Appendices

F. Design Guidance Checklists

The Philadelphia Water Department's Stormwater Plan Review Design Guidance Checklists contained in Appendix F are a supplemental list of guidelines for regulatory compliance, plan creation, hydrologic modeling and calculations, and the design of specific stormwater management practices. They are provided to assist in the formation of both sound, compliant stormwater management designs and complete Post-Construction Stormwater Management Plan (PCSMP) submissions. The designer should use the checklists as guidance during the design and calculation stages or as useful quality assurance/quality control checks prior to PCSMP Review Phase submission.

F.1 Stormwater Regulation Compliance

F.1.1 Water Quality

1. Infiltrating Projects
    a. Verify that all DCIA within the project's limits of earth disturbance is routed to an SMP. [Section 1.2.1; Section 3.4.1]
    b. Verify infiltration of the Water Quality Volume from all DCIA within the limits of earth disturbance. This is achieved by providing static storage of the Water Quality Volume below the lowest outlet elevation of each SMP. [Section 3.4.1]
    c. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 1.2.1; Section 3.4.1]
2. Non-Infiltrating Projects Located in Combined Sewer Areas
    a. Verify that 100% of the Water Quality Volume is routed through an acceptable pollutant-reducing practice. Refer to Table 3.1-3 of the Manual for reference. [Section 1.2.1; Section 3.4.1]
    b. Verify that the hydrologic calculations include routing of the Water Quality storm event. [Section 1.2.1; Section 3.4.1]
    c. Verify that the release rate for the Water Quality Volume does not exceed 0.05 cfs per acre of DCIA. [Section 1.2.1; Section 3.4.1]
    d. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 1.2.1; Section 3.4.1]
3. Non-Infiltrating Projects Not Located in Combined Sewer Areas
    a. Verify that 100% of the Water Quality Volume is routed through an acceptable pollutant-reducing practice. Refer to Table 3.1-3 of the Manual for reference. [Section 1.2.1; Section 3.4.1]
    b. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 1.2.1; Section 3.4.1]

F.1.2 Channel Protection

1. Verify if the Channel Protection requirement is applicable.
    a. The project is exempt from Channel Protection if it is a Redevelopment project with less than one acre of earth disturbance. [Section 1.2.1]
    b. The project is exempt from Channel Protection if it is a Redevelopment project which reduces impervious area within the limits of earth disturbance (excluding public right-of-way) by at least 20%, based on a comparison of predevelopment impervious area to post-development DCIA. [Section 1.2.1]
    c. The project is exempt from Channel Protection if it is a Redevelopment project located in the Delaware Direct or Lower Schuylkill Watersheds. [Section 1.2.1]
    d. The project is exempt from Channel Protection if it is the development of new Streets and Street Maintenance Activities. [Section 1.2.1]

2. Verify that runoff from all DCIA, within the project's limits of earth disturbance, for the one-year, 24-hour storm event is released at a maximum rate of 0.24 cfs per acre of DCIA in no more than 72 hours. [Section 1.2.1; Section 3.4.1]

F.1.3 Flood Control

1. Verify if the Flood Control requirement is applicable.
    a. The project is exempt from Flood Control if it is a Redevelopment project that reduces impervious area within the limits of earth disturbance (excluding public right-of-way) by at least 20%, based on a comparison of predevelopment impervious area to post-development DCIA. [Section 1.2.1]
    b. The project is exempt from Flood Control if it is a Redevelopment project located in Flood Management District C that discharges directly to the Delaware Direct or Lower Schuylkill main channels without the use of City infrastructure. [Section 1.2.1]
    c. The project is exempt from Flood Control if it is a Redevelopment project located in District C-1 that discharges directly to the Tookany/Tacony-Frankford main channel or major tributaries without the use of City infrastructure. This exemption applies only to peak rates of runoff for storm events greater than the five-year storm. [Section 1.2.1]
    d. The project is exempt from Flood Control if it is a Redevelopment project located in the Delaware Direct Watershed or Lower Schuylkill Watershed, but situated outside of District C, that can discharge directly to the Delaware Direct or Lower Schuylkill main channels without the use of City infrastructure. [Section 1.2.1]
    e. The project is exempt from Flood Control if it is the development of new Streets and Street Maintenance Activities. [Section 1.2.1]
2. Verify that the project meets or reduces peak rates of runoff, as determined by its Flood Management District, from predevelopment to post-development conditions during certain storm events. Refer to Table 3.4-1 of the Manual for reference. [Section 1.2.1; Section 3.4.1]

F.1.4 Public Health and Safety Release Rate

1. If a Public Health and Safety (PHS) release rate applies to the project, verify that, for all areas within the project's limit of earth disturbance (pervious and impervious, alike), the post-development peak runoff release rate does not exceed the project-specific PHS Release Rate requirement (cfs per acre of limit of disturbance) when routing the one-year through ten-year, 24-hour storm events. [Section 1.2.1]

F.1.5 Expedited PCSMP Reviews

1. Disconnection Green Review
    a. Verify that the project is a Redevelopment project that is exempt from the Channel Protection and Flood Control requirements. [Section 2.4.1]
    b. Verify that 95% or more of the post-construction impervious area within the project's limits of earth disturbance is disconnected in accordance with Section 3.1.5. [Section 2.4.1]
    c. Verify that the project's intent to qualify for a Disconnection Green Review is indicated on the submitted ERSA Application. [Section 2.4.1]

2. Surface Green Review

   a. Verify that 100% of post-construction impervious area within the project's limits of earth disturbance is managed by disconnected impervious cover (DIC) and/or bioinfiltration/bioretention basins. [Section 2.4.2]

   b. Verify that the project's intent to qualify for a Surface Green Review is indicated on the submitted ERSA Application. [Section 2.4.2]

F.2 Post-Construction Stormwater Management Plan

F.2.1 PCSMP Drawings

1. General
    a. Verify that all plans meet all of the PWD general plan sheet requirements listed in Appendix E, Table E-1. [Section 2.3.1]
    b. Verify that all plans meet, at minimum, all of the Conceptual Stormwater Management Plan requirements listed in Appendix E, Table E-3. [Section 2.3.1]
    c. Verify that all plans, reports, and calculations are signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania. [Section 2.3.1; Appendix E, Table E-1]
    d. Verify that final plans for construction are provided for the project. Only Final Construction Drawings will be considered for PCSMP Approval by PWD Stormwater Plan Review. [Section 2.3.1]
    e. Verify that a north arrow, legend, and scale are provided on plans. [Appendix E, Table E-1]
    f. Verify that the proposed building footprint is labeled. [Appendix E, Table E-1]
    g. Verify that all acronyms and symbols are identified in the plan legends. [Appendix E, Table E-1]
    h. Verify that the plan legend is consistent with the plan view. [Appendix E, Table E-1]
    i. Verify that all plan drawings are legible. [Section 2.3.1; Appendix E, Table E-1]
2. Existing Conditions Plan
    a. Verify that the Existing Conditions Plan meets all of the PWD general plan sheet requirements listed in Appendix E, Table E-1. [Section 2.1.1]
    b. Verify that the Existing Conditions Plan meets all of the specific requirements for Existing Conditions Plans listed in Appendix E, Table E-2. [Section 2.1.1]
3. Details
    a. Verify that construction details are provided for all stormwater management practices. [Section 2.3.1]
    b. Verify that a pipe connection detail is provided for the proposed connection(s) to the existing storm sewer(s). [Section 3.4.2]
    c. Verify that dimensions of the proposed outlet control structure are provided. [Section 4.12.1, 6]

4. Drainage Area Plans

   a. Verify that drainage boundaries are based on site topography and include the entire tributary area, including any off-site drainage, if applicable. [Section 3.4.1; Appendix E, Table E-7]

   b. Verify that common points of analysis are chosen to compare predevelopment and post-development conditions. [Section 3.4.1; Appendix E, Table E-7]

   c. Verify that points of analysis are clearly labeled on the plans and in the stormwater model. [Section 3.4.1; Appendix E, Table E-7]

   d. Verify that pertinent existing stormwater infrastructure necessary to define the existing drainage conditions, including roof leaders, is shown. [Appendix E, Table E-7]

   e. Verify that the inlet drainage area for each inlet, trench drain, yard drain, and/or area drain is indicated on the plans and that the following information is clearly labeled and accurate for each area: [Appendix E, Table E-7]

      i. Inlet drainage area

      ii. Inlet time of concentration

      iii. Impervious and pervious cover within each inlet drainage area

      iv. Runoff coefficient

   f. Verify that the roof drainage area for each roof leader is indicated on the plans. [Appendix E, Table E-7]

   g. Verify that boundaries and square footages of Stormwater Management Banking or Trading areas, if proposed, are clearly identified on the plans. [Section 3.2.4]

   h. Verify that boundaries and square footages of fee in lieu areas, if proposed, are clearly identified on the plans. [Section 3.4.1]

F.2.2 Grading Design

1. Verify that the proposed grading is provided. [Section 2.3.1]

   a. Verify that there is positive slope away from the proposed buildings.

   b. Verify that proposed contours are closed or tie in to the existing contours at the limit of earth disturbance.

   c. Verify that spot grades are provided as necessary.

2. Verify that all DCIA within the project's limit of earth disturbance is captured, especially at the site's ingress and egress areas. [Section 1.2.1; Section 3.4.1]

F.2.3 Utilities and Storm Sewer Design

1. Verify that the length, material, size, and slope of all piping associated with stormwater conveyance and roof drainage systems are clearly labeled on the plans. [Section 3.4.2]
2. Verify that pipe lengths, slopes, and inverts are accurate. Compare pipe information to profiles, if provided, for consistency. [Section 3.4.2]
3. If roof runoff isolation is proposed as a non-infiltrating pollutant-reducing practice, verify that the runoff discharges into a combined sewer and that the runoff is routed from a non-vehicular roof area that is not commingled with untreated runoff. [Section 3.1.7]
4. Verify that no piping conflicts exist.[Section 3.4.2]
5. Verify that inlets are not connected in series. Wye connections, or similar, may be used to ensure that inlets are offline. [Section 3.4.2]
6. Verify that roof drainage systems do not tie directly into an inlet. [Section 3.4.2]
7. Verify the separation distance between all utility crossings. A minimum of 12 inches of vertical clearance is required when a sanitary sewer line crosses above a storm sewer line. The sanitary sewer must be encased in concrete if the clearance is less than 12 inches. [Section 3.4.2]
8. Verify that any manholes between outlet structures and sewer connections in combined sewer areas have sanitary (non-vented) covers. [Section 3.4.2]
9. Verify that a cleanout is provided, at minimum, every 75 feet, at the end of all pipes, and for all 90-degree pipe bends in the storm sewer system and that a cleanout detail is provided on the plans. [Section 3.4.2]
10. If curb cuts or non-standard inlets are used to capture runoff, especially from driveways or roadways where the inlets are not in a sump condition, verify that the one-year, 24-hour storm event will be captured by the inlet. [Section 3.4.2]
11. Verify that the invert elevation(s) for the proposed connection(s) to the existing City sewer is/are specified. [Section 3.4.2]
12. Verify that the outlet culvert(s) is/are right-sized to minimize impacts on PWD infrastructure. [Section 3.4.2]
13. Verify that all stormwater conveyance pipe material is in compliance with the City of Philadelphia Plumbing Code (Plumbing Code). [Section 3.4.2]
14. Verify that a minimum cover of 36 inches is provided over all private storm sewer pipes, in accordance with the Plumbing Code. [Section 3.4.2]
15. Verify that stormwater conveyance pipes are designed with a minimum velocity of two feet per second. Designs should attempt to maintain velocity without sacrificing SMP depth. [Section 3.4.2]
16. Verify that all proposed connections to the City sewer are right-sized to convey the necessary flow while minimizing the pipe diameter. [Section 3.4.2]

17. Verify that all proposed connections to the City sewer will be inspected by PWD Water Transport Records. Instructions for obtaining a sewer connection permit can be found on the PWD **Stormwater Plan Review** ☛ www.pwdplanreview.org/ website. Refer to Section 2.5 for more information on Water Transport Records. [Section 3.4.2]
    a. Verify that commercial buildings and residential buildings with four or more stories have separate fire service connections.
    b. Verify that any sewer or water connection is made directly to the pipe and not directly to a manhole or street inlet.
    c. Verify that any sewer or water connection is made perpendicular to the pipe to which the connection is proposed.
    d. Verify that any sewer or water connection is smaller in diameter than the PWD pipe to which the connection is proposed. The minimum allowable sanitary sewer pipe diameter is 5 inches, and the minimum allowable storm and combined sewer pipe diameter is 6 inches.
    e. Verify that all PWD sewer and water mains to which connections are proposed are labeled with correct sizes and materials.
    f. Verify that, for MS4 separate sewer areas, sanitary sewer connections are made for sanitary laterals and storm sewer connections are made for storm sewer conveyance.
    g. Verify that for combined sewer areas, sanitary and storm sewer piping is kept separate. A fresh air inlet must be proposed on each pipe.
    h. Verify that connections are made to an active sewer or water main.
    i. Verify that connections are not made to an intercepting sewer or transmission main.
    j. Verify that connections are not made to a private sewer or water main or to existing lateral on an adjacent property.
    k. Verify that no structures, private drainage infrastructure (e.g., inlets, pipes, manholes, SMPs, etc.), or vertical encroachments are proposed within any public or drainage right-of-way.
    l. Verify that only RCP or rigid pipe connections are made to PWD infrastructure. Plastic pipe connections are not permitted.
    m. Verify that any sanitary lateral connection to a sanitary-only public sewer is smaller in diameter than the house drain, and is in no case less than 5 inches in diameter.
    n. Verify that any stormwater lateral is no smaller than 6 inches in diameter.
    o. Verify that any combined sanitary and stormwater lateral is no smaller than 6 inches in diameter.
18. Verify that at least two feet of clearance between the bottom of the SMP and the crown of the City sewer pipe, and/or a backflow prevention device, is provided to alleviate potential flooding from the City sewer which is regularly at full capacity. [Section 3.4.2]

19. Verify that Private Cost plans are submitted to the PWD Design Branch for review, if applicable. Refer to Section 2.5 for more information on Private Cost project requirements. [Section 2.5]
    a. Verify that all Private Cost work (i.e., extensions of PWD infrastructure, such as new sewer or water mains) or modifications to existing infrastructure (i.e, moving inlets, fire hydrants, etc.) are labeled on the plans.
    b. Verify that all PWD pipes to be abandoned are properly labeled on the plans.
    c. Verify that all City streets or drainage rights-of-way to be abandoned are properly labeled on the plans.
    d. Verify that all laterals and proposed Private Cost sewer or water mains are designed to flow by gravity.
20. Verify that a copy of the plans is submitted to the Department of Licenses and Inspections (L&I) for review if the project proposes an oil/water separator. Refer to Section 2.6 for more information on L&I permitting. [Section 2.6]
21. Verify that stormwater conveyance piping and SMPs are not receiving runoff from fueling station pads for gas stations. The drainage area under a pad's canopy must be treated by an oil/water separator then discharge directly to the sanitary sewer system. [Section 3.4.2]
22. Verify that any project which proposes stormwater conveyance piping or SMPs that encroach onto an adjacent property has obtained a drainage easement. [Section 3.4.2]

F.2.4 PCSMP Report

1. Verify that the PCSMP Report meets all of the specific PCSMP Report requirements listed in Appendix E, Table E-7. [Section 2.3.1]
2. Verify that the PCSMP Report is signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania. [Section 2.3.1; Appendix E, Table E-7]
3. Verify that the PWD Stormwater Plan Review Online Technical Worksheet is completed, as necessary, and submitted with the PCSMP Review Phase Submission Package. [Section 3.4.1; Appendix E, Table E-7]

4. Operations and Maintenance Agreement

a. Verify that a site-specific SMP Maintenance Guide is provided. [Section 6.1; Appendix E, Table E-7]

i. Verify that an SMP Maintenance Guide Site Map is included.

i. Verify that the SMP Maintenance Guide Site Map identifies the on-site SMPs and key SMP-related features which require maintenance, using unique, legible, labels, and provides a list of structures and SMP-related features, identifying the associated SMP(s) for each.

ii. Verify that the SMP Maintenance Guide Site Map includes a Color Legend that adheres to the Color Legend provided in the SMP Maintenance Guide document provided in Appendix G.

iii. Verify that the SMP Maintenance Guide Site Map is sized 11" x 17". (Multiple sheets may be used, if necessary.)

iv. Verify that the SMP Maintenance Guide Site Map is consistent in format with the SMP Maintenance Guide Sample's Site Map, provided in Appendix G.

ii. Verify that a site-specific SMP Maintenance Schedule Form is included for each proposed SMP and SMP-related structure, using the templates provided in Appendix G.

i. Verify that each schedule provides for inspection of the SMP or SMP-related structure, including routine maintenance, repair, and replacement.

ii. Verify that each schedule provides for a report documenting each inspection and all SMP maintenance activities performed as a result of the inspections.

b. Verify that the "Operations and Maintenance Agreement Information" section of the Online Technical Worksheet is completed. [Section 2.3.1; Appendix E, Table E-7]

i. Verify that the listed property owner is consistent with the property owner named in Public Records.

ii. Verify that the business title of the provided signatory is appropriate to the property owner business entity.

iii. Verify that a legal description of the property is provided in an electronically editable (Word document) format.

c. Verify that a copy of the Agreement of Sale, or similar documentation, is provided to demonstrate the current owner's intent to convey the property to the developer, if applicable.

d. Verify that documentation supporting a lot consolidation or subdivision plan is provided to demonstrate the intent to change the address of the current property, if applicable.

5. Construction Certification Package

a. Verify that a site-specific SMP Construction Certification Form is provided for each proposed SMP, customized by the project's design professional and to be completed by a registered professional during construction. [Section 5.3.1; Appendix E, Table E-7]

b. Verify that each SMP Construction Certification Form is customized to adequately record and verify all required measurements that are most critical to the listed SMP's ability to perform its designed function (e.g., elevations, outlet control sizes, surface areas, layer depths, etc.) [Section 5.3.1]

6. Verify that proof of application for applicable State and Federal permits is submitted with the PCSMP Review Phase Submission Package. This can be in the form of copies of permit applications, application receipts, or notification letters from relevant agencies. Applicable State permits include, but are not limited to, a PA DEP NPDES Permit if one acre or more of earth disturbance activity is proposed. [Section 2.3.1; Appendix E, Table E-7]
7. Verify that a discussion on proposed Stormwater Management Banking and Trading is provided, if applicable. [Section 3.2.4; Appendix E, Table E-7]
    a. Verify that the type of Stormwater Management Banking or Trading proposed is provided.
    b. Verify that a description of the area(s) proposed to be banked or traded is provided.
    c. Verify that the square footage(s) of area(s) proposed to be banked or traded is provided.
    d. Verify that justification for the proposed bank or trade, including reasons why management of the required area(s) is not feasible and why PWD may benefit from the proposal, is provided.
8. Verify that a discussion on proposed fee in lieu is provided, if applicable. [Section 3.4.1; Appendix E, Table E-7]
    a. Verify that the square footage(s) of area(s) for proposed fee in lieu is provided.
    b. Verify that all Water Quality stormwater management strategies considered and rejected are outlined.
    c. Verify that justification for the proposed fee in lieu, including reasons why all considered stormwater management strategies are not feasible or advisable, is provided.

F.3 Erosion and Sediment Control

F.3.1 E&S Plans

1. Verify that the E&S Plans meet all of the E&S Plan requirements listed in Appendix E, Table E-4. [Section 2.3.1]
2. Verify that the E&S Plans include all standard E&S notes listed in Appendix E, Table E-5. [Section 2.3.1]
3. Verify that the boundaries of, and total area encompassed by, the limit of earth disturbance are clearly indicated on the plans and that the area is consistent with the area provided on the PWD Stormwater Plan Review Online Technical Worksheet. [Section 2.3.1; Appendix E, Table E-4]
4. Verify that the limit of disturbance includes all off-site storm and utility connections. [Appendix E, Table E-4]
5. If a PA DEP NPDES Permit has not been applied for, verify that the limit of disturbance remains less than one acre. Site disturbance limits within approximately 10% of one acre are more likely to reach or exceed one acre during construction. Therefore, PWD recommends applying for a PA DEP NPDES Permit in such a situation. Should a site inspection reveal more than one acre of earth disturbance, the site will be required to apply for a PA DEP NPDES Permit. The site will be subject to the enforcement actions outlined in the Stormwater Regulations until the applicant receives an approved NPDES Permit. [Section 2.3.1]
6. Verify that soil compaction has been minimized, even in areas not proposed for infiltration SMPs, to the extent practicable. [Section 5.2.2]
7. Verify that the E&S Plans propose, in plan view, the location of any orange construction fence or silt fence proposed to protect and mark infiltration areas. [Section 5.2.2]
8. Verify that inlet protection is provided for all inlets owned by PWD that are located within one block of the project site on the plans. [Appendix E, Table E-5]
9. Verify that the E&S Plans propose silt fence and/or compost filter sock along all downward-sloping areas of the project site's perimeter. [Appendix E, Table E-4]
10. Verify that any proposed stockpile locations are clearly labeled on the plans. [Appendix E, Table E-4]
11. Verify that the E&S Plans propose silt fence surrounding any proposed stockpile areas. [Appendix E, Table E-4]
12. Verify the dimensions of the rock construction entrance. The minimum length is 50 feet, and the minimum width is 20 feet. [Appendix E, Table E-4]
13. Verify that the rock construction entrance is not located on top of any proposed infiltration practice. It may be necessary to phase the erosion and sediment control plan to avoid compaction of the infiltration area. [Section 5.2.2]
14. Verify that the E&S Plans propose tree protection fencing around existing trees that are proposed to remain and be used for tree disconnection credit. [Appendix E, Table E-4]
15. When compost filter socks are placed on paved surfaces, verify that the E&S Plans indicate that some objects of considerable mass (i.e. concrete blocks, sand bags, etc.) are to be used immediately downslope of the socks (at the same intervals as recommended by the sock manufacturer for stakes) in order to help hold them in place. [Appendix E, Table E-5]

16. Verify that the E&S Plans propose a concrete washout station. [Appendix E, Table E-4]
17. Verify that the E&S Plans propose dust control measures appropriate to the project. Refer to the City of Philadelphia Department of Public Health Air Management Services *Construction/Demolition/Earthworks Dust Control Requirements FAQ* for guidance. [Appendix E, Table E-4]

F.3.2 Sequence of Construction

1. Verify that the E&S Plans include all standard sequence of construction notes listed in Appendix E, Table E-6. [Section 2.3.1]
2. Verify that sequences of construction are provided for both overall construction and the construction of each proposed individual SMP. [Section 2.3.1]
3. Verify that the sequence of construction properly identifies all stages of SMP construction for which a registered professional must document the specific elevations and measurements found on the SMP Construction Certification Form(s) within the Construction Certification Package. [Section 5.3.1]
4. For soil amendments, verify that the following sequence of construction is clearly noted on the plans. [Section 3.3.6]
    a. Excavate two feet below the proposed infiltration bed invert elevation.
    b. Manually grade and scarify the existing soil surface. The bottom of the infiltration bed shall be at a level grade. The existing subgrade shall not be compacted or subject to excessive construction equipment.
    c. Place geotextile filter fabric immediately after approval of subgrade preparation in accordance with manufacturer's standards and recommendations.
    d. Amend in-situ soil. [Provide instructions for amending the in-situ soil. Soil amendment media can include compost, mulch, manures, sand, and manufactured microbial solutions.] The project geotechnical engineer should be on-site to observe installation of soil amendments.
    e. Place two feet of amended soil across the entire cross-section of the infiltration bed. Lightly compact each layer with light equipment, keeping equipment movement over storage bed subgrades to a minimum.
    f. Perform infiltration testing of the amended soil layer. A minimum of three infiltration tests must be performed within the amended soil layer. The procedure used must be the double-ring infiltrometer test, soil sampling and characterization are also required, and all must be in compliance with the current Philadelphia Stormwater Management Guidance Manual. Prior to infiltration testing, PWD must be called (office: 215-685-6387) to schedule an observation. The engineer must provide a signed and sealed Geotechnical Report. All information must be submitted to PWD for review and approval before proceeding with construction. If soil amendments are installed, and the tested infiltration rate is determined to be outside of the PWD allowable range of 0.4 to ten inches per hour or varies significantly from the design infiltration rate, additional soil amendments and/or a system redesign will be required. Once the infiltration test results are reviewed and determined by PWD to be acceptable, proceed with installation of the infiltration practice.
    g. Soil amendments shall not be compacted or subject to excessive construction prior to the placement of geotextile and stone bed.

h. Place geotextile and infiltration bed aggregate immediately after approval of soil amendment preparation to prevent accumulation of debris and sediment. Prevent runoff and sediment from entering the storage bed during the placement of the geotextile and aggregate bed.

i. Place geotextile in accordance with manufacturer's standards and recommendations. Adjacent strips of filter fabric shall overlap a minimum of 16 inches. Fabric shall be secured at least four feet outside of bed.

j. Install aggregate course in lifts of six to eight inches. Lightly compact each layer with light equipment, keeping equipment movement over storage bed subgrades to a minimum. If proposed, install storage structures (e.g., pipes, arches, crates, etc.) during stone bed placement. Install aggregate to grades indicated on the drawings.

k. Complete surface grading above subsurface infiltration system, using suitable equipment to avoid excess compaction.

F.3.3 E&S Details

1. Verify that an inlet protection detail is provided on the plans. Verify that appropriate inlet protection details are provided for inlets in the public right-of-way. For roadways maintenance purposes, PWD does not allow inlet protection that includes stone or berms to be used in the public right-of-way. [Section 2.3.1; Appendix E, Table E-4]
2. Verify that details for silt fence and/or compost filter socks are provided on the plans. Refer to Standard Details #4-1 and 4-7 through 4-10 of the *PA DEP Erosion and Sediment Pollution Control Program Manual* (2012 or latest) for guidance. [Section 2.3.1; Appendix E, Table E-4]
3. Verify that a rock filter outlet detail is provided on the plans. Refer to Standard Detail #4-6 of the *PA DEP Erosion and Sediment Pollution Control Program Manual* (2012 or latest) for guidance. [Section 2.3.1; Appendix E, Table E-4]
4. Verify that a rock construction entrance detail is provided on the plans. Refer to Standard Details #3-1 and 3-2 of the *PA DEP Erosion and Sediment Pollution Control Program Manual* (2012 or latest) for guidance. [Section 2.3.1; Appendix E, Table E-4]
5. Verify that a pumped water filter bag detail is provided on the plans. Refer to Standard Detail #3-16 of the *PA DEP Erosion and Sediment Pollution Control Program Manual* (2012 or latest) for guidance. [Section 2.3.1; Appendix E, Table E-4]
6. Verify that a concrete washout station detail is provided on the plans. Refer to Standard Detail #3-18 of the *PA DEP Erosion and Sediment Pollution Control Program Manual* (2012 or latest) for guidance. [Section 2.3.1; Appendix E, Table E-4]
7. If riprap is proposed, verify that the E&S Plans include a riprap detail which shows that geotextile or filter stone is provided for erosion protection of the soil beneath the riprap. Refer to Standard Details #9-1 through 9-3 of the *PA DEP Erosion and Sediment Pollution Control Program Manual* (2012 or latest) for guidance. [Appendix E, Table E-4]

F.4 Disconnected Impervious Cover

F.4.1 Rooftop Disconnection

1. Verify that any proposed rooftop disconnection is clearly labeled on the plan. [Section 3.4.1]
2. Verify that the contributing area of rooftop to each disconnected discharge is 500 square feet or less. [Section 3.1.5]
3. Verify that the soil of the pervious area is not designated as a hydrologic soil group “D” or equivalent. [Section 3.1.5]
4. Verify that the overland flow path of the pervious area has a slope of 5% or less. [Section 3.1.5]
5. Verify the percentage of roof area being disconnected based on the flow length over pervious area. Refer to Table 3.1-2 of the Manual for appropriate DCIA reductions. [Section 3.1.5]
6. Verify consistency between the rooftop disconnection information provided on the plans and that which is provided on the PWD Stormwater Plan Review Online Technical Worksheet.

F.4.2 Pavement Disconnection

1. Verify that any proposed pavement disconnection is clearly labeled on the plan. [Section 3.4.1]
2. Verify that the contributing flow path over the impervious surface is no more than 75 feet. [Section 3.1.5]
3. Verify that the length and width of overland flow over pervious areas is greater than, or equal to, the length and width of the contributing flow path over impervious pavement. [Section 3.1.5]
4. Verify that the overland flow is non-concentrated sheet flow over a vegetated area (flow through a swale is not eligible for pavement disconnection credit). [Section 3.1.5]
5. Verify that the soil of the pervious area is not designated as a hydrologic soil group “D” or equivalent. [Section 3.1.5]
6. Verify that the contributing impervious area has a slope of 5% or less. [Section 3.1.5]
7. Verify that the overland flow path of the pervious area has a slope of 5% or less. [Section 3.1.5]
8. If discharge is concentrated at one or more discrete points, verify that no more than 1,000 square feet discharges to any one point. In addition, an erosion control measure, such as a gravel strip, is required for concentrated discharges. Erosion control measures are not required for non-concentrated discharges along the entire edge of pavement; however, there must be provisions for the establishment of vegetation along the pavement edge and temporary stabilization of the area until vegetation becomes established. [Section 3.1.5]
9. Verify consistency between the pavement disconnection information provided on the plans and that which is provided on the PWD Stormwater Plan Review Online Technical Worksheet.

F.4.3 Tree Disconnection Credit

1. Existing Tree Disconnection Credit
    a. Verify that any existing tree proposed to be used for disconnection is clearly labeled on the plan as such. [Section 3.4.1]
    b. Verify that the species of the existing trees proposed to be used for disconnection credit are provided and are not any of the invasive species included in **Appendix I** ☛ water.phila.gov/development/stormwater-plan-review/manual/appendices/i-plant-lists/. [Section 3.1.5]
    c. Verify that the caliper sizes of the existing trees proposed to be used for disconnection credit are provided and at least four-inch caliper. [Section 3.1.5]
    d. Verify that the canopies of existing trees proposed to be used for disconnection credit are field measured. Alternatively, verify that an annotated aerial photo clearly showing the existing tree canopy limits is provided. [Section 3.1.5]
    e. Verify that only impervious area located directly under the canopy area of any existing tree proposed to be used for disconnection credit is being considered disconnected. [Section 3.1.5]
    f. Verify that overlapping existing tree canopy area is not counted twice toward disconnection credit. [Section 3.1.5]
    g. Verify that the DCIA reduction credit for both new and existing trees is no greater than 25% of the total ground-level impervious area, unless the width of the impervious area is less than ten feet. Up to 100% of narrow impervious areas (e.g., sidewalks and trails) may be disconnected through the application of tree credits. [Section 3.1.5]
    h. Verify consistency between the existing tree disconnection credit information provided on the plans and that which is provided on the PWD Stormwater Plan Review Online Technical Worksheet.
    i. Verify that the existing trees proposed to be used for disconnection credit are located outside of the public right-of-way. [Section 3.1.5]
2. New Tree Disconnection Credit
    a. Verify that any new tree proposed to be used for disconnection is clearly labeled on the plan as such. [Section 3.4.1]
    b. Verify that the proposed species of the new trees are provided and found on **Table I-1** ☛ water.phila.gov/development/stormwater-plan-review/manual/appendices/i-plant-lists/#Table_I.1, the recommended and native non-invasive plant list, in **Appendix I** ☛ water.phila.gov/development/stormwater-plan-review/manual/appendices/i-plant-lists/. [Section 3.1.5]
    c. Verify that the new trees are proposed to be planted within ten feet of ground-level impervious area, within the limits of earth disturbance, and outside of the public right-of-way. [Section 3.1.5]
    d. Verify that the caliper sizes of new deciduous trees are provided and at least two-inch caliper. [Section 3.1.5]
    e. Verify that the heights of new evergreen trees are provided and at least six feet tall. [Section 3.1.5]
    f. Verify that the 100-square foot DCIA reduction is being applied to the impervious area adjacent to the tree. [Section 3.1.5]
    g. Verify that overlapping 100-square foot DCIA reduction areas corresponding to adjacent new trees are not being counted twice toward disconnection credit. [Section 3.1.5]

h. Verify that the DCIA reduction credit for both new and existing trees is no greater than 25% of the total ground-level impervious area, unless the width of the impervious area is less than ten feet. Up to 100% of narrow impervious areas (e.g., sidewalks and trails) may be disconnected through the application of tree credits. [Section 3.1.5]

i. Verify consistency between the new tree disconnection credit information provided on the plans and that which is provided on the PWD Stormwater Plan Review Online Technical Worksheet.

F.4.4 Green Roof

1. Verify that the green roof design meets all applicable Design Guidance Checklist standards noted in Appendix F.9, Green Roofs.
2. Verify consistency between the green roof disconnection area information provided on the plans and that which is provided on the PWD Stormwater Plan Review Online Technical Worksheet.

F.4.5 Porous Pavement

1. Verify that the porous pavement design meets all applicable Design Guidance Checklist standards noted in Appendix F.8, Porous Pavement.
2. Verify consistency between the porous pavement disconnection area information provided on the plans and that which is provided on the PWD Stormwater Plan Review Online Technical Worksheet.

F.5 Infiltration Testing and Soil Assessment

F.5.1 Soil Characterization

1. Verify that an Infiltration Testing and Soil Characterization Plan is provided with the submitted Geotechnical Report. [Section 3.3.1; Appendix E, Table E-7]
2. Verify that information on the soil stratum and groundwater for each SMP area is obtained and provided. The invert elevation of any infiltration SMP must be at least two feet above any limiting zone, such as groundwater, bedrock, or impermeable soils. [Section 3.3.2; Section 3.3.6; Appendix H]
3. For exploratory test pits, verify the following:
    a. For projects with 15,000 square feet or more of earth disturbance, verify that a minimum of two test pits are completed for each SMP footprint. For projects with less than 15,000 square feet of earth disturbance, verify that a minimum of one test pit is completed for each SMP footprint. [Section 3.3.2]
    b. Verify that at least one test pit for each SMP is excavated to a minimum depth of four feet below the proposed infiltration interface of the SMP, which is the lowest elevation where infiltration is proposed (the SMP bottom elevation), or until bedrock or fully saturated conditions are encountered. When conditions prevent the over-excavation of test pits to the minimum required depth, soil borings, in addition to the under-excavated test pits, are used in conjunction with double-ring infiltrometer testing to provide soil classification down to the required depths. [Section 3.3.2]
4. For hollow-stem augered boreholes (soil borings), verify the following:
    a. Verify that a minimum of one soil boring is conducted for each cased borehole infiltration test. [Section 3.3.2]
    b. Verify that all soil borings are advanced to a depth of ten feet below the SMP bottom elevation or until auger refusal with continuous split spoon sampling. [Section 3.3.2]
    c. Verify that the inner tube used is no less than four inches in diameter. [Section 3.3.2]
    d. Verify that all soil borings are conducted pursuant to the Hollow-Stem Auguered Borehole Procedure provided in Section 3.3.4. [Section 3.3.4]
5. For soil sampling, verify the following:
    a. Verify that three soil samples are taken per acre of SMP footprint area, with a minimum of one soil sample per SMP. [Section 3.3.2]
    b. Verify that at least one soil sample is taken at an elevation within one vertical foot of the infiltration interface (SMP bottom elevation). [Section 3.3.2]
    c. Verify that at least one soil sample is taken from the location of an infiltration test and that a sieve analysis of the sample is conducted. [Section 3.3.2]
    d. Verify that the soil samples are classified according to ASTM D2487 (Standard Practice for Classification of Soils for Engineering Purposes [Unified Soil Classification System]) and ASTM D2488 (Standard Practice for Description and Identification of Soils [Visual-Manual Procedure]). [Section 3.3.2]
    e. Verify that the soil samples undergo laboratory particle size analysis according to ASTM D422-63 (Standard Test Method for Particle-Size Analysis of Soils), down to the No. 200 sieve. [Section 3.3.2]

f. Verify that split spoon sampling, if performed, is completed in accordance with ASTM D1586 (Standard Test Method for SPT and Split-Barrel Sampling of Soils) and that blow count data is collected from the soil samples. [Section 3.3.2]

F.5.2 Infiltration Testing

1. Verify that at least one test is conducted within one vertical foot of the proposed bottom elevation of infiltration for each SMP. [Section 3.3.3]
2. Verify that the infiltration tests are performed within 25 horizontal feet of each proposed infiltration SMP. [Section 3.3.3]
3. Verify that a presoak is performed for one hour immediately prior to infiltration testing. [Section 3.3.3]
    a. Verify that ten-minute measurement intervals are used between infiltration test readings when the drop in the water level during the last 30 minutes of the presoaking period is two inches or more. [Section 3.3.5]
    b. Verify that 30-minute measurement intervals are used between infiltration test readings when the drop in the water level during the last 30 minutes of the presoaking period is less than two inches. [Section 3.3.5]
4. Verify that either the double-ring infiltrometer or cased borehole testing method is used. [Section 3.3.3]
5. For the double-ring infiltrometer testing method, verify the following:
    a. Verify that five infiltration tests are conducted per acre of SMP footprint and a minimum of three tests are conducted. [Section 3.3.3]
    b. Verify that the diameter of the inner ring is no less than six inches. [Section 3.3.3]
    c. Verify that test pits are excavated in order to conduct double-ring infiltrometer testing. [Section 3.3.2; Section 3.3.3]
    d. Verify that no more than two double-ring infiltration tests are conducted within the same test pit. [Section 3.3.3]
    e. Verify that all tests are conducted pursuant to the Double-Ring Infiltrometer testing procedure provided in Section 3.3.5. [Section 3.3.5]
6. For the cased borehole testing method, verify the following:
    a. Verify that eight infiltration tests are conducted per acre of SMP footprint and a minimum of three tests are conducted. [Section 3.3.3]
    b. Verify that the inner diameter of the casing is no less than four inches. [Section 3.3.3]
    c. Verify that infiltration tests are not completed within the same borehole as the hollow-stem augered borehole soil characterization studies, but rather are completed no less than five feet, and no more than ten feet, away from the soil characterization borehole locations. [Section 3.3.2; Section 3.3.3]
    d. Verify that all tests are conducted pursuant to the Cased Borehole testing procedure provided in Section 3.3.5. [Section 3.3.5]
7. Verify that a minimum of eight readings are completed, or a stabilized rate of drop is obtained, whichever occurs first. A stabilized rate of drop means a difference of 0.25 inch or less of drop between the highest and lowest readings of four consecutive readings. [Section 3.3.3, Section 3.3.5]

8. Verify that an Infiltration Testing Log is provided with the submitted Geotechnical Report. Refer to Appendix H for a blank template. [Section 3.3.4; Section 3.3.5]

F.5.3 Evaluation of Infiltration Testing Results

1. Verify that the highest infiltration rate from the test results for any SMP is discarded before calculation of the geometric mean of the tested infiltration rates when more than three tests are conducted for the SMP. [Section 3.3.6]
2. Verify that the geometric mean is used to determine the average of the tested infiltration rates. [Section 3.3.6]
3. Verify that a default value based on one decimal digit less than the smallest detectable reading for that particular test method/equipment is used in calculating the geometric mean when a measured rate of zero inches per hour is obtained through testing. [Section 3.3.6]
4. Verify that the geometric mean of the tested infiltration rates is between 0.4 and ten inches per hour. Infiltration is to be considered infeasible in soils with tested infiltration rates of less than 0.4 inches per hour. Soils with tested infiltration rates in excess of ten inches per hour require soil amendments. [Section 3.3.6]
5. Verify that a factor of safety of two is applied to the geometric mean of the tested infiltration rates to obtain the SMP-specific design infiltration rate to be used for all further design and calculations. [Section 3.3.6]
6. Verify that a Geotechnical Report is submitted that meets all of the Geotechnical Report requirements listed in Appendix E, Table E-7. [Section 3.3.6]
7. When infiltration has been found to be infeasible, verify that a waiver from the infiltration requirement is requested via the Online Technical Worksheet. If the waiver is requested due to unacceptable infiltration rates, verify that a Geotechnical Report is submitted. If the waiver is requested due to contamination, verify that electronic copies of environmental reports for any testing completed, as well as a justification letter from the geotechnical engineer or environmental professional, are submitted. [Section 3.3.6]
8. Verify that a copy of any Phase I or Phase II environmental site assessment prepared for the site is provided. [Section 3.1.1]

F.5.4 Soil Amendments

1. Verify that soil amendments are proposed for any infiltration practice with a tested infiltration rate in excess of ten inches per hour. [Section 3.3.6]
2. Verify that the soil amendments span the entire cross-section of the infiltrating SMP. [Section 3.3.6]
3. Verify that the soil amendments extend a minimum of two feet below the bottom elevation of the infiltrating SMP. [Section 3.3.6]
4. Verify that a conservative infiltration rate is used in the stormwater routing calculations during the design of the SMP. [Section 3.3.6]
5. Verify that a soil amendment sequence of construction is provided on the plans pursuant to Appendix F.3.2, Sequence of Construction. [Section 3.3.6]

F.6 Hydrologic Model and Calculation Methods

F.6.1 Hydrologic Model

1. Verify that all DCIA within the project's limits of earth disturbance is routed to an SMP. [Section 1.2.1; Section 3.4.1]
2. Verify that the modeled drainage areas are accurate and consistent with the plans' drainage areas. [Section 3.4.1]
3. Verify that all SMP bypass areas within the project's limit of earth disturbance are accounted for in the hydrologic calculations' stormwater model. [Section 3.4.1]
4. Verify that the links are correct. A point of analysis (POA) must be determined for comparison of the predevelopment and post-development conditions. A POA may serve one or several drainage areas and/or SMPs. Multiple POAs must be identified for project sites with multiple points of discharge. Points of analysis should only be linked when they drain to the same sewershed or waterway. [Section 3.4.1]
5. Verify that the routing of devices within the stormwater model is provided and consistent with the plan's proposed design. [Section 3.4.1]
6. Verify that the stormwater outlet controls configuration is correct and consistent with the plans. [Section 3.4.1]
7. Verify that runoff from pervious and impervious areas is calculated separately. Weighted curve number values between pervious and impervious areas are not acceptable. [Section 3.4.3]
8. Verify that the precipitation depths used for all design storm events are in accordance with the design rainfall data listed below, pursuant to *PennDOT Drainage Manual*, Chapter 7, Appendix A, Field Manual For Pennsylvania Design Rainfall Intensity Charts From NOAA Atlas 14 Version 3 Data (2010 or latest). [Section 3.4.3]

Design Precipitation Depth (inches)							
Duration	1-year	2-year	5-year	10-year	25-year	50-year	100-year
24 hours	2.83	3.40	4.22	4.95	6.10	7.16	8.43

9. Verify that the Manning's n values used within the stormwater model are correct and consistent with the plans' proposed pipe material. A Manning's n value of 0.013 must be used for RCP, VCP, and CIP, and a value of 0.011 must be used for PVC and HDPE. [Section 3.4.3]
10. Verify that the stormwater model uses the minimum time step allowable by the implemented hydrologic software (which is 0.01 hours in HydroCAD and 1 minute in Hydraflow or a maximum of 0.01 hours. [Section 3.4.3]
11. Verify that the SMP storage provided is correct and consistent with the plans. A porosity of 0.20 for soil media, 0.30 for sand, and 0.40 for stone must be used. [Chapter 4]

F.6.2 Runoff Estimation

1. Verify that the appropriate NRCS Curve Number Method curve number values are used in the runoff estimation calculations. Refer to Table 3.4-2 of the Manual. [Section 3.4.1; Section 3.4.3]
2. When performing Water Quality slow release rate calculations for a project in a combined sewer area for which infiltration is not feasible, verify that a curve number of 98 is used with a precipitation depth of 1.7 inches when routing the Water Quality storm event. [Section 3.4.1]
3. When performing Flood Control calculations, verify that all non-forested pervious areas are considered meadow in good condition for predevelopment runoff calculations. Non-forested pervious area consists of the following cover types: meadow, grass/lawn, brush, gravel, dirt, porous pavements, and any combination of these cover types. [Section 3.4.1]
4. When performing Flood Control calculations for a Redevelopment project, verify that, in addition to any other pervious area, 20% of the existing impervious cover, when present, is considered meadow (good condition) for the predevelopment runoff calculations. [Section 3.4.1]
5. Verify that the stormwater model for Water Quality compliance analysis uses the PWD Design Storm rainfall distribution. Refer to Table 3.4-4 of the Manual. [Section 3.4.3]
6. Verify that the stormwater models for Channel Protection, Flood Control, and PHS Release Rate compliance analyses use the NRCS Type II 24-hour rainfall distribution. Refer to Table 3.4-5 of the Manual. [Section 3.4.3]

F.6.3 Flow Routing

1. Verify that time of concentration calculations are provided for all predevelopment areas. [Section 3.4.1]
2. Verify that the time of concentration paths are shown on the drainage area maps and are labeled with slopes, cover types, and lengths for each type of flow (sheet, shallow concentrated, etc.). [Section 3.4.1; Appendix E, Table E-7]
3. Verify that the time of concentration paths are shown from the hydraulically most distant point of the drainage area to a point of interest within the drainage area, and that the paths are perpendicular to each area's contours. [Section 3.4.3]
4. Verify that the minimum post-development time of concentration used for any path is six minutes. [Section 3.4.1; Section 3.4.3]
5. Verify that the correct two-year design precipitation depth (P-2) is used in the sheet flow component of the time of concentration calculations. [Section 3.4.3]
6. Verify that the correct Manning's n values (roughness coefficients) are used in the sheet flow component of the time of concentration calculations. Refer to Table 3.4-6 of the Manual. [Section 3.4.3]
7. Verify that a maximum sheet flow length of 100 feet is used if the flow is not concentrated. [Section 3.4.3]

F.6.4 Stormwater Conveyance Pipe Capacity

1. Verify that pipe capacity calculations are provided for all stormwater conveyance pipes that are not connected to the roof drainage system. [Section 3.4.2]
2. Verify that all storm sewer pipes are sized to have adequate capacity to safely convey the ten-year, 24-hour storm event without surcharging the crown of the pipe. [Section 3.4.2]
3. Verify the runoff coefficients used in the pipe capacity calculations. A runoff coefficient value of 0.35 must be used for pervious areas, and 0.95 must be used for impervious areas. [Section 3.4.2]
4. Verify the precipitation intensity used in the pipe capacity calculations. The precipitation intensity for a five-minute inlet concentration time in the ten-year storm event must be 6.96 inches per hour. [Section 3.4.2]
5. Verify that the Manning's n values used with Manning's Equation for calculating full channel pipe flow are correct and consistent with the plans. A Manning's n value of 0.013 must be used for RCP, VCP, and CIP, and a value of 0.011 must be used for PVC and HDPE. [Section 3.4.2]
6. Verify that all roof drainage systems are sized pursuant to the Philadelphia Plumbing Code. [Section 3.4.2]
    a. Verify that the minimum size of a storm drain or any of its branches that drain a roof or area drain is three inches in diameter.
    b. Verify that the main roof drain has a slope that is greater than 1/16 inch per foot.

F.7 Bioinfiltration/Bioretention

F.7.1 Bioinfiltration/Bioretention Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the bioinfiltration/bioretention SMP. Refer to Section 4.1.5 for guidance. [Section 2.3.1]
2. To avoid soil disturbance and compaction during construction, verify that the bioinfiltration area is proposed to be clearly marked before any site work begins. [Section 4.1.5, 2]
3. Verify that the plans include an appropriate cross-sectional detail for the bioinfiltration/bioretention SMP. [Section 2.3.1]

F.7.2 Bioinfiltration/Bioretention Design Standards

1. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 4.1.3, 1]
2. Verify that the loading ratio of DCIA to the horizontal footprint of the bioinfiltration/bioretention SMP does not exceed 16:1. [Section 4.1.3, 2]
3. Verify that positive overflow is provided for large storm events, up to and including the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm. [Section 4.1.3, 3]
4. Verify that overflow structures and pipes are designed to convey at least the ten-year, 24-hour storm event. [Section 4.1.3, 3]
5. Verify that the distance between the contour of a bioinfiltration/bioretention basin's Water Quality Volume elevation and any adjacent private property line is at least ten feet. This includes fully or partially lined basins. Exceptions can be made for water-tight planter boxes with their own structural integrity. It is acceptable for SMPs to be located directly adjacent to the public right-of-way (ROW) (unless a deed restriction is put in place extending at least ten feet from the perimeter of the SMP). [Section 4.1.3, 4]
6. Verify that the distance between the contour of a bioinfiltration/bioretention basin's Water Quality Volume elevation and any building or retaining wall is at least ten feet. This includes fully or partially lined basins. The following requirements and exceptions apply: [Section 4.1.3, 5]
    a. For existing and proposed buildings with basements, the setback is measured from the basement wall and may be waived if the basin is a water-tight planter box with its own structural integrity.
    b. For existing buildings without basements and existing retaining walls, the setback is measured from the foundation and may be waived if a signed and sealed geotechnical analysis is submitted that evaluates the impacts of infiltration and excavation on the existing foundation and determines it to be feasible.
    c. For proposed buildings without basements and proposed retaining walls, the setback is measured from the foundation and may be waived if the foundation is proposed to be designed with the basin's proximity in mind.
7. Verify that the invert elevation of a bioinfiltration SMP is at least two feet above any poorly infiltrating soils, seasonal high groundwater table, bedrock, or other limiting zone. [Section 4.1.3, 6b]

8. For hydrologic modeling, verify that the design infiltration rate is applied to the horizontal surface area (SMP footprint), not the wetted area. If necessary, for the purpose of meeting the Water Quality requirement, infiltration can be assumed through the horizontal projection of the wetted area up to the Water Quality Volume (WQv) water surface elevation. [Section 4.1.3, 6c]
9. Verify that the soils underlying a bioinfiltration SMP are determined to be infiltration feasible. [Section 4.1.3, 6d]
10. Verify that any soils with test infiltration rates in excess of ten inches per hour are proposed to receive soil amendments. [Section 4.1.3, 6e]
11. If the infiltration SMP is used as a temporary sediment basin during construction, verify that the invert elevation of the infiltration SMP is a minimum of three feet below the bottom elevation of the pre-basin-conversion sediment basin. [Section 4.1.3, 6f]
12. Verify that any infiltrating SMP within the zone of influence of any nearby sewers or sewer laterals is installed with an impervious liner. The zone of influence is defined by the area within a 1:1 (H:V) slope line from the outer edge of a sewer or sewer lateral. [Section 4.1.3, 6g].
13. Verify that pretreatment is provided for all runoff entering the bioinfiltration/bioretention SMP, including pretreatment of runoff from all inlets. At a minimum, this can be achieved through the use of sumps and traps for inlets, sump boxes with traps downstream of trench drains, and filter strips for overland flow. [Section 4.1.3, 8]
14. Verify that energy dissipaters, such as riprap stone, are proposed at all locations of concentrated inflow. [Section 4.1.3, 9]
15. Verify that the storage area for a bioinfiltration SMP provides static storage for the WQv between the bottom elevation of the SMP and the elevation of the lowest outlet, including the planting soil medium and stone storage void space. The minimum allowable ponding depth below the lowest outlet device is three inches. Bioinfiltration basins may also be sized per the Bioinfiltration/Bioretention Basin Sizing Table (Table 4.1-4 of the Manual) to ensure that storage requirements are achieved. For dynamically designed bioinfiltration SMPs, static storage of only one inch of the WQv must be provided if the designer demonstrates, through dynamic routing, that the full 1.5-inch WQv is managed throughout the design storm, without overflow. [Section 4.1.3, 11]
16. Verify that the storage area for a bioretention SMP provides adequate storage to control release rates to meet all applicable Stormwater Regulations. All permanent pool areas must be excluded from the SMP's storage volume estimation. Void space in the soil and/or stone layers beneath the bioretention area surface may be considered part of the available volume of the SMP. Bioretention basins may also be sized per the Bioinfiltration/Bioretention Basin Sizing Table (Table 4.1-4 of the Manual) to ensure that storage and Water Quality release rate requirements are achieved. [Section 4.1.3, 12]
17. If the basin is sized per the Bioinfiltration/Bioretention Basin Sizing Table (Table 4.1-4 of the Manual), verify that the orifice diameter proposed is appropriate to the applicable DCIA drainage area range. [Section 4.1.3]
18. Verify that the maximum storage volume statically stored within the bioinfiltration/bioretention SMP without supporting documentation (defined below) is the runoff volume from the one-year, 24-hour storm event. [Section 4.1.3, 13]

19. Verify that the maximum storage volume statically stored within the bioinfiltration/bioretention SMP with supporting documentation is the runoff volume from the ten-year, 24-hour storm event. Requirements for supporting documentation include a letter, signed and sealed by both the geotechnical and design engineer, indicating that the proposed design is recommended, with the following components acknowledged and considered. The designer is encouraged to contact PWD for further guidance when pursuing this design. [Section 4.1.3, 14]
    a. A summary of the long-term impacts to the neighboring properties, including, but not limited to subsidence, change in basement moisture/water, and structural damage;
    b. The location of the groundwater table;
    c. References to other projects that have successfully infiltrated more than the one-year, 24-hour storm event; and
    d. Rigorous pretreatment to promote longevity of the infiltration SMP.
20. Verify that, when SMPs are used in series, the storage areas for all SMPs provide cumulative static storage for the WQv. [Section 4.1.3, 15]
21. Verify that the side slopes for all open storage areas do not exceed 2(H):1(V) (the recommended side slope is 3(H):1(V)), and that the side slopes of all mowed areas do not exceed 4(H): 1(V) to avoid “scalping” by mower blades. [Section 4.1.3, 17]
22. Verify that the porosity values used for storage volume calculations are as follows: [Section 4.1.3, 18]
    a. Soil media: 0.20
    b. Sand: 0.30
    c. Stone: 0.40
23. Verify that the stone storage layer is separated from soil media by a geotextile or pea gravel filter to prevent sand, silt, and sediment from entering the SMP. [Section 4.1.3, 19]
24. Verify that the stone storage system for a bioinfiltration SMP has a level bottom or use a terraced system if installed along a slope. [Section 4.1.3, 20]
25. Verify that the planting soil medium has a minimum depth of two feet. [Section 4.1.3, 21]
26. Verify that any impervious liner, if necessary, is not interrupted by structures within the basin footprint. The plans must indicate that the impervious liner is to be continuous and extend completely up the sides of any structures that are located within the lined basin footprint to the ground surface. If additional liner material must be added to extend up the structures, the additional liner sections are to be joined to the rest of the liner with an impervious seam per the manufacturers’ recommendations. [Section 4.1.3, 24]

27. Verify that an underdrain is provided and that it meets the following requirements:
    a. Underdrains must be surrounded by a sand or stone layer to filter sediment and facilitate drainage. [Section 4.1.3, 25a]
    b. The minimum allowable depth of a sand or stone filter layer above and beneath the underdrain is six inches, which must extend across the entire basin bottom. [Section 4.1.3, 25b]
    c. Underdrains must be surrounded by a geotextile fabric, if sand is used. [Section 4.1.3, 25c]
    d. Underdrains for bioinfiltration basins must remain capped to facilitate infiltration into native soils. [Section 4.1.3, 25d]
    e. For bioretention SMPs located in the combined sewer area where infiltration is infeasible, underdrains must be capped with an appropriately sized orifice to control release rates to meet all applicable Stormwater Regulations. Orifice diameter for flow-regulating underdrains may be determined based on the Bioinfiltration/Bioretention Basin Sizing Table (Table 4.1-4 of the Manual) for basins meeting the minimum requirements of the Standard Detail (Figure 4.1-4 of the Manual). [Section 4.1.3, 25e]
    f. For bioretention SMPs located in the separate sewer area, where infiltration is infeasible, flow through the underdrain may be modeled as exfiltration at a rate of two inches per hour over the basin footprint. This exfiltration flow must be routed through the primary outlet of the bioretention area, not discarded from the stormwater model. [Section 4.1.3, 25f]
    g. The outlet pipe of an outlet control structure must have an invert at or below the invert of the underdrain. Setting the outlet pipe invert at a minimum of 7.5 inches below that of the underdrain is recommended. [Section 4.1.3, 25g]
28. Verify that an adequate number of appropriately placed cleanouts, manholes, access panels and other access features are provided to allow unobstructed and safe access to the bioinfiltration/bioretention SMP for routine maintenance and inspection of inflow, outflow, underdrains, and storage systems. [Section 4.1.3, 27]

F.7.3 Bioinfiltration/Bioretention Material Standards

1. Verify that stone designed for stormwater storage is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.1.4, 3]
2. Verify that sand, if proposed, is specified on the plans to be AASHTO M-6 or ASTM C-33 sand and to have a grain size of 0.02 inches to 0.04 inches. [Section 4.1.4, 4]
3. Verify that the planting soil medium is specified on the plans as meeting the following specifications:
    a. Planting soil should be a fertile, natural soil, free from large stones, roots, sticks, clods, plants, peat, sod, pockets of coarse sand, pavement and building debris, glass, noxious weeds including invasive species, infestations of undesirable organisms and disease causing pathogens, and other extraneous materials harmful to plant growth. [Section 4.1.4, 5a]
    b. The texture of planting soil should conform to the classification within the United States Department of Agriculture triangle for Sandy Loam or Loamy Sand. Planting soil should be a mixture of sand, silt, and clay particles as required to meet the classification. Ranges of particle size distribution, as determined by pipette method in compliance with ASTM F-1632, are as follows: [Section 4.1.4, 5b]
        i. Sand (0.05 to 2.0 mm): 50 – 85%
        ii. Silt (0.002 to 0.05 mm): 40% maximum
        iii. Clay (less than 0.002 mm): 10% maximum
        iv. Gravel (2.0 to 12.7 mm): 15% maximum
    c. Planting soil should be screened and free of stones larger than a half-inch (12.7 millimeters) in any dimension. No more than 10% of the soil volume should be composed of soil peds greater than one inch. [Section 4.1.4, 5c]
    d. Clods, or natural clumps of soils, greater than three inches in any dimension should be absent from the planting soil. Small clods ranging from one to three inches and peds, natural soil clumps under one inch in any dimension, may be present but should not make up more than 10% of the soil by volume. [Section 4.1.4, 5d]
    e. The pH of the planting soil should have a range of 5.8 to 7.1. [Section 4.1.4, 5e]
    f. Soluble salts should be less than 2.0 mmhos/cm (dS/m), typically as measured by 1:2 soil-water ratio basic soil salinity testing. Sodic soils (Exchangeable Sodium Percentage greater than 15 and/or Sodium Adsorption Ratio greater than 13) are not acceptable for use regardless of amendment. [Section 4.1.4, 5f]
    g. Organic content of planting soil should have a range of 3% to 15%, by weight, as determined by loss on ignition (ASTM D2974). To adjust organic content, planting soil may be amended, prior to placing and final grading, with the addition of organic compost. [Section 4.1.4, 5g]
4. Verify that mulch, if proposed, is specified to be free of weeds and consist of aged, double-shredded hardwood bark mulch or leaf mulch that has been shredded sufficiently to limit risk of matting, which can limit surface infiltration rates. For hydroseeding, paper mulch may be used. Approved mulching materials include organic materials such as compost, bark mulch, leaves, as well as small river gravel, pumice, or other inert materials. Grass clippings should not be used as mulch. [Section 4.1.4, 6]

5. Verify that geotextile is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.1.4, 7]
    a. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
    b. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
    c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
    d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
    e. Heat-set or heat-calendared fabrics are not permitted
6. Verify that native grass/wildflower seed mix, if proposed as an alternative to groundcover planting, is free of weed seeds. [Section 4.1.4, 10]
7. Verify that the proposed bioinfiltration/bioretention SMP plantings are indicated on the plans and are non-invasive. Refer to **Appendix I** ☛ water.phila.gov/development/stormwater-plan-review/manual/appendices/i-plant-lists/ for plant lists. [Section 4.1.4, 11]
8. Verify that the underdrain is made of continuously perforated high-density polyethylene (HDPE) plastic piping with a smooth interior and a minimum inner diameter of four inches. HDPE pipe must be specified on the plans to meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.1.4, 12]
9. Verify that cleanouts are made of material with a smooth interior having an inner diameter that is no less than four inches and matches that of its connecting pipe up to eight inches. If the pipe is larger than eight inches in diameter, verify that the cleanout is eight inches in diameter. [Section 4.1.3, 14]

F.8 Porous Pavement

F.8.1 Porous Pavement Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the porous pavement. Refer to Section 4.2.5 for guidance. [Section 2.3.1]
2. To avoid soil disturbance and compaction during construction, verify that the infiltration area is proposed to be clearly marked before any site work begins. [Section 4.2.5, 1]
3. Verify that the plans include an appropriate cross-sectional detail for the porous pavement. [Section 2.3.1]

F.8.2 Porous Pavement Design Standards

1. Verify the drainage area directed to any proposed porous pavement. The porous surface cannot receive any runoff in addition to the direct (1:1) rainfall onto it. For porous pavement over a structural SMP, the additional runoff must be conveyed directly to the underlying SMP. The porous surface over the structural SMP footprint must be considered, and modeled as, DCIA. The SMP beneath the porous pavement requires infiltration testing. [Section 4.2.1]
2. For porous pavement over a structural SMP, if infiltration is feasible, verify that the porous pavement design meets all Design Guidance Checklist design standards noted in Appendix F.10, Subsurface Infiltration. [Section 4.2.3, 2]
3. For porous pavement over a structural SMP, if infiltration is infeasible, verify that the porous pavement design meets all Design Guidance Checklist design standards noted in Appendix F.14, Subsurface Detention. [Section 4.2.3, 3]
4. For porous pavement DIC systems:
    a. Verify that the porous pavement DIC is installed on-site such that it does not create any areas of concentrated infiltration or discharge. [Section 4.2.3, 1a]
    b. Verify that the surface slope in any direction across porous pavement does not exceed 5%. [Section 4.2.3, 1b]
    c. Verify that the choker course depth is a minimum of two inches. [Section 4.2.3, 1c]
    d. If an underdrain is proposed, verify that the first 1.5 inches of runoff are stored below the lowest invert of the underdrain. [Section 4.2.3, 1d]
    e. Verify that an appropriate porous pavement curve number value is used when performing Flood Control calculations. [Section 4.2.3, 1e]
    f. Verify that the stone storage bed depth is a minimum of eight inches, except when located beneath walkways or play surfaces, for which a depth of four inches is allowable. [Section 4.2.3, 6a]
    g. Verify that stone is separated from soil media by a separation barrier, such as a geotextile or a pea gravel filter, to prevent sand, silt, and sediment from entering the system. [Section 4.2.3, 6b]
    h. Verify that the stone storage system has a level bottom. Terraced systems may be used to maintain a level infiltration interface with native soil while accommodating significant grade changes. [Section 4.2.3, 6c]

5. Verify that pretreatment is provided for all runoff entering the porous pavement, including pretreatment of runoff from all inlets. At a minimum, this can be achieved through the use of sumps and traps for inlets and sump boxes with traps downstream of trench drains. [Section 4.2.3, 4]
6. Verify that, when SMPs are used in series, the storage areas for all SMPs provide cumulative static storage for the WQv. [Section 4.2.3, 9]
7. Verify that any impervious liner, if necessary, lines a minimal portion of the total porous area. If a significant area needs to be lined, porous pavement may not be an appropriate management strategy. [Section 4.2.3, 10]
8. Verify that underdrains, if proposed for porous pavement DIC systems, meet the following requirements:
    a. Underdrains must be surrounded by a sand or stone layer to filter sediment and facilitate drainage. [Section 4.2.3, 11a]
    b. The minimum allowable thickness of a sand or stone filter layer is six inches both above and beneath the underdrain. [Section 4.2.3, 11b]
    c. To prevent clogging, underdrain pipes must be surrounded by a geotextile fabric if a sand layer is used. [Section 4.2.3, 11c]
9. Verify that inlets or area drains are provided for all porous pavement areas in excess of 5,000 square feet, in order to provide positive overflow. [Section 4.2.3, 12]
10. Verify that an adequate number of appropriately placed cleanouts, manholes, access panels and other access features are provided to allow unobstructed and safe access to the structural SMPs beneath porous pavement for routine maintenance and inspection of inflow, outflow, underdrains, and storage systems. [Section 4.2.3, 14]
11. Verify that an observation well is provided for a storage system that includes stone storage and that it meets the following requirements:
    a. The observation well must be placed at the invert of the stone bed. [Section 4.2.3, 15a]
    b. An observation well must be located near the center of the stone bed system to monitor the level and duration of water stored within the SMP (drain down time). [Section 4.2.3, 15b]
    c. Adequate inspection and maintenance access to the observation well must be provided. [Section 4.2.3, 15c]
    d. A manhole may be used in lieu of an observation well if the invert of the manhole is installed at or below the bottom of the SMP and the manhole is configured in such a way that stormwater can flow freely between the SMP and the manhole at the SMP's invert. [Section 4.2.3, 15d]
12. Verify that access features are provided for all underground storage systems that are not stone storage beds. [Section 4.2.3, 16a]
13. Verify that a sufficient number of access points in the system are provided to efficiently inspect and maintain the infiltration area. [Section 4.2.3, 16b]
14. For cast-in-place vault systems, verify that access features consist of manholes or grated access panels or doors. Grated access panels are preferred to maintain airflow. [Section 4.2.3, 16c]
15. For grid storage or other manufactured systems, verify that the manufacturer's recommendations are followed. [Section 4.2.3, 16d]

16. Verify that ladder access is proposed for vaults greater than four feet in height. [Section 4.2.3, 16e]
17. Verify that header pipes, at minimum 36-inch diameter, connected to manholes at each corner of the subsurface system are provided. Alternatively, smaller header pipes may be used if cleanouts are provided on the manifold/header pipe junction for each distribution pipe. The cleanouts must be on alternating sides of the SMP. [Section 4.2.3, 16f]

F.8.3 Porous Pavement Material Standards

Porous Asphalt Binder Course Aggregate Gradation	
U.S. Standard Sieve Size	**Percent Passing by Weight**
1”	100%
3/4”	90-100%
1/2”	80-100%
3/8”	50-80%
#4	10-20%
#8	5-10%
#40	3-8%
#200	0-3 %

Porous Asphalt Wearing Course Aggregate Gradation	
U.S. Standard Sieve Size	**Percent Passing by Weight**
5/8”	100%
1/2”	95-100%
3/8”	70-95%
#4	20-40%
#8	10-20%
#40	0-8%
#200	0-3%

1. Verify that porous bituminous asphalt, if proposed, is specified on the plans as meeting the following specifications: [Section 4.2.4, 2]
    a. Bituminous surface must be laid with a bituminous mix of 5.75% to 6% by weight dry aggregate.
    b. In accordance with American Society of Testing and Materials (ASTM) D6390, drain down of the binder must be no greater than 0.3%.
    c. Aggregate material in the asphalt must be clean, open-graded, and a minimum of 75% fractured with at least one fractured face by mechanical means of each individual particle larger than ¼-inch, and it must have the following gradations:
    d. Neat asphalt binder modified with an elastomeric polymer to produce a binder meeting the requirements of PG 76-22 as specified in American Association of State Highway and Transportation Officials (AASHTO) MP-1. The elastomer polymer must be styrene-butadiene-styrene, or approved equal, applied at a rate of 3% by weight of the total binder.
    e. Hydrated lime should be added at a dosage rate of 1% by weight of the total dry aggregate to mixes containing granite.
        i. The additive must be able to prevent the separation of the asphalt binder from the aggregate and achieve a required tensile strength ratio of at least 80% on the asphalt mix when tested in accordance with AASHTO T 283.
        ii. The asphaltic mix must be tested for its resistance to stripping by water in accordance with ASTM D-1664.
        iii. If the estimated coating area is not above 95%, anti-stripping agents must be added to the asphalt.
    f. The asphaltic mix must be tested for its resistance to stripping by water in accordance with ASTM D 3625. If the estimated coating area is not above 95%, anti-stripping agents must be added to the asphalt.
2. Verify that porous concrete, if proposed, is specified on the plans as meeting the following specifications: [Section 4.2.4, 3]
    a. Porous concrete must use Portland Cement Type I or II conforming to ASTM C 150 or Portland Cement Type IP or IS conforming to ASTM C 595.
    b. Aggregate must be No. 8 coarse aggregate (3/8-inch to No. 16) per ASTM C 33 or No. 89 coarse aggregate (3/8-inch to No. 50) per ASTM D 448.
    c. An aggregate/cement ratio range of 4:1 to 4.5:1 and a water/cement ratio range of 0.34 to 0.40 should produce porous pavement of satisfactory properties in regard to permeability, load carrying capacity, and durability characteristics.
3. Verify that permeable paver and grid systems, if proposed, are specified on the plans as meeting the following specifications: [Section 4.2.4, 4]
    a. Permeable paver and grid systems must conform to manufacturer specifications.
    b. The systems must have a minimum flow through rate of five inches per hour and a void percentage of no less than 10%.
    c. Gravel used in interlocking concrete pavers or plastic grid systems must be well-graded and washed to ensure permeability.

4. Verify that stone designed for stormwater storage, if proposed, is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.2.4, 6a]
5. Verify that all aggregates used within a porous pavement system meets the following requirements: [Section 4.2.4, 6b]
    a. Maximum wash loss: 0.5% per AASHTO T-11
    b. Minimum durability index: 35 per ASTM D3744
    c. Maximum abrasion: 10% for 100 revolutions and 50% for 500 revolutions per ASTM C131
6. Verify that all choker course aggregate meets the specifications of AASHTO No. 57 and meets the gradation listed in Table 4.2-3 of the Manual. [Section 4.2.4, 6c]
7. Verify that sand, if proposed, is specified on the plans to be AASHTO M-6 or ASTM C-33 sand and to have a grain size of 0.02 inches to 0.04 inches. [Section 4.2.4, 7]
8. Verify that storage chambers for porous pavement over a structural SMP, if proposed, are specified on the plans as meeting the following specifications: [Section 4.2.4, 8]
    a. Pipe used within a subsurface infiltration SMP must be continuously perforated and have a smooth interior with a minimum inner diameter of four inches.
    b. High-density polyethylene (HDPE) pipe, if proposed, must meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S.
    c. Any pipe materials outside the SMP are to meet City Plumbing Code Standards.
9. Verify that geotextile, if proposed, is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.2.4, 9]
    a. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
    b. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
    c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
    d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
    e. Heat-set or heat-calendared fabrics are not permitted
10. Verify that underdrains, if proposed, are made of continuously perforated HDPE plastic piping with a smooth interior and a minimum inner diameter of four inches. HDPE pipe must be specified on the plans to meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.2.4, 10]
11. Verify that observation wells are specified on the plans as consisting of perforated plastic pipe with a minimum inner diameter of six inches. [Section 4.2.4, 12]
12. Verify that cleanouts are made of material with a smooth interior having an inner diameter that is no less than four inches and matches that of its connecting pipe up to eight inches. If the pipe is larger than eight inches in diameter, verify that the cleanout is eight inches in diameter. [Section 4.2.4, 13]

F.9 Green Roofs

F.9.1 Green Roof Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the green roof. Refer to Section 4.3.5 for guidance. [Section 2.3.1]
2. Verify that the plans include an appropriate cross-sectional detail for the green roof. [Section 2.3.1]
3. Verify that a roof drainage plan is provided and that the roof drainage is consistent with the green roof design. [Appendix E, Table E-7]

F.9.2 Green Roof Design Standards

1. Verify that runoff from impervious roof area onto the green roof is dispersed evenly across the green roof surface and passes through the growing medium either by sheet flow or a level spreading device. [Section 4.3.3, 1]
2. Verify that the flow path of runoff across the green roof surface is greater than or equal to the contributing DCIA length. [Section 4.3.3, 2]
3. Verify that structural loading is considered for the green roof design, and that the green roof design is coordinated with a licensed structural engineer for both new building construction and retrofits to existing structures. [Section 4.3.3, 3a]
4. If runoff estimation calculations are required, verify that the correct curve number for the proposed green roof is used in the calculations. Refer to Table 3.4-2 of the Manual. [Section 4.3.3, 4a]
5. If flow routing is required, verify that the rational coefficient used is 0.40. [Section 4.3.3, 4b]
6. If flow routing is required, verify that the time of concentration used is six minutes. [Section 4.3.3, 4c]
7. Verify that the total amount of impervious surfaces within the designated boundary of the green roof footprint does not exceed 1/3 of the combined area. [Section 4.3.3, 5]
8. If runoff is conveyed via piping, verify that a distribution piping manifold embedded in a gravel strip, along with an appropriate detail, is provided on the plans to dissipate energy and promote uniform flow. [Section 4.3.3, 7]
9. For green roofs that receive direct (1:1) rainfall only, verify the following:
    a. The minimum allowable thickness of the green roof growing medium is three inches. This can include both an upper finer-grained medium and a basal foundation growth media (lightweight drainage aggregate). The minimum allowable thickness of the foundation growth media is one inch. [Section 4.3.3, 9a]
    b. Green roofs that meet minimum growing medium thickness requirements are permitted a DCIA reduction equal to the entire area of the green roof. [Section 4.3.3, 9b]

10. For green roofs that receive runoff from contributing impervious roof catchments, verify the following:
    a. Impervious roof areas that direct runoff onto the green roof cannot exceed 50% of the green roof area, which is equivalent to a maximum hydraulic impervious runoff loading ratio of 0.5:1. [Section 4.3.3, 10a]
    b. The minimum thickness of the green roof growing medium must be calculated as follows, where the "impervious roof area to green roof area" ratio is less than or equal to 0.50: [Section 4.3.3, 10b]

$$\text{Minimum thickness (in inches) of green roof growing medium} = 3 \text{ inches} + \left[3 * \left(\frac{\text{Impervious roof area}}{\text{Green roof area}} \right) \right]$$

    c. Green roofs that meet minimum growing medium thickness requirements are permitted a DCIA reduction equal to the entire area of the green roof. Impervious roof areas that drain to these green roofs can be also considered as disconnected impervious cover, and, thus, included in the green roof's DCIA reduction. [Section 4.3.3, 10c]
    d. In areas that will receive tributary discharge, verify that the plans include specifications that demonstrate that the drainage layer is not a high-transmissivity drainage layer, defined as a layer with a transmissivity of 0.005 m^2/s or greater (ASTM D4716). In general, this will exclude peg-style or egg-carton-style geosynthetic sheets. High-transmissivity drainage layers will allow runoff to effectively flow under the green roof, minimizing contact with medium and plant roots. Typical granular aggregate, or coarse granular green roof medium, with a grain-size distribution complying with ASTM gradation No. 7 will satisfy the requirement, as will also a variety of mats and composite drainage layer assemblies. [Section 4.3.3, 10d]
    e. Verify that any deck built atop a green roof that does not allow for sheet flow runoff is slotted, and that the minimum thickness of growing medium required for the green roof is maintained under the entire extent of the deck. [Section 4.3.3, 10e]
11. Verify that the plans indicate that the saturated permeability of the growing medium, in its compacted state [ASTM E2399], is not less than six inches per hour. [Section 4.3.3, 11]
12. Verify that a drainage layer is provided and that it prevents ponding of runoff in the growing medium during the ten-minute maximum rainfall rate associated with the one-year, 24-hour storm event. [Section 4.3.3, 13]
13. Verify that the contributing area of rooftop to each disconnected discharge point is equal to, or less than, 500 square feet. [Section 4.3.3, 15]
14. Verify that details are provided on the plans that demonstrate that all drains and scuppers are covered and protected by an enclosure, typically a square or round chamber with a locking lid. These chambers are designed to prevent clogging of the drains by debris. [Section 4.3.3, 17]
15. Verify that the roof drainage system and the remainder of the site drainage system safely convey roof runoff to the storm sewer, combined sewer, or receiving water. [Section 4.3.3, 18]
16. Verify that the green roof is designed to allow for safe access and working conditions for green roof inspection and maintenance personnel. This access must be a permanent feature of the building, such as a pilot house, roof hatch, or exterior stairs to the green roof. Retractable, unsecured ladders should not be required for routine maintenance and inspections. The design may include other permanent personal safety measures. For green roofs, designers must specifically assess applicability to Occupational Safety and Health Administration (OSHA) Fall Protection Safety Standards and the American National Standards Institute (ANSI) and American Society of Safety Engineers (ASSE) consensus-based fall protection standards. [Section 4.3.3, 20]

F.9.3 Green Roof Material Standards

1. Verify that the green roof growing medium is specified on the plans to be a lightweight mineral material with a minimum of organic material that meets the following specifications: [Section 4.3.4, 2]
    a. Moisture content at maximum water holding capacity (ASTM E2399 or FLL): 40% to 60% (vol)
    b. Porosity at maximum water holding capacity (ASTM E2399 or FLL): 10% to 15%
    c. Density at maximum water holding capacity (ASTM E2399 or FLL): ≤ 85 lb/ft3
    d. Total organic matter (MSA): 6% to 10% (dry weight)
    e. pH (MSA): 6.5 to 7.8
    f. Soluble salts (DPTA saturated media extraction): ≤ 2 mmhos/cm
    g. Water permeability (ASTM E2399 or FLL): 0.25 in/min to 1.25 in/min
    h. Grain-size distribution consisting of ≤ 4.5% passing for clay (0.002 mm) and 5% to 15% passing for silt (0.05 mm)
    i. The nutrients must be initially incorporated in the formulation of a suitable mix for the support of the specified plant materials.
    j. The medium must withstand freeze/thaw cycles.
2. Verify that the foundation growth media (lightweight drainage aggregate) is specified on the plans to be composed of blended media that meets the following specifications: [Section 4.3.4, 3]
    a. Density at maximum water capacity (ASTM E2399-05): ≤ 65 lbs/ft^3
    b. Maximum water holding capacity: 15% to 25%
    c. Water permeability (ASTM E2396-05): ≥ 25 in/min
    d. Total organic matter by loss on ignition (ASTM F1647): ≤ 1%
    e. Porosity (ASTM C29): 20% to 65%
    f. Grain-size distribution (ASTM C136) consisting of the following gradations:
        i. Pct. Passing US#18 sieve (1.0 mm): ≤ 5%
        ii. Pct. Passing ¼-inch sieve: ≤ 30%
        iii. Pct. Passing 3/8-inch sieve (9.5 mm): ≥ 75%
        iv. Pct. Passing ½-inch sieve (12 mm): 100%
3. Verify that geotextile is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.3.4, 4]
    a. Grab Tensile Strength (ASTM-D4632): ≤ 120 lbs
    b. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
    c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
    d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
    e. Heat-set or heat-calendared fabrics are not permitted

4. For vegetated cover assemblies with an overall thickness of five inches or greater, verify that the drainage layer is specified on the plans to meet the following specifications: [Section 4.3.4, 5b]
    a. Abrasion resistance (ASTM-C131-96): ≤ 25% loss
    b. Soundness (ASTM-C88): ≤ 5% loss
    c. Porosity (ASTM-C29): ≥ 25%
    d. Percent of particles passing 1/2-inch sieve (ASTM-C136): ≥ 75%
    e. The minimum thickness of the granular layer must be two inches. The granular layer may be installed in conjunction with a synthetic reservoir sheet.
5. Verify that all waterproof membranes meet appropriate ASTM specifications. PVC membranes must meet ASTM D4434 requirements, EPDM membranes must meet ASTM D4637 requirements, and TPO membranes must meet ASTM D6878 requirements. [Section 4.3.4, 6b]
6. Verify that all waterproofing membranes are fully waterproof with properly sealed seams, corners, and protrusions to prevent any intrusion of standing water above the membrane. [Section 4.3.4, 6c]
7. Verify that roofing membranes meet all building code requirements and guidelines of the City of Philadelphia. [Section 4.3.4, 6d]
8. Verify that the proposed green roof plantings are indicated on the plans and that the proposed plantings and are non-invasive. Refer to **Appendix I** ☛ water.phila.gov/development/stormwater-plan-review/manual/appendices/i-plant-lists/ for plant lists. [Section 4.3.4, 7]
9. Verify that sedum sarmentosum, also known as star sedum, gold moss, stringy stonecrop, or graveyard moss, is not proposed. [Section 4.3.4, 10]

F.10 Subsurface Infiltration

F.10.1 Subsurface Infiltration Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the subsurface infiltration SMP. Refer to Section 4.4.5 for guidance. [Section 2.3.1]
2. To avoid soil disturbance and compaction during construction, verify that the infiltration area is proposed to be clearly marked before any site work begins. [Section 4.4.5, 1]
3. Verify that the plans include an appropriate cross-sectional detail for the subsurface infiltration SMP. [Section 2.3.1]

F.10.2 Subsurface Infiltration Design Standards

1. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 4.4.3, 1]
2. Verify that the loading ratio of DCIA to the horizontal footprint of the subsurface infiltration SMP does not exceed 10:1. [Section 4.4.3, 2]
3. Verify that positive overflow is provided for large storm events, up to and including the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm. [Section 4.4.3, 3]
4. Verify that overflow structures and pipes are designed to convey at least the ten-year, 24-hour storm event. [Section 4.4.3, 3]
5. Verify that the distance between subsurface infiltration basins and any adjacent private property line is at least ten feet. This includes partially lined basins. It is acceptable for SMPs to be located directly adjacent to the public right-of-way (ROW) (unless a deed restriction is put in place extending at least ten feet from the perimeter of the infiltrating SMP). [Section 4.4.3, 4]
6. Verify that the distance between subsurface infiltration basins and any building or retaining wall is at least ten feet. This includes partially lined basins. The following requirements and exceptions apply: [Section 4.4.3, 5]
    a. For existing and proposed buildings with basements, the setback is measured from the basement wall.
    b. For existing buildings without basements and existing retaining walls, the setback is measured from the foundation and may be waived if a signed and sealed geotechnical analysis is submitted that evaluates the impacts of infiltration and excavation on the existing foundation and determines it to be feasible.
    c. For proposed buildings without basements and proposed retaining walls, the setback is measured from the foundation and may be waived if the foundation is proposed to be designed with the basin's proximity in mind.
7. Verify that the invert elevation of the subsurface infiltration SMP is at least two feet above any poorly infiltrating soils, seasonal high groundwater table, bedrock, or other limiting zone. [Section 4.4.3, 6b]
8. For hydrologic modeling, verify that the design infiltration rate is applied to the horizontal surface area (SMP footprint), not the wetted area. [Section 4.4.3, 6c]

9. Verify that the soils underlying the subsurface infiltration SMP are determined to be infiltration feasible. If infiltration feasibility is unknown and determination is deferred until construction, the applicant must submit two complete designs (e.g. plans, calculations, Online Technical Worksheet, etc.) for both infiltrating and non-infiltrating scenarios to be fully reviewed. A PCSMP Conditional Approval will be issued, and the approval letter will feature both plan sets. Following infiltration testing, only the applicable design's plan set will be included on the PCSMP Approval Letter. [Section 4.4.3, 6d]
10. Verify that any soils with test infiltration rates in excess of ten inches per hour are proposed to receive soil amendments. [Section 4.4.3, 6e]
11. If the infiltration SMP is used as a temporary sediment basin during construction, verify that the invert elevation of the infiltration SMP is a minimum of three feet below the bottom elevation of the pre-basin-conversion sediment basin. [Section 4.4.3, 6f]
12. Verify that any infiltrating SMP within the zone of influence of any nearby sewers or sewer laterals is installed with an impervious liner. The zone of influence is defined by the area within a 1:1 (H:V) slope line from the outer edge of a sewer or sewer lateral. [Section 4.4.3, 6g]
13. Verify that pretreatment is provided for all runoff entering the subsurface infiltration SMP, including pretreatment of runoff from all inlets. At a minimum, this can be achieved through the use of sumps and traps for inlets, sump boxes with traps downstream of trench drains, and filter strips for overland flow. [Section 4.4.3, 8]
14. Verify that the storage area provides static storage for the Water Quality Volume (WQv) between the bottom elevation of the subsurface infiltration SMP and the elevation of the lowest outlet, including storage voids. Storage or distribution pipes alone are not sufficient in providing static storage. A minimum of at least three inches of forced storage via an outlet control device is recommended in order to give the statically stored volume time to infiltrate. [Section 4.4.3, 11]
15. Verify that the maximum storage volume statically stored within the subsurface infiltration SMP without supporting documentation (defined below) is the runoff volume from the one-year, 24-hour storm event. [Section 4.4.3, 12]
16. Verify that the maximum storage volume statically stored within the subsurface infiltration SMP with supporting documentation is the runoff volume from the ten-year, 24-hour storm event. Requirements for supporting documentation include a letter, signed and sealed by both the geotechnical and design engineer, indicating that the proposed design is recommended, with the following components acknowledged and considered. The designer is encouraged to contact PWD for further guidance when pursuing this design. [Section 4.4.3, 13]
    a. A summary of the long-term impacts to the neighboring properties, including, but not limited to subsidence, change in basement moisture/ water, and structural damage;
    b. The location of the groundwater table;
    c. References to other projects that have successfully infiltrated more than the one-year, 24-hour storm event; and
    d. Rigorous pretreatment to promote longevity of the infiltration SMP.
17. Verify that, when SMPs are used in series, the storage areas for all SMPs provide cumulative static storage for the WQv. [Section 4.4.3, 14]

18. Verify that void space provided by linear chamber systems, plastic grids, or other related structures is as specified by the manufacturer and noted in supporting documentation. [Section 4.4.3, 16]
19. Verify that pipe, vault, grid, and chamber storage areas are adequately bedded with stone to prevent settling or subsidence. [Section 4.4.3, 17a]
20. Verify that bedding thickness is not less than six inches. [Section 4.4.3, 17b]
21. Verify that foundations/footers are provided as warranted by system loading, geotechnical conditions, and manufacturer's recommendations. Foundation designs must be performed by an appropriate design professional. [Section 4.4.3, 17d]
22. Verify that the storage design accounts for potential loading from vehicles, as appropriate, based on expected maximum active loading, including consideration for emergency vehicles. [Section 4.4.3, 18]
23. Verify that the porosity values used for storage volume calculations are as follows: [Section 4.4.3, 19]
    a. Soil media: 0.20
    b. Sand: 0.30
    c. Stone: 0.40
24. Verify that the stone storage layer, if proposed, is separated from soil media by a geotextile or pea gravel filter to prevent sand, silt, and sediment from entering the system. [Section 4.4.3, 20]
25. Verify that stone storage systems have a level bottom or use a terraced system if installed along a slope. [Section 4.4.3, 21]
26. Verify that an adequate number of appropriately placed cleanouts, manholes, access panels and other access features are provided to allow unobstructed and safe access to the subsurface infiltration SMP for routine maintenance and inspection of inflow, outflow, underdrains, and storage systems. [Section 4.4.3, 23]
27. Verify that an observation well is provided for a subsurface infiltration SMP that includes stone storage and that it meets the following requirements:
    a. The observation well must be placed at the invert of the stone bed. [Section 4.4.3, 24a]
    b. An observation well must be located near the center of the stone bed system to monitor the level and duration of water stored within the SMP (drain down time). [Section 4.4.3, 24b]
    c. Adequate inspection and maintenance access to the observation well must be provided. [Section 4.4.3, 24c]
    d. A manhole may be used in lieu of an observation well if the invert of the manhole is installed at or below the bottom of the SMP and the manhole is configured in such a way that stormwater can flow freely between the SMP and the manhole at the SMP's invert. [Section 4.4.3, 24d]
28. Verify that access features are provided for any subsurface infiltration SMP that is not comprised of a stone storage bed. [Section 4.4.3, 25a]
29. Verify that a sufficient number of access points in the SMP are provided to efficiently inspect and maintain the infiltration area. [Section 4.4.3, 25b]
30. For cast-in-place vault systems, verify that access features consist of manholes or grated access panels or doors. Grated access panels are preferred to maintain airflow. [Section 4.4.3, 25c]

31. For grid storage or other manufactured systems, verify that the manufacturer's recommendations are followed. [Section 4.4.3, 25d]
32. Verify that ladder access is proposed for vaults greater than four feet in height. [Section 4.4.3, 25e]
33. Verify that header pipes, at minimum 36-inch diameter, connected to manholes at each corner of the subsurface infiltration SMP are provided. Alternatively, smaller header pipes may be used if cleanouts are provided on the manifold/header pipe junction for each distribution pipe. The cleanouts must be on alternating sides of the SMP. [Section 4.4.3, 25f]

F.10.3 Subsurface Infiltration Material Standards

1. Verify that stone designed for stormwater storage, if proposed, is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines "clean-washed" as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.4.4, 3]
2. Verify that sand, if proposed, is specified on the plans to be AASHTO M-6 or ASTM C-33 sand and to have a grain size of 0.02 inches to 0.04 inches. [Section 4.4.4, 4]
3. Verify that storage pipe, if proposed, is specified on the plans as meeting the following specifications:
    a. Pipe used within the subsurface infiltration SMP must be continuously perforated and have a smooth interior with a minimum inner diameter of four inches. [Section 4.4.4, 5a]
    b. High-density polyethylene (HDPE) pipe, if proposed, must meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.4.4, 5b]
    c. Any pipe materials outside the SMP are to meet City Plumbing Code Standards. [Section 4.4.4, 5c]
4. Verify that geotextile, if proposed, is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.4.4, 6]
    a. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
    b. Mullen Burst Strength (ASTM-D3786): ≥ 25 psi
    c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
    d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
    e. Heat-set or heat-calendared fabrics are not permitted
5. Verify that observation wells are specified on the plans as consisting of perforated plastic pipe with a minimum inner diameter of six inches. [Section 4.4.4, 8]
6. Verify that cleanouts are made of material with a smooth interior having an inner diameter that is no less than four inches and matches that of its connecting pipe up to eight inches. If the pipe is larger than eight inches in diameter, verify that the cleanout is eight inches in diameter. [Section 4.4.4, 9]

F.11 Cisterns

F.11.1 Cistern Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the cistern. Refer to Section 4.5.5 for guidance. [Section 2.3.1]
2. Verify that the plans include an appropriate cross-sectional detail for the cistern. [Section 2.3.1]

F.11.2 Cistern Design Standards

1. Verify that irrigation as a use for runoff stored in a cistern is not a proposed strategy for meeting the Stormwater Regulations. [Section 4.5.1]
2. Verify that the time for drain down/withdrawal from the cistern for any portion of storage intended to meet the Water Quality requirement is within the acceptable 72-hour period after the 24-hour storm event. If the water demand fluctuates seasonally, verify that the cistern drains within 72 hours based on usage in all seasons. [Section 4.5.3, 1]
3. Verify that positive overflow is provided for large storm events, up to and including the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm. [Section 4.5.3, 2]
4. Verify that overflow structures and pipes are designed to convey at least the ten-year, 24-hour storm event. [Section 4.5.3, 2]
5. Verify that the minimum allowable freeboard above maximum ponding depth is four inches or the diameter of the outlet pipe, whichever is greater. [Section 4.5.3, 3]
6. Verify that the proposed indoor uses and pipe labeling and routing (i.e., separate stud bays) are allowable per the City's Building and Plumbing Codes (administered by the City of Philadelphia Department of Licenses and Inspections (L&I)). [Section 4.5.3, 5]
7. Verify that appropriate treatment and management of harvested rainwater is proposed per State and Federal codes. [Section 4.5.3, 5]
8. In cases where a municipal backup supply is used, verify that rainwater harvesting systems propose backflow preventers or air gaps to keep non-potable harvested water separate from the potable water supply. Distribution and waste pipes, internal to the building, must be designated as such per the City's Building and Plumbing Codes (administered by L&I). [Section 4.5.3, 6]
9. Verify that pretreatment is provided for all runoff entering the cistern, including pretreatment of runoff from all inlets. At a minimum, this can be achieved through the use of sumps and traps for inlets, sump boxes with traps downstream of trench drains, and filter strips for overland flow. [Section 4.5.3, 8]
10. Verify that gutters and downspouts are fitted with leaf/debris screens along the entire length of the gutter leading to the cistern tank. Leaf/debris screens must be made from a corrosion-resistant material with screen openings in the range of 0.25 inches to 0.50 inches. Leaf screens must be inspected on a regular basis to prevent accumulated leaves and debris from clogging the gutter openings. [Section 4.5.3, 9a]
11. Verify that all inlets and vents to a cistern are protected by 1/6-inch stainless steel mesh screens, which keep insects, vermin, leaves and other debris from entering the cistern. [Section 4.5.3, 9b]

12. Verify that approximately one to two gallons of water per 100 square feet of roof collection surface are diverted to a first-flush chamber instead of the cistern tank. [Section 4.5.3, 10a]
13. Verify that, once the first-flush chamber is full, the remainder of the stormwater is directed to the cistern tank. A slow release control valve or drip system is typically included in the design to empty the first-flush chamber automatically in between storm events. [Section 4.5.3, 10b]
14. Verify that the first-flush diverter system includes an accessible cleanout. [Section 4.5.3, 10c]
15. Verify that the storage area provides adequate storage for the Water Quality Volume (WQv) between the overflow elevation and the controlling low flow orifice elevation. If the water reuse demand is less than the WQv, and only a portion of the WQv drains down or is withdrawn in 72 hours, only that portion of volume will be considered for compliance, and the remainder of the WQv must be managed by an additional SMP in series. Refer to Section 3.2.3 for information on using SMPs in series. Any portion of the storage that will not drain down or be withdrawn within 72 hours must be excluded from the system's storage volume estimation. [Section 4.5.3, 12]
16. Verify that, when SMPs are used in series, the storage areas for all SMPs provide cumulative static storage for the WQv. [Section 4.5.3, 13]
17. Verify that detailed calculations to demonstrate the anticipated daily, 72-hour, and monthly water use are provided. For toilet use, volume must be calculated based on the number of flushes per day multiplied by gallons per flush. [Section 4.5.3, 15]
18. If volume in excess of the WQv is proposed for on-site reuse and the volume is estimated by a weekly water balance of rainfall and water reuse, verify that the difference on a weekly basis between rainfall depth (in Table 4.5-1 of the Manual) and water depth is estimated. This deficit must be multiplied by the roof drainage area to obtain an estimate of the cistern volume needed. [Section 4.5.3, 16]
19. Verify that the cistern is watertight and sealed using a water-safe, non-toxic substance. [Section 4.5.3, 17]
20. Verify that cistern storage areas are adequately bedded with stone to prevent settling or subsidence. [Section 4.5.3, 18a]
21. Verify that bedding thickness is not less than six inches. [Section 4.5.3, 18b]
22. Verify that foundations/footers are provided as warranted by system loading, geotechnical conditions, and manufacturer's recommendations. Foundation designs must be performed by an appropriate design professional. [Section 4.5.3, 18d]
23. Verify that the storage design for subsurface cisterns accounts for potential loading from vehicles, as appropriate, based on expected maximum active loading, including consideration for emergency vehicles. [Section 4.5.3, 19]
24. Verify that the overflow conveyance has a capacity equal to or greater than the inflow pipe(s) and has a diameter and slope sufficient to drain the cistern while maintaining an adequate freeboard height. [Section 4.5.3, 20]
25. Verify that the overflow conveyance is screened to prevent access to the cistern by small mammals and birds. [Section 4.5.3, 20]
26. Verify that the discharge from the overflow is directed to an acceptable flow path that will not cause erosion. [Section 4.5.3, 20]

27. Verify that an adequate number of appropriately placed cleanouts, manholes, access panels and other access features are provided to allow unobstructed and safe access to the cistern for routine maintenance and inspection of inflow, outflow, underdrains, and storage systems. [Section 4.5.3, 22]
28. Verify that access features are provided for all subsurface cisterns. [Section 4.5.3, 23a]
29. Verify that a sufficient number of access points in the subsurface cistern are provided to efficiently inspect and maintain the storage area. [Section 4.5.3, 23b]
30. For cast-in-place vault systems, verify that access features consist of manholes or grated access panels or doors. Grated access panels are preferred to maintain airflow. [Section 4.5.3, 23c]
31. For manufactured systems, verify that the manufacturer's recommendations are followed. [Section 4.5.3, 23d]
32. Verify that ladder access is proposed for vaults greater than four feet in height. [Section 4.5.3, 23e]
33. Verify that the access opening for a subsurface cistern is installed in such a way as to prevent surface or groundwater from entering through the top of any fittings, and verify that it is secured/locked to prevent unwanted entry. [Section 4.5.3, 23f]

F.11.3 Cistern Material Standards

1. Verify that the cistern is not constructed of non-galvanized steel, wood, or other products prone to environmental corrosion/decay. [Section 4.5.4, 3]
2. Verify that the cistern is opaque or otherwise shielded to prevent the growth of algae. [Section 4.5.4, 5]
3. Verify that cleanouts are made of material with a smooth interior having an inner diameter that is no less than four inches and matches that of its connecting pipe up to eight inches. If the pipe is larger than eight inches in diameter, verify that the cleanout is eight inches in diameter. [Section 4.5.4, 7]
4. Verify that the first-flush diverter system includes an accessible cleanout. [Section 4.5.4, 8]
5. Verify that serviceways consist of manhole openings with lockable manhole covers. Depending on the size of the cistern, multiple serviceway openings are recommended to support inspection, repair, and cleaning. [Section 4.5.4, 9]

F.12 Blue Roofs

F.12.1 Blue Roof Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the blue roof. Refer to Section 4.6.5 for guidance. [Section 2.3.1]
2. Verify that the plans include an appropriate cross-sectional detail for the blue roof. [Section 2.3.1]
3. Verify that a roof drainage plan is provided and that the roof drainage is consistent with the blue roof design. [Appendix E, Table E-7]

F.12.2 Blue Roof Design Standards

1. Verify that structural loading is considered for the blue roof design, and that the blue roof design is coordinated with a licensed structural engineer for both new building construction and retrofits to existing structures. [Section 4.6.3, 1]
2. Verify that the maximum surface ponding depth is four to six inches. [Section 4.6.3, 2]
3. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 4.6.3, 3]
4. Verify that positive overflow is provided for large storm events, up to and including the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm. [Section 4.6.3, 4]
5. Verify that overflow structures and pipes are designed to convey at least the ten-year, 24-hour storm event. [Section 4.6.3, 4]
6. Verify that the blue roof storage area is underlain by a waterproofing membrane. [Section 4.6.3, 5]
7. Verify that the storage system provides adequate storage to control release rates to meet all applicable Stormwater Regulations. [Section 4.6.3, 7]
8. Verify that a porosity of 0.40 is used for ballast stone. [Section 4.6.3, 9]
9. For roofs without ballast, verify that enough weight is provided to secure the waterproofing membrane. [Section 4.6.3, 10]
10. For roofs with ballast, verify that the depth and porosity of the ballast are accounted for when calculating the potential storage volume. [Section 4.6.3, 10]
11. Verify that roof drain restrictors, if proposed, are sized according to the desired release rate and ponding depth. [Section 4.6.3, 11]
12. Verify that safe access to the blue roof is provided for periodic cleaning, inspection, and maintenance by trained building personnel. Easy access must be provided to each of the outlet controls, low-flow discharge points, and overflow connections to permit removal of debris under saturated conditions. [Section 4.6.3, 13]

F.12.3 Blue Roof Material Standards

1. Verify that stone or gravel used for ballast within the stormwater storage area, if proposed, is specified on the plans as being uniformly graded, clean-washed stone, either crushed or smooth, and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.6.4, 2a]
2. Verify that the size of the stone, if proposed, does not exceed the mesh size of the outlet control screen or slots. Ballast stone typically falls within the size range of 3/8 inch to two inches. [Section 4.6.4, 2b]
3. Verify that ballast, if proposed, meets all American Society of Testing and Materials (ASTM) D1863 requirements for mineral aggregate used on built-up roofs. [Section 4.6.4, 2c]
4. Verify that all waterproof membranes meet appropriate ASTM specifications. PVC membranes must meet ASTM D4434 requirements, EPDM membranes must meet ASTM D4637 requirements, and TPO membranes must meet ASTM D6878 requirements. [Section 4.6.4, 3b]
5. Verify that all waterproofing membranes are fully waterproof with properly sealed seams, corners, and protrusions to prevent any intrusion of standing water above the membrane. [Section 4.6.4, 3c]
6. Verify that roofing membranes meet all building code requirements and guidelines of the City of Philadelphia. [Section 4.6.4, 3d]

F.13 Ponds and Wet Basins

F.13.1 Pond and Wet Basin Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the pond or wet basin. Refer to Section 4.7.5 for guidance. [Section 2.3.1]
2. Verify that the plans include an appropriate cross-sectional detail for the pond or wet basin. [Section 2.3.1]

F.13.2 Pond and Wet Basin Design Standards

1. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 4.7.3, 1]
2. Verify that positive overflow is provided for large storm events, up to and including the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm. [Section 4.7.3, 2]
3. Verify that overflow structures and pipes are designed to convey at least the ten-year, 24-hour storm event. [Section 4.7.3, 2]
4. Verify that, during the 100-year storm, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm, the freeboard between the peak storage elevation and the emergency spillway invert elevation is a minimum of one foot. [Section 4.7.3, 3]
5. Verify that the distance between the emergency spillway crest elevation and the top-of-berm elevation is a minimum of one foot. [Section 4.7.3, 4]
6. Verify that the basin length-to-width ratio is a minimum of 2:1. [Section 4.7.3, 5]
7. Verify that the basin has a minimum width of ten feet. [Section 4.7.3, 6]
8. Verify that the sediment forebay has a minimum length of ten feet. [Section 4.7.3, 7]
9. Verify that the distance between the basin inflow and outflow points is maximized. [Section 4.7.3, 8]
10. Verify that a curve number of 98 is used for the area below the water surface elevation, where required for hydrologic calculations. [Section 4.7.3, 9]
11. Verify that all areas deeper than four feet must have two aquatic safety benches extending a combined total of 15 feet, at minimum, inward from the perimeter of the basin. One bench must be above the normal water surface elevation and extend up to the pond side slopes at a maximum slope of 10%. The other bench must be below the water surface extending into the pond at a 10% slope to a maximum depth of 18 inches. [Section 4.7.3, 10]
12. Verify that a dewatering mechanism is proposed for facilities that are not in connection with groundwater. [Section 4.7.3, 11]
13. Verify that pretreatment is provided for all runoff entering the pond or wet basin, including pretreatment of runoff from all inlets. At a minimum, this can be achieved through the use of sumps and traps for inlets, sump boxes with traps downstream of trench drains, and filter strips for overland flow. [Section 4.7.3, 12]
14. Verify that energy dissipaters, such as riprap stone, are proposed at all locations of concentrated inflow. [Section 4.7.3, 14]

15. Verify that the storage area provides static storage for the Water Quality Volume (WQv) between the overflow elevation and the basin's water surface. All permanent pool areas must be excluded from the SMP's storage volume estimation. [Section 4.7.3, 16]
16. Verify that the side slopes for all open storage areas do not exceed 2(H):1(V) (the recommended side slope is 3(H):1(V)), and that the side slopes of all mowed areas do not exceed 4(H): 1(V) to avoid "scalping" by mower blades. [Section 4.7.3, 18]
17. Verify that a minimum planting soil medium depth of 18 inches is provided under emergent planting zones. [Section 4.7.3, 19]
18. Verify that the planting design provides for at least 85% cover of the emergent vegetation zone (the area of the pond that is less than 18 inches deep) and buffer area. [Section 4.7.3, 23]
19. Verify that a vegetated pond buffer extends outward 25 feet from the permanent pool. [Section 4.7.3, 24]
20. Verify that energy dissipaters, such as riprap stone, are placed at the end of the primary outlet to prevent erosion. [Section 4.7.3, 26]
21. Verify that the primary and low-flow outlets are protected from clogging by an external trash rack. [Section 4.7.3, 27]
22. Verify that the emergency spillway does not direct flow toward neighboring properties. [Section 4.7.3, 28]
23. Verify that stabilized vehicular access is provided for sediment removal. Areas must be at least nine feet wide, have a maximum slope of 15%, and be stabilized as needed to provide load support for vehicles. [Section 4.7.3, 30]

F.13.3 Pond and Wet Basin Material Standards

1. Verify that the planting soil medium is specified on the plans as meeting the following specifications: [Section 4.7.4, 3]
    a. Hydrologic soil groups "C" and "D" are suitable, without modification, for underlying soils.
    b. If natural topsoil from the site is to be used, it must have at least 8% organic carbon content by weight in the A-horizon for sandy soils and 12% for other soil types.
    c. If planting soil is imported, it must be made up of equivalent proportions of organic and mineral materials.
2. Verify that native grass/wildflower seed mix, if proposed as an alternative to groundcover planting, is free of weed seeds. [Section 4.7.4, 6]
3. Verify that the proposed pond or wet basin plantings are indicated on the plans and are non-invasive. Refer to **Appendix I** ☛ water.phila.gov/development/stormwater-plan-review/manual/appendices/i-plant-lists/ for plant lists. [Section 4.7.4, 7]

F.14 Subsurface Detention

F.14.1 Subsurface Detention Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the subsurface detention SMP. Refer to Section 4.8.5 for guidance. [Section 2.3.1]
2. Verify that the plans include an appropriate cross-sectional detail for the subsurface detention SMP. [Section 2.3.1]

F.14.2 Subsurface Detention Design Standards

1. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 4.8.3, 1]
2. Verify that positive overflow is provided for large storm events, up to and including the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm. [Section 4.8.3, 2]
3. Verify that overflow structures and pipes are designed to convey at least the ten-year, 24-hour storm event. [Section 4.8.3, 2]
4. Verify that the distance between subsurface detention basins and any adjacent private property line is at least ten feet. This includes lined basins. Exceptions can be made for water-tight vaults with their own structural integrity, such as concrete or fiberglass vaults. It is acceptable for SMPs to be located directly adjacent to the public right-of-way (ROW) (unless a deed restriction is put in place extending at least ten feet from the perimeter of the infiltrating SMP). [Section 4.8.3, 4]
5. Verify that the distance between subsurface detention basins and any building or retaining wall is at least ten feet. This includes lined basins. The following requirements and exceptions apply: [Section 4.8.3, 5]
    a. For existing and proposed buildings with basements, the setback is measured from the basement wall and may be waived if the basin is a water-tight vault with its own structural integrity, such as a concrete or fiberglass vault.
    b. For existing buildings without basements and existing retaining walls, the setback is measured from the foundation and may be waived if a signed and sealed geotechnical analysis is submitted that evaluates the impacts of residual infiltration and excavation on the existing foundation and determines it to be feasible.
    c. For proposed buildings without basements and proposed retaining walls, the setback is measured from the foundation and may be waived if the foundation is proposed to be designed with the basin's proximity in mind.
6. Verify that pretreatment is provided for all runoff entering the subsurface detention SMP, including pretreatment of runoff from all inlets. At a minimum, this can be achieved through the use of sumps and traps for inlets, sump boxes with traps downstream of trench drains, and filter strips for overland flow. [Section 4.8.3, 6]
7. Verify that the storage area provides adequate storage to control release rates to meet all applicable Stormwater Regulations. All permanent pool areas must be excluded from the SMP's storage volume estimation. [Section 4.8.3, 9]
8. Verify that pipe, vault, grid and chamber storage areas are adequately bedded with stone to prevent settling or subsidence. [Section 4.8.3, 10a]

9. Verify that bedding thickness is not less than six inches. [Section 4.8.3, 10b]
10. Verify that foundations/footers are provided as warranted by system loading, geotechnical conditions, and manufacturer's recommendations. Foundation designs must be performed by an appropriate design professional. [Section 4.8.3, 10d]
11. Verify that the storage design accounts for potential loading from vehicles, as appropriate, based on expected maximum active loading, including consideration for emergency vehicles. [Section 4.8.3, 11]
12. Verify that the porosity values used for storage volume calculations are as follows: [Section 4.8.3, 13]
    a. Soil media: 0.20
    b. Sand: 0.30
    c. Stone 0.40
    d. Void space provided by linear chamber systems, plastic grids, or other related structures must be as specified by the manufacturer and noted in supporting documentation.
13. Verify that the stone storage layer, if proposed, is separated from soil media by a geotextile or pea gravel filter to prevent sand, silt, and sediment from entering the system. [Section 4.8.3, 14]
14. Verify that any impervious liner, if necessary, is not interrupted by structures within the basin footprint. The plans must indicate that the impervious liner is to be continuous and extend completely up the sides of any structures that are located within the lined basin footprint to the ground surface. If additional liner material must be added to extend up the structures, the additional liner sections are to be joined to the rest of the liner with an impervious seam per the manufacturers' recommendations. [Section 4.8.3, 16]
15. Verify that an adequate number of appropriately placed cleanouts, manholes, access panels, and other access features are provided to allow unobstructed and safe access to the subsurface detention SMP for routine maintenance and inspection of inflow, outflow, underdrains, and storage systems. [Section 4.8.3, 17]
16. Verify that an observation well is provided for a subsurface detention SMP that includes stone storage and that it meets the following requirements:
    a. The observation well must be placed at the invert of the stone bed. [Section 4.8.3, 18a]
    b. An observation well must be located near the center of the stone bed system to monitor the level and duration of water stored within the system (drain down time). [Section 4.8.3, 18b]
    c. Adequate inspection and maintenance access to the observation well must be provided. [Section 4.8.3, 18c]
    d. A manhole may be used in lieu of an observation well if the invert of the manhole is installed at or below the bottom of the SMP and the manhole is configured in such a way that stormwater can flow freely between the SMP and the manhole at the SMP's invert. [Section 4.8.3, 18d]
17. Verify that access features are provided for any subsurface detention SMP that is not comprised of a stone storage bed. [Section 4.8.3, 19a]
18. Verify that a sufficient number of access points in the SMP are provided to efficiently inspect and maintain the storage area. [Section 4.8.3, 19b]

19. For cast-in-place vault systems, verify that access features consist of manholes or grated access panels or doors. Grated access panels are preferred to maintain airflow. A minimum of 50 square feet of grate area is recommended for permanent pool designs. [Section 4.8.3, 19c]
20. For grid storage or other manufactured systems, verify that the manufacturer's recommendations are followed. [Section 4.8.3, 19d]
21. Verify that ladder access is provided for vaults greater than four feet in height. [Section 4.8.3, 19e]
22. Verify that header pipes, at minimum 36-inch in diameter, connected to manholes at each corner of the subsurface detention SMP are provided. Alternatively, smaller header pipes may be used if cleanouts are provided on the manifold/header pipe junction for each distribution pipe. The cleanouts must be on alternating sides of the SMP. [Section 4.8.3, 19f]

F.14.3 Subsurface Detention Material Standards

1. Verify that stone designed for stormwater storage, if proposed, is specified on the plans as being uniformly graded, crushed, clean-washed stone, and that it is noted that PWD defines "clean-washed" as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and AASHTO No. 57 stones can meet this specification. [Section 4.8.4, 3]
2. Verify that sand, if proposed, is specified on the plans to be AASHTO M-6 or ASTM C-33 sand and to have a grain size of 0.02 inches to 0.04 inches. [Section 4.8.4, 4]
3. Verify that storage pipe, if proposed, is specified on the plans as meeting the following specifications:
    a. Pipe used within the subsurface detention SMP must have a minimum inner diameter of four inches. [Section 4.8.4, 5a]
    b. High-density polyethylene (HDPE) pipe must meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.8.4, 5b]
    c. Any pipe materials outside the SMP are to meet the City Plumbing Code Standards. [Section 4.8.4, 5c]
4. Verify that geotextile, if proposed, is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.8.4, 6]
    a. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
    b. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
    c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
    d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
    e. Heat-set or heat-calendared fabrics are not permitted
5. Verify that observation wells are specified on the plans as consisting of perforated plastic pipe with a minimum inner diameter of six inches. [Section 4.8.4, 8]
6. Verify that cleanouts are made of material with a smooth interior having an inner diameter that is no less than four inches and matches that of its connecting pipe up to eight inches. If the pipe is larger than eight inches in diameter, verify that the cleanout is eight inches in diameter. [Section 4.8.4, 9]

F.15 Media Filters

F.15.1 Media Filter Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the media filter. Refer to Section 4.9.5 for guidance. [Section 2.3.1]
2. Verify that the plans include an appropriate cross-sectional detail for the media filter. [Section 2.3.1]

F.15.2 Media Filter Design Standards

1. Verify that the following information is submitted for each proposed media filter as part of the applicant's Post-Construction Stormwater Management Plan (PCSMP) Review Phase Submission Package: [Section 4.9.3, 1]
    a. Inflow and outflow event mean concentrations and percent removals for Total Suspended Solids (TSS) for sand/media filters (Designs must demonstrate a maximum effluent event mean concentration (EMC) of 15 milligrams per liter for TSS at a point of analysis (POA) downstream of the SMP);
    b. Third-party certifications for proprietary media filters;
    c. Hydrologic and hydraulic model files, if applicable;
    d. Product specifications for proprietary media filters;
    e. Manufacturer's guidelines for installation for proprietary media filters;
    f. Construction sequence; and
    g. Maintenance requirements, including product life and replacement schedule, if applicable.
2. For proprietary media filters, verify the following:
    a. Verify that the manufacturer's design guidance for appropriate pretreatment is followed. [Section 4.9.3, 7]
    b. Verify that the manufacturer's design guidance for inlet control configuration is followed. [Section 4.9.3, 9]
    c. Verify that the manufacturer's design guidance for filter sizing is followed. [Section 4.9.3, 11]
    d. Verify that the manufacturer's design guidance for outlet control configuration is followed. [Section 4.9.3, 22]
    e. Verify that the manufacturer's design guidance for inspection and maintenance access is followed [Section 4.9.3, 27]
3. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 4.9.3, 2]
4. Verify that the filter footprint is sized pursuant to the filter media flow-through rate. [Section 4.9.3, 3]
5. Verify that positive overflow is provided for large storm events, up to and including the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm. [Section 4.9.3, 4]
6. Verify that overflow structures and pipes are designed to convey at least the ten-year, 24-hour storm event. [Section 4.9.3, 4]

7. Verify that proposed filters without detention are able to convey the ten-year, 24-hour storm event. [Section 4.9.3, 5]
8. Verify that proposed filters with detention are designed to safely store and/or convey the 100-year, 24-hour storm event. [Section 4.9.3, 6]
9. Verify that pretreatment is provided for all runoff entering the media filter, including pretreatment of runoff from all inlets. At a minimum, this can be achieved through the use of sumps and traps. [Section 4.9.3, 8]
10. Verify that the filter system provides enough storage to allow the Water Quality storm to flow through the filter media. Upstream SMPs can be used to store this flow. [Section 4.9.3, 12]
11. Verify that, when SMPs are used in series, the storage areas for all SMPs provide cumulative static storage for the Water Quality Volume (WQv). [Section 4.9.3, 13]
12. Verify that the porosity values used for storage volume calculations are as follows: [Section 4.9.3, 15]
    a. Soil media: 0.20
    b. Sand: 0.30
    c. Stone: 0.40
    d. Porosity values of any proprietary rapid media should be obtained from the appropriate manufacturer.
13. Verify that filters have a minimum surface area as computed by the following equation: [Section 4.9.3, 16a]

$$A_f = \frac{(WQv \; x \; 0.8)}{k}$$

Where:
Af = surface area of the filter (square feet);
WQv = Water Quality Volume, the 1.5-inch Water Quality Volume over directly connected impervious area (DCIA) (cubic feet); and
k = saturated hydraulic conductivity of the filter media (feet per day)

14. Verify that a filtration rate of two inches per hour for sand and soil is used when computing surface area (accounting for the reduction in filtration rates for sand over time due to build-up of fine material). [Section 4.9.3, 16b]
15. Verify that the determination of filtration rate for proprietary or mixed media is obtained from manufacturers or from evaluation of similar applications. High filtration rates at installation associated with some media types may yield small required surface area values. Verify that the assumed infiltration rate accounts for the potential for filter systems to clog over time. [Section 4.9.3, 16c]
16. Verify that the filter media depth is a minimum of 18 inches (greater depths may be used but do not alter filter sizing requirements). [Section 4.9.3, 17]
17. Verify that stone is not used as filter media. It can be used within filter systems to provide additional storage. [Section 4.9.3, 18]
18. Verify that pipe, vault, grid, and chamber storage areas are adequately bedded with stone to prevent settling or subsidence. [Section 4.9.3, 19a]
19. Verify that bedding thickness is not less than six inches. [Section 4.9.3, 19b]

20. Verify that foundations/footers are provided as warranted by system loading, geotechnical conditions, and manufacturer's recommendations. Foundation designs must be performed by an appropriate design professional. [Section 4.9.3, 19d]
21. Verify that the storage design accounts for potential loading from vehicles, as appropriate, based on expected maximum active loading, including consideration for emergency vehicles. [Section 4.9.3, 20]
22. Verify that the system has a level bottom and uses a terraced system, if installed along a slope. [Section 4.9.3, 21]
23. Verify that impervious liners are provided for all filter systems not contained in impermeable structures. [Section 4.9.3, 23]
24. Verify that any impervious liner, if necessary, is not interrupted by structures within the filter footprint. The plans must indicate that the impervious liner is to be continuous and extend completely up the sides of any structures that are located within the lined filter footprint to the ground surface. If additional liner material must be added to extend up the structures, the additional liner sections are to be joined to the rest of the liner with an impervious seam per the manufacturers' recommendations. [Section 4.9.3, 23]
25. Verify that an underdrain is provided for any non-infiltrating system and that it meets the following requirements:
    a. Underdrains must be surrounded by a sand layer or stone to filter sediment and facilitate drainage. [Section 4.9.3, 24a]
    b. The minimum allowable depth of a sand or stone filter layer above and beneath the underdrain is six inches. [Section 4.9.3, 24b]
    c. Underdrains must be surrounded by a geotextile fabric if sand is used. [Section 4.9.3, 24c]
    d. The outlet pipe of an outlet control structure must have an invert at or below the invert of the underdrain. Setting the outlet pipe invert at a minimum of 7.5 inches below that of the underdrain is recommended. [Section 4.9.3, 24d]
26. For filters located in the separate sewer area, where infiltration is infeasible, flow through the underdrain may be modeled as exfiltration at a rate of two inches per hour for sand media and at an appropriate rate for other filter media, then routed through the underdrain system. Verify that this exfiltration flow is routed through the primary outlet of the filter, not discarded from the stormwater model. Determination of filtration rate for proprietary or mixed media must be obtained from the manufacturer or from evaluation of similar applications. [Section 4.9.3, 25]
27. Verify that an adequate number of appropriately placed manholes, access panels and other access features are provided to allow unobstructed and safe access to the media filter for routine maintenance and inspection of inflow, outflow, underdrains, and storage systems. [Section 4.9.3, 28]
28. Verify that access features are provided for underground storage SMPs within which filters are contained and that are not stone storage beds. [Section 4.9.3, 29a]
29. Verify that a sufficient number of access points in the SMP are provided to efficiently inspect and maintain the storage area. [Section 4.9.3, 29b]
30. For cast-in-place vault systems within which filters are contained, verify that access features consist of manholes or grated access panels or doors. Grated access panels are preferred to maintain airflow. [Section 4.9.3, 29c]

31. Verify that ladder access is proposed for vaults, within which filters are contained, greater than four feet in height. [Section 4.9.3, 29f]

F.15.3 Media Filter Material Standards

1. Verify that stone, if proposed, designed for stormwater storage is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.9.4, 3a]
2. Verify that stone, if proposed, is separated from filter media by a geotextile or a pea gravel filter. [Section 4.9.4, 3b]
3. Verify that sand used as filter media, if proposed, is specified on the plans to be clean, medium to fine sand, and to have organic material meeting the specifications of AASHTO M-6 or ASTM C-33 sand and a grain size of 0.02 inches to 0.04 inches. [Section 4.9.4, 4a]
4. Verify that sand used as filter media, if proposed, is capable of generating a maximum effluent EMC of 15 milligrams per liter for TSS accumulated at a POA downstream of the SMP. [Section 4.9.4, 4b]
5. Verify that peat, if proposed, has an ash content of less than 15%, a pH range of 3.3 to 5.2, and a loose bulk density range of 0.12 g/cc to 0.14 g/cc. [Section 4.9.4, 5b]
6. Verify that any filter media other than sand or peat is capable of generating a maximum effluent EMC of 15 milligrams per liter for TSS accumulated at a POA downstream of the SMP, meets all other filter design and water quality specifications set forth in Section 4.9, and has a demonstrated record of high performance within urban settings. [Section 4.9.4, 5c]
7. Verify that geotextile, if proposed, is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.9.4, 6]
    a. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
    b. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
    c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
    d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
    e. Heat-set or heat-calendared fabrics are not permitted
8. Verify that underdrains, if proposed, are made of continuously perforated HDPE plastic piping with a smooth interior and a minimum inner diameter of four inches. HDPE pipe must be specified on the plans to meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.9.4, 7]

F.16 Pretreatment

F.16.1 Filter Strip Design and Material Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the filter strip. Refer to Section 4.10.2 for guidance. [Section 2.3.1]
2. If discharge of concentrated flow to the filter strip is proposed, verify that a level spreading device is proposed to provide uniform sheet flow. [Section 4.10.2, 2]
3. If filter strips are proposed in high-use areas, verify that precautions are taken to minimize disturbance of the filter strip, such as signage fences, and placement of sidewalks or paths to minimize pedestrian or vehicular traffic. [Section 4.10.2, 3]
4. If energy dissipaters and/or flow spreaders are not proposed to be installed with the filter strip, verify that the flow path to the filter strip does not exceed 75 feet for impervious ground cover or 150 feet for pervious ground cover. [Section 4.10.2, 4]
5. Verify that the contributing drainage area does not exceed five acres and does not exceed a drainage area to filter strip area ratio of 6:1. [Section 4.10.2, 5]
6. If no energy dissipaters and/or flow spreaders are provided up-gradient of the filter strip, verify that the slope of the contributing drainage area to the filter strip does not exceed 5%. [Section 4.10.2, 6]
7. Verify that the slope of the filter strip does not exceed 8%. Slopes less than 5% are generally preferred. Filter strips with slopes that exceed 5% should implement check dams to encourage ponding and prevent scour and erosion of the filter strip area. [Section 4.10.2, 7]
8. Verify that the slope (parallel to the flow path) of the top of the filter strip, after a flow spreading device, is less than 1% and gradually increases to the designed value to protect from erosion and undermining of the device. [Section 4.10.2, 8]
9. Verify that the plans indicate that plants must be established at the time of filter strip completion (at least three months after seeding), and that runoff must not be allowed to flow across the filter strip until the vegetation is established. [Section 4.10.2, 9]
10. Verify that the filter strip length is in accordance with Table 4.10-2 of the Manual. [Section 4.10.2, 10]
11. For contributing flow paths less than 30 feet in length, verify that the filter strip length is in accordance with Figure 4.10-1 of the Manual. [Section 4.10.2, 11]
12. For contributing flow paths greater than 30 feet in length, verify that the filter strip meets the required flow characteristics for maximum velocity and depth listed in Table 4.10-3 of the Manual. [Section 4.10.2, 12]

F.16.2 Forebay Design and Material Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the forebay. Refer to Section 4.10.3 for guidance. [Section 2.3.1]
2. For forebays within large SMPs such as ponds and wet basins, verify that the forebay contains 10% to 15% of the total permanent pool volume of the larger SMP. [Section 4.10.3, 1]
3. For forebays within smaller SMPs such as bioinfiltration/bioretention basins, verify that the storage volume is sized to retain 0.25 inches of runoff per acre of contributing directly connected impervious area (DCIA), with an absolute minimum of 0.1 inch per impervious acre. [Section 4.10.3, 2]
4. Verify that the plans include a stone berm to physically separate the forebay from its associated SMP. The berm should span the entire width of the basin. [Section 4.10.3, 3]
5. Verify that the plans include inlet controls for the forebay, including riprap aprons, stone placed in concrete, or some other type of energy dissipation device to rapidly reduce the inflow velocity for erosion/scour protection and to encourage settlement of suspended solids. [Section 4.10.3, 4]
6. Verify that the plans indicate that permanent vertical markers constructed of durable materials are to be installed within the forebay area to indicate the sediment depth. [Section 4.10.3, 5]
7. Verify that adequate inspection and maintenance access is provided to allow for periodic sediment removal; this is most commonly provided via stabilized and mildly sloping graded areas that can be accessed by heavy equipment. [Section 4.10.3, 6]
8. Verify that exit velocities from the forebay are non-erosive. Refer to the latest edition of the *Pennsylvania Department of Environmental Protection (PA DEP) Erosion and Sediment Pollution Control Program Manual* for information on design standards for erosion and sedimentation control practices. [Section 4.10.3, 7]

F.16.3 Swale Design and Material Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the swale. Refer to Section 4.10.4 for guidance. [Section 2.3.1]
2. If a swale is designed as a primary SMP, verify that the swale meets all Design Guidance Checklist design standards noted in Appendix F.7, Bioinfiltration/Bioretention, as well as all applicable swale Design Guidance Checklist design standards below. [Section 4.10.4, 1]
3. Verify that the swale can convey the ten-year, 24-hour storm event with a minimum of six inches of freeboard and a maximum depth of 18 inches. Flow over check dams may be estimated using a weir equation. [Section 4.10.4, 2]
4. Verify that the swale is designed to resist erosion. It is recommended that the swale convey the two-year, 24-hour storm event without erosion. The latest edition of the *PA DEP Erosion and Sediment Pollution Control Program Manual* is recommended as a reference for these calculations. Verify that soil mix, vegetation, and temporary or permanent stabilization measures are adjusted as needed. [Section 4.10.4, 3]
5. Verify that the plans indicate that plants must be established at the time of swale completion (at least three months after seeding). [Section 4.10.4, 4]
6. Verify that energy dissipaters are provided at points of concentrated inflow into the swale. [Section 4.10.4, 5]

7. Verify that the side slopes for all parabolic channel swales do not exceed 2(H):1(V) (the recommended side slope is 3(H):1(V)), and that the side slopes of all mowed areas do not exceed 4(H): 1(V) to avoid “scalping” by mower blades. [Section 4.10.4, 7]
8. Verify that check dams intended to provide ponding in swale SMP designs are not porous, as water should be ponded behind each check dam and forced to infiltrate. If the swales are only being used for conveyance or to increase time of concentration, etc., check dams may be porous. [Section 4.10.4, 8]

F.17 Inlet Controls

F.17.1 Flow Splitter Design and Material Standards

1. Verify that the bypass elevation is set, at minimum, at the design storage elevation in the SMP. Flow will then only start to bypass the SMP once it exceeds the design storage elevation of the SMP. The design storage elevation is the water surface elevation at which the SMP storage area contains the runoff volume from a design storm event (for example, the WQv or the 10-year, 24-hour storm). [Section 4.11.2, 1]
2. Verify that positive overflow is provided for large storm events, up to and including the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm. [Section 4.11.2, 2]
3. Verify that overflow structures and pipes are designed to convey at least the ten-year, 24-hour storm event. The system should have enough capacity to transmit larger flows over the bypass weir without surcharging the structure. [Section 4.11.2, 2]

F.17.2 Curbless Design/Curb Opening Design and Material Standards

1. If flow is to be introduced through curb openings, verify that the pavement edge is slightly higher than the elevation of the vegetated areas within the SMP. [Section 4.11.3, 1]
2. Verify that curbless design/curb openings are designed to convey flow into an SMP without inducing erosive conditions. Integration of energy dissipaters is recommended where appropriate. [Section 4.11.3, 2]
3. Verify that curb openings are designed to reduce bypass of gutter flow past the curb opening. This is a common problem with many curb openings that are oriented perpendicular to flow. [Section 4.11.3, 3]
4. If curb openings are used to capture runoff, especially from driveways or roadways where the curb openings are not in a sump condition, verify that documentation that runoff from the one-year, 24-hour storm event will be captured by the curb opening is provided. [Section 4.11.3, 4]
5. Verify that erosion control fabric, if proposed, is designed in accordance with the channel design procedures in the latest edition of the *Pennsylvania Department of Environmental Protection (PA DEP) Erosion and Sediment Pollution Control Program Manual*, or per the manufacturer's specifications. [Section 4.11.3, 6]
6. Verify that curb openings are designed as gaps in otherwise continuous sections of concrete or granite curb conforming to the specifications of the *City of Philadelphia Department of Streets, Standard Construction Items (1997)*. [Section 4.11.3, 7]
7. Verify that all subsurface portions of concrete or granite curb (i.e. below finished pavement grade) are continuously installed within the extents of the curb opening. [Section 4.11.3, 8]
8. Verify that curb openings are appropriately sized to convey the design discharge. Curb openings are typically 12 to 48 inches wide. Verify that curb openings are at least eight inches wide to prevent clogging and for ease of maintenance. [Section 4.11.3, 10]

F.17.3 Energy Dissipater Design and Material Standards

1. Verify that an energy dissipater is proposed if flow is concentrated at the entrance to a surface SMP. [Section 4.11.4, 1]
2. Verify that riprap is designed and sized in accordance with the riprap apron design procedures in the latest edition of the *PA DEP Erosion and Sediment Pollution Control Program Manual* or *U.S. Army Corps of Engineers, Hydraulic Engineering Center Circular 14 (HEC-14)*. [Section 4.11.4, 2]
3. Verify that riprap stone is angular, graded stone aggregate meeting the specifications of *PennDOT Publication 408, Section 703.2, Coarse Aggregate, Type A*. [Section 4.11.4, 3]
4. For stream outfalls, verify that the energy dissipation design tools HEC 11, HEC 14, and HEC 15 are used for riprap, energy dissipaters, and flexible linings, respectively. [Section 4.11.4, 4]

F.17.4 Inlet Design and Material Standards

1. Verify that inlets are not connected in series. Similarly, roof drainage systems must not be directly connected to inlets. [Section 4.11.5, 1]
2. Verify that all inlets include a sump and trap or sump and hood for pretreatment of stormwater runoff. The sump depth must be at least 15 inches below the bottom of the trap or at least 12 inches below the bottom of the hood. [Section 4.11.5, 2]
3. If non-standard inlets are used to capture runoff, especially from driveways or roadways where the inlets are not in a sump condition, verify that documentation that runoff from the one-year, 24-hour storm event will be captured by the inlet is provided. [Section 4.11.5, 3]
4. Verify that inlet spacing is designed to prevent water from overtopping the curb and gutter or drainage ditch. [Section 4.11.5, 4]
5. Verify that inlets are sized based on the size of the contributing drainage area, the amount of sediment expected from the discharging waters, the size and frequency of runoff events, and the amount of maintenance expected, recognizing that an undersized system will require more frequent maintenance. For large inlet drainage areas, area drains and yard drains 18 inches in diameter or smaller, or smaller than 2’ x 2’, should be upsized to at least 2’ x 2’ inlets. [Section 4.11.5, 5]
6. Verify that all area drains and yard drains 18 inches in diameter or smaller, or smaller than 2’ x 2’, include a permanent pretreatment device, such as a filter bag insert, for pretreatment of stormwater runoff. [Section 4.11.5, 6]

F.18 Outlet Controls

F.18.1 General Design Standards

1. Verify that outlet controls provide positive overflow for their associated SMP, allowing stormwater to flow out of the SMP when the water level reaches a maximum design elevation in a subsurface feature or a maximum ponding depth in a surface feature without surcharging the SMP. Positive overflow from an SMP can either flow to another SMP or to an approved point of discharge. [Section 4.12.1, 2]
2. Verify that outlet control structures are sized to convey at least the ten-year, 24-hour storm event without surcharging the structure. [Section 4.12.1, 2]
3. Verify that the outlet controls are designed to convey flows from the SMP up to the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm, without surcharging the SMP. If flow reaches the SMP via a flow splitter, this structure can provide the positive overflow. [Section 4.12.1, 2]
4. Verify that outlet controls are located so as to be easily and readily accessible for maintenance purposes. [Section 4.12.1, 3]
5. Verify that all outlet control structures in combined sewer areas include a sump and trap or sump and hood. The sump depth must be at least 15 inches below the bottom of the trap or at least 12 inches below the bottom of the hood, and the traps or hoods must be air-tight. [Section 4.12.1, 4]
6. Verify that ladder bars are included within all outlet control structures. [Section 4.12.1, 5]
7. Verify that any manholes between outlet structures and sewer connections in combined sewer areas have sanitary, non-vented covers. [Section 4.12.1, 6]
8. Verify that outlet control structures have solid, non-grated, tops. [Section 4.12.1, 7]
9. Verify that the outlet pipe of an outlet control structure has an invert at or below the invert of the inlet pipe(s). Setting the outlet pipe invert at a minimum of 7.5 inches below that of the inlet pipe(s) is recommended. [Section 4.12.1, 8]

F.18.2 Orifice Design and Material Standards

1. Verify that the orifice diameter for a traditional orifice (i.e., that which is not part of an underdrain) is no smaller than one inch. [Section 4.12.2, 1]
2. Verify that the orifice diameter for an underdrain orifice (i.e., that which is located at the capped end of an underdrain) is no smaller than 0.5 inch. [Section 4.12.2, 1]
3. Verify that a trash rack is provided for any orifice draining surface basins. [Section 4.12.2, 2]

4. For any traditional orifice three inches in diameter or smaller, verify the following:
    a. To prevent clogging, verify that screening is provided over the orifice. The dimensions of the openings within the screening must be half the diameter of the orifice. The screening should be separated from the orifice, not placed directly over the orifice. A minimum 12-inch sump must be provided beneath the invert of the orifice to prevent the collection of debris. [Section 4.12.2, 3]
    b. Verify that an outlet structure box with one manhole access lid on each side of the weir wall is proposed for maintenance access. Adequate space to perform maintenance on the orifice must be provided on each side of the weir wall; it is recommended that at least four feet by three feet of space be provided on each side of the weir wall [Section 4.12.2, 4]
5. Verify that suitable access is provided to inspect and maintain all orifices. [Section 4.12.2, 6]

F.18.3 Weir Design and Material Standards

1. For impermeable weirs, verify the following:
    a. Verify that check dams, when placed within swales, are evenly spaced and no more than six to 12 inches high. [Section 4.12.3, 3a]
    b. Verify that check dams that provide ponding in swales and are designed for infiltration are not porous, as water should be ponded behind each check dam and forced to infiltrate. [Section 4.12.3, 3b]
2. Verify that permeable weirs are not proposed in areas that receive high sediment loads. [Section 4.12.3, 4]
3. For spillways, verify the following:
    a. Verify that, during the 100-year, 24-hour storm event—or, if project is exempt from Flood Control, the ten-year, 24-hour storm event—a minimum of one foot of freeboard is provided between the ponding elevation and the invert elevation of the emergency spillway. [Section 4.12.3, 5a]
    b. Verify that a minimum of one foot is provided between the invert elevation of the emergency spillway and the top-of-berm elevation. [Section 4.12.3, 5b]
    c. Verify that all emergency spillways are stabilized with stone, geotextile, or plant material that can withstand strong flows. [Section 4.12.3, 5c]
    d. Verify that spillway flow is not directed toward neighboring properties. [Section 4.12.3, 5d]
4. Verify that weir walls within outlet control structures are proposed to be poured monolithically. [Section 4.12.3, 6]

F.18.4 Riser Design and Material Standards

1. Verify that riser design balances providing positive overflow with allowing for adequate static storage. Overflow must be provided at the maximum Water Quality storm ponding depth for all SMPs and, for bioinfiltration/bioretention basins, at the minimum height to provide sufficient static storage of the Water Quality Volume (WQv). [Section 4.12.4, 1]
2. Verify that riser pipes are specified on the plans to be constructed of high-density polyethylene (HDPE) plastic, corrugated metal, concrete, or other weather resistant material. [Section 4.12.4, 2]

3. Verify that riser boxes are constructed of precast or cast-in-place concrete with reinforcing as warranted. All concrete must be specified on the plans to be Class C, conforming to the specifications of the *City of Philadelphia Department of Streets, Standard Construction Items (1997)*. [Section 4.12.4, 3]
4. Verify that trash racks or screens are proposed with the riser and that they are specified on the plans to be constructed of durable, weather-resistant materials resistant to photo-degradation, weathering, oxidation, or other corrosive impacts. [Section 4.12.4, 4]

F.18.5 Underdrain Design and Material Standards

1. Verify that capped underdrains are provided for all proposed bioinfiltration/bioretention basins. For bioinfiltration SMPs, the cap at the end located within the outlet control structure must be a solid cover to promote infiltration. For bioretention SMPs, the cap within the outlet control structure must be outfitted with an orifice, sized appropriately to meet all applicable release rate requirements. [Section 4.12.5, 1]
2. Verify that all underdrains are designed to be level (i.e., with no slope). [Section 4.12.5, 2]
3. Verify that all underdrains are constructed of continuously perforated HDPE plastic piping with a smooth interior and a minimum inner diameter of four inches. HDPE pipe must be specified on the plans to meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.12.5, 3]
4. Verify that all underdrains are surrounded by a sand or stone layer to filter sediment and facilitate drainage. [Section 4.12.5, 4]
5. Verify that the sand or stone layer surrounding the underdrain is specified on the plans to be at least six inches both above and beneath the underdrain. [Section 4.12.5, 5]
6. If a sand layer is proposed, verify that the underdrain is surrounded by geotextile fabric to prevent clogging. [Section 4.12.5, 6]
7. Verify that stone surrounding an underdrain is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.12.5, 7]
8. Verify that sand, if proposed, is specified on the plans to be AASHTO M-6 or ASTM C-33 sand and to have a grain size of 0.02 inches to 0.04 inches. [Section 4.12.5, 8]
9. Verify that geotextile fabric is placed between the stone layer and surrounding soil to prevent sediment contamination. [Section 4.12.5, 9]
10. Verify that geotextile is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.12.5, 10]
    a. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
    b. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
    c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
    d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
    e. Heat-set or heat-calendared fabrics are not permitted

11. Verify that cleanouts or maintenance access structures are provided at the end of all underdrain pipes and that a cleanout detail is provided on the plans. [Section 4.12.5, 11]
12. Verify that cleanouts are provided for all 90-degree bends, located upstream of complicated bends, and evenly spaced during straight pipe runs and that a cleanout detail is provided on the plans. [Section 4.12.5, 12]
13. Verify that all intermediate cleanouts and domed riser pipe connections are located upstream of the connected outlet control structure to allow for cleaning equipment to flush in the direction of the structure. [Section 4.12.5, 13]
14. Verify that an anti-seep collar is installed around outlet pipes passing through embankments. Anti-seep collars must be constructed in accordance with the latest edition of the *PA DEP Erosion and Sediment Pollution Control Program Manual*. [Section 4.12.5, 14]
15. Verify that cleanouts are made of material with a smooth interior having an inner diameter that is no less than four inches and matches that of its connecting pipe up to eight inches. If the pipe is larger than eight inches in diameter, verify that the cleanout is eight inches in diameter. [Section 4.12.5, 15]
16. Verify that the outlet pipe of an outlet control structure has an invert at or below the invert of the underdrain. Setting the outlet pipe invert at a minimum of 7.5 inches below that of the underdrain is recommended. [Section 4.12.5, 16]

F.18.6 Level Spreader Design and Material Standards

1. Verify the level spreader length. Level spreader length for a dense grass ground cover condition must be 13 linear feet for every one cubic feet per second (cfs) of flow during the ten-year, 24-hour storm event. Level spreader length for forested areas with no ground cover must be 100 linear feet for every one cfs of flow during the ten-year, 24-hour storm event. [Section 4.12.6, 1]
2. Verify that all level spreaders are designed to safely diffuse flows up to, and including, the 100-year, 24-hour storm event. [Section 4.12.6, 2]
3. Verify that the edge of the level spreader over which flow is distributed is specified on the plans to be exactly level. If there are small variations in height on the downstream lip, small rivulets will form. Experience suggests that variations of more than 0.25 inch can cause water to re-concentrate and potentially cause erosion downstream of the level spreader. The site selected for the installation of a level spreader must be a level grade (a constant horizontal elevation, to within +/- four inches). [Section 4.12.6, 3]
4. Verify that the downslope side of the level spreader is clear of debris. [Section 4.12.6, 4]
5. Verify that the first three feet downslope of the level spreader is stabilized with soil/turf reinforcement matting and grass or other approved vegetation and that matting specifications are provided on the plans. [Section 4.12.6, 5]
6. Verify that level spreaders are not constructed in newly deposited fill. [Section 4.12.6, 6]
7. For level spreaders that do not direct discharge to a receiving stream or sewer, verify that the distance between the level spreader and any downslope property boundary is no less than 15 feet. If this requirement cannot be met, a drainage easement may be required. [Section 4.12.6, 7]

8. For level spreaders that direct discharge to a receiving stream or sewer via overland flow, verify that the distance between the level spreader and any receiving stream or sewer is no greater than 100 feet. Distances greater than 100 feet but less than 150 feet may be considered on a case-by-case basis for very mild slopes (less than or equal to 1%) and heavily vegetated (grassy) areas. [Section 4.12.6, 8]
9. Verify that the first ten feet downslope of the level spreader does not exceed a slope of 4%. [Section 4.12.6, 9]
10. Verify that earthen berms, treated lumber, and geotextile-covered berms are not used as level spreaders. [Section 4.12.6, 10, 11, 12]
11. For concrete curbs, troughs, and half-pipes, verify the following:
    a. Verify that concrete curbs, troughs, and half-sections of pipe are between four and 12 inches deep. [Section 4.12.6, 13a]
    b. Verify that curbs and troughs are specified on the plans to be constructed of Class C concrete or reinforced concrete, conforming to the specifications of the *City of Philadelphia Department of Streets, Standard Construction Items (1997)*. [Section 4.12.6, 13b]
    c. Verify that half-pipes are specified on the plans to be either Class C concrete or reinforced concrete, conforming to the specifications of the *City of Philadelphia Department of Streets, Standard Construction Items (1997)* or HDPE plastic meeting the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.12.6, 13c]
12. For subsurface discharge through level perforated pipes (bubble-up level spreaders), verify the following:
    a. Verify that perforated pipes are between four and 12 inches in diameter. HDPE pipe must be specified on the plans to meet AASHTO M252, Type S or AASHTO M294, Type S standards. [Section 4.12.6, 14a]
    b. Verify that the pipes are enveloped in stone and that the stone is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.12.6, 14b]
    c. Verify that geotextile is placed between the stone aggregate and soil. [Section 4.12.6, 14c]
    d. Verify that geotextile is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.12.6, 14d]
        i. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
        ii. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
        iii. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
        iv. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
        v. Heat-set or heat-calendared fabrics are not permitted
13. For surface discharge to plunge pools, verify the following:
    a. Verify that the plans specify that underlying soils within plunge pools remain undisturbed, uncompacted, and protected from heavy equipment to preserve infiltration capacities. [Section 4.12.6, 15a]
    b. Verify that riprap stone is sized in accordance with the riprap apron design procedures in the latest edition of the *PA DEP Erosion and Sediment Pollution Control Program Manual*. [Section 4.12.6, 15b]

F.18.7 Impervious Liner Design and Material Standards

1. Verify that the impervious liner is specified on the plans to have a permeability of less than, or equal to, 10^{-6} cm/sec. [Section 4.12.7, 3]
2. Verify that the plans indicate that the impervious liner is to be continuous and extend completely up the sides of any structures that are located within the lined basin footprint to the ground surface. If additional liner material must be added to extend up the structures, the additional liner sections are to be joined to the rest of the liner with an impervious seam per the manufacturers' recommendation. [Section 4.12.7, 4]
3. For compacted till liners, verify the following:
    a. Verify that the compacted till liner thickness is no less than 18 inches (after compaction). [Section 4.12.7, 5a]
    b. Verify that soil is compacted to 95% minimum dry density, modified proctor method (ASTM D-1557). [Section 4.12.7, 5b]
    c. Verify that soil is placed in six-inch lifts. [Section 4.12.7, 5c]
    d. Verify that the proposed soils are specified on the plans as meeting the gradation listed in Table 4.12-3 of the Manual. [Section 4.12.7, 5d]
4. For clay liners, verify the following:
    a. Verify that the clay liner thickness is no less than 12 inches (after compaction). [Section 4.12.7, 6a]
    b. Verify that the clay liner is specified on the plans as meeting the specifications listed in Table 4.12-4 of the Manual. [Section 4.12.7, 6b]
5. For geomembrane liners, verify the following:
    a. Verify that the geomembrane liner material is specified on the plans to be smooth high-density polyethylene (HDPE) or linear low-density polyethylene (LLDPE) with a minimum thickness of 30 mil. [Section 4.12.7, 7a]
    b. Verify that the geomembrane liner material is specified on the plans to be resistant to mildew, rot, ultraviolet radiation, insects, and rodents. [Section 4.12.7, 7b]
    c. Verify that a geotextile is placed between the geomembrane liner and the stone storage layer, and it is specified on the plans to meet, or exceed, the strength properties listed in Table 4.12-5 of the Manual. [Section 4.12.7, 7c]
    d. Verify that a sand layer is placed beneath the geomembrane liner to prevent puncture of the liner. [Section 4.12.7, 7d]
    e. Verify that smooth HDPE and LLDPE geomembrane liners are specified on the plans to conform to the physical requirements stipulated in the Geosynthetic Research Institute (GRI) GM13 and GM17 Standard Specifications for HDPE and LLDPE geomembranes, respectively. [Section 4.12.7, 7e]
    f. Verify that boot collars are included at any point where a pipe penetrates a geomembrane liner. This includes utility crossings, distribution pipes, and underdrain pipes. [Section 4.12.7, 7f]

6. For concrete liners, verify the following:
    a. Verify that the concrete is no less than five inches thick, Class A or better, with ordinary surface finish. [Section 4.12.7, 8a]
    b. When underlying soil is clay or if it has an unconfined compressive strength of 0.25 ton per square foot or less, verify that the concrete has a minimum six-inch compacted aggregate base composed of coarse sand and river stone, crushed stone, or equivalent, with diameter of 0.75 inch to one inch. [Section 4.12.7, 8b]
7. Verify that anti-seep collars are provided on all pipes entering or exiting the storage media of infiltrating SMPs where infiltration is not desired outside of the system (e.g. pipes that cross utilities and underdrain connections to the sewer-connected inlet). Where space allows, anti-seep collar should be placed offset from the SMP. [Section 4.12.7, 9]

F.18.8 Micro Siphon Drain Belt Design and Material Standards

1. Verify that the micro siphon drain belt connects to a downslope underdrain or collector pipe and that the elevation of the belt in the immediate vicinity of the downslope connection is at least four inches above the top of the underdrain or collector pipe. [Section 4.12.8, 1]
2. Verify that the end of the micro siphon drain belt that is not connected to the collector pipe is sealed to prevent the intrusion of solids or other clogging materials. The sealant must be suitable for use in submerged environments. [Section 4.12.8, 2]
3. Verify that a minimum belt slope of 1% is proposed. A belt slope of 3% to 5% is recommended to maintain laminar flow within the micro channels. [Section 4.12.8, 3]
4. Verify that the micro siphon drain belt is proposed to be installed in a layer of sand. [Section 4.12.8, 4]
5. Verify that sand is specified on the plans to be ASTM C-33 aggregate concrete sand and to have a grain size of 0.02 inches to 0.08 inches. [Section 4.12.8, 4]
6. Verify that manufacturer's recommendations are followed to determine the number, size, and specific configuration of belts required to provide adequate flow capacity for specific applications. [Section 4.12.8, 5]
7. Verify that the micro siphon drain belt is spaced around the underdrain or collector drain pipe at a maximum of alternating five-foot centers. [Section 4.12.8, 6]

F.18.9 Low Flow Device Design and Material Standards

1. Verify that the following information is submitted for each proposed low flow device as part of the applicant's Post-Construction Stormwater Management Plan (PCSMP) Review Phase Submission Package. [Section 4.12.9, 1]
    a. Performance/discharge curves;
    b. Third-party certifications;
    c. Hydrologic and hydraulic model files, if applicable;
    d. Product specifications;
    e. Manufacturer's guidelines for installation;
    f. Construction sequence; and
    g. Maintenance requirements, including product life and replacement schedule, if applicable.
2. Verify that appropriate design measures are taken to prevent clogging for all orifices. [Section 4.12.9, 2]
3. Verify that suitable access is provided to inspect and maintain all orifices. [Section 4.12.9, 3]

F.19 Landscaping

- The designer is referred to **Appendix F.4.3** ☛ p. 15 for design requirements of Tree Disconnection Credits
- The designer is referred to **Appendix F.7** ☛ p. 24 for design requirements of Bioinfiltration/Bioretention basins.
- The designer is referred to **Appendix F.9** ☛ p. 35 for design requirements of Green Roofs.
- The designer is referred to **Appendix F.13** ☛ p. 48 for design requirements of Ponds and Wet Basins.

F.19.1 Landscaping Material Standards

1. Verify that stone designed for stormwater storage is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.13.4, 1]
2. Verify that sand, if proposed, is specified on the plans to be AASHTO M-6 or ASTM C-33 sand and to have a grain size of 0.02 inches to 0.04 inches. [Section 4.13.4, 2]
3. Verify that the planting soil medium is specified on the plans as meeting the following specifications:
    a. Planting soil should be a fertile, natural soil, free from large stones, roots, sticks, clods, plants, peat, sod, pockets of coarse sand, pavement and building debris, glass, noxious weeds including invasive species, infestations of undesirable organisms and disease causing pathogens, and other extraneous materials harmful to plant growth. [Section 4.13.4, 3a]
    b. The texture of planting soil should conform to the classification within the United States Department of Agriculture triangle for Sandy Loam or Loamy Sand. Planting soil should be a mixture of sand, silt, and clay particles as required to meet the classification. Ranges of particle size distribution, as determined by pipette method in compliance with ASTM F-1632, are as follows: [Section 4.13.4, 3b]
        i. Sand (0.05 to 2.0 mm): 50 – 85%
        ii. Silt (0.002 to 0.05 mm): 40% maximum
        iii. Clay (less than 0.002 mm): 10% maximum
        iv. Gravel (2.0 to 12.7 mm): 15% maximum
    c. Planting soil should be screened and free of stones larger than a half-inch (12.7 millimeters) in any dimension. No more than 10% of the soil volume should be composed of soil peds greater than one inch. [Section 4.13.4, 3c]
    d. Clods, or natural clumps of soils, greater than three inches in any dimension should be absent from the planting soil. Small clods ranging from one to three inches and peds, natural soil clumps under one inch in any dimension, may be present but should not make up more than 10% of the soil by volume. [Section 4.13.4, 3d]
    e. The pH of the planting soil should have a range of 5.8 to 7.1. [Section 4.13.4, 3e]

f. Soluble salts should be less than 2.0 mmhos/cm (dS/m), typically as measured by 1:2 soil-water ratio basic soil salinity testing. Sodic soils (Exchangeable Sodium Percentage greater than 15 and/or Sodium Adsorption Ratio greater than 13) are not acceptable for use regardless of amendment. [Section 4.13.4, 3f]

g. Organic content of planting soil should have a range of 3% to 15%, by weight, as determined by loss on ignition (ASTM D2974). To adjust organic content, planting soil may be amended, prior to placing and final grading, with the addition of organic compost. [Section 4.13.4, 3g]

4. Verify that mulch, if proposed, is specified to be free of weeds and consist of aged, double-shredded hardwood bark mulch or leaf mulch that has been shredded sufficiently to limit risk of matting, which can limit surface infiltration rates. For hydroseeding, paper mulch may be used. Approved mulching materials include organic materials such as compost, bark mulch, leaves, as well as small river gravel, pumice, or other inert materials. Grass clippings should not be used as mulch. [Section 4.13.4, 4]

5. Verify that geotextile is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.13.4, 5]

   a. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs

   b. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi

   c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2

   d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%

   e. Heat-set or heat-calendared fabrics are not permitted

6. Verify that native grass/wildflower seed mix, if proposed as an alternative to groundcover planting, is free of weed seeds. [Section 4.13.4, 8]

7. Verify that the proposed plantings are indicated on the plans and are non-invasive. Refer to Appendix I for plant lists. [Section 4.13.4, 9]