# PWD Stormwater Plan Review Design Guidance

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I. Regulation Compliance

A) Water Quality (Where Infiltration is Feasible)

1. Verify that all DCIA within the project’s limit of earth disturbance is routed to a stormwater management practice (SMP).

2. Verify that static storage of the Water Quality volume is provided below the lowest outlet of the SMP.

3. Verify that the system drains within the acceptable 72-hour period.

B) Water Quality (Where Infiltration is Not Feasible, Separate Sewer Areas)

1. Verify that 100% of the Water Quality volume is routed through an acceptable volume reducing SMP. Refer to Table 4.3 of the PWD Stormwater Management Guidance Manual (PWD Manual) for reference.

2. Verify that the system drains within the acceptable 72-hour period.

C) Water Quality (Where Infiltration is Not Feasible, Combined Sewer Areas)

1. Verify that a minimum of 20% of the Water Quality volume is routed through an acceptable volume reducing SMP. Refer to Table 4.3 of the PWD Manual for reference.

2. Verify that the hydrologic calculations include routing of the Water Quality storm event.

3. Verify that the release rate for the Water Quality volume does not exceed 0.24 cfs per acre of DCIA.

4. Verify that the system drains within the acceptable 72-hour period.

D) Channel Protection

1. Verify if the Channel Protection requirement is applicable.
   a. The project is exempt from Channel Protection for the proposed conditions’ peak rate of runoff if it is a redevelopment project located in District C and can discharge directly to the Delaware or Schuylkill River Watersheds without the use of City infrastructure.
   b. The project is exempt from Channel Protection for the proposed conditions’ peak rate of runoff greater than the 5-year storm if it is a redevelopment project located in District C-1 and can discharge directly to the Tookany-Tacony Frankford main channel or major tributaries without the use of City infrastructure.
   c. The project is exempt from Channel Protection if it is a redevelopment project and the total post-development DCIA within the limits of earth disturbance (excluding public right-of-way) is at least 20% less than predevelopment impervious area.
d. The project is exempt from Channel Protection if it is a redevelopment project with earth disturbance of less than one acre.
e. The project is exempt from Channel Protection if it is a redevelopment project that qualifies for a Green Project Review.

2. Verify that runoff from DCIA, within the project’s limit of earth disturbance, for the 1-year storm event is released at a rate of less than 0.24 cfs per acre of DCIA and takes a minimum of 24 hours to drain.

E) Flood Control

1. Verify if the Flood Control requirement is applicable.
   a. The project is exempt from Flood Control for the proposed conditions’ peak rate of runoff if it is a redevelopment project located in District C and can discharge directly to the Delaware or Schuylkill River Watersheds without the use of City infrastructure.
   b. The project is exempt from Flood Control for the proposed conditions’ peak rate of runoff greater than the 5-year storm if it is a redevelopment project located in District C-1 and can discharge directly to the Tookany-Tacony Frankford main channel or major tributaries without the use of City infrastructure.
   c. The project is exempt from Flood Control if it is a redevelopment project and the total post-development DCIA within the limits of earth disturbance (excluding public right-of-way) is at least 20% less than predevelopment impervious area.
   d. The project is exempt from Flood Control if it is a redevelopment project that qualifies for a Green Project Review.

2. Verify that post-development peak runoff rates meet the Flood Control requirements for the site’s Flood Management District. Refer to Table 4.2 of the PWD Manual for guidance.

F) Public Health and Safety Rate

1. If applicable, verify that, for all area within the project’s limit of earth disturbance (not just DCIA), post-development peak runoff rates for the 1 through 10-year storm events meet the Public Health and Safety Rate requirement.

2. Verify that the proposed pipe connection is approved.

G) NPDES Permit

1. Verify that the project has applied for a PADEP NPDES Permit if one acre or more of earth disturbance activity is proposed. PWD requires proof of NPDES application to PADEP. This can be in the form of a copy of the application receipt or a notification letter from PADEP.

H) Green Project Review

1. Verify that the project is a redevelopment project.

2. Verify that 95% or more of proposed DCIA is disconnected in accordance with Section 4.2 of the PWD Manual.
3. Verify that the project is identified as being eligible for a Green Project Review in the letter of transmittal sent with the PCSMP submittal.

**I) O&M Agreement**

1. Verify that a site-specific Operations and Maintenance (O&M) Schedule is provided for each proposed SMP that meets the following minimum requirements:
   a. Provides for inspection of the SMP, including repair, replacement, or other routine maintenance
   b. Provides for completion of a written report documenting each inspection and all SMP repairs or maintenance activities performed as a result of the inspection

2. Verify that a completed Worksheet 4 is provided.
   a. Verify that the listed property owner is consistent with the property owner named in Public Records.
   b. Verify that the business title of the provided signatory is appropriate to the property owner/lessee business entity.
   c. Verify that a legal description of the property is provided, both in a hard copy format and an electronically editable (Word document) format.

3. 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.

4. Verify that a copy of the lease agreement between the property owner and the lessee is provided, if applicable.

5. Verify that documentation supporting a Lot Consolidation/Subdivision Plan is provided to demonstrate the intent to change the address of the current property, if applicable.

**J) Record Drawings**

1. 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 licensed professional during construction. Templates for these forms can be found in the Construction Certification Package document in the PWD Technical Library of www.PWDPlanReview.org.

2. Verify that each SMP Construction Certification Form is customized to adequately record all required measurements pertinent to verification of the SMP’s installation and functionality.

3. Verify that the submitted Record Drawings comply with the Record Drawing requirements detailed in Section 5.4.5 of the PWD Manual.

**K) Overall Compliance**

1. Verify that the project complies with all applicable Stormwater Regulations.
II. Plan Sheet Requirements

A) General

1. Verify that all plans, reports, and calculations are signed and sealed by a PA professional engineer. An original signature (not an electronic or scanned copy) and seal must be on the plan set cover sheet. Subsequent plan sheets may be signed and sealed electronically.

2. Verify that final plans for construction are provided for the project. Only plans finalized for construction will be considered for PCSMP Approval by PWD Stormwater Plan Review.

3. Verify that a north arrow, legend, and scale are provided on plans.

4. Verify that the proposed building footprint is labeled.

5. Verify that all acronyms and symbols are identified in the plan legends.

6. Verify that the plan legend is consistent with the plan view.

7. Verify that all plan drawings are legible.

8. Verify that the scale of the plan maps is large enough to clearly depict the topographic features of the site.

B) Grading Plan

1. Verify that the proposed grading is correct.
   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.

C) Utility Plan

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.

2. Verify that pipe lengths, slopes, and inverts are accurate. Compare pipe information to profiles, if provided, for consistency.

3. Verify that no piping conflicts exist.
4. 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.

5. Verify that inlets are not connected in series. Wye connections, or similar, may be used to ensure that inlets are offline.

6. Verify that a cleanout is provided for all 90-degree pipe bends in the storm sewer system.

7. Verify that all paved areas exceeding 5,000 square feet and all roof areas exceeding 300 square feet are drained to an approved point of disposal.

8. Verify that the invert elevation(s) for the proposed connection(s) to the existing City sewer is/are specified.

9. Verify that all stormwater conveyance pipe material is in compliance with the Philadelphia Plumbing Code.

10. Verify that roof drainage systems do not tie directly into an inlet.

11. Verify that all proposed connections to the City sewer will be reviewed by PWD Water Transport Records Unit. Obtain a Connections Permit from PWD Water Transport Records Unit as applicable.

12. Verify that a copy of the plans is submitted to the PWD Industrial Waste Unit for review if the project proposes an oil/water separator.

13. Verify that Private Cost plans are submitted to the PWD Design Unit for review, if applicable. More information on Private Cost requirements can be found in the PWD Technical Library of www.PWDPlanReview.org.

D) Detail Sheet

1. Verify that details are provided for all stormwater management practices.

2. Verify that a pipe connection detail is provided for the proposed connection(s) to the existing storm sewer(s).

3. Verify that dimensions of the proposed outlet control structure are provided.

4. Verify that any manholes between outlet structures and sewer connections in combined sewer areas have sanitary (non-vented) covers.

5. Verify that any outlet structure in a combined sewer area includes a sump and trap or sump and hood. The sump depth must be 15 inches below the bottom of the trap or 12 inches below the bottom of the hood, and the traps or hoods must be air-tight.

6. Verify that all inlet structures include a sump and trap or sump and hood for pretreatment of stormwater runoff. The sump depth must be 15 inches below the bottom of the trap or 12 inches below the bottom of the hood. Traps or hoods in combined sewer areas must be air-tight.

7. If an orifice with a diameter of less than 3 inches is proposed in an outlet control structure, verify the following:
a. Verify that an Orifice Waiver Request Worksheet is provided for the small orifice. Refer to Appendix F.4.2 of the PWD Manual for more information.

b. Verify that protection from clogging is provided for the small orifice.

c. Verify that ladder bars are included in the outlet structure for maintenance of the small orifice.

d. Verify that a large enough outlet structure, with two manhole access lids for access to both sides of the weir wall, is provided for maintenance of the small orifice. It is recommended to allow for at least 4 feet by 3 feet of space on each side of the weir wall.

E) Drainage Area Plans

1. Verify that drainage boundaries are based on site topography and include the entire tributary area, including any off-site drainage, if applicable.

2. Verify that common points of analysis are chosen to compare predevelopment and post-development conditions.

3. Verify that points of analysis are clearly labeled on the plans and in the stormwater model.

4. Verify that pertinent existing stormwater infrastructure, including roof leaders, is shown on the plans in order to define the existing drainage conditions.

5. 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:
   a. Inlet drainage area
   b. Impervious and pervious cover within each inlet drainage area
   c. Runoff coefficient
   d. Inlet concentration time

6. Verify that the roof drainage area for each roof leader is indicated on the plans.
III. Disconnecting Impervious Cover

A) Rooftop Disconnection

1. Verify that any proposed rooftop disconnection is clearly labeled on the plan.
2. Verify that the contributing area of rooftop to each disconnected discharge is 500 square feet or less.
3. Verify that the soil is not designated as a hydrologic soil group “D” or equivalent.
4. Verify that the overland flow path has a positive slope of 5% or less.
5. Verify the percentage of roof area being disconnected based on the flow length over pervious area. Refer to Table 4.1 of the PWD Manual for appropriate DCIA reductions.
6. Verify consistency between the rooftop disconnection information provided on the plans and that which is provided on PWD Worksheet 2.

B) Pavement Disconnection

1. Verify that the plans minimize impervious areas to the extent practicable.
2. Verify that any proposed pavement disconnection is clearly labeled on the plan.
3. Verify that the contributing flow path over the impervious surface is no more than 75 feet.
4. Verify that the length of overland flow over pervious area is greater than or equal to the contributing length of the flow path over impervious surfaces.
5. 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.
6. Verify that the soil is not designated as a hydrologic soil group “D” or equivalent.
7. Verify that the slope of the contributing impervious area is 5% or less.
8. Verify that the overland flow path over pervious area has a positive slope of 5% or less.
9. 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, a gravel strip or other spreading device is required for concentrated discharges.
10. Verify consistency between the pavement disconnection information provided on the plans and that which is provided on PWD Worksheet 2.
C) New Tree Disconnection Credit

1. Verify that any new tree proposed to be used for disconnection is clearly labeled on the plan as such.

2. Verify that the caliper sizes of proposed deciduous trees and heights of proposed evergreen trees are provided. New deciduous trees must be at least 2-inch caliper, and new evergreen trees must be at least 6 feet tall, to be eligible for disconnection credit.

3. Verify that the proposed species of the new trees are provided. The tree species must be in compliance with Chapter 8 of the PWD Manual.

4. Verify that the proposed trees are planted within 10 feet of ground level DCIA within the limits of earth disturbance.

5. Verify that the 100-square foot DCIA reduction credit is being applied to ground level DCIA not already being counted toward disconnection credit and within the limits of earth disturbance adjacent to (within 10 feet of) the proposed tree.

6. 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 10 feet, i.e. a sidewalk or path. For these impervious areas, 100% of the DCIA may be disconnected through tree credits.

7. Verify consistency between the new tree disconnection credit information provided on the plans and that which is provided on PWD Worksheet 2.

D) Existing Tree Disconnection Credit

1. Verify that any existing tree proposed to be used for disconnection is clearly labeled on the plan as such.

2. Verify that the caliper sizes of the existing trees proposed to be used for disconnection credit are provided. Existing trees must be at least 4-inch caliper to be eligible for disconnection credit.

3. Verify that the species of the existing trees proposed to be used for disconnection credit are provided. The tree species must be in compliance with Chapter 8 of the PWD Manual.

4. Verify that the canopies of existing trees proposed to be used for disconnection credit are field measured. Alternatively, verify that an annotated aerial photograph clearly showing the existing tree canopy limits is provided.

5. Verify that only DCIA located directly under the canopy area of any existing tree proposed to be used for disconnection credit is being considered disconnected.

6. Verify that existing tree canopy area overlapping or overhanging that of another, separate existing tree canopy area is not being counted toward disconnection credit.

7. 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 10 feet, i.e. a sidewalk or path. For these impervious areas, 100% of the DCIA may be disconnected through tree credits.

8. Verify consistency between the existing tree disconnection credit information provided on the plans and that which is provided on PWD Worksheet 2.
IV. Infiltration

A) Infiltration Testing Procedure and Report

1. Verify that a minimum of two infiltration tests are conducted per infiltration area.

2. Verify that, for large infiltration areas, multiple test pits are evenly distributed at the rate of four to six tests per acre of stormwater management practice (SMP) area.

3. Verify that the infiltration tests are performed within 25 feet of each proposed infiltration SMP.

4. Verify that at least one test is conducted within 1 foot of the proposed bottom elevation of infiltration for each SMP.

5. Verify that a presoak is performed immediately prior to infiltration testing.
   a. For double-ring infiltrometer testing, if the drop in the water level during the last 30 minutes of the presoaking period is 2 inches or more, verify that 10-minute measurement intervals are used between infiltration test readings.
   b. For double-ring infiltrometer testing, if the drop in the water level during the last 30 minutes of the presoaking period is less than 2 inches, verify that 30-minute measurement intervals are used between infiltration test readings.
   c. For percolation testing carried out between June 1 and December 31, verify that a 24-hour presoak was performed before the testing.

6. Verify that, for a double-ring infiltrometer test, 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.

7. Verify that the tested infiltration rate is between 0.5 and 10 inches per hour. PWD considers infiltration to be infeasible in soils with tested infiltration rates less than 0.5 inches per hour. Soils with tested infiltration rates in excess of 10 inches per hour require soil amendments.

8. 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 2 feet above any limiting zone, such as groundwater or bedrock.

9. Verify that the report is signed and sealed by a registered PA professional.

10. Verify that an infiltration testing location plan is provided.

11. Verify that infiltration testing field logs are provided.

12. Verify that information regarding the weather at the time of infiltration testing is provided. Testing should not be conducted in the rain, within 24 hours of significant rainfall events (greater than 0.5 inches), or when the temperature is below freezing.

13. Verify that a copy of any Phase I or Phase II environmental site assessment prepared for the site is provided.
B) Infiltration Rate Calculation

1. Verify that the geometric mean is used to determine the tested infiltration rate.

2. Verify that the highest infiltration rate from the test results for any SMP is discarded before calculation of the geometric mean when more than two tests are conducted for the SMP.

3. Verify that any rates obtained from percolation testing are divided by the appropriate reduction factor to yield the tested infiltration rate.

4. Verify that a factor of safety of 2 is applied to the tested infiltration rate to obtain the design infiltration rate.

C) Infiltration SMP Design Requirements

1. Verify that the loading ratio of DCIA to the horizontal footprint of a subsurface infiltration SMP does not exceed 5:1.

2. Verify that the loading ratio of DCIA to the horizontal footprint of a surface vegetated SMP does not exceed 10:1.

3. Verify that infiltration SMPs are located at least 10 feet from all building foundations and property lines not abutting open public right-of-way streets, unless a deed restriction is put in place extending at least 10 feet from the perimeter of the infiltrating SMP.

4. Verify that the SMP does not statically store the entire DCIA runoff volume for storm events greater than the 1-year storm. PWD generally does not allow more runoff than that of the 1-year storm to be statically stored for infiltration. Projects may statically store runoff volumes from greater than the 1-year storm up to the runoff volume from the 10-year storm if the applicant provides 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:
   a. Provide 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. Indicate the location of the groundwater table
   c. Provide references to other projects that have successfully infiltrated the 1-year storm event
   d. Provide rigorous pre-treatment to promote longevity of the infiltration system

D) Soil Amendments

1. Verify that soil amendments are proposed for any infiltration practice with a tested infiltration rate in excess of 10 inches per hour.

2. Verify that soil amendment specifications and the following sequence of construction are clearly noted on the plan sheets.
   a. Excavate 2 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 non-woven geotextile 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 2 feet of amended soil across the entire cross-section of 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 two (2) infiltration tests must be performed within the amended soil layer. The procedure utilized must be the double-ring infiltrometer test, and it 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 infiltration testing report with a testing location plan and summary of results, along with written certification indicating that the amended soil mix meets the criteria as specified on the plans and was installed according to the plan. 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 0.5 to 10 inches per hour or varies significantly from the design infiltration rate, additional soil amendments and/or a system redesign will be required. If the tested infiltration rate is acceptable, install the remainder of the infiltration practice.

g. Existing subgrade 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 subgrade 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 4 feet outside of bed.

j. Install aggregate course in lifts of 6-8 inches. Lightly compact each layer with light equipment, keeping equipment movement over storage bed subgrades to a minimum. Install aggregate to grades indicated on the drawings.

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

3. Verify that the soil amendments span the entire surface area of the infiltration bed.

4. Verify that the soil amendments extend a minimum of 2 feet below the bottom of the infiltration bed.

5. Verify that a non-woven geotextile filter fabric or a pea gravel filter is installed between the in-situ and amended soil layers.

6. Verify that a conservative infiltration rate is used in the stormwater calculations.
V. Hydrologic Model and Stormwater Calculations

A) Stormwater Model

1. Verify that the precipitation depths used for all design storm events are in accordance with the PADOT Field Manual design rainfall data listed below.

<table>
<thead>
<tr>
<th>Precipitation Depth (inches)</th>
<th>1-year</th>
<th>2-year</th>
<th>5-year</th>
<th>10-year</th>
<th>25-year</th>
<th>50-year</th>
<th>100-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 hours</td>
<td>2.64</td>
<td>3.36</td>
<td>4.32</td>
<td>5.28</td>
<td>6.24</td>
<td>7.20</td>
<td>8.40</td>
</tr>
</tbody>
</table>

2. Verify that runoff from pervious and impervious areas is calculated separately. Weighted curve numbers combining pervious and impervious areas are not an acceptable alternative.

3. Verify that the modeled drainage areas are accurate and consistent with the plans’ drainage areas.

4. Verify that the stormwater model uses the minimum time step allowable by the hydrologic software, which is 0.01 hours in HydroCAD, 1 minute in Hydraflow, and 0.1 hour in PondPack.

5. Verify that all DCIA within the project’s limit of earth disturbance is routed to a stormwater management practice (SMP).

6. Verify that all SMP bypass areas within the project’s limit of earth disturbance are accounted for in the hydrologic calculations’ stormwater model.

7. Verify that the SMP storage provided is correct and consistent with the plans. Use a porosity of 0.20 for soil, 0.30 for sand, and 0.40 for stone storage.

8. Verify that the outlet structure configuration is correct and consistent with the plans.

9. Verify that the Manning’s n values used within the stormwater model are correct and consistent with the plans. Use 0.013 for RCP, VCP, and CIP, and use 0.011 for PVC and HDPE.

10. Verify that the routing of devices within the stormwater model is provided and consistent with the plan’s proposed design.

11. Verify that the links are correct. Points of interest should only be linked when they drain to the same sewer shed or waterway.

B) Curve Numbers

1. Verify that the correct curve numbers are used in the calculations. Refer to Table 5.4 of the PWD Manual.

2. When performing Flood Control calculations, verify that all non-forested, pervious areas on-site are considered meadow (good condition) in predevelopment runoff calculations. Non-forested, pervious
area includes the following cover types: meadow, grass/lawn, brush, gravel, dirt, pervious pavements, and any combination of these cover types.

3. When performing Flood Control calculations, verify that 20% of all existing impervious cover on-site is considered meadow (good condition) in predevelopment runoff calculations.

4. Verify that a curve number of 98 is used with a precipitation depth of 1.2 inches when routing the Water Quality storm event for combined sewer areas where infiltration is not feasible.

5. Verify that a curve number of 100 is used for the area below the water surface elevation in an above-ground wet pond (retention basin) for the applicable storm event, where required.

C) Time of Concentration

1. Verify that time of concentration calculations are provided for all predevelopment areas.

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.).

3. Verify that the time of concentration paths are shown from the hydraulically most distant point of the watershed to a point of interest within the watershed and that the paths are perpendicular to the contours.

4. Verify that a maximum sheet flow length of 100 feet is used if the flow is not concentrated.

5. Verify that the correct Manning’s roughness coefficients (n) are used in the sheet flow component of the time of concentration calculations. Refer to Table 5.5 of the PWD Manual.

6. Verify that the correct 2-year precipitation depth (P-2) is used in the sheet flow component of the time of concentration calculations.

7. Verify that the minimum time of concentration is shown as 6 minutes.

D) 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.

2. Verify that all storm sewer pipes are sized to have adequate capacity to safely convey the 10-year storm event without surcharging the crown of the pipe.

3. Verify the precipitation intensity used in the pipe capacity calculations. The precipitation intensity for a 5-minute inlet concentration time in the 10-year storm event is 6.95 in/hr.

4. Verify the runoff coefficients used in the pipe capacity calculations. Use 0.35 for pervious areas and 0.95 for impervious areas.

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. Use 0.013 for RCP, VCP, and CIP, and use 0.011 for PVC and HDPE.
6. 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 1-year storm will be captured by the inlet.

7. Verify that all roof drainage systems are sized per the Philadelphia Plumbing Code.

8. Verify that the minimum size of a storm drain or any of its branches that drain a roof or area drain is 3 inches diameter per the Philadelphia Plumbing Code.

9. Verify that the main roof drain has a slope that is greater than 1/8 inch per foot.
VI. Erosion and Sediment Control Plan

A) Plans

1. 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 PWD Worksheet 2.

2. Verify that the limit of disturbance includes all off-site storm and utility connections.

3. If a PADEP 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 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 PADEP NPDES Permit. The site will be subject to the enforcement actions outlined in the Stormwater Regulations until the applicant receives an approved NPDES Permit.

4. Verify that soil compaction has been minimized, even in areas not proposed for infiltration SMPs, to the extent practicable.

5. Verify that infiltration areas are marked prior to any land-disturbing activities.

6. 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.

7. Verify that silt fence or compost sock is shown along all downward-sloping areas of the project site’s perimeter.

8. When compost socks are placed on paved surfaces, verify that some objects of considerable mass (i.e. concrete blocks, sand bags, etc.) are 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.

9. Verify that any proposed stockpile locations are clearly labeled on the plans.

10. Verify that silt fence surrounds any proposed stockpile areas.

11. Verify the dimensions of the rock construction entrance. The minimum length is 50 feet, and the minimum width is 20 feet.

12. 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.

13. Verify that tree protection fencing is provided around existing trees that are proposed to remain and be used for tree disconnection credit.

14. If riprap is proposed, verify that geotextile or filter stone is provided for erosion protection of the soil beneath the riprap.

15. Verify that the following E&S Control notes are included on the plans:
a. An industrial waste permit will be required should pumping to City-owned infrastructure become necessary during construction. All pumping of water from any work area shall be done according to the procedure described in this plan, over undisturbed vegetated areas.

b. Inlet protection should be provided for all inlets owned by PWD that are located within one block of the project site.

c. PWD is not responsible for any cleaning or repairs needed on City-owned infrastructure due to failure of any erosion and sediment control practices. (applicant to indicate responsible party)

d. Inspection and maintenance of all erosion and sediment control best management practices shall occur on a weekly basis, before any anticipated precipitation events, and after all precipitation events.

e. The maximum height for stockpiles areas shall be 35 feet. The maximum side slope for stockpile areas shall not exceed 2:1.

f. The rock construction entrance thickness shall be constantly maintained on-site. A stockpile shall be maintained on-site for this purpose. At the end of each construction day, all sediment deposited on paved roadways shall be removed and returned to the construction site. In no case shall the sediment be washed, shoveled, or swept into any roadside ditch, storm sewer, or surface water.

g. Filter fabric fence should be installed at level grade. Both ends of each fence section should be extended at least 8 feet upslope at 45 degrees to the main barrier alignment. Support stakes shall be spaced at a maximum of 8 feet. Sediment must be removed when accumulations reach 1/2 the above ground height of the filter fence.

h. Any fence section which has been undermined or topped must be immediately replaced with a rock filter outlet. Sediment must be removed when accumulations reach 1/3 the height of the outlet.

i. Erosion control blanketing shall be installed on all slopes 3H:1V or steeper within 50 feet of a surface water and on all other disturbed areas specified on the plan maps and/or detail sheets.

j. Immediately upon discovering unforeseen circumstances posing the potential for accelerated erosion and/or sediment pollution, the operator shall implement appropriate best management practices to minimize the potential for erosion and sediment pollution and notify PWD and PADEP.

k. Until the site is stabilized, all erosion and sediment BMPs shall be maintained properly. Maintenance shall include inspections of all erosion and sediment BMPs prior to any anticipated storm event, after each runoff event and on a weekly basis. All preventative and remedial maintenance work, including clean out, repair, replacement, regrading, reseeding, reremulching and renetting must be performed immediately. If the E&S BMPs fail to perform as expected replacement BMPs, or modifications of those installed, will be required.

l. All earth disturbances, including clearing and grubbing as well as cuts and fills shall be done in accordance with the approved E&S plan. A copy of the approved drawings must be available at the project site at all times. PWD shall be notified of any changes to the approved plan prior to implementation of those changes. PWD may require a written submittal of those changes for review and approval at its discretion.

m. At least three (3) days prior to starting any earth disturbance activities, or expanding into an area previously unmarked, the Pennsylvania One Call System Inc. shall be notified at 1-800-242-1776 for the location of existing underground utilities.

n. All earth disturbance activities shall proceed in accordance with the sequence provided on the plan drawings. Deviation from that sequence must be approved in writing by PWD and the PADEP prior to implementation.

o. Areas to be filled are to be cleared, grubbed, and stripped of topsoil to remove trees, vegetation, roots and other objectionable material.

p. Clearing, grubbing, and topsoil stripping shall be limited to those areas described in each stage of the construction sequence. General site clearing, grubbing and topsoil stripping may not commence in any stage or phase of the project until the E&S BMPs specified by the BMP
sequence for that stage or phase have been installed and are functioning as described in this E&S plan.

q. At no time shall construction vehicles be allowed to enter areas outside the limit of disturbance boundaries shown on the plan maps. These areas must be clearly marked and fenced off before clearing and grubbing operations begin.

r. A log showing dates that E&S BMPs were inspected as well as any deficiencies found and the date they were corrected shall be maintained on the site and be made available to PWD at the time of inspection.

s. All sediment removed from BMPs shall be disposed of in the following manner: *(applicant to describe disposal method).*

t. Areas which are to be topsoiled shall be scarified to a minimum depth of 3 to 5 inches — 6 to 12 inches on compacted soils — prior to placement of topsoil. Areas to be vegetated shall have a minimum 4 inches of topsoil in place prior to seeding and mulching. Fill outslopes shall have a minimum of 2 inches of topsoil.

u. All fills shall be compacted as required to reduce erosion, slippage, settlement, subsidence or other related problems. Fill intended to support buildings, structures and conduits, etc. shall be compacted in accordance with local requirements or codes.

v. All earthen fills shall be placed in compacted layers not to exceed 9 inches in thickness.

w. Fill materials shall be free of frozen particles, brush, roots, sod, or other foreign or objectionable materials that would interfere with or prevent construction of satisfactory fills.

x. Frozen materials or soft, mucky, or highly compressible materials shall not be incorporated into fills.

y. Fill shall not be placed on saturated or frozen surfaces.

z. Seeps or springs encountered during construction shall be handled in accordance with the standard and specification for subsurface drain or other approved method.

aa. All graded areas shall be permanently stabilized immediately upon reaching finished grade. Cut slopes in competent bedrock and rock fills need not be vegetated. Seeded areas within 50 feet of a surface water, or as otherwise shown on the plan drawings, shall be blanketed according to the standards of this plan.

bb. Immediately after earth disturbance activities cease in any area or subarea of the project, the operator shall stabilize all disturbed areas. During non-germinating months, mulch or protective blanketing shall be applied as described in the plan. Areas not at finished grade, which will be reactivated within 1 year, may be stabilized in accordance with the temporary stabilization specifications. Those areas which will not be reactivated within 1 year shall be stabilized in accordance with the permanent stabilization specifications.

cc. Permanent stabilization is defined as a minimum uniform, perennial 70% vegetative cover or other permanent non-vegetative cover with a density sufficient to resist accelerated erosion. Cut and fill slopes shall be capable of resisting failure due to slumping, sliding, or other movements.

dd. E&S BMPs shall remain functional as such until all areas tributary to them are permanently stabilized or until they are replaced by another BMP approved by PWD and PADEP.

ee. After final site stabilization has been achieved, temporary erosion and sediment BMPs must be removed or converted to permanent post-construction stormwater management BMPs. Areas disturbed during removal or conversion of the BMPs shall be stabilized immediately. In order to ensure rapid revegetation of disturbed areas, such removal/conversions are to be done only during the germinating season.

ff. As applicable, sediment basins and/or traps shall be kept free of all construction waste, wash water, and other debris having potential to clog the basin/trap outlet structures and/or pollute the surface waters.

gg. As applicable, erosion control blanketing shall be installed on all slopes 3H:1V or steeper within 50 feet of a surface water and on all other disturbed areas specified on the plan maps and/or detail sheets.
B) Sequence of Construction

1. Verify that sequences of construction are provided for both overall construction and the construction of each proposed individual SMP.

2. Verify that the overall sequence of construction includes a note stating that, at least seven (7) days prior to any earth disturbance, the Inspections Coordinator of PWD (Office: 215-685-6387) must be called to schedule a pre-construction meeting.

3. Verify that the overall sequence of construction includes a note stating that, upon completion of all earth disturbance activities and permanent stabilization of all disturbed areas, the owner and/or operator shall contact Inspections Coordinator of PWD (Office: 215-685-6387) for a final inspection prior to removal/conversion of the E&S BMPs.

4. Verify that the overall sequence of construction includes a note stating that, as soon as slopes, channels, ditches, and other disturbed areas reach final grade, they must be stabilized. Cessation of activity for four (4) days or longer requires temporary stabilization.

5. Verify that the overall sequence of construction includes a note, when applicable, stating that, the NPDES Notice of Termination (N.O.T.) must be submitted to PADEP upon completion of construction.

6. Verify that the overall sequence of construction includes a note, when applicable, stating that, water pumped from work areas should be treated for sediment removal prior to discharging to a "surface water".

7. Verify that the sequence of construction properly identifies all stages of SMP construction for which a licensed professional must document the information and measurements required on the SMP Construction Certification Form(s) within the Construction Certification Package.

8. Verify that the sequence of construction includes a note stating that all stone that makes up the infiltration SMPs must remain free of sediment, and that if sediment enters the stone, the contractor may be required to remove the sediment and replace it with clean washed stone.

9. Verify that the sequence of construction for each proposed individual SMP includes a note stating that, at least three (3) days prior to SMP installation, the Inspections Coordinator of PWD (Office: 215-685-6387) must be called to schedule an inspection.

C) Details

The following details are required on the plans. Details for additional E&S BMPs should be provided as necessary.

1. Verify that a detail for inlet protection 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.

2. Verify that details for silt fence and/or compost socks are provided on the plans.

3. Verify that a detail for a rock filter outlet is provided on the plans.

4. Verify that a detail for a rock construction entrance is provided on the plans.

5. Verify that a detail for a pumped water filter bag is provided on the plans.
VII. Bioinfiltration/Bioretention Systems

A) Plans

1. Verify that an appropriate sequence of construction is provided that is specific to the construction of the bioretention basin. Refer to pages 7-38 and 7-39 of the PWD Manual.

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.

3. Verify that an appropriate cross-sectional detail is provided.

B) Design

1. If infiltration is feasible, verify that static storage of the entire Water Quality volume is provided below the lowest outlet of the bioretention basin. The voids in the soil and/or stone layers beneath the bioretention area surface may be included as storage for the Water Quality Volume. If the soil layer is counted toward storage volume, it must be demonstrated that the runoff will infiltrate into the bioretention soil before reaching the bioretention area’s outlet control device. This can be demonstrated by routing the Water Quality storm event through the SMP to show that the only outflow from the system is discarded via exfiltration, with no outflow discharged through the primary outlet.

2. If infiltration is not feasible, verify that static storage of the entire Water Quality volume is provided between the bioretention basin’s planting surface and the lowest outlet in the bioretention area. Void space in the soil and/or stone layers beneath the bioretention area surface may not be considered part of the available storage volume of the SMP.

3. Verify that the loading ratio of DCIA to the horizontal footprint of the bioretention basin does not exceed 10:1.

4. Verify that the system drains within the acceptable 72-hour period.

5. Verify that infiltrating bioretention SMPs are located at least 10 feet from all building foundations and property lines not abutting open public right-of-way streets, unless a deed restriction is put in place extending at least 10 feet from the perimeter of the infiltrating SMP.

6. Verify that positive overflow is provided at the maximum ponding depth for all storms up to and including the 100-year storm event.

7. Verify that the bioretention planting soil medium is a minimum of 2 feet thick.

8. Verify the porosity used in the storage volume calculations. Use a porosity of 0.20 for soil, 0.30 for sand, and 0.40 for stone storage.

9. Verify the design infiltration rate used in the calculations. The infiltration should be 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 wetted area up to the Water Quality (1-inch storm) water surface elevation. If infiltration is infeasible, flow through the underdrain...
may be modeled as exfiltration at a rate of 2 inches per hour. This exfiltration flow must be routed through the primary outlet of the bioretention area, not discarded from the stormwater model.

10. Verify that the bioretention basin does not statically store the entire runoff volume from DCIA for storm events greater than the 1-year storm.

11. Verify that the invert elevation of an infiltrating bioretention SMP is at least 2 feet above any limiting zone, such as groundwater or bedrock.

12. Verify that the side slopes of the bioretention basin do not exceed 2:1.

13. Verify that energy dissipaters (such as riprap stone) are used if the flow is concentrated at the entrance to the bioretention area.

14. Verify that any proposed riprap aprons are sized for the 10-year storm event.
   a. Verify that the tailwater condition has been determined from the basin model for the 10-year storm event.
   b. Verify the riprap apron length, initial apron width, and terminal apron width, per Figures 21 and 22 of the PA E&S Manual.
   c. Verify the minimum blanket thickness, using 9 inches for R-3 stone and 14 inches for R-4 stone.

15. Verify that pretreatment is provided on sites that generate high sediment loads.

16. Verify that pretreatment of runoff from all inlets and roof drainage systems is provided for infiltrating bioretention SMPs. At a minimum, this can be achieved through the use of sumps and traps for inlets, sump boxes with traps downstream of roof drainage systems and trench drains, and filter strips for overland flow.

17. Verify that the stone storage layer, if applicable, is separated from the soil medium by a non-woven geotextile filter fabric or a pea gravel filter.

18. If a pea gravel filter is proposed to surround an underdrain, verify that the filter includes at least 3 inches of gravel under the underdrain pipe and 6 inches above the underdrain pipe.

19. For non-infiltrating bioretention basins with impermeable liners, verify that impermeable liners are not interrupted by structures within the bioretention basin footprint. Impermeable liners must be continuous and extend completely up the sides of any structures that are located within the lined bioretention basin footprint to the ground surface. If additional liner material must be added to extend up the structures, the additional liner sections must be joined to the rest of the liner with an impervious seam per the manufacturers’ recommendation.

C) Specifications

1. Verify that the proposed bioretention plantings are indicated on the plans and are in accordance with Chapter 8 of the PWD Manual.

2. Verify that specifications for the bioretention planting soil media are provided on the plans and that they meet the recommended specifications detailed on page 8-7 of the PWD Manual.

3. Verify that mulch is proposed on the bioretention surface to a depth of 2 to 3 inches, and that the mulch is organic, aged, double-shredded, hardwood bark mulch or composted leaf mulch free of weeds.
4. Verify that the plant quantities per 100 square feet of bioretention area meet the following recommended specifications. If desired, the project’s landscaping professional can offer variations to be reviewed by PWD accordingly.
   a. 1 large tree
   b. 2-4 small trees or shrubs
   c. 6 ferns or grass-like plants (1-gallon containers)
   d. Groundcover plantings and wildflower plugs on 12 inch centers with triangular spacing.
   e. A native grass/wildflower seed mix can be used as an alternative to groundcover planting. The seed mix shall be free of weed seeds.

5. Verify that specifications for the sand storage layer are provided on the plans, if applicable, and that they meet the following specifications:
   a. AASHTO M-6 or ASTM C-33 sand
   b. Grain size of 0.02” – 0.04”

6. Verify that the stone storage layer, if applicable, 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.

7. Verify that the underdrain, if proposed, meets the following specifications:
   a. Surrounded by a sand layer or gravel to filter sediment and facilitate drainage
   b. Surrounded by a non-woven geotextile fabric if a sand layer is used
   c. Continuously perforated with a smooth interior
   d. Minimum inside diameter of 4 inches
   e. If high-density polyethylene (HDPE) pipe is proposed, verify that it meets the specifications of AASHTO M252, Type S, or AASHTO M294, Type S.

8. Verify that specifications for the geotextile are provided on the plans, if applicable, and that they indicate that it consists of needled, non-woven polypropylene fibers and meets the following requirements (AASHTO Class 1 or Class 2 geotextile is recommended):
   a. Grab Tensile Strength (ASTM-D4632) ≥ 120 lbs
   b. Mullen Burst Strength (ASTM-D3786) ≥ 225 psi
   c. Flow Rate (ASTM-D4491) ≥ 95 gal/min/ft²
   d. UV Resistance after 500 hrs (ASTM-D4355) ≥ 70%
   e. Heat-set or heat-calendared fabrics are not permitted

9. Verify that cleanout access is provided for all underdrained systems, if applicable, and that the cleanouts are rigid with a smooth interior, having a minimum inside diameter of 4 inches.

10. In areas where infiltration is infeasible due to contamination or unstable fill that threatens an existing structure, verify that an impervious liner (compacted till liner, geomembrane liner, or concrete liner with a permeability less than or equal to 10⁻⁷ cm/sec) is specified.

11. Where bioretention is used for areas that require groundwater protection (as in karst, stormwater hot spots, or source water protection locations) or in close proximity to basements, verify that an appropriate impervious liner is specified. Clay liners should be of an appropriate design as specified by a geotechnical engineer. Synthetic liners, such as HDPE or PVC, should be of appropriate thickness (at least 30 mil is recommended). Sections of geosynthetic liner must be joined by heat sealing or as required to form an impervious seam by the manufacturer.
VIII. Subsurface Infiltration Systems

A) Plans

1. Verify that an appropriate sequence of construction is provided that is specific to the construction of the subsurface infiltration SMP. Refer to page 7-79 of the PWD Manual.

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.

3. Verify that an appropriate cross-sectional detail is provided.

B) Design

1. Verify that static storage of the entire Water Quality volume is provided below the lowest outlet of the subsurface infiltration SMP.

2. Verify that the loading ratio of DCIA to the horizontal footprint of the subsurface infiltration SMP does not exceed 5:1.

3. Verify that the system drains within the acceptable 72-hour period.

4. Verify that the subsurface infiltration SMP is located at least 10 feet from all building foundations and property lines not abutting open public right-of-way streets, unless a deed restriction is put in place extending at least 10 feet from the perimeter of the infiltrating SMP.

5. Verify that positive overflow is provided for all storms up to and including the 100-year storm event.

6. Verify the porosity used in the storage volume calculations. Use a porosity of 0.40 for stone storage.

7. Verify the design infiltration rate used in the calculations. The infiltration should be applied to the horizontal surface area (SMP footprint), not the wetted area.

8. Verify that the subsurface infiltration SMP does not statically store the entire runoff volume from DCIA for storm events greater than the 1-year storm.

9. Verify that the invert elevation of the subsurface infiltration SMP is at least 2 feet above any limiting zone, such as groundwater or bedrock.

10. Verify that pretreatment is provided for all runoff entering the subsurface infiltration SMP, including pretreatment of runoff from all inlets and roof drainage systems. At a minimum, this can be achieved through the use of sumps and traps for inlets, sump boxes with traps downstream of roof drainage systems and trench drains, and filter strips for overland flow.

11. Verify that the stone storage layer, if applicable, is separated from the soil medium by a non-woven geotextile filter fabric or a pea gravel filter.
12. Verify that, minimum, 36-inch diameter header pipes and manholes at each corner of the subsurface infiltration SMP are provided. Alternatively, smaller header pipes may be used if cleanouts are provided on every second manifold pipe/header pipe junction, on alternating sides, of the SMP.

13. Verify that an observation well is provided near the center of the subsurface infiltration SMP, in order to monitor water drainage from the system. The observation well must extend to the bottom of the SMP. A manhole may be used in lieu of an observation well only if the invert of the manhole is installed at the same invert elevation as the SMP and the manhole is configured in such a way that stormwater can flow freely between the SMP and the manhole at the manhole’s invert.

14. Verify that any intermediate sump box or manhole within the subsurface infiltration SMP includes a sump and trap or sump and hood for pretreatment of stormwater runoff. The sump depth must be 15 inches below the bottom of the trap or 12 inches below the bottom of the hood. Traps or hoods in combined sewer areas must be air-tight.

C) Specifications

1. Verify that the stone storage layer, if applicable, 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.

2. Verify that the storage pipe meets the following specifications:
   a. Continuously perforated with a smooth interior
   b. Minimum inside diameter of 4 inches
   c. If high-density polyethylene (HDPE) pipe is proposed, verify that it meets the specifications of AASHTO M252, Type S, or AASHTO M294, Type S

3. Verify that specifications for the geotextile are provided on the plans, if applicable, and that they indicate that it consists of needled, non-woven polypropylene fibers and meets the following requirements (AASHTO Class 1 or Class 2 geotextile is recommended):
   a. Grab Tensile Strength (ASTM-D4632) ≥ 120 lbs
   b. Mullen Burst Strength (ASTM-D3786) ≥ 225 psi
   c. Flow Rate (ASTM-D4491) ≥ 95 gal/min/ft²
   d. UV Resistance after 500 hrs (ASTM-D4355) ≥ 70%
   e. Heat-set or heat-calendared fabrics are not permitted

4. Verify that the observation well consists of a minimum 4-inch diameter perforated plastic pipe placed vertically at the invert of the infiltration bed and is equipped with a lockable above-ground cap.
IX. Porous Pavement

A) Plans

1. Verify that an appropriate sequence of construction is provided that is specific to the construction of the porous pavement. Refer to pages 7-87 and 7-88 of the PWD Manual.

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.

3. Verify that an appropriate cross-sectional detail is provided.

B) Design

1. Verify that the travel surface slope does not exceed 5% in any direction across the porous pavement.

2. Verify that the system is designed with a level bottom. Use a terraced subbase system on slopes to ensure a level bottom, and provide a detail of the terracing, if proposed.

3. Verify that the aggregate storage stone bed depth is a minimum of 8 inches, except when located beneath walkways or play surfaces, for which 4 to 6-inch depths are allowable.

4. Verify that the choker course depth is a minimum of 2 inches.

5. Verify the drainage area directed to any proposed porous pavement. If impervious runoff is directed onto porous pavement, the porous pavement cannot be considered disconnected. It must instead be modeled as an SMP with at least 8 inches aggregate storage stone, and its subsurface must be tested for infiltration feasibility. All impervious surfaces draining to the SMP, including the porous pavement itself, must then be considered DCIA and modeled with a curve number of 98.

6. Verify that static storage of the entire Water Quality volume is provided below the lowest outlet, or perforated horizontal drain pipe, of the porous pavement.

7. If designed as an infiltrating SMP, verify that the loading ratio of DCIA to the horizontal footprint of the porous pavement does not exceed 5:1.

8. If designed as an infiltrating SMP, verify that the porous pavement system drains within the acceptable 72-hour period.

9. If designed as an infiltrating SMP, verify that the porous pavement is located at least 10 feet from all building foundations and property lines not abutting open public right-of-way streets, unless a deed restriction is put in place extending at least 10 feet from the perimeter of the infiltrating SMP.

10. If the porous pavement is designed as an infiltrating SMP, verify that positive overflow is provided for all storms up to and including the 100-year storm event.

11. Verify the porosity used in the storage volume calculations. Use a porosity of 0.40 for stone storage.
12. If the porous pavement is designed as an infiltrating SMP, verify the design infiltration rate used in the calculations. The infiltration should be applied to the horizontal surface area (SMP footprint), not the wetted area.

13. Verify that the porous pavement does not statically store the entire runoff volume from DCIA for storm events greater than the 1-year storm.

14. If designed as an infiltrating SMP, verify that the invert elevation of the porous pavement is at least 2 feet above any limiting zone, such as groundwater or bedrock.

15. Verify that the stone storage layer is separated from the soil medium by a non-woven geotextile filter fabric or a pea gravel filter.

16. If designed as an infiltrating SMP, verify that an observation well is provided near the center of the porous pavement in order to monitor water drainage from the system. The observation well must extend to the bottom of the SMP. A manhole may be used in lieu of an observation well only if the invert of the manhole is installed at the same invert elevation as the SMP and the manhole is configured in such a way that stormwater can flow freely between the SMP and the manhole’s invert.

C) Specifications

1. If porous asphalt is proposed, verify that porous asphalt mix specifications are provided. Refer to page 7-86 of the PWD Manual for guidance.

2. If porous concrete is proposed, verify that porous concrete mix specifications are provided on the plans and that they conform to the following:
   a. Portland Cement Type I or II conforming to ASTM C 150, or Portland Cement Type IP or IS conforming to ASTM C 595
   b. No. 8 coarse aggregate (3/8 to No. 16) per ASTM C 33, or No. 89 coarse aggregate (3/8 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 pervious pavement of satisfactory properties in regard to permeability, load carrying capacity, and durability characteristics.

3. If porous pavers are proposed, verify that porous paver specifications are provided and that they conform to the following:
   a. Paver and grid systems shall conform to manufacturer specifications
   b. A minimum flow-through rate of 5 inches per hour, or a void percentage of no less than 10%

4. Verify that the stone storage layer 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.

5. Verify that the choker course aggregate meets the specifications of AASHTO No. 57 stone.

6. Verify that the porous pavement detail includes a note stating that the subgrade shall not be compacted during construction.

7. Verify that the storage pipe, if proposed, meets the following specifications:
   a. Continuously perforated with a smooth interior
   b. Minimum inside diameter of 4 inches
c. If high-density polyethylene (HDPE) pipe is proposed, verify that it meets the specifications of AASHTO M252, Type S, or AASHTO M294, Type S.

8. Verify that specifications for the geotextile are provided on the plans, if applicable, and that they indicate that it consists of needled, non-woven polypropylene fibers and meets the following requirements (AASHTO Class 1 or Class 2 geotextile is recommended):
   a. Grab Tensile Strength (ASTM-D4632) ≥ 120 lbs
   b. Mullen Burst Strength (ASTM-D3786) ≥ 225 psi
   c. Flow Rate (ASTM-D4491) ≥ 95 gal/min/ft²
   d. UV Resistance after 500 hrs (ASTM-D4355) ≥ 70%
   e. Heat-set or heat-calendared fabrics are not permitted

9. If the porous pavement is designed as an infiltrating SMP, verify that the observation well consists of a minimum 4-inch diameter perforated plastic pipe placed vertically at the invert of the infiltration bed and is equipped with a lockable above-ground cap.
X. Green Roofs

A) Plans

1. Verify that an appropriate sequence of construction is provided that is specific to the construction of the green roof. Refer to pages 7-6 and 7-7 of the PWD Manual.

2. Verify that an appropriate cross-sectional detail is provided.

3. Verify that a roof drainage plan is provided and that the roof drainage is consistent with the green roof design.

B) Design

1. If stormwater runoff calculations are required, verify that the correct curve number for the proposed green roof is used in the calculations. Refer to Table 5.4 of the PWD Manual.

2. Verify the depth of the growing medium. The minimum thickness of the green roof growing medium is 3 inches. When only a portion of a roof is a green roof, it is acceptable to drain runoff from the impervious portion of the roof to the green roof. The minimum thickness of the green roof qualifying as pervious area is determined using the following formula, where impervious roof area/green roof area ≤ 0.50: Minimum thickness (inches) of green roof growing medium = 3” + [(3”)*(impervious roof area/green roof area)]

3. Verify that the contributing area of impervious rooftop to each disconnected discharge point onto the green roof is 500 square feet or less.

4. Verify that the drainage layer prevents ponding of runoff in the planting medium during the 10-minute maximum rainfall rate associated with the 1-year storm.

5. Verify that all drains and scuppers are covered and protected by an enclosure, typically a square or round chamber with a locking lid.

C) Specifications

1. Verify that the proposed green roof plantings are indicated on the plans and that they meet the following recommended specifications:
   a. Green roof plantings should be able to withstand heat, cold, and high winds.
   b. After establishment, green roof plantings should be self-sustaining and tolerant of drought conditions, with little to no need for fertilizers or pesticides.
   c. For extensive green roofs, about half of the plants should be varieties of sedums. At least four different species of sedum should be used, and the remainder of the plants should be herbs, meadow grasses, or meadow flowers.
   d. Sedum sarmentosum, also known as star sedum, gold moss, stringy stonecrop, or graveyard moss, is known to be invasive and should be avoided.
   e. Green roofs should include a significant percentage of evergreen plants.
2. Verify that the growing medium specifications are provided on the plans. Green roof growing medium should be a lightweight mineral material with minimal organic content and should generally meet the following specifications:
   a. Moisture content at maximum water holding capacity (ASTM E2399 or FLL) ≥ 35%
   b. Porosity at maximum water holding capacity (ASTM E2399 or FLL) ≥ 6%
   c. Total organic matter (MSA): 3-8%
   d. pH (MSA): 6.5-8.0
   e. Soluble salts (DPTA saturated media extraction) ≤ 6 mmhos/cm
   f. Water permeability (ASTM E2399 or FLL) ≥ 0.5 in/min
   g. Grain-size distribution, as recommended by FLL

3. Verify that the plans indicate that the geotextile consists of needled, non-woven polypropylene fibers and allows for root penetration, but prevents the growing medium from passing through into the drainage layer.

4. Verify that the drainage layer promotes aerated conditions. For vegetated roof cover assemblies with overall thicknesses of less than 5 inches, synthetic drainage layers may be used in lieu of granular drainage layers.

5. For vegetated roof cover assemblies with overall thicknesses of 5 inches or greater, verify that the drainage layer specifications are provided on the plans and that they meet the following requirements:
   a. Abrasion resistance (ASTM-C131-96) ≤ 25% loss
   b. Soundness (ASTM-C88) ≤ 5% loss
   c. Porosity (ASTM-C29) ≥ 25%
   d. Percent of particles passing ½-inch sieve (ASTM-C136) ≥ 75%
   e. The minimum thickness of the granular layer shall be 2 inches. The granular layer may be installed in conjunction with a synthetic reservoir sheet.
XI. Cisterns and Reuse Systems

A) Plans

1. Verify that an appropriate sequence of construction is provided that is specific to the installation of the cistern. Refer to page 7-15 of the PWD Manual.

2. Verify that an appropriate cross-sectional detail is provided.

B) Design

1. Verify that irrigation use for runoff stored in a cistern is not a proposed strategy for meeting the Regulations. Runoff reused for irrigation purposes is not an acceptable strategy for meeting the Regulations as it is not a year-round use.

2. Verify the anticipated water demand on a daily basis.

3. Verify that the Water Quality volume drains from the cistern within the acceptable 72-hour period. If the Water Quality volume is not used within 72 hours, other SMPs must be implemented. If the water demand fluctuates seasonally, verify that the cistern drains within 72 hours based on usage in all seasons.

4. Verify that positive overflow is provided for all storms up to and including the 100-year storm event.

5. Verify that leaf/debris screening is provided along the entire length of the gutters and downspouts that are directed to the SMP.

6. Verify that a first-flush diverter is provided at each gutter and downspout on the plans.

7. Verify that a manhole or access hatch is provided for maintenance of the cistern tank.

C) Specifications

1. Verify that the overflow pipe is no smaller than 4 inches in diameter and that it is protected with a screen with openings of less than 0.25 inches.

2. Verify that leaf/debris screening is made from a corrosion-resistant material with screen openings in the range of 0.25 to 0.50 inches.

3. Verify that the first-flush diverter deflects approximately 1 to 2 gallons of water per 100 square feet of roof collection surface.
XII. Surface Detention Systems

A) Plans

1. Verify that an appropriate sequence of construction is provided that is specific to the construction of the surface detention SMP. Refer to page 7-46 of the PWD Manual.

2. Verify that an appropriate cross-sectional detail is provided.

B) Design

1. Verify that the system drains within the acceptable 72-hour period.

2. Verify that a sediment forebay is provided with a minimum length of 10 feet.

3. Verify that the primary and low-flow outlets are protected from clogging by an external trash rack.

4. Verify that the basin water depth does not exceed 10 feet.

5. Verify that an emergency overflow capable of passing the 100-year design storm is provided and that the emergency spillway does not direct flow toward neighboring properties.

6. Verify that basin freeboard is provided at a minimum of 1 foot above the 100-year design storm, between the crest elevation of the emergency spillway and the top of berm elevation.

7. Verify that the planting soil medium is a minimum of 6 inches thick.

8. Verify that the elevation of the basin bottom is at least 2 feet above the seasonal high water table elevation.

9. Verify that the basin width is a minimum of 10 feet.

10. Verify that the basin length to width ratio is a minimum of 2:1.

11. Verify that the side slopes of the basin embankments do not exceed 3:1.

12. Verify that energy dissipaters (such as riprap stone) are placed at the end of the primary outlet to prevent erosion.

13. Verify that any proposed riprap aprons are sized for the 10-year storm event.
   a. Verify that the tailwater condition has been determined from basin model for 10-year storm event.
   b. Verify the riprap apron length, initial apron width, and terminal apron width, per Figures 21 and 22 of the PA E&S Manual.
   c. Verify minimum blanket thickness, using 9 inches for R-3 stone and 14 inches for R-4 stone.

14. Verify that the stone storage layer, if applicable, is separated from the soil medium by a non-woven geotextile filter fabric or a pea gravel filter.
15. If a pea gravel filter is proposed to surround an underdrain, verify that the filter includes at least 3 inches of gravel under the underdrain pipe and 6 inches above the underdrain pipe.

16. For detention basins with impermeable liners, verify that impermeable liners are not interrupted by structures within the basin footprint. Impermeable liners must 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 must be joined to the rest of the liner with an impervious seam per the manufacturers’ recommendation.

17. Verify that a curve number of 100 is used for the area below the water surface elevation in an above-ground wet pond (retention basin) for the applicable storm event, where required.

C) Specifications

1. Verify that the proposed basin plantings are indicated on the plans and are in accordance with Chapter 8 of the PWD Manual.

2. Verify that specifications for the planting soil media are provided on the plans and that they meet the recommended specifications detailed on page 8-7 of the PWD Manual.

3. Verify that mulch is proposed on the basin surface to a depth of 2 to 3 inches, and that the mulch is organic, aged, double-shredded, hardwood bark mulch or composted leaf mulch free of weeds.

4. Verify that specifications for the sand storage layer are provided on the plans, if applicable, and that they meet the following specifications:
   a. AASHTO M-6 or ASTM C-33 sand
   b. Grain size of 0.02” – 0.04”

5. Verify that the stone storage layer, if applicable, 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.

6. Verify that the underdrain, if proposed, meets the following specifications:
   a. Surrounded by a sand layer or gravel to filter sediment and facilitate drainage
   b. Surrounded by a non-woven geotextile fabric if a sand layer is used
   c. Continuously perforated with a smooth interior
   d. Minimum inside diameter of 4 inches
   e. If high-density polyethylene (HDPE) pipe is proposed, verify that it meets the specifications of AASHTO M252, Type S, or AASHTO M294, Type S.

7. Verify that specifications for the geotextile are provided on the plans, if applicable, and that they indicate that it consists of needled, non-woven polypropylene fibers and meets the following requirements (AASHTO Class 1 or Class 2 geotextile is recommended):
   a. Grab Tensile Strength (ASTM-D4632) ≥ 120 lbs
   b. Mullen Burst Strength (ASTM-D3786) ≥ 225 psi
   c. Flow Rate (ASTM-D4491) ≥ 95 gal/min/ft²
   d. UV Resistance after 500 hrs (ASTM-D4355) ≥ 70%
   e. Heat-set or heat-calendared fabrics are not permitted
8. Verify that cleanout access is provided for all underdrained systems, if applicable, and that the cleanouts are rigid with a smooth interior, having a minimum inside diameter of 4 inches.

9. In areas where infiltration is infeasible due to contamination or unstable fill that threatens an existing structure, verify that an impervious liner (compacted till liner, geomembrane liner, or concrete liner with a permeability less than or equal to $10^{-7}$ cm/sec) is specified.

10. Where detention is used for areas that require groundwater protection (as in karst, stormwater hot spots, or source water protection locations) or in close proximity to basements, verify that an appropriate impervious liner is specified. Clay liners should be of an appropriate design as specified by a geotechnical engineer. Synthetic liners, such as HDPE or PVC, should be of appropriate thickness (at least 30 mil is recommended). Sections of geosynthetic liner must be joined by heat sealing or as required to form an impervious seam by the manufacturer.
**XIII. Level Spreaders**

**A) Plans**

1. Verify that an appropriate sequence of construction is provided that is specific to the construction of the level spreader.

2. Verify that an appropriate cross-sectional detail is provided.

3. Verify that the level spreader is located away from newly deposited earth and that the downstream side is clear of debris.

**B) Design**

1. Verify that the system drains within the acceptable 72-hour period.

2. Verify that the distance between the proposed discharge point (including the level spreader) and any downslope property boundary is a minimum of 15 feet. A drainage easement may be required.

3. Verify that the distance between the proposed discharge point (including the level spreader) and any receiving stream or storm sewer is a minimum of 100 feet and, ideally, does not exceed 150 feet. Smaller distances may be considered on a case-by-case basis for very mild slopes (≤ 1%) and heavily vegetated (grassy) areas.

4. Verify that the level spreader is proposed to be installed at level grade (a constant horizontal elevation, to within ± 4 inches).

5. Verify that the first 10 feet downslope of the level spreader does not exceed a slope of 4%.

6. Verify that the first 3 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.

7. Verify that there is a smooth transition between the level spreader and existing ground.

8. Verify that pretreatment (e.g. a forebay) is provided before the level spreader.

9. Verify that geotextile-covered berms are not used as level spreaders. Concrete curbs may be used as level spreaders.

10. Verify the level spreader length. Level spreader length for a dense grass ground cover condition is recommended to be 13 linear feet for every 1 cfs of flow, and for forested areas with no ground cover, 100 linear feet for every 1 cfs of flow is recommended. Level spreaders should be designed for the 10-year storm event and shall safely diffuse flows up to the 100-year storm event.

11. Verify that the stone storage layer is separated from the soil medium by a non-woven geotextile.
C) Specifications

1. Verify that the stone storage layer 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.

2. Verify that the underdrain, if proposed, meets the following specifications:
   a. Surrounded by a sand layer or gravel to filter sediment and facilitate drainage
   b. Surrounded by a non-woven geotextile fabric if a sand layer is used
   c. Continuously perforated with a smooth interior
   d. Minimum inside diameter of 4 inches
   e. If high-density polyethylene (HDPE) pipe is proposed, verify that it meets the specifications of AASHTO M252, Type S, or AASHTO M294, Type S.

3. Verify that specifications for the geotextile are provided on the plans and that they indicate that it consists of needled, non-woven polypropylene fibers and meets the following requirements (AASHTO Class 1 or Class 2 geotextile is recommended):
   a. Grab Tensile Strength (ASTM-D4632) ≥ 120 lbs
   b. Mullen Burst Strength (ASTM-D3786) ≥ 225 psi
   c. Flow Rate (ASTM-D4491) ≥ 95 gal/min/ft²
   d. UV Resistance after 500 hrs (ASTM-D4355) ≥ 70%
   e. Heat-set or heat-calendared fabrics are not permitted