

EMBANKMENT REQUIREMENTS





Embankment Requirements

The following embankment specifications apply to all stormwater and water quality facilities with embankments that are designed to hold water, even if the embankment is designed to hold water only during a storm event:

Fill Materials

The following parameters apply to materials used to construct earthen embankments:

Borrow material shall be classified as ML, MH, SC, SM, CL or CH soils according to the Unified Soil Classification System (ASTM D2487) or any mixture of these soils.

Borrow materials shall have a liquid limit (LL) between 40 and 60 and a plasticity index (PI) between 15 and 30 (ASTM D4318).

Materials shall be free of topsoil, organic or frozen material, roots, stumps, brush, rocks larger than 3.0", subsoil, debris, vegetation, and other foreign matter.

All material clods will be broken down with tillers and/or discs to provide a homogeneous soil that is free of clay clods greater than 3.0" in diameter.

Construction

The following steps apply to construction of an earthen embankment:

1. Foundation Preparation

- a. Compact foundation to density requirements for subsequent fill materials.
- b. Cut out soft areas of foundation not capable of compaction in place.
- c. Scarify foundation surface to depth of 6.0".
- d. Proof roll foundation to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

2. Seepage Key Placement

- a. Seepage key trench will be located between embankment abutments.
- b. Seepage key shall extend to a minimum depth of 4.0' or as required through geotechnical seepage analysis. A minimum bottom trench width shall be 10.0' and the trench sidewalls shall be sloped or benched to promote stability and bonding between the sidewall soils and seepage key fill.

3. Fill Placement

- a. Earthen embankment fill shall be constructed at 3:1 slopes or as shown on the drawings. Demonstration of appropriate safety factors against failure through geotechnical analysis shall be required for slopes steeper than 3:1.
- b. Fill soils shall be placed in loose lifts not to exceed 8.0” in thickness and be compacted to a minimum of 95% maximum dry density (Standard Proctor ASTM D698) with a moisture content within $\pm 3\%$ of the optimum, unless otherwise specified by the engineer.
- c. Fill soils should be placed in continuous, horizontal layers from abutment to abutment. Existing slopes greater than 4:1 shall be benched to promote bonding of newly placed fill with existing soils. Benching shall be performed at maximum of 2.0’ vertical intervals and shall extend a minimum of 4.0’ horizontally or as specified on Drawings.
- d. Within the upper 12.0” of earthen embankment, fill soils should be compacted to 100% of its Standard Proctor (ASTM D698) maximum dry density.
- e. Fill against supported structures. Do not fill against unsupported structures.
- f. Place fill simultaneously on each side of unsupported structures until supports are in place.
- g. Place a minimum of 6.0” of Planting Mix (Ref City of Charlotte Landscape Construction Standards) across dam embankment to promote vegetative growth.

4. Outfall Pipe Fill Placement

- a. Fill of the culverts shall be placed and compacted in 6.0” thick loose lifts around the drop inlets and up to 2.0’ above the culverts.
- b. Compaction shall be performed by hand tampers or small hand operated compactors.
- c. Compaction shall be a minimum of 95% maximum dry density (Standard Proctor ASTM D698) with a moisture content within $\pm 3\%$ of the optimum, unless otherwise specified by the engineer.
- d. Additional compaction of lifts 2.0’ or greater above culverts shall conform to the Fill Placement section of this specification.

5. Field Quality Control

- a. Laboratory Testing
 - i. Perform laboratory material tests in accordance with ASTM D422, ASTM D698, ASTM D2216, and ASTM D4318.
 - ii. Test at a frequency of every 500cy of earthen embankment fill material placed, when materials used for embankment fill change, and/or as directed by the Engineer.
 - iii. Sample size shall be 50-lb.

b. In-Place Compaction and Natural Moisture Content Tests

- i. Perform in place compaction tests in accordance with ASTM D1556, ASTM D2922, or ASTM D2937 and natural moisture content test in accordance with ASTM D2216.
- ii. Frequency of compaction/natural moisture content tests:

Embankment Fill: Each lift at a minimum frequency of 1 per 2,500 sq. ft.

Pipe Installation: Each lift at a minimum frequency of 1 per 30 lf of pipe.
- iii. When tests indicate work does not meet specified requirements, remove work, replace, rework, recompact, and retest.

Allowable Variances

Earthen embankment specifications may be modified based on site-specific geotechnical investigation and engineering design.

References

Charlotte-Mecklenburg BMP Design Manual

City of Charlotte Landscape Construction Standards

ASTM D422 - Standard test Method for Particle-Size Analysis of Soils (Grain Size with Hydrometer)

ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).

ASTM D1556 – Standard Test Method for Density of Soil In-Place by the Sand-Cone Method.

ASTM D2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

ASTM D2487 – Standard Practices for Classification of Soil for Engineering Purposes (Unified Soil Classification System)

ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).

ASTM D2937 - Standard Test Method for Density of Soil In-Place by the Drive-Cylinder Method Test.

ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.