

Stormwater Plan Reviewer Guidelines

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Regulation Compliance



Water Quality Requirement (Infiltration Feasible):

1. Verify that the entire DCIA is routed to the stormwater management practice.
2. Verify that static storage of the water quality volume is provided below lowest outlet from stormwater management practice.
3. Verify that the system drains within the acceptable 72-hour period.

Water Quality Requirement (Infiltration Not Feasible, Separate Sewer Area):

1. Verify that 100% of the water quality volume is routed through a PWD-approved volume-reducing stormwater management practice (Table 4.3 in manual).
2. Verify that the system drains within the acceptable 72-hour period.

Water Quality Requirement (Infiltration Not Feasible, Combined Sewer Area):

1. Verify that a minimum of 20% of the water quality volume is routed through a PWD-approved volume-reducing stormwater management practice (Table 4.3 in manual).
2. Verify that stormwater model includes routing of the water quality storm event.
3. Verify that release rate for the water quality volume is less than 0.24 cfs per acre of DCIA.
4. Verify that the system drains within the acceptable 72-hour period.

Channel Protection Requirement:

1. Verify if the channel protection requirement is applicable.
 - a) The project is exempt from channel protection if it is a redevelopment project and discharges to the Delaware or Schuylkill Watersheds or to the channelized portion of the Tacony-Frankford Watershed.
 - b) The project is exempt from channel protection if it is a redevelopment project and the DCIA is reduced by 20% from pre-development conditions.
 - c) The project is exempt from channel protection if it is a redevelopment project with an earth disturbance of less than 1 acre.

2. Verify that runoff from DCIA 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.

Flood Control Requirement:

1. Verify if the flood control requirement is applicable.
 - a) The project is exempt from flood control if it is a redevelopment project and the DCIA is reduced by 20% from pre-development conditions.
2. Verify that release rates meet requirements set in Table 4.2 of manual for each flood management district.

Public Health and Safety Rate:

1. Verify that pipe connection is approved.
2. Verify that release rate requirement is met.

PADEP Regulation:

1. For sites greater than 1 acre, verify that there is no increase in runoff volume between the pre-development and post-development 2-year storm events.

Green Review:

1. Verify that the project is a redevelopment project.
2. Verify that 95% of proposed DCIA is disconnected.

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Plan Sheet Requirements



General:

1. Verify that all plans and reports are signed and sealed by a PA professional engineer.
2. Verify that a north arrow, legend, and scale are provided on plans.
3. Verify that proposed building footprint is labeled.
4. Verify that all acronyms are identified in the plan legend.
5. Verify that the plan legend is consistent with the plans and identifies all symbols used in the plan.


Grading Plan:

1. Verify that the proposed grading is correct.
 - a) Verify that there is positive slope from the proposed buildings.
 - b) Verify that proposed contours are closed or tie in to their correct location at the property line.
 - c) Ask for additional spot grades as necessary.
2. Verify that all DCIA is captured, especially at entrances.

Utility Plan:

1. Verify that all stormwater conveyance is shown and clearly labeled.
2. Verify that pipe lengths, slopes, and inverts are accurate. Compare pipe information to profiles (if provided) for consistency.
3. Verify there are no piping conflicts.
4. Verify that inlets are not in series.

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5. Verify that the invert elevation is specified for the proposed connections to the existing storm sewer.
6. Indicate the roof drainage area for each roof leader.
7. Verify the stormwater connection with Rich Williams prior to stormwater approval.
8. Verify that Private Cost Sewer is submitted to the PWD Design Unit.

Detail Sheets:

1. Verify that a pipe connection detail is provided for the proposed connection to the existing storm sewer.
2. Verify that details are provided for all stormwater management practices.
3. Verify that the outlet structure dimensions are provided.
4. Verify that a waiver request is provided if the outlet structure has an orifice with a diameter of less than 3 inches.
5. Verify that screening is provided over the small orifice.
6. Verify that ladder bars are included in the outlet structure for maintenance of the small orifice.
7. Verify that the outlet structure is large enough to access both sides of the weir wall if a small orifice is used.
8. Verify that the inlet structures include a sump and trap. The sump depth shall be 15 inches below the bottom of the trap.

Drainage Area Maps:

1. Verify that drainage boundaries are based on site topography and include entire tributary area (including any off-site drainage, if applicable).
2. Verify that common points of interest are chosen to compare pre-development and post-development conditions.
3. Verify that points of interest are clearly marked on the plans and in the stormwater model.
4. Verify that existing stormwater infrastructure, including roof leaders, is shown on the plans to help clarify the existing drainage conditions.

Inlet Drainage Area Map:

1. Verify that the following information is clearly labeled and accurate for each inlet:
 - a) Inlet Drainage Area
 - b) Breakdown of Impervious and Pervious Cover
 - c) Runoff Coefficient
 - d) Inlet Concentration Time

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Disconnecting Impervious Cover



Rooftop Disconnection:

1. Verify that 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 HSG "D" or equivalent.
4. Verify that the overland flow path has a positive slope of 5% or less.
5. Verify the information provided on PWD Worksheet #2. DCIA reduction is based on Table 4.1 of the manual.
6. Verify what percentage of the roof is being disconnected based on the flow length over pervious area


Pavement Disconnection:

1. Verify that disconnection is clearly labeled on the plan.
2. Verify that the contributing flow path over impervious cover is no more than 75 feet.
3. Verify that the length of overland flow over pervious area is greater than or equal to the contributing length.
4. Verify that the soil is not designated as HSG "D" or equivalent.
5. Verify that the slope of the contributing impervious area is 5% or less.
6. Verify that the slope of the overland flow path is 5% or less.
7. Verify that if discharge is concentrated at one or more discrete points 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.
8. Verify the information provided on PWD Worksheet #2.

Maximize Tree Canopy Over Impervious Cover – New Trees:

1. Verify that disconnection is clearly labeled on the plan.
2. Verify that the sizes of the proposed trees are provided.

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3. Verify that the species of the proposed trees are provided and acceptable.
4. Verify that deciduous trees are at least 2-inch caliper.
5. Verify that evergreen trees are at least 6 feet tall.
6. Verify that the proposed trees are planted within 10 feet of ground level DCIA within the limits of earth disturbance.
7. Verify that credit is being applied to ground level DCIA within the limits of earth disturbance adjacent to the proposed tree.
8. Verify that the DCIA reduction for both new and existing trees is a maximum of 25% of the DCIA (unless the width of the impervious area is less than 10 feet. In that case, 100% of the DCIA may be disconnected.)
9. Verify the information provided on PWD Worksheet #2. A DCIA reduction of 100 square feet per tree is permitted.
10. Verify that trees are not on the Prohibited List, Section 8.4 of PSMGM.

Maximize Tree Canopy Over Impervious Cover – Existing Trees:

1. Verify that disconnection is clearly labeled on the plan.
2. Verify that the sizes of the existing trees are provided.
3. Verify that the species of the existing trees are provided and acceptable.
4. Verify that the existing trees are at least 4 inch caliper.
5. Verify that the existing trees are located within 20 feet of ground level DCIA within the limits of earth disturbance.
6. Verify that credit is being applied to ground level DCIA within the limits of earth disturbance adjacent to the existing tree.
7. Verify that the DCIA reduction for both new and existing trees is a maximum of 25% of the DCIA (unless the width of the impervious area is less than 10 feet. In that case, 100% of the DCIA may be disconnected.)
8. Verify the information provided on PWD Worksheet #2. A DCIA reduction equal to ½ of the canopy area is permitted.

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Infiltration



Infiltration Testing Report:

1. Verify that the report is signed and sealed by a registered professional.
2. Verify that a minimum of two infiltration tests are provided per infiltration area.
3. Verify that the infiltration testing is conducted at the proposed bottom of bed elevation.
4. Verify that the infiltration testing is performed within 25 feet of the proposed infiltration BMP.
5. Verify that an infiltration testing location plan is provided.
6. Verify that infiltration testing field logs are provided.
7. Verify that the soil stratum and groundwater information is provided and that there is a minimum of 2 feet from the bottom of the proposed system from any limiting zone (groundwater table, bedrock).
8. Verify that information regarding the weather at the time of testing is provided.
9. Verify that a pre-soak was performed if a percolation test was done.
10. Verify that the tested infiltration rate is in the PWD-allowable range of 0.5-10 inches/ hour. Indicate that soil amendments are required if tested infiltration rate is over 10 inches/ hour. (Refer to Soil Amendments Checklist).

Infiltration Rate:


1. Verify that a factor of safety of 2 is applied to the tested infiltration rate.
2. Verify that the reduction factor is applied to percolation testing data (in addition to the factor of safety).

Soil Amendments:

1. Verify that instructions similar to those below, are clearly noted on the plan sheets.

Soil amendments will be required so that the tested infiltration rate is within the PWD allowable range of 0.5 to 10 inches per hour. Please note that a factor of safety of 2 should be employed to the tested infiltration rate for use in the stormwater design calculations. Please revise the plans and calculations to address the following requirements:

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- a) The soil amendments should span the entire area of the infiltration bed and extend a minimum of 2 feet below the infiltration bed.
- b) A non-woven geotextile fabric should be installed between the in-situ and amended soil layers.

Please revise the sequence of construction to include the following steps:

- 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.
 - c) Place non-woven geotextile fabric.
 - d) Amend in-situ soil by ... (Provide instructions for amending soil)
 - e) Place two feet of amended soil across the entire cross-section of infiltration bed.
 - f) Perform infiltration testing of the amended soil layer. If the tested infiltration rate is determined to be out of the PWD-allowable range of 0.5-10 inches per hour (or varies significantly from the design infiltration rate), additional soil amendments and system redesign will be required.
 - g) The owner shall provide certification in writing to PWD indicating that the amended soil mix meets the criteria as specified on the plans.
 - h) Upon approval from PWD, install the remainder of the infiltration practice. (Refer to Section 7.12 for guidance.)
2. Verify that the soil amendments span the entire surface area of the infiltration bed.
 3. Verify that the soil amendments extend a minimum of 2 feet below the invert of the infiltration bed.
 4. Verify that a non-woven geotextile fabric is installed between the in-situ and amended soil layers.
 5. Verify that a conservative infiltration rate is used in the stormwater calculations.

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Stormwater Model and Calculations



Stormwater Model:

1. Verify that the precipitation depths are correct for all design storm events. The correct precipitation depths are listed below.


Precipitation Depth (inches)							
Duration	1-year	2-year	5-year	10-year	25-year	50-year	100-year
24 hours	2.64	3.36	4.32	5.28	6.24	7.20	8.40

2. Verify that impervious and pervious areas are calculated separately.
3. Verify that the drainage areas are accurate and consistent with the plans.
4. Verify that the minimum time step is used in the stormwater model. (The minimum time step is 1 minute in Hydraflow and 0.01 hours in HydroCAD).
5. Verify that the entire DCIA is routed to the stormwater management practice.
6. Verify that bypass areas are accounted for in the stormwater calculations.
7. Verify that the 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 value of the piping is correct and consistent with the plans. Use 0.013 for RCP and CIP and 0.011 for PVC.
10. Verify that routing of devices is correct.
11. Verify that the links are correct. Points of interest should only be linked when they drain to the same sewer shed or waterway.

Curve Numbers:

1. Verify that the correct curve numbers are used in the calculations. Refer to Table 5.4 of manual.
2. Verify that all non-forested, pervious areas are considered as meadow for pre-development flood control calculations.
3. Verify that 20% of the existing impervious cover is considered as meadow for pre-development flood control calculations.

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4. Verify that a curve number of 98 is used with a precipitation depth of 1.20 inches or that a curve number of 100 is used with a precipitation depth of 1.0 inch when performing water quality calculations 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 each storm event) in an above-ground detention basin.

Time of Concentration Calculations:

1. Verify that time of concentration path is shown from the hydraulically most distant point of the watershed to a point of interest within the watershed and that the path is perpendicular to the contours.
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 minimum time of concentration is shown as 6 minutes.
4. Verify that time of concentration calculations are provided for all pre-development areas.
5. Verify that the maximum sheet flow length of 100 feet is used if the flow is not concentrated.
6. Verify the Manning's n value used in the sheet flow component of the time of concentration calculation.
7. Verify the 2-year precipitation depth (P-2) in the sheet flow component of the time of concentration calculation.

Stormwater Conveyance:

1. Verify the sizing of all stormwater conveyance and roof drainage systems. All pipes are required to have adequate capacity to convey the 10-year storm event without surcharging the crown of the pipe.
2. Verify that the length, material, size, and slope of all stormwater conveyance and roof drainage systems is clearly labeled on the plans.
3. Verify that the roof leaders are sized per the Philadelphia Plumbing Code.
4. Verify that the roof drainage area is labeled for every roof leader.
5. Verify that all stormwater conveyance material is in compliance with the Philadelphia Plumbing Code.
6. Verify that inlets are not connected in series.
7. Verify that the roof drainage system does not tie directly into an inlet.
8. 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.
9. 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 6.00 in/hr.

10. Verify the runoff coefficient used in the pipe capacity calculations. Generally, 0.35 is used for pervious areas and 0.95 is used for impervious areas.
11. Verify that a cleanout is provided for all 90 degree bends.
12. Verify the Manning's n value used in the pipe capacity calculations. Use 0.013 for RCP and CIP and 0.011 for PVC.
13. Verify that the minimum size of a storm drain or any of its branches that drain a roof or area drain shall be 3 inches.
14. Verify that the main roof drain has a slope that is greater than 1/8 inch per foot.

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Erosion and Sediment Control Plan



Plans:

1. Verify that the following plan notes are included:
 - a) An industrial waste permit will be required should pumping to City-owned infrastructure become necessary during construction.
 - 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. (Indicate responsible party)
 - d) Inspection and maintenance of all erosion and sediment 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.
 - f) The maximum side slope for stockpile areas shall not exceed 2:1.
 - g) 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.
 - h) 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.
 - i) 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.
2. Verify that the limit of disturbance is clearly shown on the plans and is consistent with PWD Worksheet #2.
3. Verify that the limit of disturbance includes all off-site storm and utility connections.
4. Verify that a sequence of construction is provided.

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5. Verify that inlet protection is installed and infiltration areas are marked prior to any land-disturbing activities.
6. Verify the dimensions of the rock construction entrance. (The minimum length is 50 feet and the minimum width is 20 feet or entire width of entrance.)
7. Verify that the rock construction entrance is not shown on top of proposed infiltration areas.
8. Verify that silt fence is shown around the perimeter of the site.
9. Verify that tree protection fence is shown around trees to remain.
10. Verify that the stockpile location is clearly labeled.
11. Verify that silt fence is shown around the stockpile area.

Details:

1. Verify that the following details are provided:
 - a) Inlet Protection
 - b) Silt Fence
 - c) Rock Filter Outlet
 - d) Rock Construction Entrance
 - e) Pumped Water Filter Bag

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Bioinfiltration-Bioretenion Facilities




Plans:

1. Verify that the proposed plantings are provided and acceptable.
2. Verify that appropriate construction sequence is provided. Refer to Page 7-40 of manual.
3. Verify that the proposed infiltration area is clearly marked before any site work begins to avoid soil disturbance and compaction during construction. (Look for note in sequence of construction and fencing on plans.)
4. Verify that an appropriate cross-section is provided.
5. Verify that energy dissipaters (such as stone) are used if the flow is concentrated at the entrance to the bioretention area.
6. Bioretention practices should be a minimum of 10 feet from property lines and building foundations.

Design Calculations:

1. If infiltration is not feasible, verify that static storage of the entire water quality volume is provided from the top of soil elevation to the lowest outlet in the bioretention area. If infiltration is feasible, the voids in the soil and stone layers can be included as storage for the water quality volume.
2. Verify that the system drains within the acceptable 72-hour period.
3. Verify that positive overflow is provided for larger storms (i.e. check basin elevations in all storm events).
4. Verify that the growing medium is a minimum of 2 feet.
5. Verify that the effective head is less than 2 feet.
6. Verify that the loading ratio is less than 10:1.
7. Verify the porosity used in the storage volume calculations. (Use 0.20 for soil, 0.30 for sand, 0.40 for stone.)
8. Verify the infiltration rate used in the calculations. Indicate that infiltration should be over surface area, not wetted area.

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Design Specifications (See Section 8.0 of PSMGM):

1. The planting soil filter media shall meet the following specifications:
 - a) Clay content: less than 5%
 - b) Sand content: 50 - 60%
 - c) Leaf compost or aged leaf mulch: 20 - 30%
 - d) High quality topsoil: 20 - 30%
 - e) Permeability of at least 1.0 feet per day (0.5 inches per hour)
 - f) Free of stones, stumps, roots, or other woody material over 1 inch in diameter
 - g) Free of brush or seeds from noxious weeds
2. The sand storage layer, if applicable, shall meet the following specifications:
 - a) AASHTO M-6 or ASTM C-33 sand
 - b) Grain size of 0.02” – 0.04”
3. The stone storage layer, if applicable, shall meet the following specifications:
 - a) Uniformly-graded, crushed, washed AASHTO No. 3 or AASHTO No.5 stone
 - b) Separated from soil medium by a non-woven geotextile fabric or a pea gravel filter
4. The underdrain, if applicable, shall meet the following specifications:
 - a) Surrounded by a sand layer or gravel filter to filter sediment and facilitate flow
 - b) Surrounded by a non-woven geotextile fabric if a sand layer is used to prevent clogging
 - c) Continuously perforated with a smooth interior
 - d) Minimum inside diameter of 4 inches
 - e) High-density polyethylene pipe meeting the specifications of AASHTO M252, Type S or AASHTO M294, Type S.
5. The geotextile shall consist of needled non-woven polypropylene fibers and meet the following properties:
 - a) Grab Tensile Strength (ASTM-D4632) \geq 120 lbs
 - b) Mullen Burst Strength (ASTM-D3786) \geq 225 psi
 - c) Flow Rate (ASTM-D4491) \geq 95 gal/min/ft²
 - d) UV Resistance after 500 hrs (ASTM-D4355) \geq 70%
 - e) Heat-set or heat-calendared fabrics are not permitted
6. The cleanout, if applicable, shall meet the following specifications:
 - a) Cleanout access must be provided for all underdrained systems
 - b) Rigid with a smooth interior
 - c) Minimum inside diameter of 4 inches
7. The bioretention mulch shall meet the following specifications:
 - a) Aged, double-shredded hardwood bark mulch or composted leaf mulch
 - b) Free of weeds
 - c) Placed on bioretention surface to a depth of 2 - 3 inches
8. The following quantities per 100 square feet of bioretention area are suggested:
 - 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. A native grass/wildflower seed mix can be used as an alternative to groundcover planting. The seed mix shall be free of weed seeds.
 - e) Plants must not be on the Prohibited List (Section 8.4 of PSMGM)
9. The pea gravel filter, if applicable, shall include at least 3 inches of gravel under the underdrain pipe and 6 inches above the underdrain pipe.
10. Where bioretention is used for areas that require groundwater protection (karst, stormwater hot spots, or source water protection) or in close proximity to basements, an appropriate impervious liner should be specified. Clay liners should be of an appropriate impervious material as specified by a geotechnical engineer. Synthetic liners, such as HDPE or PVC should be of appropriate thickness (at least 30 mil recommended).

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Subsurface Infiltration Systems




Plans:

1. Verify that the system is at least 10 feet from all property lines and structures unless the system is located along a road right-of-way.
2. Verify that the system is at least 100 feet up-gradient of all property lines and structures.
3. Verify that the invert elevation of the system is at least 2 feet above the limiting zone.
4. Verify that pretreatment is provided.
5. Verify that an observation well is provided near the center of the basin to monitor water drainage from the system.
6. Verify that a sequence of construction is provided specific for the infiltration basin. See page 7-80 of manual for guidance.
7. Verify that the proposed infiltration area is clearly marked before any site work begins to avoid soil disturbance and compaction during construction. (Look for note in sequence of construction and fencing on plans.)
8. Verify that an appropriate cross-section is provided.

Design Calculations:

1. Verify that static storage of entire water quality volume is provided below lowest outlet in basin.
2. Verify that the loading ratio is less than 5:1.
3. Verify that the effective head is less than 2 feet.
4. Verify the infiltration rate used in the calculations. Indicate that infiltration should be over surface area, not wetted area.
5. Verify that the system drains within the acceptable 72-hour period.
6. Verify that positive overflow is provided for larger storms (i.e. check basin elevations in all storm events).

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Design Specifications:

1. The stone storage layer shall be uniformly-graded, crushed, washed AASHTO No. 3 stone and shall be separated from the soil medium by a non-woven geotextile fabric or a pea gravel filter.
2. The geotextile shall consist of needled non-woven polypropylene fibers and meet the following properties:
 - a) Grab Tensile Strength (ASTM-D4632) \geq 120 lbs
 - b) Mullen Burst Strength (ASTM-D3786) \geq 225 psi
 - c) Flow Rate (ASTM-D4491) \geq 95 gal/min/ft²
 - d) UV Resistance after 500 hrs (ASTM-D4355) \geq 70%
 - e) Heat-set or heat-calendared fabrics are not permitted
3. The observation well shall be 4 inch diameter perforated plastic pipe and placed at the invert of the infiltration bed with a lockable above-ground cap.
4. Intermediate sump box or manhole shall have a sump and trap. The sump depth shall be a minimum of 15 inches from the bottom of the trap.

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Porous Pavement Areas



Plans:

1. Verify that the slope of travel surface is less than 5% for porous asphalt, 10% for porous concrete.
2. Verify that the system is designed with a level bottom.
3. Verify that sequence of construction is provided for porous pavement. See page 7-89 of manual for guidance.
4. Verify that the proposed infiltration area is clearly marked before any site work begins to avoid soil disturbance and compaction during construction. (Look for note in sequence of construction and fencing on plans.)
5. Verify that an appropriate cross-section is provided.


Design Calculations:

1. Verify drainage area directed to porous pavement area. (If impervious area is directed to porous pavement area, system must be modeled as a stormwater management practice with a curve number of 98 and infiltration testing is required).
2. Verify that static storage of entire water quality volume is provided below underdrain invert elevation, if applicable.
3. Verify that the effective head is less than 2 feet.
4. Verify that the system drains within the acceptable 72-hour period.
5. Verify that positive overflow is provided for larger storms (i.e. check elevations in all storm events).
6. Verify the infiltration rate used in the calculations. Indicate that infiltration should be over surface area, not wetted area.

Design Specifications:

1. Check porous concrete or porous asphalt mix to be consistent with Section 7.13 of PSMGM.
2. The stone storage layer shall be uniformly-graded, crushed, washed AASHTO No. 3 stone and shall be separated from the soil medium by a non-woven geotextile fabric. Storage stone shall be at least 8 inches deep.

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3. The geotextile shall consist of needled non-woven polypropylene fibers and meet the following properties:
 - a) Grab Tensile Strength (ASTM-D4632) \geq 120 lbs
 - b) Mullen Burst Strength (ASTM-D3786) \geq 225 psi
 - c) Flow Rate (ASTM-D4491) \geq 95 gal/min/ft²
 - d) UV Resistance after 500 hrs (ASTM-D4355) \geq 70%
 - e) Heat-set or heat-calendared fabrics are not permitted

4. Choker course aggregate shall meet the specifications of AASHTO No. 57 stone.

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Green Roofs



Plans:

1. Verify the depth of the growing medium. Minimum thickness (inches) = 3" + [3 * (impervious roof area/ green roof area)]
2. Verify that proposed plantings are provided and acceptable.
3. Verify that sequence of construction is provided for the green roof.
4. Verify that an appropriate cross-section is provided.
5. Verify that the drainage system is detailed (required if growing medium is greater than 3 inches).


Design Calculations:

1. Verify that the appropriate curve number is used in calculations.

Design Specifications:

1. Green roof growing medium should be a lightweight mineral material with a minimum organic material and should meet the following standards:
 - a) Moisture content at maximum water holding capacity (ASTM E2399 or FLL): $\geq 35\%$
 - b) Porosity at maximum water holding capacity (ASTM E2399 or FLL): $\geq 6\%$
 - 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
 - h) The geotextile shall consist of needled non-woven polypropylene fibers and shall allow root penetration, but prevent the growing medium from passing through into the drainage layer.
2. For vegetated roof cover assemblies with thicknesses of less than 5 inches synthetic drainage layers may be used in lieu of granular drainage layers.
3. For vegetated roof cover assemblies with an overall thickness of 5 inches or greater, the drainage layer shall meet the following specifications:
 - a) Abrasion resistance (ASTM-C131-96): $\leq 25\%$ loss
 - b) Soundness (ASTM-C88): $\leq 5\%$ loss
 - c) Porosity (ASTM-C29): $\geq 25\%$

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- d) Percent of particles passing 1/2 inch sieve (ASTM-C136) $\geq 75\%$
- 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.

5. All drains and scupper should be covered and protected by an enclosure, typically a square or round chamber with a locking lid.

Stormwater Plan Reviewer Guidelines

Cistern and Reuse Systems



Plans:

1. Verify the roof collection surface area (DCIA directed to cistern).
2. Verify that positive overflow is provided for larger storms.
3. Verify that leaf/ debris screens are provided along the entire length of the gutters and downspouts.
4. Verify that a first-flush diverter is provided on the plans.
5. Verify that a manhole or access hatch is provided for maintenance of the cistern tank.


Design Calculations:

1. Verify the anticipated water demand on a daily and monthly basis.
2. Verify that the water quality volume drains from the cistern within 72 hours. (If the water quality volume is not used within 72 hours, a scaled reduction in the impervious area credit will be given.)
3. Verify the impervious area disconnection credit. Verify that the information provided on PWD Worksheet #2 is correct.

Design Specifications:

1. The overflow pipe shall consist of a pipe that is at least 4 inches in diameter and shall be protected with a screen with openings of less than 0.25 inches.
2. The leaf/ debris screen shall be made from a corrosion-resistant material with screen openings in the range of 0.25 to 0.50 inches.
3. The first flush shall collect approximately 1-2 gallons of water per 100 square feet of roof collection surface.

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Surface Detention Systems




Plans:

1. Verify that a sequence of construction is provided specific for the detention basin. See page 7-48 of manual for guidance.
2. Verify that an appropriate cross-section is provided.
3. Verify the side slope of the embankment. The maximum side slope shall be 3:1.
4. Verify that the basin includes sediment forebays, micropools, and water-tolerant plantings if used to meet water quality requirements.
5. Verify that the invert elevation of the basin is at least 2 feet above the seasonal high water table elevation.
6. Verify that the primary and low-flow outlet is protected from clogging with an external trash rack.
7. Verify that emergency spillway is not directed toward neighboring properties.
8. Verify that the minimum basin width is 10 feet.
9. Verify that the water depth is less than 10 feet.

Design Calculations:

1. Verify that the system drains within the acceptable 72-hour period.
2. Verify that a curve number of 100 is used for above-ground detention basins for the area below the water level for the applicable storm event.
3. Verify that positive overflow is provided for larger storms (i.e. check basin elevations in all storm events).
4. Verify that there is at least 1 foot of freeboard between the 100-year elevation in the basin and the invert elevation of the emergency spillway.
5. Verify that there is at least 1 foot of freeboard between the invert elevation of the emergency spillway and the top of berm elevation.
6. Verify the sizing of the riprap aprons.
 - a) Determine tailwater condition from stormwater model for 10-year storm event.
 - b) Use Figures 21 and 22 in the PADEP E&S manual. Verify the riprap apron length, initial apron width, and terminal apron width.
 - c) Verify minimum blanket thickness. (Use 9 inches for R-3 stone, 14 inches for R-4 stone)

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Design Specifications:

1. The planting soil filter media shall meet the following specifications:
 - a) Clay content: less than 5%
 - b) Sand content: 50 - 60%
 - c) Leaf compost or aged leaf mulch: 20 - 30%
 - d) High quality topsoil: 20 - 30%
 - e) Permeability of at least 1.0 feet per day (0.5 inches per hour)
 - f) Free of stones, stumps, roots, or other woody material over 1 inch in diameter
 - g) Free of brush or seeds from noxious weeds

2. The sand storage layer, if applicable, shall meet the following specifications:
 - a) AASHTO M-6 or ASTM C-33 sand
 - b) Grain size of 0.02" – 0.04"

3. The stone storage layer, if applicable, shall meet the following specifications:
 - a) Uniformly-graded, crushed, washed AASHTO No. 3 or AASHTO No.5 stone
 - b) Separated from soil medium by a non-woven geotextile fabric or a pea gravel filter

4. The underdrain, if applicable, shall meet the following specifications:
 - a) Surrounded by a sand layer or gravel filter to filter sediment and facilitate flow
 - b) Surrounded by a non-woven geotextile fabric if a sand layer is used to prevent clogging
 - c) Continuously perforated with a smooth interior
 - d) Minimum inside diameter of 4 inches
 - e) High-density polyethylene pipe meeting the specifications of AASHTO M252, Type S or AASHTO M294, Type S.

5. The geotextile shall consist of needled non-woven polypropylene fibers and meet the following properties:
 - a) Grab Tensile Strength (ASTM-D4632) \geq 120 lbs
 - b) Mullen Burst Strength (ASTM-D3786) \geq 225 psi
 - c) Flow Rate (ASTM-D4491) \geq 95 gal/min/ft²
 - d) UV Resistance after 500 hrs (ASTM-D4355) \geq 70%
 - e) Heat-set or heat-calendared fabrics are not permitted

6. The cleanout, if applicable, shall meet the following specifications:
 - a) Cleanout access must be provided for all underdrained systems
 - b) Rigid with a smooth interior
 - c) Minimum inside diameter of 4 inches

7. The bioretention mulch shall meet the following specifications:
 - a) Aged, double-shredded hardwood bark mulch or composted leaf mulch
 - b) Free of weeds
 - c) Placed on bioretention surface to a depth of 2 - 3 inches

8. The following quantities per 100 square feet of bioretention area are suggested:
 - 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. A native grass/wildflower seed mix can be used as an alternative to groundcover planting. The seed mix shall be free of weed seeds.
9. The pea gravel filter, if applicable, shall include at least 3 inches of gravel under the underdrain pipe and 6 inches above the underdrain pipe.
10. Where bioretention is used for areas that require groundwater protection (karst, stormwater hot spots, or source water protection) or in close proximity to basements, an appropriate impervious liner should be specified. Clay liners should be of an appropriate impervious material as specified by a geotechnical engineer. Synthetic liners, such as HDPE or PVC should be of appropriate thickness (at least 30 mil recommended).

Stormwater Plan Reviewer Guidelines

Level Spreaders




Plans:

1. Verify that first 3 feet down slope of the level spreader is stabilized with soil/ turf reinforcement matting and that the area is stabilized with grass or other approved vegetation (with a minimum uniform ground cover of 90%).
2. Verify that the first 10 feet down slope of the level spreader should not exceed a slope of 4%.
3. Verify that specifications are provided for all components (soil/ turf reinforcement matting, perforated underdrain piping, stone storage layer)
4. Verify that sequence of construction is provided for the level spreader.
5. Verify that pretreatment is provided.
6. The minimum distance between a proposed discharge point (including the level spreader) and a down slope property boundary should be a minimum of 15 feet.
7. The maximum distance between a proposed discharge point (including the level spreader) and a receiving stream or storm sewer should be about 100 feet. Greater distances may be considered on a case-by-case basis for very mild slopes ($\leq 1\%$) and heavily vegetated (grassy) areas but ideally should not exceed 150 feet.
8. Verify that an appropriate cross-section is provided.
9. Verify that detail of rill/gully repair is provided and included in O&M Agreement.

Design Specifications:

1. The stone storage layer shall be uniformly-graded, crushed, washed AASHTO No. 3 stone and shall be separated from the soil medium by a non-woven geotextile fabric.
2. The geotextile shall consist of needled non-woven polypropylene fibers and meet the following properties:
 - 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) $\geq 70\%$
 - e) Heat-set or heat-calendared fabrics are not permitted

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Design Calculations:

1. Verify that level spreader is constructed and maintained level (i.e. constructed along an existing contour).
2. Verify level spreader length. (The BMP Manual recommends level spreader lengths for two ground cover conditions: dense grass ground cover – 13 linear feet for every 1 cfs of flow; forested areas with no ground cover – 100 linear feet for every 1 cfs of flow.) Level spreaders should be designed for the 10-year storm event and shall safely diffuse flows up to the 100-year storm.
3. Verify that the system drains within the acceptable 72-hour period.
4. Verify the infiltration rate used in the calculations. Indicate that infiltration should be over surface area, not wetted area.