



Soil Investigation Report Submittal Checklist

DATE RECEIVED: _____ **PROJECT NUMBER:** _____

PROJECT NAME: _____

The items contained on this checklist are necessary to properly evaluate and determine the completeness of any Soil Investigation Report submitted under subsection 12.1 of the Delaware Sediment and Stormwater Regulations. Complete all items. It is understood not all items will be applicable to all projects and as such marking an item "N/A" is acceptable.

- I. _____ **General Soil Investigation Reports.** The following information, as applicable, should be submitted for all projects.
- 1) _____ The signature, seal and date of a professional engineer or professional geologist experienced in soils licensed in the State of Delaware.
 - 2) _____ General description of the project, project elements, and project background.
 - 3) _____ Project site surface conditions and current use.
 - 4) _____ Regional and site geology. An initial screening of readily available data to determine feasibility of infiltration practices, if applicable, including:
 - a) _____ Site topography
 - b) _____ Soil characteristics as defined in the USDA NRCS Web Soil Survey
 - c) _____ Depth to groundwater and seasonal high water table
 - d) _____ Historical groundwater level data from the nearest Delaware Geological Survey (DGS) monitoring well or wells
 - 5) _____ Minimum number of borings or test pits conducted in accordance with the following:
 - a) _____ Surface area BMPs:
 - i) _____ Two (2) borings or pits for the first 8,000 square feet
 - ii) _____ Three (3) borings or pits for up to 16,000 square feet
 - iii) _____ Four (4) borings or pits for up to 25,000 square feet
 - iv) _____ One (1) additional boring or pit for each additional 25,000 square feet beyond the first 25,000 square feet
 - v) _____ Boring or pit locations distributed within the facility and sufficient to determine soil variability
 - b) _____ Linear BMPs:
 - i) _____ Two (2) borings or pits up to 500 linear feet, and
 - ii) _____ One (1) additional boring or pit per additional 500 linear feet of trench
 - iii) _____ Boring or pit locations distributed and sufficient to determine soil variability

Soil Investigation Report Submittal Checklist

- 6) ____ Borings or test pits advanced to the depth of the limiting layer or a minimum of three (3) feet below bottom of the proposed facility, whichever is encountered first.
- 7) ____ Borehole or test pit logs including the following information:
 - a) ____ Project name
 - b) ____ Name of individual collecting the field data
 - c) ____ Date field data was collected
 - d) ____ Type of boring or test pit excavation method and equipment used
 - e) ____ Air temperature and precipitation, including significant precipitation prior to investigation
 - f) ____ Elevation of ground at boring location based on site benchmark
 - g) ____ Visual description of soil profile layers, and depths below grade encountered
 - h) ____ Sample numbers
 - i) ____ Depths to any indications of instability such as cave in, sloughing, flowing sands, or obstructions
 - j) ____ Blow counts if Standard Penetration Test (SPT) borings are performed
 - k) ____ Depth of seasonal high water table indicators such as mottling
 - l) ____ Depth of encountered free water during and after excavation
 - m) ____ Depth to bedrock if encountered
 - n) ____ General observations
 - o) ____ Testing standards
- 8) ____ Depth and type of field testing performed. A summary of the laboratory testing conducted, if applicable.
- 9) ____ Project soil and rock conditions including a description of the soil and rock units encountered, and how the units tie into the site geology.
- 10) ____ Description of groundwater conditions, including the identification of any of the following:
 - a) ____ Confined aquifers
 - b) ____ Artesian pressures
 - c) ____ Perched water tables
 - d) ____ Potential seasonal variations, if known
 - e) ____ Any influences on the ground water levels observed
 - f) ____ Direction and gradient of groundwater, if known
- 11) ____ Discussion of rock structure, if applicable, including but not limited to:
 - a) ____ The results of any field structure mapping using photographs as needed,
 - b) ____ Joint condition

Soil Investigation Report Submittal Checklist

- c) ___ Rock strength
- d) ___ Potential for seepage.
- 12) ___ Summary of geological hazards identified and their impact on the project design, if any. Description of the location and extent of the geological hazard.
- 13) ___ For analysis of unstable slopes including existing settlement areas, cuts, and fills, include background regarding the analysis approach, assessment of failure mechanisms, and determination of design parameters. Include a description of any back-analyses conducted, the results of those analyses, comparison of those results to any laboratory test data obtained, and the conclusions made regarding the parameters to be used for final design.
- 14) ___ Geotechnical recommendations for structural earthwork including:
 - a) ___ Embankment design recommendations, as applicable, including but not limited to the following:
 - i) ___ Slope required for stability
 - ii) ___ Need and extent of removal of any unsuitable materials beneath the proposed fills
 - iii) ___ Any other measures that need to be taken to provide a stable embankment
 - iv) ___ Embankment settlement magnitude and rate
 - b) ___ Cut design recommendations, as applicable, including but not limited to the following:
 - i) ___ Slope required for stability
 - ii) ___ Seepage and piping control
 - iii) ___ Erosion control measures
 - iv) ___ Any special measures required to provide a stable slope
 - c) ___ Determination of adequacy of excavated material for use as structural fill or spoil
 - d) ___ Data for structural designs of BMP outlet works
- 15) ___ Long-term or construction monitoring needs, if applicable.
 - a) ___ Recommendation for types of instrumentation needed to evaluate long-term performance or to control construction
 - b) ___ Specify the reading schedule required
 - c) ___ Specify how the data should be used to control construction or to evaluate long-term performance
 - d) ___ Specify the zone of influence for each instrument.
- 16) ___ Address issues of construction staging, shoring needs and potential installation difficulties, temporary slopes, potential foundation installation problems, earthwork constructability issues, and dewatering, as applicable.
- 17) ___ Appendices to support geotechnical recommendations.

Soil Investigation Report Submittal Checklist

II. _____ **Infiltration Test Reports.** The following information, as applicable, should be submitted for all stormwater management BMPs that rely upon infiltration.

- 18) _____ Description of approved infiltration testing method.
- a) _____ Field Permeability Testing conducted in accordance with ASTM-D5126 "Comparison of Field Methods for Determining Hydraulic Conductivity in the Vadose Zone".
 - b) _____ Single Ring or Double Ring Infiltrometer test method
 - c) _____ Cased Borehole Permeameter test method
 - i) _____ Department or Delegated Agency approval granted prior to conducting the test
 - ii) _____ Minimum four (4) inch diameter casing used
 - d) _____ Any deviation from infiltration testing procedures approved by the Department or Delegated Agency noted in the report.
- 19) _____ Summary table of location of test, depth of test, elevation of test if available and field verified infiltration rate.
- 20) _____ The minimum number of field measured infiltration tests are based on the proposed facility's dimensions as follows:
- a) _____ For an infiltration trench with less than 10,000 square feet of impervious drainage area:
 - i) _____ One (1) test up to 500 linear feet, and
 - ii) _____ One (1) additional test per 250 linear feet of trench, and
 - iii) _____ Sufficient to determine variability.
 - b) _____ For an infiltration trench with greater than 10,000 square feet of impervious drainage area:
 - i) _____ One (1) test up to 250 linear feet, and
 - ii) _____ One (1) additional test per 250 linear feet of trench, and
 - iii) _____ Sufficient to determine variability.
 - c) _____ For an infiltration trench used with roadway perforated pipe layouts:
 - i) _____ One (1) test up to 500 linear feet, and
 - ii) _____ One (1) additional test per 500 linear feet of trench, and
 - iii) _____ Sufficient to determine variability.
 - d) _____ For an infiltrating bioretention system:
 - i) _____ One (1) test for the first 8,000 square feet
 - ii) _____ Two (2) tests for up to 16,000 square feet
 - iii) _____ Three (3) tests for up to 25,000 square feet
 - iv) _____ One (1) additional test for each additional 25,000 square feet beyond the first 25,000 square feet

Soil Investigation Report Submittal Checklist

- v) ___ Test locations distributed within the facility and sufficient to determine variability.
- e) ___ For a surface infiltration basin:
 - i) ___ One (1) test for the first 8,000 square feet
 - ii) ___ Two (2) tests for up to 16,000 square feet
 - iii) ___ Three (3) tests for up to 25,000 square feet
 - iv) ___ One (1) additional test for each additional 25,000 square feet beyond the first 25,000 square feet.
 - v) ___ Test locations distributed within the facility and sufficient to determine variability.
- f) ___ For a subsurface infiltrating practice:
 - i) ___ One (1) test per infiltration area
 - ii) ___ One (1) additional test for every 8,000 square feet of infiltration area
 - iii) ___ Test locations distributed within the facility and Sufficient to determine variability
- 21) ___ Infiltration test log, including:
 - a) ___ Name and license number of individual performing test. Individuals in responsible charge of infiltration testing possesses a Class D On-Site License issued by DNREC Division of Water Groundwater Discharges Section or be licensed in the State of Delaware as a Professional Engineer or Professional Geologist.
 - b) ___ Date test was performed
 - c) ___ Type of test method
 - d) ___ Air temperature and precipitation
 - e) ___ Depth of test below ground surface and elevation. Separation to a limiting layer such as bedrock or groundwater of at least two (2) feet maintained.
 - f) ___ Diameters of boring and casing
 - g) ___ Depth of casing penetration
 - h) ___ Time and depth from reference point for each time increment.
 - i) ___ A saturation period of one hour or a drop of 12 inches or 30.5 centimeters achieved. Saturation period not used in determining field verified infiltration rate.
 - ii) ___ After the saturation period, a minimum of two (2) test periods completed or until at least two (2) consecutive test periods are consistent and achieve a stabilized infiltration rate. Each test period has a maximum reading interval of 15 minutes and meets one (1) of the following criteria:
 - (1) ___ A minimum of one hour as determined by the sum of the interval times
 - (2) ___ A drop of at least 12 inches in 15 minutes or less for a minimum of 30 minutes as determined by the sum of the interval times

Soil Investigation Report Submittal Checklist

- iii) ___ Stabilized infiltration rate met as defined as one of the following:
 - (1) ___ A difference of 0.25 inches or less of drop between the highest and lowest reading of four (4) consecutive readings for infiltration rates greater than two (2.0) inches per hour
 - (2) ___ A difference of 0.125 inches or less of drop between the highest and lowest reading of four (4) consecutive readings for infiltration rates equal to or less than two (2.0) inches per hour.
- iv) ___ When using the constant head test method, water level inside the casing maintained at a constant level or refilled to the starting level after each reading throughout the test period at no more than 15 minute intervals.
- v) ___ When using the falling head test method each test period starts with the same initial head.
- 22) ___ Infiltration rate graph for each test charting the field verified infiltration rate versus elapsed time of test. Append to each graph a table of the testing results. The field verified infiltration rate is the final steady state reading of the test performed.
- 23) ___ Geotechnical recommendations for each stormwater management facility, including the following:
 - a) ___ Recommended design infiltration rate based on the following:
 - i) ___ Apply a minimum factor of safety of 2.0 to field results from Single Ring or Double Ring Infiltrometer testing
 - ii) ___ Apply a minimum factor of safety of 2.5 to field results from Cased Borehole Permeameter testing.
 - iii) ___ Provide an elevation range over which the recommended design rates are applicable.
 - iv) ___ The maximum design infiltration rate is less than or equal to 15 inches per hour.
 - b) ___ Impact of infiltration on adjacent facilities
 - c) ___ Effect of infiltration on slope stability
 - d) ___ If the facility is located on a slope, stability of slopes within the facility
 - e) ___ Foundation bearing resistance
 - f) ___ If steady state conditions for a given test are not achieved, provide an explanation as to why steady state could not be achieved and the professional's opinion regarding the use of the results for design purposes. If steady state is not achieved for a given test and a reasonable professional opinion is not provided, the Department or Delegated Agency may require additional testing.

Soil Investigation Report Submittal Checklist

III. _____ **Geotechnical Reports for Embankments.** The following information, as applicable, should be submitted for all stormwater management BMPs containing an embankment.

- 24) _____ The signature, seal and date of a professional engineer licensed in the State of Delaware.
- 25) _____ Subsurface Exploration
 - a) _____ Explorations every 200 feet on center along the length of the embankment.
 - b) _____ Unless bedrock is encountered at a shallower depth, explorations at a depth twice the proposed height from bottom of pond to top of embankment.
 - c) _____ If bedrock is encountered, a minimum five (5) foot rock core performed. If organic, plastic, or soils with an actual or estimated N-value less than four (4) are encountered, extended exploration to a depth of four (4) times the proposed embankment height.
 - d) _____ If there is a potential for a significant groundwater gradient beneath an embankment or surface water levels are significantly higher on one side of the embankment than the other, the effect of reduced soil strength caused by water seepage has been evaluated.
 - e) _____ Seepage effects considered when an embankment is placed on or near the top of a slope that has known or potential seepage through it.
- 26) _____ Summary of design analyses, which provide the project description and basis of the design recommendations.
- 27) _____ Summary of stability analyses, which provide the results of the stability analyses performed for the given embankment dimensions.
- 28) _____ Summary of settlement analyses, including design assumptions and settlement results for above-grade embankments.
- 29) _____ Design recommendations for embankment construction identifying the following actions:
 - a) _____ Construction procedures for placement of material in embankment widening areas
 - b) _____ Embankment cut-off and core trench materials for above-grade embankments
 - c) _____ Special notes for excavation of unsuitable material, with specific backfill requirements
 - d) _____ Specific measures required prior to placing embankment material
 - e) _____ Installation of appropriate erosion control and vegetative cover