineers are encouraged to take these guidelines into consideration in the planning phase of any project to minimize required changes.. The designing engineer on any project should use judgment and experience to determine any additional information that may be necessary for review. The ultimate responsibility for a given design is that of the engineer of record.

All improvements that are required off-site for a fully functional development project and are to be performed as part of the development project must be included in the Plan submittal.

This manual will be reviewed periodically for updating, and more frequent updates/revisions will be made as significant changes or additions are made to the material covered. Revisions will be available on the website.

1.1. Reference Standards

The latest revision of the "NCDOT Standard Specifications for Roads and Structures" and the "NCDOT Design Manual" shall apply to all roadway and storm drainage construction unless otherwise specified herein this manual. Furthermore, all references to specifications and/or standards by the following institutes, associations, and societies shall be made to the latest revision of each specification:

ANSI - American National Standards Institute
ASTM - American Society for Testing Materials
AWWA - American Water Works Association
AASHTO - American Association of State Highway and Transportation Officials
MUTCD - Manual on Uniformed Traffic Controlled Devices
NCAC – North Carolina Administrative Code

1.2. General Contractors and Subcontractors

In order to perform work in the Town of Mooresville whether for the Town or in the Town zoning limits, ALL General Contractors and Subcontractors must be licensed by the NCLBGC for the specific type of work that will be performed. All limitations and classifications of the NCLBGC apply.

1.3. Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
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ANSI	American National Standards Institute
APWA	American Public Works Association
ASTM	American Society of Testing and Materials
AWWA	American Water Works Association
BC (BOC)	Back of curb
BCBC	Bituminous Concrete Base Course
cfs	Cubic feet per second
CI	Cast iron
C/L	Centerline
DE	Drainage easement
DENR	NC Department of Environment and Natural Resources.
DIP	Ductile iron pipe
DME	Drainage Maintenance Easement
EP (EOP)	Edge of pavement
EIP	Existing iron pipe or pin
ETJ	Extra Territorial Jurisdiction
FES	Flared end section
FF	Face to face
gpm	Gallons per minute
ID	Internal Diameter
INV	Invert
MH	Manhole
mph	Miles per hour
MSL	Mean Sea Level
MUTCD	Manual on Uniform Traffic Control Devices
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment & Natural Resources
NCDEM	North Carolina Division of Environmental Management
NCDOT	North Carolina Department of Transportation
NCLBGC	North Carolina Licensing Board for General Contractors
NEC	National Electric Code
OD	Outside Diameter
PC	Point of Curvature
PE	Professional Engineer
ppm	parts per million
PSDE	Permanent storm drainage easement
psi	pounds per square inch
PT	Point of Tangency
PVC	Point of Curvature on Vertical Curve (road) or Polyvinyl Chloride (pipe)
PVI	Point of Vertical Intersection
PVT	Point of Tangency on Vertical Curve
RCP	Reinforced concrete pipe
RLS	Registered Land Surveyor
R/W	Right-of-way
SCS	Soil Conservation Service (Natural Resources Conservation Service)

VCP

Vitrified clay pipe

Section 2. Plan Guidelines

2.1. Erosion Control

Each set of Drawings must include appropriate design of erosion and sedimentation control measures in accordance with the requirements of the N.C. Department of Environment and Natural Resources (NCDENR), Division of Land Resources. Erosion control plans must be approved by NCDENR prior to construction.

2.2. Datum and State Plane Coordinates

All horizontal control shall be correlated to the North Carolina State Plane Coordinate System, all vertical control shall be correlated to the North American Datum (NAD) 1983/86 and North American Vertical Datum (NAVD) 88. All digital files must be tied to the State Plane Coordinate System using two Town of Mooresville or NCGS Monuments. No assumed elevations may be used.

2.3. General Notes for All Land Development Drawing Sets

- a. Construction notes as listed in the Details shall be included in every project.
- b. Construction plans shall be 24" x 36" only. Plans other than that size submitted for Town approval will not be reviewed.

2.4. Domestic Steel and Iron Products Policy

All iron and steel products covered by this Materials Specification shall be purchased from domestic suppliers in conformance with Article 106-1 Paragraph B, "Domestic Steel", of the NCDOT Standard Specifications for Roads and Structures. This specification is in conformance with the "Buy American Act" of Congress. All gray iron castings for heavy duty applications shall be manufactured and tested in according to ASTM A48, Class 35B of AASHTO M306. Foundry certifications and test results, with matching dates and production numbers shall be furnished upon request. Castings shall be of uniform quality, free from sand holes, gas holes, shrinkage cracks, and other surface defects. For traffic surface castings, bearing surfaces between manhole covers and rings or grates and frames shall be cast or machined with such precision to prevent rocking. Manufacturer's published casting weights shall vary +/- 5%.

Section 3. Water Design Standards

3.1. General

- a. All projects which use these specifications shall be designed in accordance with and shall meet all requirements of NCAC Title 15A, Subchapter 18C. It is the responsibility of the Engineer of Record to ensure that all requirements are met. In cases where a statement herein conflicts with such requirements, the more restrictive shall apply. Variations or exceptions to the following guidelines must be approved by Town of Mooresville Director of Engineering.
- b. Water system design must be consistent with the Town's current Water and Sewer Master Plan and overall needs of the Town.
- c. Waterlines must be extended in streets and other easements to the property line or as required by the Director of Engineering. The waterline design shall ensure future service is available to the remainder of adjacent properties.
- d. When fire protection is to be provided, system design shall be such that fire flows and facilities are in accordance with the requirements of the State Insurance Services Office and the most current Fire Code including all Appendices.
- e. A minimum fire flow of 1,000 gpm shall be used for residential developments and 1,500 gpm for nonresidential, however the Town Fire Marshall may require a higher flow rate to be provided based on Fire Code. When requested by the Director of Engineering, the Engineer of Record shall submit the calculations of fire flow requirements and domestic water demands for the project for review and approval.
- f. Design shall be based on a Hazen-William "C" value of 130 for ductile iron pipe (DIP) and 150 for PVC pipe. The acceptable range for pipeline velocity shall be 3-fps to 6-fps for normal working conditions. Sustained high discharge velocities can scour the pipe's interior and increase leakage. Minimum velocity must be maintained to prevent sediment accumulation and bacteriological growth.
- g. Water mains shall be designed to provide a minimum residual service flow of 10 gallons per minute (gpm) at a pressure of 20 pounds per square inch (psi) at any point within the system during periods of combined average daily flow and fire flow.
- h. The water distribution systems and any extensions shall be designed to supply the demands of all customers while maintaining the following minimum pressures and velocity.

- (1) 40 psi for maximum daily flow
 - (2) 30 psi for peak hourly flow
 - (3) 20psi for instantaneous flow plus fire flow. If this requirement cannot be met due to system limitations, the minimum pipe diameter shall be 8-inches.
 - (4) 4 feet per second (fps) for flushing
- i. Transmission mains larger than 12-inches shall be designed on the basis of the most recent system wide demand data and hydraulic modeling.
 - j. Open cut construction on existing paved roads shall be avoided. Existing paved roads shall be bored or tunneled as appropriate.
 - k. Water mains will have a minimum of 3 feet of cover, unless reduced cover is required to avoid a conflict. At no time shall cover be less than 24 inches. Designs resulting in less than 3 feet of cover or more than 10 feet of cover must be accompanied with a letter requesting an exception, documentation showing all alternatives, substantiating the depth of the water line. The letter must be approved by the Director of Engineering.
 - l. Water mains shall be located within dedicated street rights-of-way or Town utility easements. Water mains should be located 5 feet behind the back of curb, typically 1 foot in front of the edge of sidewalk.
 - m. Water main depths along road right-of-way shall consider future road widening. Projections of future grades may require increased depths or additional easements for the water main.
 - n. Permanent Utility Easement (PUE) shall be a minimum width of 25-feet. Larger pipe or deep sewers may require additional permanent easement as required by the Director of Engineering and as summarized in the following Table:

Minimum Permanent Utility Easement (PUE) Width (feet)

Diameter (inches)	Maximum Pipe Invert Depth (ft)					
	10	12	14	16	18	20
4	25'	25'	30'	35'	40'	45'
6	25'	25'	30'	35'	40'	45'
8	25'	25'	30'	35'	40'	45'
10	25'	25'	30'	35'	40'	45'
12	25'	25'	30'	35'	40'	45'
14	25'	30'	30'	35'	40'	45'
16	25'	30'	30'	35'	40'	45'
18	25'	30'	30'	35'	40'	45'
20	25'	30'	30'	35'	40'	45'
24	25'	30'	30'	35'	40'	45'
30	30'	35'	40'	45'	50'	50'
36	30'	35'	40'	45'	50'	50'
42	30'	35'	40'	45'	50'	50'

- o. A Temporary Construction Easement (TCE), of an additional 12.5' on each side of the PUE, shall be in place for the duration of the construction project.
- p. Two-inch-diameter shall be allowed for short cul-de-sacs (400 feet or less) serving less than 5 lots, and shall be looped through the cul-de-sac back to the main line to promote water quality. Longer cul-de-sacs require 8-inch diameter water line and must include a fire hydrant at the end.
- q. Automatic air release valves shall be located at all high points along water main transmission lines.
- r. Blow-off assemblies or fire hydrants shall be located at water main dead ends. Fire hydrants shall function as the blow-off on the end of 6-inch, or larger, water mains. Two-inch blow-off assemblies are to be used for temporary dead end water mains, short two-inch water mains, or as directed by the Town.
- s. Main line valves shall be located at all pipeline intersections and at changes in pipe diameter. Maximum valve spacing shall be 1500 feet. Two valves shall be provided at tees and three valves at crosses, with valves located either at road intersection radius points or as close to the fittings as possible. Where valves must be located away from intersections, they should be located at hydrant installations. If the line is a one way feed, the valve should be on the dead end side of the hydrant branch.
- t. Thrust restraint shall be provided via restrained joint pipe unless sufficient pipe length is not available, and shall be calculated based on a minimum test pressure of 200 psi and skin friction coefficients supplied by the pipe manufacturer with a safety factor of 1.5.

3.2. Water Mains In Relation To Sewers

- a. Lateral Separation of Sewers and Water Main: Water mains shall be laid at least 10 feet laterally from existing or proposed sewers, unless local conditions or barriers prevent a 10-foot lateral separation--in which case the sewer line shall be constructed of DIP and:
 - (1) The water main shall be laid 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
 - (2) The water main shall be laid in the same trench as the sewer with the water main located at one side on 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.
- b. Crossing a Water Main Over a Sewer: Whenever it is necessary for a water main to cross 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. In cases where local conditions or barriers prevent an 18 inch vertical separation, both the water main and the sewer shall be constructed of ferrous materials with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing.

- c. Crossing a Water Main Under a Sewer. Whenever it is necessary for a water main to cross under a sewer, both the water main and the sewer shall be constructed of ferrous materials and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing.

3.3. Service Connections and Meters

- a. All water meters shall be sized in accordance with the latest revision of AWWA M22 (Sizing Water Service Lines and Meters). Water meters are provided and installed by the Town of Mooresville Water Department.
- b. Meters (and cleanouts) must be located behind the sidewalk and at the center of the lots at the right-of-way line. Meters (and cleanouts) shall be located in the grass and shall not be located in streets, parking lots or driveways. Water meter shall be located a maximum distance of 30 inches from the sewer clean-out. Corner lots, basement lots, or lots with rear or side sewer connections may be exempted from this pending approval from the Town.
- c. Pipes for water meter service connections greater than 2" shall be restrained joint DIP, pressure class 350. Three-inch diameter DIP shall not be used for service connections.
- d. When the maximum static pressure in a new system exceeds 80 psi, businesses and/or residences shall be equipped with a pressure-reducing valve (PRV). The PRV shall be located on the outlet side of the meter. It is the property owner's responsibility to install and maintain the PRV.
- e. All water service connections shall be metered. Dedicated fire lines are not metered.
- f. Approved tapping saddles (Model 313 by Smith-Blair or approved equal) shall be used for 2 inch and smaller taps. Direct taps shall not be used.
- g. Stainless steel or mechanical joint tapping sleeves shall be used for taps over 2 inch. Mechanical joint sleeves shall be a split sleeve with mechanical joint end connections and a flanged outlet. Stainless steel sleeves shall be split sleeves with drop in bolts and a mechanical joint outlet. Twelve-inch and smaller sleeves shall be rated for 200 psi working pressure. Sixteen-inch and larger shall be rated for 150 psi working pressure.
- h. All connections to the Town's water system with the exception of a single family residence's main service connection shall have a RP backflow preventer installed.
- i. Meter boxes shall be Model MB16 for ¾" services and Model MB17 for 1" services, manufactured by Southeastern Distributors, Inc. The product numbers are:
 - (1) ¾" – MB16: Part No. 176 (Box), and Part No. 170WE36 (Lid)
 - (2) 1" – MB17: Part No. 178 (Box), and Part No. 174 WE37

- j. All meters 1 ½” and larger shall be installed in precast concrete vaults as detailed. Vaults shall be approved for use in NCDOT rights-of-way and shall be used for H-20 loading.

3.4. Waterline Materials

- a. The following materials are acceptable for waterline extensions:

Size (inches)	Allowable Materials
Service Connection (2 inch and smaller)	Copper Only
Service Connection (3 inch)	NOT ALLOWED
Service Connection (4 inch and larger)	RJ DIP
Waterline (2 inch and 3 inch)*	PVC SDR 13.5
Waterline (4 inch through 12 inch)	PVC C900 DR 14, DIP
Waterline (16 inch and larger)	DIP

* 3 inch pipe is not allowed for public waterline extensions

- b. Ductile Iron Pipe and Fittings

Ductile iron pipe for all water applications shall be designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with ANSI/AWWA C151/A21.51. Pipe shall have a cement mortar lining in accordance with ANSI/AWWA C104/A21.4. Ductile iron pipe shall be push-on type or mechanical type joint manufactured in accordance with ANSI/AWWA C111/A21.11, for rubber gasket joints. The exterior of ductile iron pipe shall be coated with a bituminous coating.

Ductile iron pipe up to 12 inch diameter must be thickness pressure Class 350. Pipe diameters 16 inch and larger must have a minimum thickness pressure Class 250. Any deviations in pressure class must be approved by the Director of Engineering.

Ductile iron fittings shall be compact fittings conforming to ANSI/AWWA C153/A21.53, and will be of the mechanical joint type in accordance to ANSI/AWWA C111/A21.11. All glands shall be ductile iron, not gray iron. The interior of fittings will be cement-mortar lining of standard thickness in accordance with ANSI/AWWA C104/A21.4. The exterior of all fittings shall be coated with bituminous coating. Fittings coated on the interior and exterior with 8 mils of fusion-bonded epoxy in accordance with ANSI/AWWA C116/A21.16 are acceptable.

- c. Flanged Ductile Iron Pipe

Flange joint pipe is approved for use only in non-buried applications, such as meter vaults. All flange fittings shall be ductile iron and have minimum working pressures of 250 psi. Flange joints shall be manufactured and tested in accordance with AWWA C110/A21.10. Flanges, flange bolts and nuts, and gaskets shall conform to the dimensional requirements of ANSI B16.1 for Class 125 flanges. Flange pipe accessories shall be in accordance to ANSI/AWWA C115/A21.15. Bolts shall have standard hexagonal heads and shall be provided with standard hexagonal cold pressed nuts unless otherwise specified. Bolts and

nuts shall be made of the best quality refined iron or mill steel and shall have sound, well fitting threads.

d. Restrained Joint Ductile Iron Pipe

All restrained joint pipe shall have flexible push-on joints designed to deflect a minimum of 3° per joint. Field welding will not be allowed. Factory supplied field cut kits shall be used as directed by the pipe manufacturer. Approved restrained retainer glands shall be used to connect pipe to mechanical joint fittings. Restrained joint pipe is subject to approval by the Director of Engineering, whose acceptance or rejection shall be final.

Restrained joint development length calculations shall be performed using the Ductile Iron Pipe Research Association (DIPRA) *Thrust Restraint Design for Ductile Iron Pipe* computer program which can be downloaded from <http://www.dipra.org/>. The output shall be submitted to the Town for review and approval. The Director of Engineering reserves the right to specify the type of restrained pipe to be used on specific projects and specific field applications. Approved restrained joint pipe are:

- (1) Field Lok 350® Gaskets
- (2) TR Flex by U.S. Pipe
- (3) Snap-Lok by Griffin
- (4) Super-Lock by Clow.
- (5) Flex-Ring by American

Threaded rods, tie bolts and washers used for thrust restraint shall be ¾” stainless steel.

Retainer glands shall be wedge action glands with torque limiting twist off nuts or glands with wedge type gripping gaskets. Approved glands shall be the following:

- (1) Megalug Series 1200 by EBBA Iron Sales, Inc.,
- (6) MJ Field Lok® Gaskets by U. S. Pipe
- (7) Approved Equal

e. Polyethelyne Encasement for Ductile Iron Pipe

Materials and installation shall conform to ANSI/AWWA C105/A21.5. The polyethylene shall have a minimum thickness of 8 mil, shall be tubing type, and shall be manufactured of virgin material. Installation of the polyethylene tubing shall conform to Method “B” outlined in Section 4.3.2.2 of ANSI/AWWA C105/A21.5. The tape used for installation of polyethylene tubing shall be plastic-backed adhesive with a thickness of 12 mils and a minimum width of 1 ½”. The tape shall be capable of bonding to metal, bituminous coating and polyethylene at a temperature range of 32 to 120 degrees F.

f. PVC Pipe 4 inches and larger

All PVC pipe 4” and larger shall be manufactured in conformance with AWWA Standard C 900, ASTM 2241 and shall conform to the requirements of DR 14 class 200 psi. The

exterior of all PVC shall bear a continuous stamp indicating the AWWA certification, DR ratio, size and manufacturer. 12 gauge copper tracer wire shall be installed with all PVC pipe (see tracer wire paragraph).

All PVC shall have a bell with integral rubber gasket and be slip joint manufactured in accordance with AWWA C 151.

Bells of pipe shall be contoured to receive a bulb shaped circular rubber gasket and spigot end shall have sufficient taper to facilitate installation. Jointing shall be achieved by lubricating joint with approved lubricant, guiding spigot end of pipe into bell end of adjacent pipe until contact is made with gasket and exerting enough compressive force to drive the spigot forward into the bell until they achieve full contact. No joint shall exceed the maximum deflection allowed by the manufacturer, normally 11" in a 20' joint.

Fittings for PVC pipe 4 inches through 16 inches shall be mechanical joint ductile iron with a minimum pressure rating of 250 psi as conforming to ANSI/AWWA Standard C110/A21.10 and A21.4.

PVC pipe shall be blue for potable water and green for sewer force main applications.

g. Restrained Joint PVC Pipe

Restrained joints for PVC pipe shall be Uni-Flange Series 1350 for PVC-PVC joints and Uni-Flange Series 1300 or EBBA PV2000 fittings for PVC-DIP joints, or equal.

Restrained joint development length calculations shall be performed using the EBBA Iron *Restrained Length Calculator* computer program which can be found at <http://rcp.ebaa.com/>. The output shall be submitted to the Town for review and approval.

h. 2 inch PVC Pipe

2 inch PVC pipe shall be SDR 13.5 and manufactured in accordance with ASTM D2241. Pipe shall be slip joint with integral bell and gasket meeting ASTM F477. 12 gauge copper tracer wire shall be installed with all PVC pipe (see tracer wire paragraph).

i. Tracer Wire

All PVC pipe shall have a 12 gauge copper tracer wire securely installed on top of the pipe at the 12 o'clock position. The wire shall be held in place with nylon cable ties (or equal means of attachment) at each end and on 48-inch centers along the pipe sections. The wire shall be of sufficient length to be extendable to the surface at each valve box, allowing a current to be induced through the wire to detect the location of the pipeline. The wire shall be brought to the surface inside a dummy valve box through a length of 3-inch PVC pipe with a threaded cap, terminated with a tinned wire connector. Dummy valve boxes shall be located at a minimum at every valve location but no less than every 1,000 feet.

j. Copper Pipe and Fittings

All copper pipes shall conform to ASTM B88, and shall be Type K, soft copper. All joints shall be compression fittings.

3.5. Valves

a. Air Release

All air release valves shall conform to ANSI/AWWA C512. The air release valve shall be designed for potable water applications and be a pressure air valve (operating pressure 0-200 psi) manufactured by GA Industries, Crispin or an approved equal. Valves shall be used as described by the manufacture for clean water air release valves and for potable water lines. All interior iron surfaces of the air valve shall be coated with a minimum of 8 mils of fusion bonded epoxy or liquid epoxy in accordance with ANSI/AWWA C550. All internal working parts shall be stainless steel. All valves shall be furnished with back flushing attachments. The bronze ball valve curb stops shall have a minimum working pressure of 300 psi.

b. Valves (Gate)

All gate valves shall be resilient-seated gate valves which meet the specifications of ANSI/AWWA C509 or ANSI/AWWA C515. The valve body, bonnet and seal plate shall be coated on all exterior and interior surfaces with a minimum of 8-10 mils of fusion bonded epoxy in accordance with ANSI/AWWA C550. The valve shall incorporate a guide system with guide lugs on the wedge or on the body. The wedge shall be gray or ductile iron, fully encapsulated with rubber (including guide lugs and stem nut holder). Non-rising stem valves shall have two O-ring seals above the stem thrust collar that can be replaced with the valve under pressure. Non-rising stem valves shall also have a thrust washer on the stem thrust collar. Valves used for buried service will have a non-rising stem, mechanical joint end connections, and a 2" square operating nut. The word "OPEN" and an arrow to indicate the direction of opening the valve shall be cast on the flanged base of the operating nut. Above ground valves, unless otherwise specified, will have an outside screw and yoke rising stem or a non-rising stem, flanged end connections, and a hand wheel to operate the valve. The word "OPEN" and an arrow to indicate the direction of opening the valve shall be cast on the rim of the hand wheel. All valves will open by turning the nut or hand wheel counterclockwise. Valves installed in manholes will normally be considered to be buried service valves and valves installed in vaults will normally be considered to be above ground valves.

Resilient-seated gate valves shall be designed for a minimum working pressure of 200 psi. Each valve shall be seat tested at the rated working pressure and shell tested at twice the rated working pressure in accordance with ANSI/AWWA C509 - Section 5 or ANSI/AWWA C515 - Section 5. All valves shall be warranted for 10 years from date of purchase against defective materials and workmanship. Gate valves furnished under these specifications must be manufactured by one of the following:

- (1) Clow Valve Company
- (2) M & H Valve Company
- (3) American Flow Control
- (4) U.S. Pipe and Foundry Company
- (5) Mueller Company
- (6) Kennedy Valve Company

c. Tapping Sleeves & Valves

Tapping sleeves and valves shall be used for “wet” taps into existing water mains. The tapping valve shall meet all specifications for “gate valves”. Mechanical Joint valves shall be used on tapping sleeves with Mechanical Joint outlets. Flange by Mechanical Joint tapping valve shall have an inlet flange (with centering ring) for connection to the flanged sleeve outlet of the flanged tapping sleeve, conforming to AWWA C207, Class D, ANSI 150 lb. drilling, mechanical joint end conforming to AWWA C111. Tapping valves shall be supplied with mechanical joint accessories, high strength low alloy steel bolts, and heavy hexagon nuts conforming to ANSI/AWWA C111/A21.11. Tapping valve seal plates and bonnets shall have 316 stainless steel bolts and nuts.

All tapping sleeves and valves shall be water tested before the tap is made. Test pressure shall be 200 psi. All tapping sleeves and valves shall be installed level.

Approved tapping valves are as follows:

- (1) Clow Valve Company
- (2) M & H Valve Company
- (3) American Flow Company
- (4) U.S. Pipe and Foundry Company
- (5) Mueller Company
- (6) Kennedy Valve Company

d. Mechanical Joint Tapping Sleeve

Mechanical joint tapping sleeves shall be furnished complete with joint accessories including split glands, split end gaskets, bolts, etc., and shall be compatible with the type and class of pipe being tapped. Mechanical joint tapping sleeves shall have mechanical joint seals conforming to AWWA C111, with outlet flange and drilling conforming to ANSI B16.1, class 125. Flange gaskets shall be of the rubber type rated to 250 psi, with three rows of raised o-rings. Flange gaskets shall be Flange-Tyte® by U.S. Pipe or approved equal. Mechanical joint tapping sleeves shall be Mueller Co. Model H-615 or approved equal.

e. Stainless Steel Tapping Sleeve

Stainless steel tapping sleeves shall be manufactured from type 304 stainless steel. The outlet shall be mechanical joint outlet to be used with a standard mechanical joint valve. The mechanical joint outlet shall be stainless steel. The sleeve shall include a test plug for

pressure testing the installed sleeve prior to making the tap. All welds shall be passivated for corrosion resistance. Stainless steel tapping sleeves shall be Smith-Blair 665 or JCM 439, 459 or approved equal.

f. Valve Boxes (Round Top)

Cast iron valve boxes will conform to ASTM A48, Class 30B. Valve boxes shall be free from holes, cracks or any other defects. Lid shall be clearly labeled "WATER" or "SEWER" as appropriate. Locking lids identifying valve as Mooresville shall be used in areas where private utilities are also located. Lids must have a minimum 1-1/2" skirt and weigh at least 13 lbs. Lids in areas subject to vehicle traffic may require extended 4 inch skirts and weigh at least 24 lbs. Valve box extensions are to be of ductile iron in and along roadways or areas that may be widened. Unless directed plastic valve box extensions such as C-900 are acceptable in other areas. Valve boxes are to be manually adjusted to grade in roadways. Valve box riser rings cannot be used to adjust final grade.

All castings will be thoroughly coated with an asphaltic varnish. Valve boxes that do not meet specifications shall be rejected. Cast iron valve boxes furnished under these specifications shall be supplied by one of the following East Jordan Iron Works – Made in USA or an approved equal.

3.6. Trenchless Utility Installation (Jack & Bore)

Water and sewer lines which cross NCDOT or Town roads shall be installed via jack and bore. Steel casing pipe shall extend a minimum of 10-feet beyond the edge of pavement on both sides of the roadway unless specific existing constraints preclude it.

a. Casing Pipe

Steel encasement pipe shall be smooth wall pipe with welded joints. All section joints of steel casing pipe shall be full penetration welded with a continuous circumferential weld. The pipe shall have minimum yield strength of 35,000 psi in accordance with ASTM A139 and A283. The encasement pipe must be capable of withstanding highway loadings and must have an inside diameter which will allow the carrier pipe to be removed subsequently without disturbing the encasement pipe. Encasement pipe and joints shall be of leak proof construction. The inside diameter of the encasement pipe shall be at least 2 inches greater than the largest outside diameter of the carrier pipe, joints or couplings, for carrier pipe less than 6 inches in diameter; and at least 4 inches greater for carrier pipe 6 inches and larger in diameter. In general, to determine the casing size you should double the size of the carrier pipe, i.e., a 8" carrier pipe requires a 16" casing pipe. The Engineer shall verify the clearance is sufficient to allow the carrier pipe to be removed without disturbing the casing pipe.

Minimum steel casing pipe size and wall thickness shall be as indicated as follows:

Carrier Pipe (inches)	Casing Pipe (inches)	Thickness (inches)	
		NCDOT	Railroad
6	16	.250	.281
8	20	.250	.344
12	24	.250	.375
16	30	.312	.469
18	30	.312	.469
24	36	.375	.562
30	48	.500	.750

b. Carrier Pipe

The carrier pipe shall be restrained joint ductile iron in all cases.

c. Casing Spiders

Casing spiders shall be made of Type 304 stainless steel (including risers and hardware). Each shell shall be PVC lined and shall have bolted flanges. Casing spacer runners shall be constructed of ultra high molecular weight polymer (minimum 1 ½” wide) with a friction coefficient of not more than 0.12. Risers shall be 10 gauge. Risers and runners for top and bottom shells shall be of equal height. With approval of the Town, unequal height risers and runners may be used to obtain proper grade for sanitary sewer mains. Casing spacers must be designed to ensure that only the runners of the spacer are in contact with the steel encasement pipe. The bell of the carrier pipe will not be allowed to be in contact with the encasement. Casing spacers shall be manufactured by one of the following:

- (1) Cascade Waterworks Manufacturing Company
- (2) Advance Products and Systems, Inc.
- (3) BWM Company

3.7. Fire Hydrants

- a. All fire hydrants private and public connected to the Town’s water supply shall be Storz dry-barrel fire hydrants, which comply with ANSI/AWWA C502.
- b. Fire hydrants shall be placed on lot lines no closer than one foot from the back of the curb. In general the following spacing applies, pursuant to approval by the Town of Mooresville Fire Marshall and Engineering Department:

Single Family Detached Residential	500 ft
Multi-Family Attached Residential	300 feet from center of each lot to closest hydrant
Commercial	
Industrial	
Transmission mains on Multi-lane Roads	

- c. All hydrants shall be opened by turning counter clockwise, and the direction of opening shall be indicated by means of an arrow and appropriate wording on the top of the hydrant. A weather cap around the operating nut on top of the hydrant is required. All hydrants will have a 6" mechanical joint base connection.
- d. Hydrants shall be designed for a minimum working pressure of 200 psi. Each hydrant shall be assembled at the factory with one 5" steamer nozzle with the 5" Storz connection and cap. Each hydrant shall have two 2 1/2" nozzles.
- e. All hydrants will be furnished with the breakable traffic feature that will break upon impact. The feature shall consist of a breakaway safety flange on the barrel and a breakable safety coupling in the main valve stem. The bottom of the breakaway flange shall be 1 to 4 inches above finished grade.
- f. A blue reflective pavement marker shall be placed at the centerline of multi-lane roads adjacent to the fire hydrant per NCDOT Standard Detail 1251.01 and Section 1086 "Pavement Marker" of the NCDOT Standard Specifications for Roads and Structures.
- g. All exterior surfaces of hydrants placed in the public right-of-way shall be painted two coats of "Safety Yellow" or to the town's satisfaction with Rust-Oleum Industrial Enamel Paint 944402 or approved equal. Private fire hydrants shall be painted silver. Plastic "Out of Use" disks or bags must be placed on hydrants immediately upon fire hydrant installation.
- h. Hydrant will normally be three and one-half feet from the ground to the bottom of the hydrant (42" bury depth). However, when plans indicate deeper bury is required, such hydrants will be furnished conforming to the depth of bury as shown on the plans. Hydrant extensions will be installed only if necessary.
- i. Hydrants accepted by the Town of Mooresville are as follows:
 - (1) Super Centurion 250, A-423 5-1/4" manufactured by Mueller Company
 - (2) 5-1/4" American Darling B-84-B, manufactured by American Flow Control
 - (3) K-81A 5-1/4" Guardian, manufactured by Kennedy Valve Company
 - (4) Medallion Hydrant 5-1/4", manufactured by Clow Valve Company

3.8. Concrete and Reinforcing Steel

a. Concrete

All concrete will be made of Portland cement, water and aggregate and shall have a minimum 28-day compressive strength of 3,600 psi unless stated otherwise. Aggregate shall conform to ASTM C33. Ready-mix concrete shall conform to ASTM C94. Any concrete poured that has a slump over 4 inches as per ASTM C143, or has a batched time

of more than 90 minutes, will be considered unacceptable. Concrete shall be air entrained with 5-7% air. Retarders and accelerators shall be used only as directed by the Director of Engineering.

A design of the mix made by an independent laboratory for each class of concrete will be submitted to the Town for approval before concreting is started. No waterproofing material or admixture will be used in the concrete without the Town's approval.

During the progress of work, standard compressive strength test specimens will be made, cured in accordance with ASTM C31 and tested by an independent testing laboratory in accordance with ASTM C39. At least four cylinders will be made for each test (one 7-day, two 28-day, and one reserve). Tests will be submitted for each 50 cubic yards or fraction thereof for each class of concrete used for the first 200 cubic yards of each class placed. For the next 300 cubic yards used, one test will be furnished for each 100 cubic yards and for all over 500 cubic yards, one test for each 500 cubic yards. The Director of Engineering determines testing rates and testing dates as necessary. Sampling concrete for test cylinders may be required at any time.

The Director of Engineering may request that high early strength concrete be used in certain situations. High Early Strength Concrete shall conform to Article 1000-7, "High Early Strength Portland Cement Concrete", of the NCDOT Standard Specifications for Roads and Structures.

b. Sand

All sand used in mortar or as fine aggregate in concrete will be clean, sharp, practically free from loam, clay or vegetable matter, and so graded as to insure workability and water-tightness when mixed with other ingredients. Sand will conform to ASTM C33, and when made into mortar will have a compressive strength at 7 and 28 days of not less than 100 percent of mortar made with standard sand. Independent laboratory tests will be submitted for approval of the Town. Mortar sand shall meet the requirements of article 1040-6, "Mortar Sand," of the NCDOT Standard Specifications for Road and Structures. Sand used for concrete shall meet the requirements of Section 1014, "Aggregate For Portland Cement Concrete," of the NCDOT Standard Specifications for Road and Structures.

c. Reinforcing Steel

All reinforcement steel bars will conform to ASTM A615 (Grade 60) and all reinforcement welded steel wire fabric will conform to ASTM A185. All steel will be free from rust or other coatings which would destroy the bond between the steel and the concrete. Bars shall be tied together and supported to prevent damage by construction loads or pouring of concrete.

3.9. Pressure Test

Piping and other equipment designed to carry fluids under pressure shall be tested as a whole, or in sections valved or bulkheaded at the ends. Testing shall be under a hydrostatic pressure equal to the design pressure, but not less than 150 psi. All pressure testing shall be performed in accordance with AWWA C600 or AWWA C605, current editions, as applicable.

Test pressure shall be applied by means of a pump and a tap in the pipe. The rate of leakage shall be determined by means of volumetric measurement of the water added during the test, for a minimum of 2 hours after the rate of leakage has stabilized.

Any defective pieces discovered in any pipeline as a result of the test shall be removed, replaced with sound pieces and retested until tight.

Tests of insulated and concealed piping shall be made before the piping is covered or concealed.

For pressure pipelines installed in the ground, the rate of leakage shall not exceed the following:

$$L = \frac{SD \sqrt{P}}{148,000}$$

Where:

L = testing allowance (makeup water), in gallons per hour

S = length of pipe tested, in feet

D = nominal pipe diameter, in inches

P = average test pressure during hydrostatic test, in psi

3.10. Chlorination

Water distribution systems, including storage tanks and water mains, after flushing to remove sediment and other foreign matter, and after testing for leaks, shall be disinfected by the addition and thorough dispersion of a chlorine solution in concentrations sufficient to produce a chlorine residual of at least 50 milligrams per liter (or ppm) in the water throughout the distribution system, including all water mains and storage tanks.

The chlorine solution shall remain in contact with interior surfaces of the water system for a period of 24 hours. Then the water system shall be flushed with fresh water from an approved water source until the chlorine solution is dispelled to a maximum of 2.0 milligrams per liter (or ppm) free chlorine.

Representative samples of the water shall then be collected. If bacteriological tests of the samples indicate that the water quality is satisfactory, the water mains and storage tanks may be placed in service.

Section 4. Sanitary Sewer Design Standards

4.1. General

- a. All projects which use these guidelines shall be designed in accordance with and shall meet all requirements of North Carolina Administrative Code (NCAC). It is the responsibility of the Engineer of Record to ensure that all requirements are met. In cases where a statement herein conflicts with such requirements, the more restrictive shall apply. Variations or exceptions to the following guidelines must be approved by Town of Mooresville Director of Engineering.
- b. Sewer design must be consistent with the Town's current Water and Sewer Master Plan and overall needs of the sewer basin, following the natural drainage pattern of the basin. All sub basins and any other basins or sub basins that may or will be pumping into the sewer being designed must be identified. The Engineer of Record shall furnish topographic maps, zoning maps, and design data to substantiate sizing of all major basin outfalls. Installation depths shall be minimized during the design process.
- c. Sewer mains must be extended on outfalls, in streets, or other easements to the property line or as required by the Director of Engineering. The sewer design shall ensure future service is available to the remainder of the drainage basin and or adjacent properties.
- d. Open cut installation of sewer mains in roads shall be avoided.
- e. Design average daily flow for residential units shall be provided by the Director of Engineering for use. Design flows for all other uses shall be as published in the NCAC.
- f. Gravity sewer sizes shall remain constant between manholes. In manholes with smaller upstream sewer line and larger downstream line, the crowns of the two sewer lines shall match. All sewers shall have a straight alignment between manholes. Sewers shall be designed with uniform slope between manholes.
- g. Minimum diameter pipe for gravity sanitary sewer applications shall be 8 inches, with a minimum of 4 inches for sanitary service laterals. Velocity calculations for determining pipe diameter shall be based on Manning's formula, minimum velocity of 2 ft/sec with an "n" value of 0.014.
- h. Sewer depths greater than 12' for all sewer lines must be approved by the Director of Engineering. Sewer depths for all sewer lines along road right-of-ways must consider future road widening. Projections of future road grades may require increased depths or additional easements.
- i. Tapping saddle connections are not allowed in new sewer design/construction.
- j. Laterals 6" or larger must connect to manholes. Rubber couplings or "No-hub bands" are not allowed on sewer laterals or sewer lines. Mechanical joint sleeves or approved equal must be used on pipe material transitions. However, transitions from Vitrified Clay Pipe

must use a rubber coupling (repair clamp). Approved couplings must have a wide solid stainless steel center band .012" thick, with 4 stainless steel screw clamps, Mission Flex-seal ARC coupling or approved equal.

- k. Pipes designed at minimum slopes shall be avoided. Minimum slopes are difficult to maintain during installation, and limits the ability to make necessary field changes. Pipe designed to be constructed at minimum slopes must have a letter submitted with necessary documentation showing all alternatives, substantiating the design, and must be approved by the Director of Engineering. Minimum slope is 1 percent, for dead-end lines. Otherwise, minimum slopes must conform to the following Table:

PIPE DIA. (in)	MIN. DESIGN SLOPE	MAX. DESIGN SLOPE
8	0.6%	18%
10	0.3%	16%
12	0.3%	13%
15	0.2%	9%
18	0.2%	7%
24	0.1%	5%
30+	0.1%	4%

- l. Bores, encasement pipes, creek crossings or other grade limiting situations are not to be designed with minimum slopes. Manholes shall be placed adjacent to these situations and adjacent sewer lines shall be designed to allow for field changes in grade.
- m. Permanent Utility Easement (PUE) shall be a minimum width of 25-feet. Larger pipe or deeper sewers may require additional permanent easement as required by the Director of Engineering and as summarized in the following:

PIPE SIZE	MIN. PERMANENT UTILITY EASEMENT WIDTH
8"	25'
12"	25'
15"	25'
18"	25'
24"	30'
30"	35'
36"	35'
42"	40'

A Temporary Construction Easement (TCE), of an additional 12.5' on each side of the PUE, shall be in place for only the duration of the construction project.

- n. Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction where shallow cover and high groundwater or flooding

conditions are anticipated. For design purposes, assume water to top of pipe and pipe is empty.

- o. Where design velocities are projected to be greater than 15 feet per second, the sewers and manholes shall be protected against displacement by erosion and impact. Design velocities greater than 15 feet per second must have a letter submitted with necessary documentation showing all alternatives, substantiating the design, and must be approved by the Director of Engineering. Ductile iron pipe (DIP) material is required when design velocities are 15 feet per second or greater.

4.2. Sewers In Relation To Streams And Other Water Bodies

- a. Permanent stream crossings for maintenance access shall be provided. As a result, additional easements may be necessary to construct creek crossings for maintenance adjacent to aerial stream crossings.
- b. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. The following cover requirements shall be met:
 - (1) One foot of cover where the sewer is located in rock
 - (2) Three feet of cover in other material. In major streams, more than three feet of cover may be required;
 - (3) In paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement.
- c. Sewers located along streams, lakes or impoundments, shall be located at least 20 feet outside of the stream bank or sufficiently removed therefrom to provide for future possible stream widening and to prevent siltation of the stream during construction. A distance of 50 feet shall be maintained between sewers and water classified as WS-II, WS-III, B, SA, ORW, HQW, or SB (from normal high water [or tide elevation]). Sewer lines less than 100 feet from a water supply well shall be DIP with water-tight joints. Sanitary sewer lines shall not be located less than 25 feet from a private well.
- d. 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.
- e. Sewers crossing streams shall be designed to cross the stream as nearly perpendicular to the stream flow as possible. Sewer systems shall be designed to minimize the number of stream crossings.
- f. Sewers entering or crossing streams shall be constructed of ductile iron pipe with mechanical joints. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.

- g. Aerial stream crossings are to be avoided and must be substantiated, and approved by the Director of Engineering. Restrained joints and adequate supports to prevent excessive flexion shall be provided for all aerial pipe crossings. DIP is required and pipe spans must be installed to manufacturer's specifications. Suspended joints and adjacent joints shall be Mech-Lok® Rigid Restrained joint by Griffin Pipe (or approved equal). Supports shall be designed to prevent frost heave, overturning, and settlement.
- h. 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.
- i. For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the 25 year flood.
- j. Concrete piers are required for creek crossings and areas subject to erosion. Steel H-piles are allowed on a case-by-case basis in which concrete piers cannot be installed.
- k. In areas where the sewer trench has the potential to drain wetlands, anti-seepage collars shall be installed. Please be advised, in these areas, a 401/404 permit may be necessary.

4.3. Piping Materials

- a. Sewer laterals less than 3 feet or over 12 feet deep must be ductile iron pipe. Sewer laterals located in the right-of-way of major roads, or as directed by the Director of Engineering, will also be ductile iron pipe. Otherwise Schedule 40 PVC pipe can be used for sewer laterals.
- b. Pipe material requirements are based on specific use, installation conditions, and the Director of Engineering. The following types of pipe are allowable for gravity sewer applications:

- (1) Extra Strength Vitrified Clay Pipe (VCP)
- (2) Polyvinyl Chloride (PVC) Pipe
- (3) Ductile Iron Pipe (DIP)

- c. Gravity Sewer Ductile Iron Pipe and Fittings

Ductile iron pipe shall be designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with ANSI/AWWA C151/A21.51. Ductile iron pipe shall be push-on type or mechanical type joint manufactured in accordance with ANSI/AWWA C111/A21.11, for rubber gasket joints. The exterior of ductile iron pipe shall be coated with a bituminous coating. Ductile iron pipe up to 12 inch diameter must be thickness pressure Class 350. Pipe diameters 16 inch and larger must have a minimum thickness pressure Class 250. Any deviations in pressure class must be approved by the Director of Engineering.

Ductile iron pipe and fittings used for all force mains and creek crossings shall be lined with 40 mils of Protecto 401™ Ceramic Epoxy or approved equal. All bells and spigots for pipes which require Protecto 401™ must be coated with a minimum of 8 mils of Protecto 401™ Joint Compound. Gravity sewer outfalls or gravity sewer in commercial/industrial locations may also require lining at the discretion of the Director of Engineering. All other gravity sewer may be cement lined ductile iron. Ductile iron sewer pipe must be easily recognized by the brownish red bells and spigots, as well as stenciling of the words showing “For Sewer Only”.

d. Restrained Joints

All restrained joint pipe shall have flexible push-on joints designed to deflect a minimum of 30 per joint. Field welding will not be allowed. Factory supplied field cut kits shall be used as directed by the pipe manufacture. Approved restrained retainer glands shall be used to connect pipe to mechanical joint fittings. Restrained joint pipe is subject to approval by the Director of Engineering, whose acceptance or rejection shall be final. The Director of Engineering reserves the right to specify the type of restrained pipe to be used on specific projects and specific field applications. Restrained pipe shall be lined per the requirements for push-on joint DIP for sewer. Approved restrained joint pipe are:

- (1) Field Lok 350® Gaskets
- (2) TR Flex by U.S. Pipe
- (3) Snap-Lok by Griffin
- (4) Super-Lock by Clow.
- (5) Flex-Ring by American

e. Rigid Restrained Joints

Rigid restrained joint pipe, when required, shall be Mech-Lok™ by Griffin Pipe. All rigid restrained joint pipe shall be lined with 40 mils of Protecto 401™. Details of pipe joints and structural support of aerial crossings shall be submitted to the Director of Engineering for review and approval prior to construction.

f. Flanged Joints and Accessories (Sewer)

Flange joint pipe is approved for use only in above ground applications, such as pump stations and valve vaults. All flange fittings shall be ductile iron and have minimum working pressures of 250 psi. Flange joints shall be manufactured and tested in accordance with AWWA C110/A21.10. Flanges, flange bolts and nuts, and gaskets shall conform to the dimensional requirements of ANSI B16.1 for Class 125 flanges. Flange pipe accessories shall be in accordance to ANSI/AWWA C115/A21.15. Bolts shall have standard hexagonal heads and shall be provided with standard hexagonal cold pressed nuts unless otherwise specified. Bolts and nuts shall be made of the best quality refined iron or mill steel and shall have sound, well fitting threads. Flanged joint pipe and fittings shall be lined with 40 mils of Protecto 401™.

g. Ductile Iron Pipe Fittings (Sewer)

Ductile iron pipe fittings for all sewer applications, except for local residential subdivisions shall be lined with 40 mils of Protecto 401™ Ceramic Epoxy, or approved equal, and be compact fittings conforming to ANSI/AWWA C153/A21.53. Fittings will be of the mechanical joint type in accordance to ANSI/AWWA C111/A21.11. All glands shall be ductile iron, not gray iron. The exterior of all fittings shall be coated with bituminous coating. The interior shall be lined to match the DIP on either side of the fitting. All fittings are subject to approval by the Director of Engineering, whose acceptance or rejection shall be final.

h. Gravity Sewer PVC Pipe and Fittings

Sewer pipe 8-inches through 15-inches in diameter may be Poly Vinyl Chloride (PVC) sewer pipe and fittings with a minimum Standard Dimension Ratio (SDR) of 26 and shall meet all requirements of ASTM Specification D3034. Sewer pipe 18-inches through 27-inches in diameter may be Polyvinyl Chloride Pipe (PVC) large diameter sewer pipe with a minimum pipe stiffness of 46 PSI in accordance with ASTM Specification F679. Pipe joining shall be push-on elastomeric joints only, and joints with integral bells and with gaskets that are permanently installed at the factory, in accordance with ASTM Specification D3212. The pipe shall be furnished in nominal lengths of 13 feet. At the discretion of the town, PVC pipe shall be covered with an opaque material while permitting adequate air circulation around the pipe.

AWWA C900 pipe (normally for pressure applications) with a DR 18 or less is also acceptable for gravity sewer applications.

PVC pipe shall contain the markings required by ASTM D-3034, ASTM F-679, or AWWA C900 as applicable. The manufacture shall submit certifications that the pipe has been found to meet all requirements. Test samples shall be as selected by the manufacture or testing laboratory unless otherwise stipulated.

Fittings shall be in accordance with ASTM D_3034, F-679, AWWA C900 and /or D-3212 as applicable, with stiffness and wall thickness equal to or greater than the pipe. Adapters shall be provided to join different materials.

i. PVC for Sewer Service Lateral Applications

PVC pipe for gravity sewer service lateral applications, including the cleanout stack shall be PVC Schedule 40, manufactured in accordance with ASTM D1785, "Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe" solvent cement joints (type SC).

j. PVC Pipe and Fittings (Forcemain)

Refer to Water Design Standards, Section 3.4 for material specifications.

k. Vitrified Clay Pipe (VCP)

Vitrified clay pipe (VCP) shall be manufactured in accordance with ANSI/ASTM C700, tested in accordance with ANSI/ASTM C301 and shall be classified as extra strength pipe. The specific type of joint shall be the O-ring compression type joint. This joint shall conform to ANSI/ASTM C425. All VCP will be unglazed. All VCP shall be subject to inspection by the Town and its acceptance or rejection will be final. Pipe shall be manufactured by Logan Clay Products Company or approved equal.

l. Service Saddles

Service saddles for 4" sewer connections to existing sewer mains shall be style CB Sewer Saddle by Romac Industries, Inc. or approved equal.

4.4. Manholes

a. Manholes shall be installed on all gravity sewer mains at: the end of each line, changes in grade, changes in main size, changes in alignment, and all intersections. Spacing shall not exceed 400 feet for all sewers.

b. Manholes will be furnished with the following clear inside diameters according to depth and the sewer main diameter:

- (1) 8" to 18" pipe 4' Manhole (< 12' deep)
- (2) 8" to 18" pipe 5' Manhole (\geq 12' deep)
- (3) 21" to 36" pipe 5' Manhole
- (4) 39" to 54" pipe 6' Manhole
- (5) 54" and larger 8' Manhole

c. Manholes shall be constructed of precast reinforced concrete designed for H-20 loads per ASTM C478. Manhole shelves and channels must be of the precast type, by the manufacturer. Steps are required in all structures greater than 36-inches deep. All manhole steps shall conform to current OSHA standards and ASTM C478. Channels shall be built to a depth and width to conform to the outside diameter of the influent and effluent pipes. The channel shall be constructed with a 0.2 foot drop from the invert of the influent pipe to the invert of the effluent pipe through the manhole.

d. Manhole shelves shall slope from the manhole wall to the channel at a minimum slope of 0.5" per foot. A maximum of two inches (2") shall be allowed for the protrusion of the influent and effluent pipes beyond the inside wall of the manhole. Manhole shall have precast inverts for all lateral connections directing flow to the manhole outlet. All inlet and outlet pipes shall be joined to the manhole, with flexible watertight connections (rubber boots). Mortar shall be placed around all pipe connections.

e. All manhole joints shall be sealed on the outside of the manhole with butyl adhesive tape (minimum 6" wide). Manhole joints shall be assembled using Type B-Butyl Rubber conforming to AASHTO M-198. The tape shall be EZ-Wrap by Press-Seal Gasket Corp.,

or approved equal. Manholes on outfalls or in un-maintained areas shall be flat-top manholes 24" to 36" above existing ground. The types of manholes are subject to approval by the Director of Engineering, whose acceptance or rejection shall be final.

f. Manhole Linings

Manholes on the receiving end of a force main shall be coated with an epoxy lining system to prevent corrosion. The lining system shall be a two component, spray applied system, Cor-Cote SC Sewer-Cote as manufactured by Sherwin-Williams, Inc.

Existing manholes that are connected to by a new force main shall be sand blasted and cleaned in accordance with SSPC-SP13/NACE 6 prior to application of the lining. Any repairs to the concrete including reinforcing steel shall be made as part of the surface preparation. Corobond 100 Epoxy Primer/Sealer as manufactured by Sherwin-Williams, Inc. shall be used to repair holes in the concrete as recommended by the manufacturer.

All work shall be performed in accordance with the manufacturer's recommendations and by an experienced applicator.

g. Manhole Rings and Covers

Standard manhole rings and covers will be made of cast iron and will conform to ASTM A48, Class 35B. Metal riser rings shall not be used. In addition, all manhole rings and covers shall be designed to support an H-20 wheel load. All castings will conform to the shape and dimensions shown on the Town of Mooresville detail drawing (Detail S-2) and will be free from holes, cracks or any other defects. Rings and covers will have machined seats so that the cover will not rattle. Rings will weigh a minimum of 190 pounds and covers a minimum of 120 pounds. The name of the foundry and the part number shall be cast permanently on the ring and the cover. Castings that do not meet specifications shall be rejected. Rings and covers furnished under these specifications shall be manufactured by one of the following:

- (1) East Jordan Iron Works, Inc. (Ring - Part No. V-1384-1; Cover - Part No. V-1384)
- (2) U.S. Foundry & Manufacturing Corp. (Ring - Part No. 669; Cover - Part No. KL)

h. Sealed Ring and Cover

Secured rings and covers shall meet all specifications for Secured Rings and Covers and shall conform to the Town of Mooresville detail drawing for Sealed Rings and Covers (Detail S-4). Sealed covers shall have no vent holes. Rings and covers shall be manufactured by one of the following:

- (1) East Jordan Iron Works, Inc. (Ring - Part No. V-2384; Cover - Part No. V-1385)
- (2) U.S. Foundry & Manufacturing Corp. (Part No. 669-KL-BWTL)

i. Flat Top Manhole Sealed Ring and Cover

Flat top manhole sealed covers shall meet all specifications for Standard rings and covers, except that rings will weigh a minimum of 136 pounds and covers a minimum of 120 pounds. All rings and covers shall conform to the Town of Mooresville detail drawing for Type 3. Covers shall not have vent holes. Flat-top manholes shall have flat top sealed covers cast into the top. Rings and covers shall be manufactured by one of the following:

- (1) East Jordan Iron Works, Inc. (Ring - Part No. V-2484; Cover - Part No. V-2384)
- (2) U.S. Foundry & Manufacturing Corp. (Ring - Part No. 571; Cover - Part No. KK)

4.5. Sewer Valves

a. Combination Air Vacuum Valves

All air release valves shall be of the combination air vacuum type and shall conform to ANSI/AWWA C512. The air release valve shall be a pressure air valve (operating pressure 0-150 psi) manufactured by GA Industries, Crispin or an approved equal designed for sewer applications. The valves shall be capable of exhausting air as the pipeline fills, and allowing air to enter as the pipeline empties. All interior iron surfaces of the air valve shall be coated with a minimum of 8 mils of fusion bonded epoxy or liquid epoxy in accordance with ANSI/AWWA C550. All internal working parts shall be stainless steel. Valve shall be furnished with back flushing attachments. The bronze ball valve curb stops shall have a minimum working pressure of 300 psi.

b. Swing Check Valves

All swing check valves shall meet the specifications of AWWA C508. The valves shall have an iron body, be of the clear waterway type and have bronze to bronze or rubber to bronze seat construction. End connections can be flanged or mechanical joint, depending on the application. Check valves shall be designed for a working pressure of 175 psi for 2-12 inch valves. Assembled check valves shall be subjected to the following hydrostatic tests in accordance with AWWA C508-Section 5:

- (1) Shell Test: 350 psi for 2-12 inch valves
300 psi for 16-24 inch valves
- (2) Seat Test: 175 psi for 2-12 inch valves
150 psi for 16-24 inch valves

Check valves will be lever and weight operated only. At any time, the Town Engineer can require and specify the type of check valve. All valves shall have two coats of asphalt varnish applied to the outside ferrous metal surfaces. All interior iron surfaces (including the disc, clapper and clapper arm) shall be coated with a minimum of 8 mils of fusion bonded epoxy or liquid epoxy in accordance with ANSI/AWWA C550. Check valves furnished under these specifications must be Golden Anderson, Cushioned Swing Check or approved equivalent. Approved manufacturers:

- (1) Golden Anderson
- (3) Mueller Company
- (4) American Flow Control
- (5) M & H Valve Company

4.6. Testing Requirements

a. Exfiltration Test

Gravity sewer pipe shall be tested for leaks using a low pressure air test method. Pressure loss shall not exceed 0.5 psi during the required testing time. Testing time in minutes shall conform to ASTM F1417, latest revision, for PVC and DIP. Testing time for VCP shall conform to C828, latest revision. The contractor shall furnish supplies for exfiltration testing.

b. Deflection Test

Not less than 30 days following completion of backfill, gravity sewer pipe shall be tested for deflection with a 5% mandrel sized as defined in ASTM D-3034. Mandrels shall be furnished by the Town of Mooresville. The mandrel shall be pulled through each section of pipe from manhole to manhole. The mandrel must slide freely through the pipe with only a nominal hand force applied. No mechanical device shall be used in pulling the mandrel. Any pipe which refuses the mandrel shall be removed and replaced or re-rounded and the bedding shall be properly constructed as specified to prevent excessive deflection. Such sections shall be re-tested for deflection after completion of backfill.

4.7. Pumping Stations

- a. Whenever possible, sanitary sewerage facilities shall be designed so as to avoid the necessity of providing pumping stations.
- b. Sanitary sewer pump station design information must be submitted for approval along with all other civil design drawings and specifications.
- c. These standards refer to design of the wet well (submersible) variety only. Regional pump stations of the wet pit/dry pit variety as determined necessary by the Town's Master Plan will be designed on a case by case basis.

- d. Pumps shall be equipped with 3-phase motors and shall be manufactured by one of the following:
 - (1) BJM
 - (2) Hydromatic (25 HP and below only)
 - (3) Flygt
 - (4) Gorman-Rupp
 - (5) Myers
- e. Pumps shall be selected such that the design point is at or near the maximum efficiency for that model.
- f. A stand-by internal combustion power source shall be provided for pumping stations. All stand-by power sources must be installed in a weatherproof building structure suitable to accommodate the power source, controls, alarm system, and all required appurtenances. The structure must be large enough to allow for servicing of all equipment and must meet all building codes.
- g. An 800 compatible SCADA system shall be installed. Specifications shall be coordinated by the engineer through Wireless Communication (704- 213-6204).
- h. All wiring shall be installed in cable trays. No conduit shall be allowed.
- i. The following items shall be provided with any pump station:
 - (1) Six foot high vinyl coated chain link fence with twelve foot clear gate
 - (2) Site security lighting with manual all-weather switch
 - (3) Wooden shelter over control panel with shingled roof. The shelter shall extend 2 feet past the ends and back of the panel and 4 feet in front and shall provide 7 feet vertical clearance.
 - (4) Alarm light on top of shelter tied into the pump alarm system
 - (5) Emergency bypass connection
 - (6) 110V GFI outlet

Section 5. Drainage Design Standards

5.1. General Storm Water Management Requirements

- a. The Town of Mooresville requires that development and re-development activities properly manage and control stormwater runoff rate, volume, pollutants, and erosion/sedimentation as necessary to protect and safeguard the environment, property, health, safety and welfare of citizens within the Town's jurisdiction.
- b. The following are required stormwater management performance criteria for all land disturbing activity in the Town of Mooresville:
 - (1) Stormwater treatment shall be designed to achieve average annual 85% Total Suspended Solids (TSS) removal and must apply to the volume of post-development runoff resulting from the first one-inch of rainfall.
 - (2) The stormwater runoff volume leaving the site post-development shall not exceed the stormwater runoff volume leaving the site pre-development (existing conditions) for the local 2-year frequency, 24-hour duration storm event for all development. Runoff volume drawdown time shall be a minimum of 24 hours, but not more than 120 hours. Volume reduction may be achieved by detention, hydrologic abstraction, recycling and/or reuse, or any other accepted scientific method.
 - (3) The runoff rate leaving the site post-development shall not exceed the stormwater runoff rate leaving the site pre-development (existing conditions) for the local 1-year, 2-year, and 10-year, 24-hour duration storm events.
- c. Land disturbance within the stream channel of any perennial and intermittent stream shall be prohibited.
- d. Considerations in selecting and using stormwater management means and measures for a specific development will include, but are not limited to: site applicability, public safety, spatial requirements, soil characteristics, hydrologic benefits, slope, existing land use conditions, maintenance requirements, location within the watershed, overlay districts, buffer requirements, tree protection, easements, etc.
- e. Stormwater runoff from the development shall be transported from the development by vegetated conveyances to the maximum extent practicable.
- f. All built-upon area shall be at a minimum of 35 feet landward of all perennial and intermittent surface waters (i.e., the buffer zone). This zone shall begin at the most landward limit of the top of bank or the rooted herbaceous vegetation and extend landward a distance of 35 feet on all sides of the surface water, measured horizontally on a line perpendicular to the surface water. For ponds, lakes and reservoirs located within a natural drainage way, this zone shall begin at the most landward limit of the normal water level or the rooted herbaceous vegetation and extend landward a distance of 35 feet, measured horizontally on a line perpendicular to the surface water. A perennial or intermittent surface water shall be present if the feature is approximately shown on the

most recent version of the soil survey map prepared by the Natural Resources Conservation Service of the United States Department of Agriculture or is identified in a field survey. An exception to this requirement may be allowed when surface waters are not present in accordance with the provisions of 15A NCAC 2B .0233 (3) (a) (see <http://ncrules.state.nc.us/ncac/>).

- g. All stormwater management structures shall be located in recorded drainage easements for the purposes of operation and maintenance and shall have recorded access easements to the nearest public right-of-way. These easements shall be granted in favor of the party responsible for operating and maintaining the stormwater management structures.

5.2. Design Basis

- a. The design standards addressed in this Section shall apply to all drainage facilities designed and constructed in the Town of Mooresville. Where these standards conflict with those of the NCDOT, Iredell County, or NCDENR that applies to a given facility, the more stringent shall apply.
- b. Hydrologic Method: Catch basins and collection piping shall be sized using the Rational Method for drainage areas under two hundred (200) acres. For drainage areas over two hundred (200) acres, the SCS method shall be used. The time of concentration shall not be less than 5 minutes. Calculations used for drainage design shall be submitted along with the Plans for review and with the final approved Plans.
- c. The following Table summarizes recommend runoff coefficients for use in the Rational Method:

Recommended Runoff Coefficient Values

Description of Area	Runoff Coefficient (C)
Lawns	0.30
Wooded	0.25
Streets	0.95
Gravel Areas	0.55
Drives, Walks, Roofs	0.95
Parks and Cemeteries	0.30
Residential (including streets):	
Single-Family (lot <20,000 sf)	0.60
Single-Family (lot >20,000 sf)	0.50
Multi-Family, Attached	0.70
Industrial:	
Light	0.70
Heavy	0.80
Commercial:	
Office Parks	0.75
Shopping Centers	0.80

- d. The Sample Storm Drainage Chart (Figure 1, on page 38) shall be shown on all plans that rely on the Rational Method to size drainage facilities.
- e. Design Frequency Policy: Minimum design frequency shall be 25 years for storm sewers carrying off-site drainage and 10 years for incidental drainage. Rainfall Intensity-Duration-Frequency data for hydrologic analysis shall be based on that published for the Charlotte, NC area.
- f. Channel Design: Channel side slopes shall be stable throughout the entire length and side slope shall be a maximum of 3:1 (H:V) for ease of maintenance. Open channel drainage systems shall be designed to handle the 10-year design storm. The channel protection required to prevent erosion is determined by computing the velocity in the channel at the design discharge and comparing that velocity with the permissible value for the type of channel lining used.
- g. All streams that drain more than one square-mile in Iredell County are regulated by FEMA, therefore development in those flood plains is restricted. Please refer to Iredell County's Floodplain Management Policy (see <http://www.co.iredell.nc.us/Departments/Planning>).
- h. Hydraulics: Pipe inlets and culvert situations are to be checked for inlet and outlet headwater control so as to insure that headwater will not encroach on uphill adjacent property or create a hazard to existing and future development. Twelve-inches of freeboard is required for all culverts up to 3 feet in diameter. 18-inches of freeboard is required for larger culverts.
- i. Water Supply Watersheds: If the proposed development is located in a water supply watershed then it is subject to land development restrictions as detailed in Chapter 4.2 of the Town of Mooresville's Zoning Ordinance.

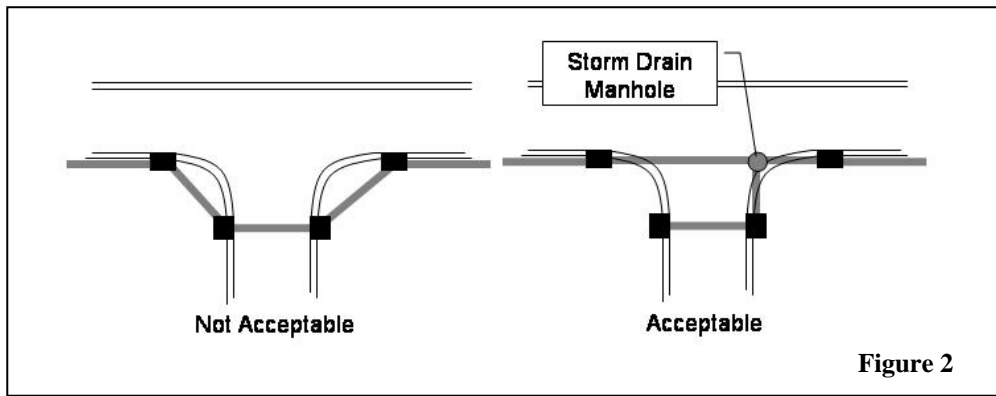
5.3. Drainage Lines

- a. Storm drainage lines that are located on private property and that do not receive runoff from public rights-of-way are not under the jurisdiction of the Town and are not subject to the requirements herein. However they will be inspected by the Town.
- b. All storm drainage lines located in the right-of-way are under the jurisdiction of the Town and must consist of reinforced concrete pipe (RCP), minimum Class III, only. HDPE may be used for drainage lines that receive runoff from the right-of-way but are not in the right-of-way. Corrugated metal pipe shall not be used.
- c. Permanent Utility Easement (PUE) for storm drainage lines shall be a minimum width of 15-feet. Larger pipe, deeper drainage lines or close proximity to existing or planned buildings may require additional PUE as required by the Director of Engineering and as summarized in the following:

PIPE SIZE	MIN. PERMANENT UTILITY EASEMENT (PUE) WIDTH
15"	15'
18"	15'
24"	15'
30"	20'
36"	20'
42"	25'
48"	25'
54" +	30' +

- d. The minimum pipe diameter for storm drainage lines shall be 15 inches.
- e. The minimum slope on all storm drainage lines shall be 1.0% or the slope that will produce a velocity of 2 feet per second (fps) when the pipe is flowing full, whichever is greater. The maximum velocity shall not exceed 10 fps at pipe outlets.
- f. Storm drainage lines shall cross under streets at right angles. Storm drainage lines greater than 18" are not to cross diagonally under the radii at intersections as illustrated below in Figure 2. Engineer must show that lines under 18" crossing radii diagonally can be fully maintained within the right-of-way or dedicated easement and the easement shall not encroach on a building envelope.

Pipes Greater than 18"



- g. When RCP is used at a stream, then an 8-foot joint must be used at the lower end (nearest the stream) to prevent undermining.
- h. Storm drainage lines shall generally be located below the curb and gutter of streets or along lot lines.
- i. Storm drainage lines shall have a minimum 18 inches of cover. Pipe diameters 30" and larger shall be deep enough to accommodate drainage structures.

- j. Concrete storm drainage lines with less than 24 inches of cover shall be Class IV pipe.
- k. Engineer of Record must ensure that proposed storm drains will not conflict with existing sanitary sewer service laterals.
- l. Storm drainage lines shall have at least a one-foot vertical separation from all water and sanitary lines.
- m. Storm drain outfalls shall be piped to the rear of any possible building envelopes.
- n. Flared-End-Sections or end walls plus an appropriate energy dissipater shall be used on the inlet/outlet end of any pipe receiving or discharging surface water (i.e., to or from a ditch, channel or creek). Flared end sections may be used with pipes 36-inches or less in diameter.
- o. The Town may, at its discretion, require that the contractor camera all or portions of installed drainage systems at no cost to the Town.

5.4. Collection System Drainage Structures

- a. Street catch basins shall be NCDOT 840.01 or 840.02 with type E grate as appropriate (NCDOT 840.03). Solid wall, square precast concrete structures conforming to NCDOT 840.45 or precast manholes conforming to NCDOT 840.52 are acceptable. Manholes shall be situated such that the barrel is under the curblin. No waffle wall boxes shall be allowed. All pipe openings in precast structures must be cast or cored. Unless the structure is stamped by the manufacturer as NCDOT approved, shop drawings must be submitted for approval prior to their installation.
- b. Junction boxes shall be NCDOT 840.31, 840.32 or 840.34. No waffle boxes shall be allowed.
- c. Frames, Grates and Hoods shall conform to NCDOT 840.03. No catch basins will be allowed in driveways.
- d. Yard inlets shall be NCDOT 840.05.
- e. All drainage structures shall be designed with 0.2 feet vertical difference between invert in and invert out.
- f. Curb and gutter is required in all cases. The minimum longitudinal grade for curb and gutter is 2%.
- g. Inlets should be placed at (upstream of) intersections and all low points in the gutter grade to prevent gutter flow from crossing traffic and pedestrian lanes of the intersecting road. There shall be no boxes in curb radii. Inlets are normally placed upstream of pedestrian crossings to intercept the gutter flow before it reaches the crosswalk. Where pavement surfaces are warped, as at cross streets, ramps, or transitions between super elevated and

- normal sections, gutter flow should be diverted into the storm drainage system to prevent water flow across the roadway. Where a curbed roadway crosses a bridge, gutter flow should be intercepted before it reaches the bridge. Runoff from areas adjacent to streets should be intercepted before reaching the pavement. This applies to water that would normally run onto the street from side streets or from cut slopes and areas along the edge of pavement. A minimum of two inlets (double catch basin) should be placed in the sag of vertical curves.
- h. Inlets on a continuous grade should be spaced to limit the spread of stormwater onto the pavement. The spacing of inlets is based on the allowable spread, grade of the street, flow and the inlet capacity. Maximum spread shall be 8 feet from the face of the curb based on a rainfall intensity of 4 inches/hour. Manning's n-value for concrete curb and gutter calculations shall be 0.016. The flow bypassing an inlet must be included in the flow arriving at the next inlet.
 - i. The maximum length of pipe without installation of a catch basin, curb inlet or junction box is 400 feet.
 - j. Spot grades or profiles shall be provided in cul-de-sacs to ensure positive drainage.
 - k. Storm drainage pipe and structure information shall be listed on each sheet of plan and profile drawings. This information shall include pipe diameter, material, grade, inverts, structure type, grate type, and the drainage area and flow into the pipe structure. A 0.2 ft drop between inlet and outlet pipes shall be provided in all structures. This information should be written in a table format with corresponding pipe or structure numbers shown in plan view. Drainage structures shall be numbered in increasing order as one moves from downstream to upstream.
 - l. All manholes shall be clearly marked with the words "storm sewer."
 - m. If a proposed structure exceeds 12'-0" vertical height, a structural design will be required for approval.

5.5. Best Management Practices (detention and treatment facilities)

- a. All Stormwater BMP's shall be designed in accordance with the "Stormwater Best Management Practices" manual, latest edition, prepared by the NCDENR. Any BMP noted as acceptable for use in the manual shall be considered acceptable by the Town, pursuant to appropriate basis of design per the manual. Developers are encouraged to maintain or provide vegetative buffers to meet water quality requirements.
- b. All BMP riser type structures shall be precast concrete and be fitted with galvanized steel trash racks. Corrugated metal is not allowed. All emergency overflow weirs shall be stabilized with cast-in-place concrete, 4-inch minimum thickness. Concrete may be grass covered. All BMP's that permanently impound water shall be fitted with ductile iron drain piping with a valve located in the riser structure. The valve shall have a riser stem such that it can be accessed from above without entering the structure. Spillways may be of

concrete or grass-covered concrete design. Grass-only spillways are not acceptable.

- c. A rip rap berm and weir shall be provided between the forebay and main pond. Rip rap shall be Class B, minimum 15" depth.
- d. Rules in the North Carolina Administrative Code (NCAC), specifically 15A NCAC 2H.1008, "Design of Stormwater Management Measures," provides information on the appropriate minimum engineering design criteria for BMP's (see <http://ncrules.state.nc.us/ncac.asp>). Earthen BMP's shall be designed with the following minimum requirements:
 - (1) Exposed side slopes shall be 3:1 or flatter
 - (2) A minimum of 10 feet at the top of dam shall be provided for maintenance access
 - (3) Design shall include a spoil area for dredged material
 - (4) Outlet pipes must be concrete.
 - (5) Detention pond worksheets are available on the Engineering Department website for use during the review process
- e. Calculations submitted for wet detention ponds shall include as a summary the Detention Worksheets found on pages 39 to 41.

Town of Mooresville Detention Worksheet

THIS SHEET MUST BE SUBMITTED WITH EACH DETENTION FACILITY

Project Name: _____ Date: _____

Total Site Acreage: _____ Acres

Total Number of Runoff Delineation Areas (sub-basins): _____

Detention Summary

Sub-basin Name and Area _____

	Storm Event*			
	1-yr.	2-yr.	10-yr.	100-yr.
Q Predevelopment (cfs)	_____	_____	_____	N/A
Q Postdevelopment Routed (cfs)	_____	_____	_____	_____
Water Surface Elevation (ft)	_____	_____	_____	_____
Freeboard (12" min.)				_____

* 24 hour duration, SCS Type II Distribution

The Engineer must submit data for each facility as shown on pages 2 and 3. The Engineer should use the attached sheets, or write in each section the specific page of the calculations from the computer output where the exact information may be found.

STORAGE / DISCHARGE CALCULATIONS

*(If applicable) Complete Underground Storage Volume Table

Elevation	Underground *	Above Ground			Total Acc. Volume (cf) (Above and Underground)
	Acc. Volume for all Structures (cf)	Area (sq. ft.)	Inc. Volume (cf)	Acc. Volume (cf)	

Stage Discharge

Co= orifice coefficient; Cw = weir coefficient. Orifice Area unit shall be square feet (sf).

Elevation / Stage (ft)	Orifice 1	Orifice 2	Weir 1	Weir 2/Em. Spillway	Outlet Control Pipe	Emergency Spillway	Total Q (cfs)
	In. Inv. Area Co=	In. Inv. Area Co=	Ft. Inv. Cw=	(Controlled by outlet pipe/struct) Ft. Inv. Cw=	Dia. Length Inv. Co=	(Free flow out of pond) Ft. Inv. Cw=	

Underground Storage Volume Table (If applicable)

Provide additional storage volume tables if more structures are used.

Elevation	Acc. Volume (cf) Underground Structure #	Acc. Volume (cf) Underground Structure #	Acc. Volume (cf) Underground Structure #	Acc. Volume (cf) Underground Structure #
	Length (ft.) Size/dia (ft.) Upper inv. Lower inv. Slope (%)	Length (ft.) Size/dia (ft.) Upper inv. Lower inv. Slope (%)	Length (ft.) Size/dia (ft.) Upper inv. Lower inv. Slope (%)	Length (ft.) Size/dia (ft.) Upper inv. Lower inv. Slope (%)

PRE-DEVELOPED SUB-BASIN CALCULATIONS:

Sub-basin Name/Level: _____ (Coordinate with attached drainage area map)

Type of Flow	Travel Length (ft.)	Slope (%)	Mannings (n)	Time (min.)
Sheet Unpaved				
Sheet Paved				
Shallow Conc. (Unpaved)				
Shallow Conc. (Paved)				
Channel				
Pipe				
TOTAL	N/A	N/A	N/A	Tc_{pre} =

Acreage	Land Use	Soil Type	Hydrologic Group	CN	Weighted CN (Acreage/Total Area) x (CN)
					CN_{Pre} =

POST-DEVELOPED SUB-BASIN CALCULATIONS:

Sub-basin Name/Level: _____ (Coordinate with attached drainage area map)

Type of Flow	Travel Length (ft.)	Slope (%)	Mannings (n)	Time (min.)
Sheet Unpaved				
Sheet Paved				
Shallow Conc. (Unpaved)				
Shallow Conc. (Paved)				
Channel				
Pipe				
TOTAL	N/A	N/A	N/A	Tc_{post} =

Acreage	Land Use	Soil Type	Hydrologic Group	CN	Weighted CN (Acreage/Total Area) x (CN)
					CN_{Post} =

Section 6. Roadway Design Standards

6.1. Roadway Classifications

- a. All streets within the Town's jurisdiction shall comply with the requirements of one of the following street classifications:
 - (1) Local Streets – A Street intended solely for access to adjacent properties. Consists of all roads not defined as arterials or collectors; primarily provides access to land with little or no through movement. Local streets are further classified as (1) Residential, (2) Commercial or (3) Industrial.
 - (2) Collector Streets – A Street that provides direct service to and from local areas, routing traffic to the arterial street system. A Collector Street provides the primary means of circulation between adjacent neighborhoods and can serve as a local bus route. The Street provides the dual purpose of land access and local traffic movement. Generally, these roadways are not used for through trips. Provides a less highly developed level of service at a lower speed for shorter distances by collecting traffic from local roads and connecting them with arterials. Collector streets are further classified as either (1) Major, or (2) Neighborhood.
 - (3) Arterial Streets – A thoroughfare, used primarily for through traffic rather than for access to abutting land, that is characterized by high vehicular capacity and continuity of movement. Provides the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control. Arterial streets are further classified as either two-lane, or four-lane (with median).
 - (4) Private Streets – Privately maintained streets may be used within commercial and multi-family developments. Private streets within subdivided single family developments are generally prohibited. Private streets must be built to the same standards as Town streets.
 - (5) Alleys – Privately maintained streets that provide rear access to properties, reduce curb cuts and access points along frontage streets, permit unencumbered pedestrian access along frontage streets, and provides less visible access for service functions. Alley streets exhibit a narrower pavement width to accommodate single direction movement of vehicles, adequate right-of-way width to accommodate passing, and an inverted section for drainage. Parking shall not be allowed along an Alley.
- b. All proposed public streets shall be designed to become part of the overall street system and be identified as such on all adopted plans. All streets and roads shall align with other designated roadways for continuity in the Town's street system.
- c. All new street names shall be approved by the Iredell County Planning Department. Proposed streets, which are obviously in alignment with other streets, may be required by the Iredell County Planning Department to bear the assigned name of the existing street.

- d. Any streets with on-street parking other than parallel shall be considered private driveways for purposes of Town review and approval and shall not be considered for inclusion into the Town's street system. Any street names for these private driveways is under the jurisdiction of the Iredell County Planning Department.

6.2. Design Basis

- a. The design standards described herein are the minimum requirements for roadways to be accepted and maintained by the Town of Mooresville and for private streets. Design criteria not established in this Manual shall be as set forth by the North Carolina Department of Transportation (NCDOT), Division of Highways, as taken or modified from the American Association of State Highway Officials' (AASHTO) various guidelines and requirements. Where these minimum requirements conflict with those of the NCDOT or AASHTO, the more restrictive requirements shall apply.
- b. A North Carolina Professional Engineer must sign and seal all construction plans and revisions submitted for review. A Professional Land Surveyor may certify As-Built drawings verifying that the construction was completed according to plans.
- c. Pavement markings, etc. shall be in accordance with the Manual on Uniform Traffic Control Devices for Street and Highways (MUTCD) and NCDOT Standard Specifications for Roads and Structures, current editions. The location and design of street name signs shall be approved by the Director of Engineering as in accordance with the standards set forth in the MUTCD.
- d. All signs shall be purchased from and fabricated by the Town Public Works Department before vertical construction may begin.
- e. If the property is located on or adjacent to a thoroughfare then all rights-of-way must be dedicated and lanes must be added in accordance with future widening plans.
- f. Curb and gutter and sidewalks are required on both sides for all new street construction. Curb and gutter shall be NCDOT Standard 846.01. Sidewalk is also required across the frontage of the property along any existing street.
- g. Sidewalks shall be installed at the time of roadway construction or installed in phases as approved by the Department. Sidewalks shall be a minimum of six (6) feet behind the back of curb with a minimum width of five (5) feet. The Town may require a wider sidewalk and/or planter strip in developments where a substantial amount of pedestrian or vehicular traffic is anticipated.
- h. Where sidewalks and/or greenways intersect any section of curb and gutter, wheel chair ramps are required. The current NCDOT wheelchair ramp standards shall apply. Approved colors for truncated domes are black, red, and yellow.
- i. Planting strips, located between the curb and sidewalk parallel with the street, shall be 6 feet or more in width. To maintain sight lines, trees and other objects are prohibited in the

sight distance areas. If trees or plantings are placed in the right-of-way, the property owners' association covenants shall include language which outlines how and when the trees or plantings will be maintained. The covenants must be submitted to Town Public Works Street Superintendent for review and approval. Tree types placed within the right-of-way must be approved by the Director of Engineering (See the Landscape Section). The developer and/or property owners' association must keep the trees trimmed on the road side to maintain a clear distance from the pavement to a height of 10-feet above the pavement. Approval shall be based on the assurance that the property owners' association covenants clearly state how the trees and plantings within the right-of-way will be adequately and routinely maintained and replaced if needed.

- j. When using NCDOT Standard 1264.02 End of Road Markers, a sign denoting "Future Roadway Extension" must be installed on the center marker.
- k. Design speed shall be a minimum of 5 mph greater than the posted speed limit. The posted speed limit shall not be less than 25 mph. Therefore the design speed shall be a minimum of 30 mph.
- l. Minimum travel lane width shall be 11 feet measured from lip to road centerline. Street widths are measured from lip of curb to lip of curb and spanning a median, if present.
- m. Minimum design speed, right-of-way and road widths shall be as summarized in the following Table:

DESIGN SPEED ROW AND STREET WIDTH			
Street Classification	Standard Detail Number	Min. Design Speed (mph)	Minimum Right-of-Way Width (feet)
Local Residential	R-1.0	30	50
Local Commercial	R-2.0	30	55
Local Industrial	R-3.0	30	55
Major Collector	R-4.0	40	100
Neighborhood Collector	R-5.0	30	55
2-Lane Arterial	R-6.0	40	55
3-Lane Arterial	R-6.0	40	65
4-Lane Arterial	R-7.0	40	100

- n. Roadways shall have a minimum grade of 0.5 percent. The minimum centerline radius shall be as given below. No super-elevation will be permitted without approval of the Director of Engineering. Sight distance and maximum grade parameters used for the design of vertical curves shall be as follows:

ROADWAY DESIGN PARAMETERS		
Sight Distance Parameter	Design Speed (mph)	
	30	40
Posted Speed (mph)	25	35
Maximum Grade	8%	8%
Min. Horizontal Radius (feet)	200	415
Min. "K" Value	30	44

- o. Pavement design for all streets shall be in accordance with the Standard Details. For streets in industrial zoned areas, the Director of Engineering may require a special pavement design be submitted for review and approval.
- p. Maximum cut and fill slope is three-to-one (3:1) in residential areas and two-to-one (2:1) in other areas.
- q. Retaining Walls: No retaining walls shall be allowed in the right-of-way. Retaining walls shall not be used to elevate (hold up) the right-of-way without the approval of the Director of Engineering. If so approved, only "Concrete Retaining Walls" shall be used to hold up a roadway. All retaining wall systems must be designed by a Professional Engineer.
- r. Streets that are multi-lane and/or divided will require special design reviews.
- s. Grades shall not exceed 3% for the first 300 feet from the centerline of any publicly maintained road for a residential collector/nonresidential street. Grades should not exceed 5% for the first 100 feet from the centerline of any publicly maintained road for a residential street.
- t. Turn lanes shall have a minimum width of 12 feet and be incorporated when required by traffic considerations. Tapers shall be used as necessary in street design. Approach tapers are used to shift lanes laterally. The following equations shall be used as applicable:
 - (1) $L = WS$ for posted speeds of 45 mph and greater;
 - (2) $L = WS^2 / 60$ for posted speeds of 40 mph or less;
 - (3) $L =$ Taper length in feet
 - (4) $S =$ Speed in miles per hour
 - (5) $W =$ Lateral offsets in feet
- u. Turn lane tapers shall be at least 15:1 (L:W) for posted speeds of 45 miles per hour and more. The minimum turn lane taper allowed for streets posted less than 45 miles per hour is 8:1. Symmetrical reverse curve tapers are recommended for non-thoroughfare streets. Storage lengths for the turn lanes shall be calculated using an acceptable method and approved by the Director of Engineering. The minimum storage lane length shall be 150 feet for left turn lanes and 100 feet for right turn lanes.

- v. Plans for all widenings shall show that the contractor will saw and remove the top 1-1/2" of existing pavement a minimum of 12" from the edge, or as directed by the Town, and place new pavement over the existing base. All thoroughfares shall receive a full overlay rather than patch.
- w. Guardrail shall be installed in any area where there is a risk of a vehicle going off the roadway in accordance with appropriate AASHTO requirements or when required by the Director of Engineering.
- x. Minimum on-street parking width shall be 8 feet as measured from the face of the curb or 7 feet from the lip of the gutter whichever is greater. On-street parking requires a minimum travel lane width of 12 feet. When on-street parking is allowed, a minimum travel way width of 20 feet shall be maintained at all times.
- y. Concrete traffic islands designed to direct turning movements are acceptable and shall be constructed and placed as per NCDOT standard specifications. Concrete traffic islands shall be a minimum of 4 feet wide.
- z. Medians designed to direct turning movements are acceptable and shall be constructed and placed as per NCDOT standard specifications. Medians shall be a minimum of 4 feet wide as measured from the back of curb to back of curb.

6.3. Intersections

- a. Intersections shall intersect at 90 degrees when possible, with minimum of 75 degrees.
- b. A minimum radius of 30 feet to the back of the curb is required at all intersections except in residential street to residential street intersections. A minimum radius of twenty-five (25) feet to the back of curb shall be required where residential streets intersect.
- c. Offset intersections shall be avoided; however, when necessary a minimum distance of 200 feet between centerlines shall be provided. A minimum of 800 feet shall be provided between intersections on thoroughfare and collector streets.
- d. Sight triangles of 35 feet by 35 feet shall be preserved for all intersections. Additional sight triangles of 10 feet by 70 feet shall be provided for access onto thoroughfare streets. Sight triangles shall be noted on the preliminary and final plats.
- e. If a traffic signal is required as part of a given land development project, the traffic signal will be fitted with 3M's Opticom Priority Control System. This system allows the emergency vehicle-initiated preemption of traffic signals and must be provided at the Developer's expense. All preemption equipment must be approved by the Director of Engineering.

6.4. Culverts

- a. Culvert crossings shall be designed with the following clear zone distances:

Design ADT	Clear Zone from Edge of Pavement	
	Tangent Section	Curve (within 125' of culvert)
Under 750	10'	15'
750 – 1000	12'	18'
1501 - 6000	14'	21'
Over 6000	16'	24'

- b. Handrails shall be installed behind the sidewalk unless a 10-foot pedestrian clear zone is provided behind the sidewalk. A pedestrian clear zone shall be defined as any slope at 6:1 or flatter.
- c. Handrails must extend a minimum of 20'-0" past the end of the wingwall.
- d. Slope from handrail or edge of pedestrian clear zone shall be at a slope of 2:1 or flatter

6.5. Cul-de-Sacs

- a. Permanent cul-de-sacs are permitted on local residential and commercial streets only.
- b. Cul-de-sacs shall not exceed 400 feet in length unless approved by the Town and a hydrant is provided at the end of the cul-de-sac.
- c. Cul-de-sacs shall not be used to avoid connection with existing streets. To encourage future development in an orderly manner street rights-of-way shall be extended to adjacent property and a temporary cul-de-sac or T-shaped turnaround provided as appropriate. In such instances, the width of the right-of-way of the approaching street shall be extended to the adjacent property. Curb and gutter is not required on temporary cul-de-sacs.

6.6. Driveways

- a. A driveway permit is required for all non-residential driveways, streets, or turnouts accessing public streets. Once a site plan has been approved, a driveway permit must be submitted to the Town for driveways accessing both Town and State roads.
- b. A driveway inspection is required prior to pouring concrete or placing asphalt. Once the driveway location has been approved and concrete forms set, the Town's Inspector must be notified for an inspection. Failure to request a driveway inspection and failure to

comply with the specifications may necessitate removal and replacement of the driveway apron by the property owner and/or responsible party.

- c. The arrangement of driveways should be related to adjacent driveways and nearby street intersections to avoid conflicting turning movements.
- d. Driveways shall be free from all obstructions such as water meters, cleanouts, wheelchair ramps and storm drainage structures.

6.7. Speed Humps

- a. Speed humps shall only be allowed on residential streets and must be approved by the Director of Engineering.
- b. To gain maximum effect, speed humps must be the full 3". Speed humps shall be 3" high with an allowable maximum tolerance of +/- 0.25". Developers must not exceed this height based on consideration for emergency and fire department vehicles. Because of this concern, any speed humps constructed over 3.25" must be corrected immediately.

6.8. Bicycle Lanes

- a. Bicycle lanes are the portion of the street specifically designated for the use of bicyclists by pavement markings or other means of delineation on the street. Bicycle lanes are required on all streets designated as bicycle routes on the Town of Mooresville Bicycle Master Plan.
- b. Bicycle lanes provide a clearly marked area of the street for bicycle travel and separates cyclists from motor vehicles, help reduce conflicts between motor vehicles and bicycles, provide an additional buffer between pedestrians and motor vehicles, and give motorists more confidence about passing cyclists.
- c. Placement and width of bicycle lanes is dependent on right-of-way width, traffic speed and volume, signalization, turn lanes and parking. A marked bicycle lane should be a minimum of four feet wide (not including gutter), with 5' generally preferred. Wider lanes are preferred next to on-street parking (to avoid opening car doors) and on steep hills (to allow room for weaving caused by pedaling uphill).
- d. If there is a right turn lane at an intersection, the bicycle lane should be placed to the left of the right turn lane, to clearly separate the bicycles' through movement from the motor vehicles' turning movements.
- e. Bicycle lanes, signage and pavement markings shall be in accordance with the current edition of the MUTCD.

6.9. Signage

- a. A signage plan must be submitted under Professional Engineer seal and signature to the Engineering Department for approval and all signage must be paid for in accordance to the Town's signage price list prior to any signage being installed.
- b. All signage in the right of way must be installed by the Town of Mooresville including but not limited to street name signs, regulatory signs, warning signs, etc. All signs must be in accordance with MUTCD standards.
- c. Developers or Homeowners Associations may not remove, replace or add to the Town-installed signage.
- d. Stop bars shall be placed at all stop sign locations.

6.10. Street Lighting

- a. All street lighting shall be the responsibility of the Developer. Developers should consult with the appropriate utility provider in the development of proposed street lighting plans. Street lighting shall be designed to conform to the American National Standard Practice for Roadway Lighting (ANSI/IES RP-8).
- b. Street lighting plans must be reviewed and approved by Public Works. Such plans shall show the location of each light, size of the luminaires in watts or lumens, type of luminaire, and number of street lights.
- c. In order to minimize glare and up-lighting, no acorn style street lights are allowed, only those street light fixtures considered full cutoff (180°) will be allowed.
- d. The electrical distribution system shall be underground. Distribution cable may be direct buried except under streets, driveways, sidewalks, and parking areas where it shall be in a conduit. The cable shall be sized so that the voltage drop does not exceed five percent at any point in the system.
- e. Required minimum levels of illumination (expressed in average maintained horizontal foot-candles) are presented in the following Table:

Street Classification	Illumination Levels (foot-candles)		Uniformity Ratio ¹
	Commercial	Residential	
Major Arterial	1.3	0.8	3:1
Minor Arterial	1.6	0.8	3:1
Collector	1.1	0.6	4:1
Local	0.9	0.4	6:1
Alley	0.6	0.3	6:1
Sidewalk	0.9	0.3	6:1

The uniformity ratio is defined as the ratio of the average luminous flux incident on a surface to the minimum luminous flux incident to the surface.

- f. The following standards should be used to determine the placement of street lights on residential streets:
 - (1) Street light spacing shall be determined based on the illumination level of the street. At no time shall lights be more than 220 feet apart.
 - (2) Street lights should be located at all public street intersections and at the end of all cul-de-sacs and T-turnarounds.
 - (3) Where possible, all street lights that are not located at an intersection should be located on or adjacent to a property corner.
- g. In other areas within the Town, street lighting design is based on street classification and on the uses of adjacent properties. Because these factors vary from site to site, developers should contact the Engineering Department when proposing street lighting in non-residential areas.

6.11. Plantings In Street Right-Of-Way

- a. Article 15 of the Town of Mooresville Zoning Ordinance entitled “Mooresville Tree Ordinance” governs the preservation and protection of trees in the Town and its extra-territorial jurisdiction. Where these standards conflict with those of the Zoning Ordinance, or the NCDOT, the more stringent shall apply.
- b. There will be no irrigation sprinklers or associated piping allowed in the rights-of-way, including medians.
- c. There shall be no fences, electric pet fences, lighting, boulders or trees other than approved street trees allowed in the right-of-way. No vegetation other than grass is allowed around regulatory signs or street lights.
- d. Tree grates and associated irrigation systems are only allowed in the Neighborhood Center Zoning areas. Any grates in public right-of-ways must be approved by the Director of Engineering.
- e. Landscaped islands in parking lots, and medians separating lanes of traffic on public streets and on internal drives, should be a minimum of 4' in width measured from the back of curb. If large trees are to be planted in landscape islands or medians, these islands or medians should be a minimum of 10' in width measured from the back of curb, and include a minimum of 200 sf of soil surface area per large tree. Note that if landscaped islands or medians are located within the right-of-way, irrigation sprinklers or associated piping is still not allowed.
- f. All landscaped islands and medians shall receive a minimum of 6" of topsoil over finished subgrade, and shall be graded to provide adequate drainage. Subsurface drainage is recommended for all landscaped islands and medians per the Standard Detail L-7.0.

- g. In all areas it is important to be certain that the placement of plantings does not interfere with site visibility at intersections. Adjust tree placement to avoid obstruction of sight triangle at intersection by AASHTO standards.
- h. In general the following tree placement standards apply:
- (1) Large Trees - All trees reaching a mature height of thirty five (35) feet or more should be planted a minimum of:
 - 3 feet from back of curb, edge of street pavement and driveways (allow for any proposed future widening);
 - 3 feet from sidewalks and other paved pedestrian surfaces except where urban conditions would prohibit any planting;
 - 10 feet from all buildings;
 - 15 feet from street lights, utility poles and above-ground utility wires;
 - 10 feet from all underground utilities; and
 - 10 feet from utility vaults and ground level utility structures.
 - (2) Small Trees - All trees reaching a mature height of less than 35 feet should be planted a minimum of:
 - 3 feet from back of curb, edge of street pavement and driveways (allow for any proposed future widening);
 - 2 ½ feet from sidewalks and other paved pedestrian surfaces except where urban conditions would prohibit any planting;
 - 5 feet from all buildings;
 - 10 feet from street lights and utility poles;
 - 5 feet from all underground utilities; and
 - 5 feet from utility vaults and ground level utility structures (10 feet from door side).
 - (3) Staking Trees: Support should be provided only for trees greater than 8 feet in height planted in exposed locations. Trees should be secured using vertical stakes driven into the ground outside the planting pit with constraining lines made of webbing, hose-protected wire or other material that will not abrade or become embedded in trunk. Slack should be provided in each constraining line to allow for some trunk movement and all supports should be removed after one year unless tree is excessively weak. Where required, wrap or cover straps with fluorescent flagging.
- i. General Pruning Requirements: Pruning should consist of the removal of dead, dying, diseased, interfering, obstructing and weak branches and selective thinning to lessen wind resistance and improve the appearance of trees and shrubs. All cuts should be made close to the trunk or parent limb without leaving a protruding stub and without cutting into the branch collar or the branch bark ridge. Clean cuts should be made at all times.
- j. Trees limbs too heavy to handle by hand should be precut above the final cut to prevent splitting or peeling of the bark. Where necessary to prevent tree or property damage,

- branches should be lowered to the ground with ropes or equipment. Treatment of cuts and wounds with tree wound dressing is discouraged except for cosmetic purposes in highly visible areas. If such treatment is made, materials non-toxic to the cambium layer must be used and care should be taken to treat only the exposed wood with a thin coat of dressing.
- k. Climbing spurs should not be used unless the tree is dead or is to be removed.
 - l. All shrubs located in the right-of-way in median shall be trimmed to a height of less than 3 feet.
 - m. Topsoil for Plantings: Topsoil shall be fertile, natural soil typical of the locality, free from large stones, roots, sticks, clay, peat, weeds, and sod and obtained from naturally well-drained areas. It shall not be excessively acid or alkaline, nor contain toxic material harmful to plant growth. Topsoil stockpiled on-site may be used subject to approval of the Town Inspector.

The following is a list of large maturing drought tolerant trees approved for planting in the right-of-way:

Latin Name	Common Name	Maturing Height (ft)	Maturing Width (ft)	Group
Acer campestre	Maple, Hedge	35	30	Deciduous
Acer rubrum	Maple, Red	60	50	Deciduous
Acer x fremanii	Maple, Freeman	65	50	Deciduous
Carpinus betulus	Hornbeam, European	60	40	Deciduous
Carpinus caroliniana	Hornbeam, American	35	25	Evergreen
Cedrus deodara	Cedar, Deodar	50	30	Evergreen
Celtis laevigata	Hackberry, Sugar	50	40	Deciduous
Celtis occidentalis	Hackberry, Common	60	50	Deciduous
Cryptomeria japonica	Cryptomeria, Japanese	45	20	Evergreen
Gymnocladus dioicus	Kentucky Coffeetree	75	65	Deciduous
Magnolia grandiflora	Magnolia, Southern	50	30	Evergreen
Metasequoia glyptostroboides	Dawn Redwood	80	25	Deciduous
Pistacia chinensis	Chinese Pistache	40	35	Deciduous
Quercus acutissima	Oak, Sawtooth	45	45	Deciduous
Quercus falcata	Oak, Southern Red	70	60	Deciduous
Quercus lyrata	Oak, Overcup	50	40	Deciduous
Quercus phellos	Oak, Willow	60	40	Deciduous
Quercus shumardii	Oak, Shumard	60	50	Deciduous
Quercus virginiana	Oak, Live	50	60	Evergreen
Taxodium distichum	Baldcypress	70	30	Deciduous
Tilia cordata	Linden, Little leaf	70	40	Deciduous
Ulmus parvifolia	Elm, Lacebark	50	50	Deciduous
Zelkova serrata	Zelkova, Japanese	70	55	Deciduous

The following is a list of small maturing (largely) drought tolerant trees approved for planting in the right-of-way:

Latin Name	Common Name	Maturing Height (ft)	Group
<i>Acer buergeranum</i>	Maple, Trident	30	Evergreen
<i>Cercis canadensis</i>	Redbud, Eastern	25	Deciduous
<i>Cercis chinensis</i>	Redbud, Chinese	15	Deciduous
<i>Chionanthus retusus</i>	Fringetree, Chinese	30	Deciduous
<i>Crataegus phaenopyrum</i>	Hawthorne, Washington	25	Deciduous
<i>Crataegus viridis</i> 'Winter King'	Hawthorne, Green	30	Deciduous
<i>Ilex X attenuata</i> 'Fosteri'	Holly, Foster	25	Evergreen
<i>Koelreuteria bipinnata</i>	Chinese Flame Tree	30	Deciduous
<i>Lagerstroemia indica</i>	Crape Myrtle	20	Deciduous
<i>Magnolia grandiflora</i>	Magnolia, 'Little Gem'	25	Evergreen

The following is a list of drought tolerant shrubs approved for planting in the right-of-way:

Botanical Name	Common Name	Normal Height	Group
<i>Abelia x grandiflora</i>	Abelia	3-4 ft	Evergreen
<i>Aucubajaponica</i>	Dwarf Aucuba	3-4 ft	Evergreen
<i>Berberis julianae</i>	Wintergreen Barberry	5-6 ft	Evergreen
<i>Berberis thunbergii</i>	Japanese Barberry	3-5 ft	Evergreen
<i>Buxus microphylla</i>	Japanese Boxwood	3-4 ft	Evergreen
<i>Cytissus scoparius</i>	Scotch Broom	5-6 ft	Evergreen
<i>Deutzia gracilis</i>	Slender deutzia	2-4 ft	Semi-Evergreen
<i>Hydrangea quercifolia</i>	Oakleaf Hydrangea	6-8 ft	Deciduous
<i>Ilex cornuta</i>	'Carissa' Carissa Holly	3-4 ft	Evergreen
<i>Ilex cornuta</i>	'Rotunda' Dwarf Chinese Holly	3-4 ft	Evergreen
<i>Ilex cornuta</i> ,	'Burfordii Nana' Dwarf Buford Holly	5-6 ft	Evergreen
<i>Ilex crenata</i>	'Green Lustre'	3-5 ft	Evergreen
<i>Ilex glabra</i>	Inkerry Holly	6-8 ft	Evergreen
<i>Ilex vomitoria</i>	'Nana' Dwarf Yaupon Holly	3-4 ft	Evergreen
<i>Itea virginica</i>	Virginia Sweetspire	3-5 ft	Deciduous
<i>Jaminum floridum</i>	Showy Jasmine	3-5 ft	Evergreen
<i>Jasminum nudiflorum</i>	Winter Jasmine	3-4 ft	Evergreen
<i>Juniperus davurica</i>	'Expansa' Parsons Juniper	2 ft	Conifer
<i>Juniperus hoizontalis</i>	'Plumosa,' Andorra Juniper	2 ft	Conifer
<i>Kerria japonica</i>	Japanese Kerria	3-5 ft	Evergreen
<i>Lespedeza thunbergii</i>	Thunberg Lespedeza	5-6 ft	Deciduous
<i>Lonicera pileata</i>	Privet Honeysuckle	2-3 ft	Evergreen
<i>Mahonia bealei</i>	Leatherleaf Mohonia	6-7 ft	Evergreen
<i>Nandina domestica</i>	'Harbour Dwarf' or 'Gulf Stream'	2-3 ft	Evergreen
<i>Nandina domestica</i>	Nandina or Heavenly Bamboo	5-6 ft	Evergreen
<i>Pyracantha koidzumii</i>	'Santa Cruz'	2-3 ft	Evergreen
<i>Rhaphiolepis indica</i>	Indian Hawthorne	2-4 ft	Evergreen
<i>Spiraea prunifolia</i> ,	'Plena' Bridalwreath Spirea	5-7 ft	Deciduous
<i>Spiraea vanhouttei</i>	Vanhoutte Spirea	5-7 ft	Deciduous
<i>Spiraea nipponica</i>	'Snowmound'	3-5 ft	Deciduous
<i>Spiraea thunbergii</i>	Thunberg Spirea	3-4 ft	Deciduous
<i>Spiraea x burmalda</i>	Bumald Spirea	2-3 ft	Deciduous
<i>Yucca filamentosa</i>	Adam's Needle Yucca	5-6 ft	Evergreen

