CHAPTER 3 STORMWATER

General Requirements, Calculations, Water Quality, Flood Studies, Pipe Types (RCP, HDPE, HPPP, CAMP), Special Structures, Pipe Inspections/Reports/Acceptance, SCM Escrow & Surety Estimates

A. GENERAL REQUIREMENTS

1. All work and materials shall conform to the latest edition of the NCDOT Standard Specifications for Roads and Structures, NCDOT Standard Drawings and the Kannapolis Land Development Standards.
2. Prior to beginning construction in the City of Kannapolis, a preconstruction meeting with the City Inspector shall be held, and submittals (shop drawings) shall be approved. The submittals should include all materials (roadway, storm, and utilities) to be used during construction.
3. Construction plans shall include profiles and hydraulic grade lines of all pipe systems ≥ 15".
4. The lowest finish floor elevations for residential structures must be a minimum of 2.0' above the downstream road crossing elevation or 2.0' above the calculated 100-yr flood elevation. Areas with the potential to flood during the 100-yr event shall have no basement finished floor elevation lower than the downstream catch basin rim elevation, plus 2.0'. Slab on grade residential structures must be a minimum of 1.0' above the highest point of the downstream catch basin or yard inlet.
5. **Stormwater Permit**

Site Condition	Stormwater Detention	Water Quality
< 1.0 ac & < 20,000 sf impervious area	See Note 1 below	No
< 1.0 ac & > 20,000 sf impervious area	Yes	No
> 1.0 ac & < 20,000 sf impervious area	Yes	Yes (low/high density)
> 1.0 ac & > 20,000 sf impervious area	Yes	Yes (low/high density)

Note 1:

Re-development of existing sites w/ <20,000sf of impervious area, provide detention for new impervious area that creates > 20,000sf of combined existing & proposed impervious area

Re-development of existing sites w/ >20,000sf of impervious area, provide detention for all new impervious area

6. **Access and Maintenance Easements**
   a. Minimum of 20' wide, pipe centered in easement preferably in common open space.
   b. Width requirements based on pipe depth (see Appendix A) and must provide for 1:1 excavation, bottom width = outside pipe diameter + 2'.
   c. Width requirements for channels should accommodate a minimum 10' wide path for maintenance vehicles.
   d. SCM Access & Maintenance easements may be a minimum of 10' wide and must connect to a public R/W.
   e. Shall be dedicated to the City of Kannapolis.
   f. Maximum slopes for maintenance vehicles: longitudinal = 15%, cross slopes of 5%.
   g. See LDSM details for overlapping easements.
7. **Stormwater SCM Embankments in the 100-yr floodplain**
   SCM embankments located in the 100-yr floodplain must have a licensed engineer certify the fill elevation, compaction, slope, and slope protection materials. See Appendix A for certification form.
8. Storm drainage pipe cover is a minimum 2.0'. For maximum cover, reference NCDOT Highway Design Branch Roadway Design Manual.
9. In areas where downstream impoundments will create a tailwater that backs water up into the pipe system, culverts shall be constructed with O-ring seals in the joints, which may require testing of the system. Locations of the system testing will be determined by the Director of Engineering.

10. **Storm Drainage Pressure Testing**

    When pipe testing is required, the storm structures shall also be tested as required. Vacuum testing may be used as outlined in ASTM C1244. Exfiltration tests may also be performed as follows:

    a. Plug the inlet and outlet and fill the manhole with water to within 6.0' of the top of the manhole.

    b. Allow the water to stabilize for 1/2 hr and refill the manhole to the original elevation.

    c. Mark the initial depth of water, and after 1 hr record the drop in the water level in the manhole.
    d. The maximum allowable drop in vertical water height in the manhole shall be ¼" for all diameter sizes of manholes. If the water level in the manhole drops below the allowable drop amount, the Contractor shall repair the leak and retest.

11. Storm drainage piping shall be placed in a straight alignment at uniform grade. No changes in alignment shall be allowed except at catch basins, manholes, or other junctions that provide appropriate clean out access. The maximum length between access points is 400'.

12. The interior surfaces of all storm drainage structures shall be pointed up and smoothed to an acceptable standard using mortar mixed to manufacturer's specifications.

13. All pipes in storm drain structures shall be flush with the inside wall. The floor of all storm drain structures shall be filled with concrete to an elevation flush with the downstream invert.

14. All storm drain structures over 3'-6" in height must have steps in accordance with standard details set forth in NCDOT Standard Specifications for Roads and Structures.

15. Catch basins, junction boxes, and storm drainage manholes shall be sized for the number and angle of pipes entering the structure. The following structures & non-standard structures require a PE's certification:

STRUCTURE	HEIGHT*
Brick catch basins	> 12'
Precast catch basins	> 16'
Open throat catch basins	> 16'
Drop inlets	> 12'
Junction Box	> 12'
Precast waffle wall structures	> 10'
Traffic bearing precast structures	> 15'
Precast manholes	> 30'
Brick manholes	Not Allowed

Refer to the NCDOT Roadway Standard Drawings for the location of the measurement points to determine maximum height.

16. Catch basins with frame, grates and hoods installed in curb and gutter sections less than 2'-6" wide shall offset the frame, grate, and hood to the back of the structure to maintain a consistent width of roadway.

17. Frames, grates, and hoods shall not be offset from the catch basin more than 4", front to back.

18. Density tests shall be required on trench backfill at a frequency established in the NCDOT Specifications. Test reports shall be conveyed to the City on a weekly basis.

19. Precast waffle boxes may not be used in areas with traffic bearing loads. Pipe shall enter precast waffle boxes in the area provided for knock outs, the corner or supporting wall section of a waffle box shall not be cut.

20. All graded creek banks and slopes shall be at a maximum 2:1 and not to exceed 10' without terracing, otherwise the slopes shall be designed by a Professional Geotechnical Engineer and approved by the Director of Engineering on a case-by-case basis.

21. Acceptance of the storm requires: 2 videos (the 1st video is prior to the first proof roll, the 2nd video is after the installation of dry utilities, but prior to acceptance of the streets); as-built drawings; and certification by the design engineer using the Certification Form in Appendix A.
22. For pressurized systems, use O-ring culverts.

B. CALCULATIONS

1. **Stormwater Design Calculations**:
    a. The City of Kannapolis has adopted the Charlotte-Mecklenburg Stormwater Design Manual for the design and evaluation of storm water management facilities. Storm drainage design shall conform to the standards and specifications as provided therein except for flood analysis, approximate flood limits, and detention facilities used for credits.
    b. Site grading shall not increase the flow rate or velocity of runoff onto downstream properties.
    c. Minimum pipe size is 15” to an inlet and 18” for cross pipe culverts.
    d. Storm system pipes shall be designed for non-pressure conditions using the 10-yr, 24-hr storm event.
    e. Provide hydraulic gradeline (HGL) calculations for the design storm. Minor losses are to be included in the evaluation and the HGL must be a minimum of 6” below the surface inlet elevation. Stormwater report must clearly show minor losses have been calculated.
    f. Cross-drainage storm sewers shall be designed for a 25-yr, 24-hr storm event, 50-yr 24-hr storm event for thoroughfares. Minimum size is 18”.
    g. Minimum pipe slope is 0.5% or that which produces a velocity of 2.5 fps when flowing full.
    h. Maximum pipe velocities shall not exceed 20 fps.
    i. Maximum discharge velocities at pipe outlets shall not exceed 10 fps.
    j. Inlets shall be located using a rainfall intensity of 4”/hr, maximum 400’ spacing.
    k. Double catch basins shall be provided at all sag points.
    l. Maximum headwater HW/D ≤ 1.2.
    m. Minimum freeboard:
        i. 12” for pipes ≤ 3’
        ii. 18” for pipes > 3’
        iii. 6” at yard inlets
2. **Stormwater Detention Calculations**:
    a. All proposed site plans that require a NCDEQ Sediment & Erosion Control Plan, or that will exceed 20,000sf in new impervious area, shall be required to construct stormwater detention facilities to mitigate increased runoff. Calculations shall include:
        i. Pre & post development drainage basin maps & hydrographs.
        ii. Rainfall runoff intensities and depths for Cabarrus/Rowan county.
        iii. Documentation for curve number, C values, time of concentration, and the equations used to generate the stage/storage/discharge tables.
        iv. Buoyancy calculations for the riser and uplift anchor.
        v. Detention facilities shall be designed to maintain the pre-developed runoff rate for 1-yr & 10-yr, 24-hr storm events.
        vi. Emergency spillways shall accommodate the 50-yr, 24-hr storm event.
        vii. Provide 6” of freeboard for emergency spillway.

3. **Analysis of Existing Ponds**

   a. Existing ponds upstream of proposed development:

      i. Provide jurisdictional determination of dam classification
      ii. Provide approximate flood limits and elevations resulting from a dam breach using the 100-yr storm event
      iii. Set finished floor elevations at BFE +2’

   b. Existing ponds downstream of proposed development:

      i. Provide jurisdictional determination of dam classification
      ii. If the proposed upstream development increases runoff which impacts an existing pond, provide analysis of the pond using the 1-yr, 10-yr, and 50-yr storm event. Improvements to the pond may be required.

C. WATER QUALITY DESIGN

1. The City of Kannapolis utilizes the State of North Carolina Department of Environmental Quality Design Manual for standards of design to obtain compliance to these requirements within the city limits or ETJ.
2. Alternate SCM designs may be used, but the products to be used must be part of the NCDEQ Preliminary Evaluation Period Program and include specifications for monitoring and replacement with an approved SCM if the product does not perform as designed.
3. Both point and non-point source pollutants shall be managed to comply with the Phase II NPDES Storm Water Permit requirements for post-construction pollution control. Reference the KDO for post-construction requirements.
4. All SCM embankments constructed must have a licensed engineer certify the fill elevation, compaction, slope, and slope protection materials.

D. FLOOD STUDIES

1. Flood studies documenting the impact of drainage structures to be constructed within a 100-yr floodplain are required. The culvert design capacity for these structures is the 100-yr storm event.
2. Flood Studies documenting the impact of fill placed in the 100-yr floodplain may be required for a project. See the KDO sections related to Flood Protection for additional guidance on when a flood study is required for fill placement.
3. Flood Studies submittals should include digital files of the HEC-RAS models used to evaluate the impacts and a copy of the work maps used to prepare the study.
4. Plans should clearly label the existing and proposed conditions, the existing FEMA data, and the proposed ineffective areas, floodway modifications, revised flood fringe areas, and the revised 100-yr flood fringe.
5. Guidance for the Preparation of Flood Studies can be found in the following documents:

   a. NC Department of Floodplain Mapping – Riverine Hydrologic & Hydraulic Engineering Guidelines and Standards.

   b. FEMA – Procedures For “No-Impact” Certification for Proposed Developments in Regulatory Floodways.

   c. FEMA – MT-2 Application Forms and Instructions for Conditional Letters of Map Revision and Letters of Map Revision.

   d. FEMA – MT-1 Application Forms & Instructions Conditional Letters of Map Amendment (CLOMAs), Final Letters of Map Amendment (LOMAs), Letters of Map Revision Based on Fill (LOMR-Fs) and Conditional Letters of Map Revisions Based on Fill (CLOMR-Fs).

   e. NCDOT – Guidelines for Drainage Studies and Hydraulic Design.

E. REINFORCED CONCRETE PIPE (RCP)

1. All concrete shall meet the minimum specifications set forth in Section 1032 of the NCDOT Standard Specifications for Roads and Structures.
2. Concrete pipe used within the street right-of-way shall be a minimum of Class III Reinforced Concrete Pipe, with a minimum diameter of 15” (18” minimum on cross drain culverts within the ETJ and open-ended culverts under a road). Installation of Class IV or higher concrete pipe shall be identified on the as-built plan and the City inspector shall be given documentation and notification of this information prior to construction.
3. Use flexible plastic joint material except when material of another type is specified in the contract documents. Joint material of another type may be used when permitted.
4. RCP < 42” in diameter, NCDOT Section 300 shall be used for installation.
5. RCP ≥ 42” in diameter:
    a. Wrap filtration geotextile fabric around all pipe joints. Extend geotextile at least 12” beyond each side of the joint. Secure geotextile against the outside of the pipe by methods approved by the Engineer.
    b. #57 stone shall be used as bedding. Bedding shall consist of a minimum of 7” in depth under the pipe, continuing up to the spring line of the pipe.
6. ASTM C969 and ASTM C1103 are acceptable methods of testing concrete pipe when testing is required by the Director of Engineering.

F. HIGH DENSITY POLYETHYLENE PIPE (HDPE)

1. HDPE pipe may be used outside the right-of-way.
2. The Product used shall be corrugated exterior/smooth interior pipe (Type S), conforming to the requirements of AASHTO Specification M294 (latest edition) for Corrugated Polyethylene Pipe and meet the minimum specifications set forth in Section 1032 of the NCDOT Standard Specifications for Roads and Structures.
3. Bell and spigot joints shall be required on all pipes inside the right-of-way. Bells shall cover at least 2 full corrugations on each section of pipe. The bell and spigot joint shall have an O-ring rubber gasket meeting ASTM F477 with the gasket factory installed, placed on the spigot end of the pipe. Pipe joints shall meet all requirements of AASHTO M294.
4. All HDPE pipe installed must be inspected and approved by the City’s Inspector prior to any backfill being placed. The City inspector must be present during the backfilling operation as well.
5. Bedding for HDPE pipe shall be Select Material Class III or Class II, Type 1, loosely placed to a depth as outlined in NCDOT Standard Drawing 300.01, Flexible Pipe.
6. Backfill material used to install HDPE pipe within the street right-of-way shall be Select Material, Class III or Class II, Type 1, as defined by Section 1016-3 of the NCDOT Standard Specifications for Roads and Structures. All backfill material shall be approved by the City inspector prior to placement of the material within the street right-of-way.
7. The minimum length of HDPE pipe permitted for use shall be 4’. HDPE flared end sections or fittings are not allowed.
8. All HDPE pipe installed shall be third party certified and shall bear the Plastic Pipe Institute’s (PPI) certificate sticker.
9. All HDPE pipe shall be checked for deflection using a mandrel no sooner than 30 days after installation of the final backfill and prior to the final acceptance of the pipe. The mandrel size shall not be more than 5% of the inside diameter of the pipe, see Appendix A for dimensions of mandrel.
10. ASTM F1417 or ASTM 2487 shall be used when testing is required by the Director of Engineering.

G. POLYPROPYLENE PROFILE WALL PIPE (HPPP)

1. The Director of Engineering may approve the use of HPPP for use both within and outside the right-of-way.
2. HPPP 12” – 60” dual pipe shall have a smooth interior and annular exterior corrugations; 30” – 60” triple wall pipe shall have smooth interior and exterior surfaces with the exterior having minor annular corrugations.
3. HPPP of the sizes shown or specified shall conform to:
    a. ASTM F2736 Standard Specification for 6” - 30” Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
    b. ASTM F2764 Standard Specification for 30” - 60” Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
4. Submittals shall include:
    a. Manufacturer’s product information including details of installation, joints and pipe/manhole connections; properties and strengths of pipes; and instructions on storage, handling, transporting and installation.
    b. Pipe design load calculations (suggested if deep burial is an issue).
    c. Factory test reports.
5. Pipe shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2736.
6. Pipe diameters 12” - 60” shall be watertight according to the requirements of ASTM D3212, with the addition of a 15-psi requirement. Spigot shall have 2 gaskets meeting the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gaskets are free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.
7. 12” - 60” diameters shall have a reinforced bell with a polymer composite band installed by the manufacturer.
8. Damaged pipe will be rejected and shall be replaced at the Contractor’s expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.
9. Fittings shall not be allowed. Any change in direction and/or additional pipes shall have a catch basin, manhole or junction box installed at the necessary location.
10. HPPP shall be installed within 6 months of delivery to project site unless written approval is granted from the manufacturer and approved by the Engineer. Approval of an extension in storage time must be requested in writing and accompanied by inspection within 2 weeks prior to installation by an authorized representative of the manufacturer.
11. Long-term above ground storage of HPPP and fittings shall conform to the following procedure:
    a. Pipe shall be stored on flat timber supports to facilitate placement and removal of lifting slings around pipe. All pipes shall be chocked to prevent rolling in high winds.
    b. If stacked, minimum 3” wide timber supports shall be used and placed at the quarter points with chocks. Pipe shall not be stacked higher than 10’ above the ground.
    c. Pipe and Fitting laydown should be relatively flat and free of other potentially damaging debris. Laydown area should have proper drainage. At no time, shall any portion of pipe or fittings be stored in standing water for more than 24 hrs.
12. Pipe shall be handled using textile slings or other means recommended by manufacturer. Chains and cables in direct contact with pipe are not recommended.

13. Installation
    a. Shall be in accordance with NCDOT Specifications, Section 300, and ASTM D2321 and manufacturer recommended installation guidelines.
    b. Minimum cover in traffic areas for ≤ 48” shall be 1.0’
    c. Minimum cover in traffic areas for ≥ 60” shall be 2.0’.
    d. Backfill material for minimum cover situations shall consist of:
        i. Class 1
        ii. Class 2: 95-85% SPD
        iii. Class 3: 95-90%
        iv. Class 4: 95%
14. Jointing:
    a. Clean ends of pipe and coupling components.
    b. Apply joint lubricant to pipe ends and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer.
    c. Use suitable equipment and end protection to push or pull the pipes together.
    d. Do not exceed forces recommended by the manufacturer for coupling pipe.
    e. Join pipes in straight alignment. Do not allow any deflection angle or pipe misalignment to exceed the maximum permitted by the manufacturer.
15. Backfill
    a. Use non-cohesive materials include gravels, gravel-sand mixtures, sands, and gravelly sands.
    b. Accomplish immediately after the pipe is laid.
    c. The fill around the pipe shall be placed in layers not to exceed 8”.
    d. Compacted to 95% of the maximum density with the AASHTO T 99 Modified Proctor Test.
    e. A density of 100% AASHTO T 99 Modified Proctor is required for the top 8”.
16. Testing Polypropylene Profile Wall Pipe
    a. Water tightness test (if required by the Director of Engineering) may be accomplished in accordance with ASTM F1417 or ASTM F2487.
    b. Deflection shall be checked using a mandrel no sooner than 30 days after installation of the final backfill. The mandrel size shall not be more than 5% of the inside diameter of the pipe, see Appendix A for dimensions of mandrel.
17. Provide properly trained manufacturer’s service technician employed by the manufacturer to ensure proper installation of Polypropylene Profile Wall Pipe.

H. CORRUGATED ALUMINIZED METAL PIPE - SPECIAL DESIGN (CAMP)

1. Corrugated Aluminized Steel Type 2 pipe, Corrugated Aluminum Alloy Structural Plate pipe, or Corrugated Aluminum Alloy Structural pipe arches may be used in special locations for culverts ≥ 60” in diameter. Type 1A Corrugated Metal Pipe shall not be allowed. The metal pipe shall be a minimum of 14-gauge metal. All pipe must be supplied by NCDOT approved manufacturers.
2. Bedding, installation and backfill of CAMP piping shall follow NCDOT specifications for flexible pipe in Section 300.
3. The minimum cover for CAMP piping shall follow NCDOT specifications and manufacturer recommended specifications, whichever is the more restrictive.
4. Corrugated aluminum alloy culvert pipe shall meet AASHTO M 196, except that Type IA pipe will not be permitted.

5. When a pipe is proposed to be installed in a stream with high velocity (>15 fps) runoff and with heavy bed load (especially angular rocks with sharp corners), the design and pipe gage must be evaluated for abrasion.
6. The soil water environment shall have a pH range between 4.0 to 9.0 and a resistivity of 500 ohm-cm or greater.
7. Galvanized steel, asphalt coated, and polymer coated pipe shall not be permitted.

I. SPECIAL STRUCTURES

1. Bridges, arch culverts, retaining walls, box culverts bottomless culverts, large headwalls, etc. shall be reviewed on a case-by-case basis depending on the intended use and environmental impacts associated with the project. The Director of Engineering shall set forth guidelines for the design of Special Structures.
2. All Special Structures shall be designed by a licensed professional with credentials to support the intended design and work.
3. All Special Structures shall follow the specifications, certifications and approval processes associated with Federal, State, and Local agencies, along with the requirements of this manual.

J. PIPE INSPECTIONS, REPORTS, AND ACCEPTANCE

1. All storm drainage pipe installed in the R/W and/or easements require pipe video inspections. Remote inspection video equipment shall be able to accurately measure and verify crack widths as small as 0.05”.
2. The pipe inspection report shall include the location, length, and width measurements of all cracks. Cracks shall be recorded to the nearest 0.50” for length and 0.05” for width.
3. The pipe inspection report shall include all pipe joint separations ≥ 0.50”.
4. For longitudinal cracks having widths ≥ 0.10” and ≥ 3.0’ in length, replace the pipe.
5. For circumferential cracks allowing entry of backfill, replace the pipe.
6. For multi-directional crack patterns where the damage extends over ≥ 25% of inside circumference at a single location and crack widths ≥ 0.05”, replace the pipe.
7. If infiltration or exfiltration is observed and the joint gap is < 0.75”, provide minor repair to be approved of and field verified by the design engineer.
8. If the pipe joint gap is > 0.75”, replace the pipe.
9. For pipe with spalling that has exposed reinforcement, replace the pipe.
10. For flexible pipes with deflections > 7.5%, replace the pipe.

K. SCM ESCROW, ESTIMATES, and SURETIES

Single family residential developments require SCM escrow agreements, construction and maintenance sureties which include a signed and sealed cost estimate from the design engineer. The escrow agreement provides for lifetime replacement of the SCM once installed while the surety serves as a means for the City to construct the SCM in its entirety in the event of the developer’s default. The following line items shall be included in the estimate for review and approval:

1. Contractor mobilization costs.
2. Complete SCM construction cost based on current average construction costs that would be incurred for the entire SCM, not a contractor’s bid value for the project. Assume that any existing sediment basins must be reworked prior to the conversion of the basin into a permanent SCM. The value should include the cost of installing erosion control measures for the basin construction (e.g. construction entrance, silt fence, sediment basin pump out, and any other site-specific erosion and sediment control items required to construct the SCM).
3. Maintenance costs to include mowing, annual inspections, structural and vegetative stabilization/re-stabilization, taxes, and insurance premiums.

4. Surveying costs for the as-built record drawing certifications.
5. Engineering costs for the as-built record drawing certifications.
6. Easement plat surveying for the plat dedication.
7. Easement acquisition costs including land value for the easement, attorney fees, and condemnation costs.
8. A minimum of 2 years of calculated HOA annual re-build payments contained within the stormwater escrow agreement.