04.00 STORM DRAINAGE COLLECTION FACILITIES

04.01 GENERAL

1. Adequate storm drainage shall be provided throughout the development by means of storm drainage pipe; box, elliptical, or arch culverts; or properly graded channels.

2. Storm drainage pipe shall be placed at all low points in street grade to transmit storm water transversely across the street with catch basins being constructed on both sides of the street at the low point.

3. A comprehensive storm drainage system shall be planned and implemented for each subdivision in accordance with the general standards and requirements of this Division. The general storm drainage plan shall be shown on the preliminary plan. Detail plans where required shall be submitted as part of the construction plan requirement. Where easements are required, they shall be noted on the final plan and plat.

4. Storm drainage plans shall be considered on an individual basis depending upon the situation within a given subdivision. Generally the following standards shall apply:

   A. Types of drainage ways requiring treatment.

      1) Those draining one acre of land or more.
      2) Those carrying storm water runoff from public streets either existing or proposed.
      3) Those carrying storm water runoff from large impervious surfaces other than streets.

   B. Design storms.

      1) Open drainage channels shall be designed to carry the 25-year design storm with minimum 6” freeboard.
      2) Collection system pipes that convey stormwater along a proposed street shall be designed for non-pressure conditions based upon Manning’s equation for the 10-year design storm.
      3) Cross drainage pipes (culverts) that convey the natural flow of water from one side of a street to the other side shall be designed for the 25-year design storm.
      4) Roadways crossing within the special flood hazard areas (SFHA) designated under the National Flood Insurance Program shall be designed in conformance with the City’s Flood Damage Prevention Ordinance and shall be reviewed and approved by the City’s Floodplain Administrator.

C. Types of treatment.

1) Enclosed subsurface drains;
2) Open, improved channel;
3) Open channel with flood plain and open space dedicated to the City of Monroe. This option shall not be available except in cases where the City Council agrees in principle to accept such dedication prior to final plat approval. After considering such proposed dedications, the City Council shall consider, among others, the following characteristics of the proposal: size and shape; physical condition; suitability as open space; ease of maintenance; access; relationship to surrounding property; and relationship to open space in the vicinity.

D. Easements.

1) Maintenance easements shall be required dependent upon the size of the drainage area and the maintenance responsibility as determined by the City Engineer. See Section 04.02.01.5.
2) In any case whether maintenance is to be the responsibility of the property owner, the City may require a right to enter for maintenance purposes where the City Council determines that the public health, safety, or general welfare constitutes a public necessity for such maintenance.

04.02 DESIGN

04.02.01 DESIGN CRITERIA

1. The following criteria shall be used for drainage collection facilities within rights-of-way and permanent easements to be accepted by the City:

A. Pipe shall be 15” – 60” diameter RCP Class III, or other material as approved. See Section 04.03.04.

B. Greater than 60” pipe (or arch equivalent) may be aluminum or aluminized pipe subject to approval from the City Engineer.

C. Drainage pipe for driveways shall be a 12” minimum diameter.

D. Refer to NCDOT Pipe Material Selection Guide for allowable pipe fill heights and specifications. For fill heights less than 2’ (measured from top of pipe to bottom of pavement structure) Class IV/Class V Reinforced Concrete Pipe (RCP) will be required. Designs outside of the selection guide will be approved at the discretion of the City Engineer.

E. The minimum allowable slope for pipes shall be 1.0 percent, and the maximum grade for pipes shall be 5%.

F. The minimum angle of entry for a pipe into a "built" structure shall be 75 degrees.

G. The minimum angle of entry for a pipe into a "pre-cast" structure shall be 90 degrees or other subject to approval by the City Engineer.

H. The minimum grade for open channels shall be 1.0% unless otherwise approved by the City Engineer.

I. Positive drainage and fall shall be provided along all channels.

J. Ditches shall be properly stabilized with positive fall prior to acceptance by the City of Monroe.

K. The maximum side slope for open ditches shall be 2H:1V, with 3H:1V preferred.

L. Where applicable, storm drain pipe shall be extended to the rear of the building set back line or to the edge of the buffer, whichever comes first.

2. Culverts shall be analyzed for both inlet control and outlet control conditions. Where inlet control governs conveyance, headwater depth is also limited to the ratio of headwater depth divided by pipe diameter (rise for arches) equal to 1.2 or 1.5 feet below the shoulder point (at the sag in vertical alignment), whichever results in the lower headwater depth. Where outlet control governs conveyance, the allowable Head (H) shall be limited to 2 feet maximum and provide 1.5 feet freeboard below the shoulder point.

3. Culverts must be long enough to accommodate the proposed typical roadway section with a 2:1 fill slope from shoulder point, or flatter. Handrails may be required at the direction of the City Engineer.

4. Headwalls are recommended on the inlet end of culverts 36-inch and larger. Maximum height of headwalls shall be one foot above pipe structure. Neither Mechanically Stabilized Earth (MSE) nor Modular Block walls shall be allowed for culvert headwall applications.

5. Public storm drainage easements shall be required on all open storm drainage channels and storm drainage pipes outside the street right- of-way as follows:

Open channels	0-45 Acres = 20' min. easement required
	>45 Acres = As directed by the City Engineer

Storm drainage pipe	15", 18", 24" = 15' min. easement required 30", 36", 42" or 48" = 20' min. easement required 54" Plus = 30' min. easement required

Plantings other than grass stabilization within the drainage easements must be approved by the City Engineer.

6. Not more than one-half acre or 2 cfs of runoff based on a storm of the 10-year return period may drain into the street at a single point discharge. i.e. roof drains, driveway connections, etc.

7. Any low-point that occurs in a superelevated section shall only be required to have one catch basin on the low side. However, to ensure water does not flow across the street, a catch basin will be required within 20 feet prior to the transition from normal crown.

8. No storm drainage trunk line shall extend longitudinally more than 500 feet without access to a drainage structure provided. Catch basins shall be placed on both sides of the street at the upstream end of the longitudinally placed storm drain, and connected transversely to convey Stormwater to the nearest low point in the street grade.

9. If storm drainage pipe does not extend a minimum of 10 feet beyond the back of sidewalk with a 3:1 slope or flatter (depending on depth of cover, height of fill, etc.), a hand rail may be required by PROWAG.

10. Inlets shall be spaced in such a manner that the design curb gutter flow does not exceed the spread limitations, based on a detailed study of inlet locations, capacities, and gutter spread. Design parameters are as follows:

    A. Standard rainfall intensity of 4.0 inches per hour.

    B. Inlet capacity in sags shall allow for debris blockage by providing twice the required computed opening.

    C. Maximum spread of 6 feet from lip of gutter into a travel lane based on a rainfall intensity of 4 inches per hour.

    D. Maximum spacing between inlets or drainage structures shall not exceed a maximum interval of 500 feet.

    E. Ponding at yard inlets outside the roadway shall be limited to a maximum of 6” above a grated inlet for the 10-year storm.

    F. Double catch basins shall be required where more than 2 acres of runoff along a given length of street is to be collected at a single given point except where deviations are allowed by this Detail Manual.

G. Single catch basins may be allowed if an adequate design can limit the stormwater spread in the flow line of the street to 6 feet from the lip of gutter into the travel lane.

11. Relief by curb overflow shall be provided at all sags or a sufficient number of catch basins shall be provided to limit ponding over top of basins to 6 inches for a storm of the 25-year return period. Drainage pipes within the sag shall be designed to meet this requirement.

04.02.02 HYDROLOGIC ANALYSIS

1. For drainage areas consisting of less than or equal to 200 total acres, the Engineer shall provide calculations by use of the Rational Method, NRCS Method, HEC-HMS, or method by which the Design Engineer is most familiar and can support with calculations, subject to approval by the City Engineer.

2. For drainage areas consisting of greater than 200 total acres, the Engineer shall provide calculations by use of the NRCS Method (TR-55), HEC-HMS, or method by which the Engineer is most familiar, subject to approval by the City Engineer.

3. All storm water conveyances shall be designed based on fully developed land use conditions as shown on current County and City Land Use Plans and Zoning Maps or existing land use, whichever generates the higher runoff rate.

4. Rainfall data for stormwater management design calculations shall be the most current available and shall be obtained from the National Oceanic and Atmospheric (NOAA) Precipitation Frequency Data Server website for the Monroe NC Station.

   Design nomographs, charts, tables, and a sample calculation for pipe sizing utilizing the Rational Method are provided in Appendix A. The engineer should use good engineering judgment in applying these design aids and should make appropriate adjustments when specific site characteristics dictate that these adjustments are appropriate.

5. The Engineer shall submit a copy of all storm drainage calculations with the plans to the City of Monroe Engineering Department for review.

04.02.03 CONSTRUCTION PLANS

1. For Construction Plan Requirements, refer to Standard 01.07 ROADWAY AND STORM DRAINAGE CONSTRUCTION PLAN REQUIREMENTS.

04.02.04 25 + 1 FLOOD ANALYSIS

1. For streams located outside of the mapped FEMA SFHA (Special Flood Hazard Area) limits and which serve a drainage area of 10 acres or more, the Engineer shall provide a flood analysis utilizing the 25-year design storm to establish finish floor elevations. Finish floor shall be established at least one foot above the 25-year storm elevation.

2. Runoff coefficients shall be based on assumption of full development of drainage area per current zoning.

3. Proposed calculated Flood Protection Elevations (FPE) shall be labeled on the site and grading plans for each lot. FPE shall also be shown for each lot on the Final Plat.

4. Show and label the calculated 25+1 flood elevation flood line on site plan and grading plan.

5. Show and label or describe on plan the location and elevation (ref. vertical datum, i.e. (NAVD 88) of permanent benchmark used in channel survey. All topographic information shown on grading plan shall also be referenced to this benchmark.

6. Provide a copy of all channel analysis input and output files with plan submittal.

04.03 CONSTRUCTION

04.03.01 STANDARD SPECIFICATIONS AND DETAIL REQUIREMENTS

1. All construction shall be in accordance with the City of Monroe Standard Specifications and Detail Manual. Where a construction item may not be covered by this manual, the NCDOT Standard Specifications for Roads and Structures, latest edition, and the NCDOT Roadway Standard Drawings, latest edition, shall govern.

2. All pipe materials referenced herein shall be installed in accordance with Section 300 of the current version of the NCDOT Standard Specifications for Roads and Structures, Pipe installation and the NCDOT Roadway Standard Drawings for method of pipe installation.

04.03.02 INSPECTIONS BY DEVELOPER

1. The Developer, his Agent, Engineer, and Contractor shall be responsible for developing a “Quality Control Program” that will be reviewed at the preconstruction meeting.

2. All inspections and testing shall be in accordance with Standard 01.08 INSPECTIONS and Standard 1.09 POST-CONSTRUCTION INSPECTIONS of this manual.

04.03.03 INSPECTIONS BY CITY

1. The City shall designate a construction inspector for each subdivision. The inspector shall make visits to the job-site as required to observe the progression of the work and will advise the contractor of any defects that are identified during inspections. However, failure to identify any defects shall not relieve the Developer, his Agent, Engineer and Contractor of their responsibility to complete the work in accordance with the approved plans and specifications and the City of Monroe Standard Specifications and Detail Manual.

2. All inspections and testing shall be in accordance with Standards 01.08 and 1.09 of this manual.

04.03.04 MATERIALS

1. All materials used shall be in accordance with Division 10 of the NCDOT Standard Specifications for Roads and Structures, latest edition.

2. HDPE pipe material is only approved for use when located outside the public right of way.

3. A complete materials list of all items proposed to be furnished and installed shall be included in a Stormwater Materials Table in the construction plans.

04.03.05 STORMWATER CHECKLISTS AND CONSTRUCTION NOTES

1. A completed copy of the Stormwater Gateway Checklist shall be submitted with all first plan reviews or the submittal shall be considered incomplete. A copy of the Gateway checklist may be found on the City Stormwater webpage.

2. A completed copy of the Stormwater Checklist found in Section 07.06.03 shall accompany all plan submittals.

3. Construction Notes found in Section 07.06.03 of the Stormwater checklist shall be included on all construction plans.