F.7 Bioinfiltration/Bioretention

F.7.1 Bioinfiltration/Bioretention Plan Standards

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

F.7.2 Bioinfiltration/Bioretention Design Standards

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

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

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

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

F.7.3 Bioinfiltration/Bioretention Material Standards

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

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