

SECTION 5 - STORM DRAINAGE

5.01 Design

Storm drainage facilities shall be designed in accordance with the goals and guidelines set forth in the *Unified Development Ordinance*. The goal shall be to collect and dispose of stormwater generated upon or passing through the project location. The determination of the quantities of water that must be accommodated will be based upon peak flows from storms having the following return frequency:

<u>Drainage Structure</u>	<u>Storm Event - Return Frequency</u>
Curb inlets & Gutters	10-year storm
Storm Sewer Collector	10-year storm
Detention Facility	100-year Emergency Spillway
Cross Street Drainage	100-year storm
Roadways in Flood Plain	100-year storm*
SCM Devices	UDO & NCDEQ Stormwater Design Manual

* Roadways in flood plain areas shall withstand the 100-year storm without over-topping or sustaining damage. The roadway embankments shall be fully protected from flows that may occur during a 100-year event.

Prediction of the peak flow rates resulting from a rainfall event shall be calculated using the procedure in the SCS TR-55, the Rational Method, or other calculation procedures acceptable to the Engineer. The size of storm water conduits shall be determined by utilizing the standard energy equation for inlet control or outlet control and/or headwater nomographs as published by various federal agencies such as Federal Highway Administration - HEC-5, HEC-RAS, Soil Conservation Service, etc. Calculations shall include analyses of pre- and post-development runoff rates from the project for the 1-year storm event. All calculations shall be performed under the responsible charge of an appropriately licensed design professional and sealed by that professional. Storm drainage facilities shall be designed in a manner such that upstream and downstream properties are not adversely affected.

The minimum pipe size to be used within any public right-of-way shall be 15-inch diameter. All public storm drainage facilities shall be installed in dedicated street rights-of-way (i.e. pipe inlets and outlets shall be within street rights-of-way or dedicated easement). If a property owner/developer desires to extend storm drainage piping to eliminate open channels on private property, such pipes shall be installed within a stormwater easement and maintained at the adjacent property owner's or owners' expense. A manhole or junction box shall be provided at the public right-of-way boundary. Minimum widths of storm drainage easements shall be the greater of 1) the width as dictated by the appropriate following configurations listed below; or 2) the width necessary to contain the predicted 100-year water elevation plus two feet in depth:

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- 20 feet for single pipes up to and including 36 inches nominal diameter or open channels up to 36 inches in top width
- 20 feet plus the maximum conduit (outside diameter at the barrel) or channel width (in feet) for single pipes or channels larger than 36 inches wide
- 10 feet from the edge line of the outside conduits where multiple parallel pipes are installed.

Erosion and sedimentation control measures shall be so designed to provide control from the calculated peak rates from a 10-year frequency storm. Discharge from drainage systems shall not be of such a velocity as to cause damages after leaving the pipe. At pipe outlets, flared end sections or head walls shall be provided with rip-rap aprons designed to reduce velocity and dissipate energy so that downstream damage does not occur.

Catch basins, yard inlets, manholes or structures shall be installed at each deflection of line or grade. No "blind" junction boxes shall be permitted. The minimum cover for reinforced concrete pipe shall be 2 feet from finish subgrade to the top of pipe under roadways and 1 foot under a non-roadway area. For polyethylene storm drainage pipe, the minimum cover shall be two times the nominal pipe diameter.

Stormwater shall not be allowed to flow across streets. Drainage shall be provided to intercept flow in the radius of an intersection, or the design of the street shall indicate a continuous grade around the radius to allow the flow to continue down the intersecting street. Water shall be picked up before the spread into the street exceeds 8 feet from the face of the curb. The inlets shall be spaced using a maximum capacity of 5 CFS per single curb inlet. No curb inlet shall be installed in the curb radius of any intersection.

Detention ponds and other SCM devices shall reference and adhere to standards set forth by NCDEQ in *Stormwater Design Manual*. Additional requirements by the Town include a maximum of 3:1 slopes on all sides of ponds, unless exempted by the Town Engineer.

5.02 Pipe Materials

a. General:

All storm sewer pipes to be installed in projects within the public street rights of way belonging (or to be dedicated) to the Town of Knightdale shall be reinforced concrete pipe (RCP) or high density polypropylene (HDPP) storm drainage pipe conforming to the specifications presented herein.

If an applicant desires to use any materials other than RCP or HDPP, the applicant's plan submittal must contain a formal request and be accompanied by complete background data to justify its use. Approval of the use of any materials other than RCP or HDPP may only be granted by the Assistant Town Manager upon the recommendation of the Town Representative and Town Engineer.

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b. Reinforced Concrete Pipe (RCP):

RCP shall be as per ASTM C76, or the latest revision, Class III or Class IV with a minimum 15-inch diameter. All RCP shall be top quality material; no seconds or lesser quality pipe shall be used. Joints shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210 such as "Ram-Nek or a butyl rubber sealant."

c. High Density Polypropylene Pipe (HDPP):

HDPP storm drainage pipe shall conform to AASHTO M330 Type S or Type D. The pipe shall be smooth interior finish and be furnished in 20' laying lengths with an integral bell for gasket, bell and spigot joints. The pipe shall be a double wall type, having a corrugated outer surface and a smooth inner surface, with Manning's roughness not to exceed 0.010. End treatments and fittings shall meet the requirements of AASHTO M330-20.

5.03 Materials - Storm Drainage Structures

a. General:

All structures including manholes, curb inlets, catch basins, yard inlets, junction boxes, etc., shall be constructed of clay brick masonry units, cast in place reinforced concrete units, or precast concrete (waffle boxes are not acceptable). Endwalls and headwalls shall be constructed of clay brick masonry units, concrete brick masonry units, precast or structural cast-in-place concrete.

b. Clay Brick Masonry Units:

Clay brick shall be solid, rough, sound clay brick conforming to ASTM C32, Grade MS.

c. Concrete Brick Masonry Units:

Concrete brick masonry units shall be solid units meeting the requirements of ASTM C55, Grade S-II.

d. Precast Concrete Structures:

Precast concrete structures shall meet the requirements of ASTM C478. Structures shall have joints sealed with a pre-formed plastic gasket per Federal Specifications SS-S-00210. Manholes shall be sized in accordance with the table below.

MANHOLE SIZE REQUIREMENTS		
DEPTH RANGE	OUTLET PIPE SIZE	
0' – 12'	6'	7'
12' – 18'	6'	7'
> 18'	7'	8'

e. Mortar:

Mortar shall be proportioned as shown below for either Mix No. 1 or Mix No. 2. All proportions are by volume. Water shall be added only in the amount required to make a workable mixture.

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MIX NO. 1: 1 part Portland Cement
¼ part Hydrated Lime
¾ parts Mortar Sand (maximum)

MIX NO. 2: 1 part Portland Cement
1 part Masonry Cement
6 parts Mortar Sand (maximum)

Portland cement shall be ASTM C150, Type 1. Hydrated lime shall conform to ASTM C207, Type S. Masonry cement shall meet the requirements of ASTM C91. Mortar sand shall be standard size 4S, per requirements of the NC DOT.

f. Castings:

- (1) General - All castings shall be of one of the manufacturers specified. If the Developer/ Contractor desires to use a casting of another manufacturer, samples of the casting(s) shall be provided to the Town Representative for review and approval. In addition to samples, the names of other users of the castings shall be furnished along with names and telephone numbers of persons whom the Town Representative may contact for an evaluation of the casting.

All castings shall meet the requirements of ASTM A48, Grade 30 iron.

- (2) Curb Inlet Grate, Frame & Hood - Curb inlets shall be of the grate, frame and hood type conforming to NCDOT 840.03, Type E, F and G, based on flow direction. Castings shall be Type V-4066 (2-5) as manufactured by Vulcan Foundry Company, Southern Foundry SF-102 + SF-103 (C,E,F, or G) or US Foundry #5181. Grates with slots parallel to the curb are not permitted. Curb inlet hoods shall be embossed with "Dump No Waste! Drains to Waterways."
- (3) Grates & Frames - Cast iron grates and frames for yard inlets shall conform to NCDOT 840.16 and be of the size indicated on the approved plans. Grates and frames shall be Vulcan V-4870, Southern Foundry SF-131, US Foundry 4130+6230; or their equivalent with comparable features for other larger size openings as may be required.

Grates and frames shall only be used outside of street rights-of-way.

- (4) Manhole Rings & Cover - Cast iron manhole rings and covers shall conform to NCDOT 840.54, with the words "STORM SEWER" cast on the cover. Covers shall have a minimum of two 1-inch holes. Manhole castings shall be machined to provide a continuous bearing around the full periphery of the frame. Covers shall be Vulcan V-1384, Southern Foundry SF-101 or US Foundry 669-KL or approved equivalent.

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g. Portland Cement Concrete:

Portland cement concrete used for storm drainage structures, end walls, etc. shall conform to the technical requirements presented in paragraph 2.08 of these Specifications and shall have a minimum compressive strength of 3,000 psi at 28 days. Primary structures, such as box culverts, may require concrete having a compressive strength greater than 3,000 psi and may require the submission of mix designs and testing of the concrete by an independent laboratory. These special requirements may be imposed by the Town Representative for all such structures where recommended by the Engineer.

h. Reinforcing Steel:

Reinforcing steel shall be new billet steel conforming to ASTM A615, Grade 60, deformed.

5.04 Miscellaneous Materials

a. Riprap:

Riprap shall be large aggregate of the size and class shown on the approved drawings.

b. Steps:

Steps shall be constructed using ½ inch diameter reinforcing steel encapsulated in polypropylene material. Steps shall be designed and installed to accommodate a vertical load of not less than 400 pounds and a horizontal pullout load of at least 1,000 pounds. Steps shall have a clear width of 12 inches. If the developer or contractor desires to use a pre-cast or preformed structure, specifications shall be provided to the Town Representative for review and approval.

5.05 Construction Methods

a. Trenching & Bedding for Storm Sewers:

The trench shall be excavated to the line and grade indicated on the Drawings. The trench bottom shall provide a firm and uniform support for the pipe. Where bell and spigot type pipe is used, recesses shall be excavated to receive the pipe bell.

Where the foundation is found to be of poor supporting value, the pipe foundation shall be conditioned by undercutting the unacceptable material to the required depth as directed by the Town Representative and backfilling with stone or other approved material. Where necessary, surface water shall be temporarily diverted in order to maintain the pipe foundation in a dry condition. The flow of water from such temporary diversions shall be directed into suitable erosion control devices.

b. Pipe Laying:

Concrete pipe culverts shall be laid carefully with bells or grooves up grade and ends fully and closely joined. Joints of concrete pipe shall be made with O-ring gasket or with plastic gasket material as specified. Joints shall be made in accordance with manufacturer's recommendations.

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Pipe which is not true to alignment, or which shows any settlement after laying, shall be taken up and relaid.

c. Backfilling:

The storm sewer trench shall be backfilled with approved material free from large stones or clods in 6-inch layers, loose measurement, and compacted to 95% of maximum dry density (AASHTO T-99), where the trench is within an area to be paved, or where the trench is immediately behind the curb. In streets the compaction requirement shall be increased to 100% of maximum dry density within 12" of subgrade. The backfilling shall be done on both sides of the pipe simultaneously to prevent displacement of the pipe. The backfill materials shall be moistened when necessary in the opinion of the Engineer to obtain maximum compaction. Water settling or puddling shall not be permitted. Backfill in trenches not within the limits to be paved may be compacted in 12-inch layers after backfill is one foot above the top of the pipe.

All trash, forms, debris, etc., shall be cleared from around all pipes and structures before backfilling. Backfilling around structures shall be done symmetrically and thoroughly compacted in 6-inch layers with mechanical tampers to the specified 95% density.

d. Masonry Structures:

Excavations shall be made to the required depth, and the foundation on which the brick masonry is to be laid shall be approved by the Town Representative. The brick shall be laid so that they will be thoroughly bonded into the mortar by means of the "shove-joint" method. Buttered or plastered joints will not be permitted. The headers and stretchers shall be so arranged as to thoroughly bond the mass. Brickwork shall be of alternate headers and stretchers with consecutive courses breaking joint. All mortar joints shall be at least 3/8 inches in thickness. The joints shall be completely filled with mortar. No spalls or bats shall be used except for shaping around irregular openings or when unavoidable to finish out a course. Competent masons shall be employed on the work, and all details of construction shall be in accordance with approved practice and to the satisfaction of the Town Representative.

Steps as shown on the plans shall be placed in all catch basins and inlets when they are greater than five feet in depth. The steps shall be set in the masonry as the work is built up, thoroughly bonded, and accurately spaced and aligned. Steps shall be set at 16 inches on center and project at least 5 inches from the face of the wall.

Inverts in the structures shall be shaped to form a smooth and regular surface free from sharp or jagged edges. They shall be sloped adequately to prevent sedimentation.

The castings shall be set in full mortar beds. All castings when set shall conform to the finish grade shown on the Drawings.

e. Concrete Construction:

The forming, placing, finishing and curing of Portland cement concrete shall be performed in strict accordance with all applicable requirements as contained in the *Standard Specifications for Road & Structures*, latest edition, as published by the NC DOT.

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f. Installation of Precast Concrete Structures:

Precast concrete catch basins, manholes, junction boxes, etc. shall be installed level and plumb and upon a firm, dry foundation, approved by the Town Representative. Structures shall be backfilled with suitable materials, symmetrically placed and thoroughly compacted so as to prevent displacement and deter settlement. Castings shall be set in full mortar beds to the required finished grade.

5.06 Inspection Prior to Acceptance

Prior to acceptance of any development with public storm drainage infrastructure, the utility contractor shall arrange a camera inspection of all public storm drainage lines with a 3rd party camera service and then coordinate the results with the Town Representative. Any discrepancies found in violation of these Specifications shall be repaired to the satisfaction of the Town Representative prior to acceptance and prior to issuance of any Certificates of Occupancy. When inspection indicates possible excessive deflection in PP, CSP, or CAP, the contractor shall complete a deflection test by mandrel using a rigid device approved by the Town Representative. The mandrel size shall be clearly labeled and shall be sized so as to provide a diameter of at least 95% of the inside pipe diameter. If deflection exceeds 5%, the pipe shall be Section 500 - Storm Drainage - Page 13 of 14 Effective Date: June 11, 2024 evaluated to determine what corrective measures are required.