

Town of Hope Mills

CHAPTER 6: STORMWATER COLLECTION SYSTEMS

6.1. GENERAL

6.1.1. PURPOSE

The purpose of this section is to provide design criteria for storm drain pipes, open channels, and culverts. The goal is to maintain after development, as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, siltation, and sedimentation, and local flooding.

6.1.2. APPLICABILITY

- A. No storm water run-off or natural drainage way shall be altered or diverted as to overload existing drainage systems, or create flooding or the need for additional drainage structures on other private properties or public lands without mitigating those impacts. Formal approval from the Town is required.
- B. These criteria apply to all development or redevelopment of land except agricultural and forestry land management practices specifically exempted by State statute.
- C. Stormwater runoff calculations shall be provided for all proposed storm drainage structures including, but not limited to, culverts, piped storm drainage systems, inlets, ditches, open channels, BMPs, outlet protection, etc. and shall be sealed and signed by a registered design professional.
- D. Other local, state and federal permits may be required. It shall be the responsibility of the developer to acquire all applicable permits. A copy of all permits shall be provided to the Town prior to final Construction Plan Approval.

6.2. GENERAL REQUIREMENTS

6.2.1. TOWN-MAINTAINED

- A. All storm sewers serving a public purpose to be owned and maintained by the Town shall be installed in a public right-of-way or public drainage easement as noted on recorded plats with the Cumberland County Register of Deeds.
- B. Public drainage easements should be located in open space to the maximum extent practicable.

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- C. Public drainage easements should not be combined with other utility easements. The easements may overlap but the physical utility shall not encroach on the easement of another utility.
- D. The Town may deny acceptance of any drainage system that does not provide the proper legal authority for access, operation and maintenance of the system.

6.2.2. PRIVATELY MAINTAINED

- A. All storm sewers to be privately owned and maintained shall be installed in a private drainage easement. These easements shall be maintained by homeowner or property owner associations, or in the absence thereof, the individual property owner.
- B. Private drainage easements should be located in open space to the maximum extent practicable.

6.2.3. EASEMENT STANDARDS

- A. The minimum width of all drainage easements shall comply with the following standards:
 - 1. A pipe diameter of 48 inches or less shall have a minimum easement of 20 feet.
 - 2. A pipe diameter of more than 48 inches shall have a minimum easement of 30 feet.

The Town Representative may require additional easement width for systems with invert depths in excess of 6 feet from finished grade or multiple pipe installations.

- B. Encroachments into any drainage easement, except those expressly permitted in the Town of Hope Mills Code of Ordinances, shall be prohibited.
- C. When a yard swale drains two or more upstream properties or conveys a 10-year storm event peak flow rate of 2 cfs or greater, a storm drainage easement shall be provided.
 - 1. All drainage easements shall be drivable and constructed of a solid surface (see the Town of Hope Mills Code of Ordinances, (and/or) Town of Hope Mills standard details for surface material options) where they intersect a roadway.
 - 2. The maximum longitudinal slope permitted is 5:1 (horizontal: vertical).

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3. The maximum cross slope permitted is 10:1 (horizontal: vertical)

6.3. DESIGN STANDARDS

6.3.1. BASIS FOR DESIGN

- A. Systems shall be designed based on rainfall intensities or storm events as follows:

1. **Inlet Spacing (Spread)**

For inlet spacing (spread), 4 inches per hour storm intensity. Spread widths shall not exceed $\frac{1}{2}$ the width of a travel lane, with an absolute maximum of 8 feet.

2. **Inlet Bypass**

Bypass shall be limited to less than 0.10-cubic feet per second (cfs) into an intersection.

3. **Open Channels**

For open channels, the erosion potential of the soil shall be evaluated for the 10-year, 24-hour storm event at non-erosive velocities with regard to anticipated velocities. Appropriate measures shall be taken to protect the soil and/or reduce velocities to prevent erosion.

4. **Enclosed Pipe Sizing System**

- a. For enclosed pipe system sizing, the Hydraulic Grade Line (HGL) shall not exceed the crown of pipe elevation for the 10-year, 24-hour storm event.
 - b. For enclosed pipe system sizing, the Hydraulic Grade Line (HGL) shall not exceed the top of structures or gutter line elevation as appropriate for the 25-year, 24-hour storm event.

5. **Culverts**

For culverts, the 25-year, 24-hour storm shall be used unless otherwise required by the Town Representative.

6. **Areas Prone to Flooding**

For areas prone to flooding, the 100-year, 24 hour storm shall be used.

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7. Riprap

Riprap energy dissipater or approved alternative outlet protection calculations shall be provided for all storm drain outlets, consistent with current NCDENR methodologies.

- B.** The Rational Method must be utilized to determine peak runoff rates for drainage areas that do not exceed 5 acres, and the USDA NRCS Hydrologic Urban Hydrology for Small Watersheds (formerly the SCS Method) must be utilized to determine peak runoff rates for drainage areas that exceed 5 acres. The corresponding C, CN, and hydrologic soil groups for soil types must utilize the information provided within the current edition of the Stormwater Best Management Practices Manual published by the North Carolina Department of Environment and Natural Resources (NCDENR).
- C.** Pre-existing surface cover on-site shall be based on Cumberland County colored aerials, assuming good hydrologic condition, unless the current surface cover conditions provides a better “undisturbed” natural condition. All off-site drainage areas shall be assumed to be in fully developed good condition, per the current land use mapping.
- D.** A Hydraulic Grade Line (HGL) study shall be performed for all storm drainage systems. The study shall include profiles that show inverts, slopes, proposed finished grade and hydraulic grade line for each design storm year, 24-hour storm event.
 - 1. The downstream hydraulic gradient at the outlet end of the storm drain system shall be the “known” water surface elevation (based on the downstream backwater elevation), the crown of the pipe, or the storm elevation in the downstream stormwater facility, whichever is greater.
 - 2. Where the HGL cannot be fully contained within the pipe due to physical or engineering constraints, the Town Representative may allow O-Ring gasketed pipe meeting ASTM C443/AASHTO M198 – Joints for Concrete Pipe and Manholes using Rubber Gaskets, to be used for the affected line segments. Additional alternatives may be considered (see Section 1.3.3.2., Alternative Standards Procedure).

6.3.2. GENERAL STANDARDS

- A.** Discharge points shall be a minimum of 20 feet downhill from the building envelope.
- B.** Structures shall be spaced to intercept flow at the uphill turnout of intersections (where curb tangent meets the radius portion) unless the street design provides a

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continuous downhill grade around the radius and down the intersecting street. Low points should not be located at street or driveway intersections.

- C. Roof drains and leaders shall be designed based on the current North Carolina plumbing code.
- D. No inaccessible storm drainage structure shall be allowed.
- E. A minimum of 1 foot of freeboard shall be provided in BMPs for the 100 year, 24-hour storm event.
- F. Dam impoundments up to 5 feet high (measured from downstream toe of slope to top of berm) shall have a minimum width of 8 feet , and impoundments greater than 5 feet high shall have a minimum width of 10 feet.
- G. No building, proposed or existing, shall be flooded or have water impounded within 10 feet of it during the 100-year, 24-hour storm event. A separate grading plan sheet may be required to delineate area of overland relief.
- H. The following discharges are specifically prohibited from being connected to the stormwater system:
 - 1. Sanitary sewers, sanitary sewer services, or septic tanks;
 - 2. Flows from commercial car washes;
 - 3. Discharges from swimming pools (these may be discharged as overland flow slowly over time so as to not impact adjacent properties, surface waters, or roadways); and
 - 4. Air conditioning condensate line discharges (these may be discharged as overland flow).

6.3.3. DRAINAGE PIPES

A. Size

- 1. Storm drainage pipes shall be sized in accordance with the Manning Equation and applicable nomographs to carry the design flow and to provide a velocity of no less than 2 feet per second during the 2-year storm.
- 2. The minimum pipe diameter shall be 15 inches except for landscape and area drains collecting 500 SF or less, where a minimum diameter of 8 inches shall be considered.

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B. Other

1. See NCDENR Division of Water Quality Stormwater Best Management Practices (BMP) Manual and Standard Specifications for horizontal and vertical separation requirements between storm drainage pipes, water lines, and sanitary sewer lines.
2. The minimum acceptable pipe slope shall be 0.5% and maximum acceptable slope shall be 10%. Exceptions to this shall be submitted to the Town Representative for approval with a written justification and supporting information by a Professional Engineer.
3. Pipe shall be installed to provide a true line and grade between structures.
4. Pipes shall maintain a minimum of 2 feet of cover from top of pipe to bottom of pavement structure within a roadway, or finished grade when not within a load bearing area.
5. Structures shall be installed at each deflection of line and/or grade.
6. Couplings are not permitted. Change in pipe material shall only take place at the structure.
7. The maximum length between access points shall be 400 feet for all pipe sizes.

6.3.4. OPEN CHANNEL SYSTEMS

- A.** Channels and ditches shall be designed to carry the design flow at non-erosive velocities, and contain the design storm within the banks. Calculations indicating design velocities shall be provided along with typical channel cross-sections. The non-erosive velocities shall be based on the permanent cover and temporary lining proposed as per Table 8.05a in the "North Carolina Erosion and Sediment Control Planning and Design Manual," published by NCDENR.
- B.** The minimum slope for open channel systems (ditches, swales) shall be 2%.

6.3.5. INLETS

- A.** Inlets shall be spaced to provide a maximum spread equal to or less than one-half the width of the travel lane for the design storm, not to exceed 8 feet. In areas of heavy pedestrian traffic or alleys, the maximum allowable spread may be decreased by the Town Representative.

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- B.** Inlet bypass flows shall be limited to 0.1 cubic feet per second (cfs) into an intersection.
- C.** Inlet capacity calculations shall assume a 50% clogging factor for inlets located in a sump condition.

6.3.6. CULVERTS

- A.** Culverts shall be sized in accordance with the Energy Equation and applicable nomographs to carry the design flow and to provide a velocity of at least 2 feet per second during the 2-year, 24-hour storm.
- B.** Inlet control calculations shall be provided for all culverts and demonstrate a headwater over depth (HW/D) ratio less than or equal to 1.0 preferred, with an absolute maximum of 1.2.
- C.** Outlet control calculations shall be provided for all culverts and demonstrate a headwater over depth (HW/D) ratio less than or equal to 1.0 preferred, with an absolute maximum of 1.2.
- D.** The downstream hydraulic gradient at the outlet end of the culvert shall be the “known” water surface elevation (based on downstream backwater elevation) or the crown of the pipe, whichever is greater.
- E.** The minimum slope for culverts shall be 1% unless the existing stream channel is flatter. In no case should pipe slopes be less than 0.5%.
- F.** Culvert design on Town maintained roads shall provide 1 foot of freeboard from the edge of road surface during the:
 - 1. 25-year, 24-hour storm event for all driveways, alleys, local streets, and main streets.
 - 2. 50-year, 24-hour storm even for all other streets
- G.** Culvert design shall not overtop the road for the 100-year, 24-hour storm.
- H.** Culverts on State maintained roads, or roads the Town has identified as potentially being turned over to the State’s system, shall meet NCDOT standards.
- I.** Stream crossings requiring greater than a 24-inch culvert will necessitate a back water study of the 100-year storm.

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- J.** There should be no more than two pipe culverts per crossing. Installation shall include box culverts or elliptical pipe, of no more than two barrels, if requiring greater than double pipe culverts.

6.4. MATERIALS

6.4.1. PIPE MATERIALS

A. Reinforced Concrete Pipe (RCP)

1. Reinforced Concrete Pipe (RCP) shall conform to ASTM C76, Table III or Table I V (Class III minimum).
2. Joints shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant.
3. All drainage pipes to be maintained by the Town shall be RCP.

B. High Density Polyethylene (HDPE) Corrugated Pipe

1. High Density Polyethylene (HDPE) Corrugated Pipe shall be used only in areas outside of public right of way and public easements. When used in private locations, pipe material shall be rated on approved plans and include the submission of design criteria.
2. Installation of HDPE pipe shall adhere to design criteria standards.
3. Pipe material shall meet the product specifications of ASTM F667 and shall have a smooth interior.
4. Pipe joints shall consist of an integral bell and spigot type joint with “O” ring rubber gasket meeting ASTM F477 placed on the spigot end. At least two corrugations of the spigot end must insert in the bell end. Installation shall adhere to the specification of ASTM D2321 and certified by an engineer.
5. HDPE pipe with a diameter of 24 inches or under may be used under pavement or curb and gutter in private locations only.

C. Polyvinyl Chloride (PVC) pipe

1. Polyvinyl Chloride (PVC) Pipe shall only be used in areas outside of public rights-of-way and easements. When used in private locations, material pipe shall be rated and include design criteria standards.

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2. Installation of PVC pipe shall adhere to design criteria standards.
3. Pipe material shall meet the product specifications of ASTM F949-93a and shall have a smooth interior.

6.4.2. DRAINAGE STRUCTURE MATERIALS

- A. All storm drainage structures such as manholes, inlets, junction boxes, and catch basins shall be constructed of solid block or precast concrete in accordance with the current NCDOT construction specification and details. Elevation adjustments must be made by solid block and mortar methods or precast structures of 4 inches minimum. No “waffle” boxes shall be permitted in public rights-of way or public easements.
- B. Concrete block shall be solid and conform to ASTM C139 as to design and manufacture. The block shall be embedded in a mortar bed to form a ½- inch-thick mortar joint.
- C. Precast concrete manholes shall meet ASTM C478 as to design and manufacture. All manhole cones shall be the eccentric type. Joints shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant.
- D. Manhole frames and covers shall be as specified in the standard details, with “STORM SEWER”, stamped on the cover and two 1-inch-diameter holes.
- E. Steps shall meet the material, strength, and installation requirements as specified by NCDOT’s standard drawings. Location of steps for storm drainage shall be per detail.
- F. Concrete end-sections or concrete headwalls and endwalls shall be required at the beginning and end of all storm drain pipes. Headwalls and endwalls may be constructed in accordance with the current NCDOT construction specification and details. Installation of precast headwalls and endwalls shall be in accordance with the manufacturer's recommendations.
- G. Frames, grates, and hoods shall be cast iron and meet the ASTM requirements set forth in the latest edition of the NCDOT “Standard Specifications for Roads and Structures” and the dimensional requirements set forth in the latest edition of the NCDOT “Roadway Standard Drawings #840.03.” Grates shall be stamped with the NCDOT specification number as evidence of satisfying the above requirements.

6.5. EXCAVATION AND PREPARATION

6.5.1. GENERAL

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- A.** Trenching for pipes (e.g. water, sewer, pressure, natural gas, liquid petroleum, drainage, irrigation, etc.) and lines (e.g. power, communication, etc.) shall be excavated to the required depth to permit the installation of the pipe or line (inclusive of pipes, wires, cables, ducts, and conduits) along the lines and grades shown on the construction drawings. Trenches located with-in pavement areas or within the public right-of-way shall be compacted to 95% Standard Proctor Test. Trenches located out of the pavement area shall be compacted to a minimum of 90% Standard Proctor Test.
- B.** Prior to trenching for the construction of any utility mains or connections, the contractor shall locate all existing utilities within the construction zone. This may involve, at a minimum, contacting the North Carolina One Call Center at 1-800-632-4949. In sensitive areas where utilities cannot be located by traditional means, specialized Sub-surface Utility Engineering (utility locating), such as vacuum excavation or ground penetrating radar (GPR), may be required to locate existing utilities before excavating.
- C.** The contractor shall be responsible for implementing all required safety provisions for trenching in compliance with the Occupational Safety and Health Administration (OSHA) regulations and all other applicable safety requirements and procedures.

6.5.2. TRENCH DIMENSIONS

- A.** The minimum trench width at the top of the pipe or line shall be at least 18 inches greater than the outside diameter of the pipe. Rock shall be removed to a depth of at least 6 inches below the bottom of the pipe or line and the trench backfilled with suitable material.
- B.** Open trenches shall not exceed a length of 100 feet.
- C.** All trenches shall be confined to the limits of the right-of-way or utility easement. Trenches in paved areas shall not be sloped.
- D.** All trenches along roadways, and otherwise as directed by the Town Representative, shall be properly backfilled at the end of each working day.

6.5.3. TRENCH PROTECTION

- A.** Wet trenches shall be stabilized with a base layer of #78 M or #57 stone. The bottom of the trench shall be shaped to provide uniform support along the entire length of the pipe.
- B.** A space shall be excavated at each bell to provide ample space to join the pipes or lines with no misalignment.

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- C. The contractor shall take all necessary measures to prevent water from entering the trench.

6.6. INSTALLATION

6.6.1. GENERAL

- A. All pipes shall be installed per Section 300, "Pipe Installation", of the North Carolina Department of Transportation (NCDOT) Standard Specifications for Roads and Structures, January 2002 edition, unless stated otherwise.
- B. Backfill material used to install pipe within the street right-of-way shall be Select Material, Class I-VI, as defined by Section 1016-3 of the NCDOT Standard Specifications for Roads and Structures, January 2002 edition or latest approved edition. Upon submittal of written certification of material suitability by a Professional Geotechnical Engineer, NCDOT Class I material may be used. All backfill material shall be approved by the Geotechnical Engineer prior to placement of material within the street right-of-way.
- C. Pipe may enter through the corner of all structure material types except precast concrete "waffle" boxes.
- D. A reinforced concrete slab designed by a North Carolina Professional Engineer may be used at oversized structures to adjust an inlet to standard dimensions, provided it meets H-20 loading.
- E. The minimum cover for storm sewer pipe shall be 2 feet to finished subgrade under roads and 1 foot to finished grade in non-load-bearing areas.
- F. Pipe shall not project into a drainage structure, but shall be finished flush with the inside of the structure.
- G. Catch basins between 5 and 20 feet in depth shall have minimum interior dimensions of 4 feet by 4 feet, and those over 20 feet in depth shall have minimum interior dimensions of 5 feet by 5 feet.
- H. Each drainage structure shall have an invert constructed from concrete and shaped to conform to the pipe inside diameter, and a bench with a maximum 5:1 slope. The bench shall begin at a height of one-half the pipe diameter for pipes with a diameter or 12 to 24 inches, one-third the pipe diameter for pipes with a diameter of 30 to 48 inches, and one-fourth the diameter for pipe with a diameter greater than 48 inches.
- I. Precast headwalls and endwalls shall only be installed at single pipe culverts.

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- J. Precast concrete structures may be installed only to depths certified as acceptable by the manufacturer.
- K. Each curb's inlet must be installed such that the front wall is straight and aligned with the curb and gutter.

6.6.2. INLETS AND OUTLETS

- A. Headwalls, endwalls, or flared end sections shall be installed at all discharge points, and inlets where there is not a structure.
- B. Flared end sections may be installed, as appropriate based on surrounding grade, on single pipe culverts up to and including 36 inches in diameter. The flared end section shall be installed with appropriate curtain wall. Flared end sections may not be installed on multiple pipe culverts.
- C. Headwalls and endwalls shall be installed on single pipe culverts greater than 36 inches in diameter, and on multiple pipe culverts.
- D. Energy dissipaters shall be installed at all discharge points and shall be properly sized to ensure that stormwater is released at a non-erosive velocity.
- E. A geotextile fabric barrier shall be installed between dissipation pads and the natural ground.
- F. The system shall include scour protection for drainage ways.
- G. Details and design of headwalls, endwalls, and flared end sections shall be in accordance with NCDOT standard detail requirements. These details shall be shown on plan submissions.
- H. Additional information on the impact of stormwater discharge onto adjacent properties may be required by the Town Representative.

6.7. PIPE LAYING AND BACKFILLING

6.7.1. PIPE LAYING

- A. Open ends of pipe shall be plugged when pipe laying is not in progress to prevent trench water, soil, and debris from entering.
- B. All pipes shall be laid in accordance with the manufacturer's recommendations and all applicable Town Standard Details & Notes or Specifications.

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- C. Pipe laying shall be accomplished in a manner and with the required resources to provide a properly aligned and sealed pipeline and joints.
- D. Pipe deflection limits shall not exceed manufacturer requirements.
- E. All piping shall be installed beginning with the downhill section at the lowest elevation, and advance upgrade to the terminus of the main. All bell ends shall be oriented facing the uphill direction.

6.7.2. BACKFILL

- A. Backfill material shall be free from construction material, frozen material, organic material, or unstable material. Backfill with a high clay content or high shrink-swell potential that cannot meet compaction requirements shall be deemed unsuitable and replaced.
- B. Backfill materials that have been allowed to become saturated with moisture contents not conducive to meeting compaction requirements shall be deemed unsuitable and replaced.
- C. When original excavated materials have been deemed unsuitable, granular material must be imported to the site to backfill utility trenches and meet compaction requirements. The following materials shall be acceptable forms of granular backfill:
 - 1. Aggregate base course
 - 2. Soil type base course
 - 3. Select backfill material;
 - 4. Sand or screenings in accordance with NCDOT specifications; and
 - 5. Recommendations by the on-site Professional Geotechnical Engineer
- D. In all open trenches, backfill shall be compacted to 95% maximum dry density as measured by AASHTO method T99. The contractor shall be responsible for verifying that compaction requirements have been met or exceeded by providing soils testing data from an approved geotechnical firm. The soil test results shall be certified by a Professional Geotechnical Engineer. These certified soil test results and corresponding reports shall be provided to the Town Representative.
- E. Backfill for trenches shall be placed in lifts of un-compacted soil no more than 6 inches high and compacted with a mechanical tamp before placing additional layers.

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