Chapter 23

Stormwater Management

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Part 1

General Provisions

§23-101. Short Title.

This Chapter shall be known and may be cited as the "Reading Township Stormwater Management Ordinance."

(*Ord. 2012-01*, 10/15/2012, §101)

§23-102. Statement of Findings.

The Board of Supervisors of Reading Township finds that:

A. Stormwater is an important water resource, which provides groundwater recharge for water supplies and base flow of streams, which also protects and maintains surface water quality.

B. Inadequate management of accelerated runoff of stormwater resulting from development throughout a watershed increase flows and velocities, contributes to erosion and sedimentation, overtaxes the carrying capacity of streams and storm sewers, greatly increases the cost of public facilities to carry and control stormwater, undermines flood plain management and flood control efforts in downstream communities, reduces groundwater recharge, threatens public health and safety, and increases non-point source pollution of water resources.

C. A comprehensive program of stormwater management for the Reading Township watershed(s), including reasonable regulation of development and activities causing accelerated runoff, is fundamental to the public health, safety, and welfare and the protection of people of the Commonwealth, their resources, and the environment.

(*Ord. 2012-01*, 10/15/2012, §102)

§23-103. Purpose.

The purpose of this Chapter is to promote health, safety, and welfare within Reading Township and its watersheds by minimizing the harm and maximizing the benefits described in §23-102 of this Chapter, through provisions designed to:

A. Meet legal water quality requirements under State law, including regulations at 25 Pa.Code, Chapter 93, to protect, maintain, reclaim, and restore the existing and designated uses of the waters of this Commonwealth.

B. Preserve the natural drainage systems as much as possible.

C. Manage stormwater runoff close to the source.

D. Provide procedures and performance standards for stormwater planning and management.

E. Maintain groundwater recharge to prevent degradation of surface and groundwater quality and to otherwise protect water resources.

F. Prevent scour and erosion of stream banks and stream beds.

G. Provide proper operation and maintenance of all SWM BMPs that are

implemented within Reading Township.

H. Provide standards to meet NPDES permit requirements.

(*Ord. 2012-01*, 10/15/2012, §103)

§23-104. Statutory Authority.

Reading Township is empowered to regulate land use activities that affect stormwater impacts by the authority of the Act of October 4, 1978, P.L. 864 (Act 167), 32 P.S. §680.1, *et seq*., as amended, the "Storm Water Management Act."

(*Ord. 2012-01*, 10/15/2012, §104)

§23-105. Applicability.

1. All regulated activities and all activities that may affect stormwater runoff are subject to regulation by this Chapter.

2. Any submission that does not require a stormwater management plan at the time of subdivision or land development will still be required to address stormwater management at the time the individual lots are developed or construction commences, unless the subdivision proposes infrastructure features, such as a cul-de-sac street, for which stormwater management controls ordinarily are required.

3. Development of the individual lots is subject to stormwater management as defined within this Chapter.

(*Ord. 2012-01*, 10/15/2012, §105)

§23-106. Other Ordinance Provisions.

In the instance where any other ordinance provision or regulation of Reading Township is inconsistent with any of the provisions or regulations of this Chapter, then this Chapter will supersede any other such provision or regulation so as to give this Chapter full force and effect.

(*Ord. 2012-01*, 10/15/2012, §106)

§23-107. Compatibility with Other Requirements.

Approvals issued and actions taken under this Chapter do not relieve the applicant of the responsibility to secure required permits or approvals for activities regulated by any other code, law, regulation, or ordinance. In the event of a conflict between this Chapter and any other ordinance, the more restrictive shall apply.

(*Ord. 2012-01*, 10/15/2012, §108)

§23-108. Interpretation.

Unless otherwise expressly stated, the succeeding shall, for the purposes of this Chapter, be interpreted in the following manner:

A. Words used in the present tense also imply the future tense.

B. Words used in the singular imply the plural, and vice versa.

C. Words of masculine gender include feminine gender, and vice versa.

D. The words and abbreviation "includes," "including," "shall include," "such

as,"and "e.g." are not limited to the specific example(s) given but are intended to extend the word's or words' meaning(s) to all other instances of like kind and character.

E. The words "person," "applicant," or "developer" include, a partnership, corporation, or other legal entity, as well as an individual.

F. The words "shall," "required," or "must" are mandatory; the words "may" and "should" are permissive.

(*Ord. 2012-01*, 10/15/2012, §109)

§23-109. Erroneous Permit.

Any permit or authorization issued or approved based on false, misleading or erroneous information provided by an applicant is void without the necessity of any proceedings for revocation. Any work undertaken or use established pursuant to such permit or other authorization is unlawful. No action may be taken by a board, agency or employee of Reading Township purporting to validate such a violation.

(*Ord. 2012-01*, 10/15/2012, §110)

§23-110. Duty of Persons Engaged in the Development of Land.

Each property owner is responsible for managing stormwater runoff in a manner consistent with the provisions of this Chapter so as not to create an adverse impact on other properties or cause erosion. The requirements set forth in this Chapter, if followed, are intended to, but not guaranteed to, enable property owners to properly manage stormwater on their property. In the event stormwater management designs and facilities are approved by the Township and installed in accordance with approved design but still fail to manage stormwater flows so that such flows do not adversely affect other properties or cause erosion, the property owner shall install such additional facilities or take other remedial measures as are necessary to properly manage stormwater runoff so that such runoff does not adversely affect other properties or cause erosion.

(*Ord. 2012-01*, 10/15/2012, §111)

§23-111. Municipal Liability Disclaimer.

1. Neither the granting of any approval under this Chapter, nor the compliance with the provisions of this Chapter or with any condition imposed by a Township official hereunder, shall relieve any person from any responsibility or damage to person or property resulting therefrom or as otherwise imposed by law, nor impose any liability upon Reading Township for damages to person or property.

2. The granting of a permit which includes any stormwater management facilities shall not constitute a representation, guarantee, or warranty of any kind by Reading Township, or by an official or employee thereof, of the practicability or safety of any structure, use or other plan proposed, and shall create no liability upon or cause of action against such public body, official or employee for any damage that may result pursuant thereto.

(*Ord. 2012-01*, 10/15/2012, §112)

Part 2

Definitions

§23-201. Terms Defined.

As used in this Chapter, the following terms shall have the following meanings:

ACCD–Adams County Conservation District.

Agricultural activity–activities associated with agriculture such as, but not limited to, agricultural cultivation, agricultural operations, and animal heavy use areas. This includes the work of producing crops including tillage, land clearing, plowing, disking, harrowing, planting, harvesting crops or pasturing and raising of livestock and installation of conservation measures. Construction of new buildings or impervious area is not considered an agricultural activity.

Applicant–a landowner, developer, or other person who has filed an application to Reading Township for approval to engage in any regulated activity at a project site in Reading Township.

Best management practice (BMP)–activities, facilities, designs, measures, or procedures used to manage stormwater impacts from regulated activities, to meet State water quality requirements, to promote groundwater recharge, and to otherwise meet the purposes of this Chapter. Stormwater BMPs are commonly grouped into one of two broad categories or measures: "structural" or "nonstructural." In this Chapter, nonstructural BMPs or measures refer to operational and/or behavior-related practices that attempt to minimize the contact of pollutants with stormwater runoff whereas structural BMPs or measures are those that consist of a physical device or practice that is installed to capture and treat stormwater runoff. Structural BMPs include, but are not limited to, a wide variety of practices and devices, from large-scale retention ponds and constructed wetlands, to small-scale underground treatment systems, infiltration facilities, filter strips, low impact design, bioretention, wet ponds, permeable paving, grassed swales, riparian or forested buffers, sand filters, detention basins, and manufactured devices. Structural stormwater BMPs are permanent appurtenances to the project site.

BMP Manual–Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006, (Document #363-0300-002), as amended and updated.

Conservation District–The Adams County Conservation District,(ACCD), which district is as defined in §3(c) of the Conservation District Law, 3 P.S. §851(c), that has the authority under a delegation agreement executed with DEP to administer and enforce all or a portion of the regulations promulgated under 25 Pa.Code, Chapter 102.

County–Adams County, Pennsylvania.

Culvert–a structure which carries surface water through an obstruction.

Dam–an impoundment structure regulated by the Pennsylvania DEP promulgated under 25 Pa.Code, Chapter 105.

DEP–the Pennsylvania Department of Environmental Protection.

Design storm–the magnitude and temporal distribution of precipitation from a storm event measured in probability of occurrence, e.g., a 5-year storm, and duration, e.g., 24 hours, used in the design and evaluation of stormwater management systems. Also see "return period."

Detention basin–a structure designed to retard stormwater runoff by temporarily storing and releasing the runoff at a predetermined rate. This basin is designed to drain completely after a storm event.

Detention volume–the volume of runoff that is captured and released into the waters of this Commonwealth at a controlled rate.

Developer–any person, partnership, association, corporation or other entity; or any responsible person therein or agent thereof, that undertakes any regulated activity.

Development site (site)–see "project site."

Disconnected impervious area (DIA)–an impervious or impermeable surface that is disconnected from any stormwater drainage or conveyance system and is redirected or directed to a pervious area, which allows for infiltration, filtration, and increased time of concentration as specified in Appendix A, "Stormwater Management Design Assistance Manual for Minor Land Development Activities." [*Ord. 2014-01*]

Disturbed area–an unstabilized land area where an earth disturbance activity is occurring or has occurred.

Drainage plan–the documentation of the stormwater management system, if any, to be used for a given project site.

Earth disturbance activity–a construction or other human activity which disturbs the surface of the land, including, but not limited to: clearing and grubbing; grading; excavations; embankments; land development; agricultural plowing or tilling; operation of animal heavy use areas; timber harvesting activities; road maintenance; oil and gas activities; well drilling; mineral extraction; building construction; and the moving, depositing, stockpiling, or storing of soil, rock, or earth materials.

Easement–a property right granted for limited use of private land for a public or quasi-public or private purpose, and within which the owner of the property shall not have the right to make use of the land in a manner that violates the right of the grantee.

Engineer–a professional engineer registered as such in the Commonwealth of Pennsylvania.

Erosion–the natural process by which the surface of the land is worn away by water, wind, or chemical action.

E & S Manual–the Pennsylvania DEP *Erosion and Sediment Pollution Control Manual*, as amended and updated.

Erosion and sediment control plan–a site specific plan consisting of both drawings and a narrative that identifies BMPs to minimize accelerated erosion and sedimentation before, during and after earth disturbance activities.

Excavation–any activity by which earth, sand, gravel, rock, or any other similar material is dug into, cut, quarried, uncovered, removed, displaced, relocated, or bulldozed and the resulting conditions.

Existing condition–the dominant land cover during the 5-year period immediately preceding a proposed regulated activity.

Evapotranspiration–the combined process of water surface evaporation, soil moisture evaporation, and plant transpiration.

FEMA–Federal Emergency Management Agency.

Floodplain–any land area susceptible to inundation by water from any natural source as delineated by applicable FEMA maps and studies as being a special flood hazard area.

Floodway–the channel of the watercourse and those portions of the adjoining floodplains that are reasonably required to carry and discharge the 100-year flood. Unless otherwise specified, the boundary of the floodway is as indicated on maps and flood insurance studies provided by FEMA. In an area where no FEMA maps or studies have defined the boundary of the 100-year floodway, it is assumed, absent evidence to the contrary, that the floodway extends from the stream to 50 feet from the top of the bank of the stream.

Forest management/timber operations–planning and activities necessary for the management of forest land. These include conducting a timber inventory, preparation of forest management plans, silvicultural treatment, cutting budgets, logging road design and construction, timber harvesting, site preparation, and reforestation.

Hydrologic soil group (HSG)–infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSGs (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. The NRCS defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of the development site may be identified from a soil survey report that can be obtained from local NRCS offices or conservation district offices. Soils become less pervious as the HSG varies from A to D (NRCS 3, 4).

Impervious surface (impervious area)–a surface that prevents the infiltration of water into the ground. Impervious surfaces and areas shall include, but not be limited to, roofs, additional indoor living spaces, patios, garages, storage sheds and similar structures, and any new streets and sidewalks. However, any surface or area designed, constructed and maintained to permit infiltration as specified herein shall be considered pervious, not impervious. For the purposes of this Chapter, a surface or area shall not be considered impervious if such surface or area does not diminish the capacity for infiltration of stormwater for storms up to, and including, a 2-year 24-hour storm event.

Infiltration–the entrance of surface water into the soil, usually at the soil-air interface.

Land development–shall include any of the following activities:

(1) The improvement of one lot or two or more contiguous lots, tracts, or

parcels or land for any purpose involving:

(a) A group of two or more residential or nonresidential buildings, whether proposed initially or cumulatively, or a single nonresidential building on a lot or lots regardless of the number of occupants or tenure; or an accessory structure to a single family residential structure.

(b) The division or allocation of land or space between or among two or more existing or prospective occupants by means of, or for the purpose of streets, common areas, leaseholds, condominium, building groups, or other features.

(2) A subdivision of land.

(3) Land development shall not include:

(a) The conversion of an existing single-family detached dwelling or single-family semi-detached dwelling into not more than three residential units, unless such units are intended to be a condominium.

(b) The addition of an accessory building or buildings provided:

1) Such building or buildings will be used exclusively in connection with the agricultural use of the property.

2) The cumulative square footage of ground floor area of the proposed building or buildings and all other buildings is less than 5,000 square feet more than the square footage of all buildings located within such tract, lot or parcel on

3) The addition of an accessory building or building provided:

a) Such building or buildings will not be used exclusively in connection with the agricultural use of the property.

b) The cumulative square footage of ground floor area of the proposed building or buildings and all other buildings is less than 400 square feet more than the square footage of all buildings located within such tract, lot or parcel.

Limit of disturbance–a line provided on the E&S plan or SWM plan that indicates the total area to be disturbed over the life of the project.

Loading ratio–the ratio of impervious area draining to a stormwater management facility to the area of the stormwater management facility itself.

Municipality–Reading Township, Adams County, Pennsylvania.

Noxious plant–those species as listed in the PA Noxious Weed Control Law, 3 P.S. §255.1–255.11, as amended and/or recodified.

NPDES–National Pollution Discharge Elimination System, as authorized by the Clean Water Act, 33 U.S.C. §1251 *et seq*., as amended.

NPDES permit–a permit required for stormwater discharges associated with construction activities, as required by the Clean Water Act, 33 U.S.C. §1251 *et seq*., as amended.

NRCS–USDA Natural Resources Conservation Service (previously SCS).

O & M–operation and maintenance.

O & M plan–operation and maintenance plan. PCSWMP–

post-construction stormwater management plan.

Peak discharge–the maximum rate of stormwater runoff from a specific storm event.

Percolation–the downward movement, under the influence of gravity, of water under hydrostatic pressure through interstices of the soil or rock.

Person–includes natural person, public or private corporation, partnership, firm trust, estate, municipality, governmental unit, public utility or any other entity which may at any time own land or engage in regulated activities. Whenever used in any Section prescribing or imposing a penalty, the term "person" shall include the members of a partnership, the officers, agents and servants of a corporation and the officers of a municipality.

Pervious area–any area not defined as impervious.

Project site–the specific area of land where any regulated activities within the corporate limits of Reading Township are planned, conducted, or maintained. Areas of the same tract within 500 feet of the proposed impervious surface shall be considered part of the project site. In the event new impervious surface is proposed to be created by an owner of an easement or right-of-way, the project site shall be considered to include all areas over which the one proposing new impervious surface has an easement or right-of-way that are within 500 feet of the proposed impervious surface. No area of any development outside the corporate limits of Reading Township shall be considered part of the project site.

Qualified person–any person licensed by the State of Pennsylvania or otherwise qualified by law to perform the work required by this Chapter.

Reduction factor–a form of safety factor that, when multiplied by the site tested infiltration rate, is used to help determine the design infiltration rate for a stormwater management facility.

Regulated activities–any earth disturbance activities or any activities that involve the alteration or development of land in a manner that may affect stormwater runoff.

Regulated earth disturbance activity–activity involving earth disturbance subject to regulation under 25 Pa.Code Chapter 92, 25 Pa.Code Chapter 102, or the Clean Streams Law, 35 P.S. §691.1 *et seq*.

Retention basin–an impoundment in which stormwater is stored and not released during a storm event. Stored water may be released from the basin at a pre-determined rate at some time after the end of a storm.

Retention volume/removed runoff–the volume of runoff that is captured and not released directly into the surface waters of this Commonwealth during or after a storm event.

Return period–the average interval, in years, within which a storm event of a given magnitude can be expected to occur one time. For example, the 25-year return period rainfall would be expected to occur on average once every 25 years; or stated in another way, the probability of a 25-year storm occurring in any one year is 0.04, i.e., a 4 percent chance.

Riparian buffer–a best management practice that is an area of permanent vegetation along surface waters. (Such areas serve as natural vegetative filters between upland landscapes and waterways.)

Road maintenance activities–see definition as found in 25 Pa.Code, Chapter 102.1.

Runoff–any part of precipitation that flows over the land.

Safety factor–an adjustment applied to a site-tested infiltration rate to ensure that the designed infiltration rate for a stormwater facility is less than that shown under tested conditions.

Sediment–soils or other materials transported by surface water as a product of erosion.

Sheet flow–water flow with a relatively thin and uniform depth.

Simplified approach (SA)–a process that property owners proposing certain types of projects may utilize to prepare a stormwater management plan without having to conduct the detailed technical analysis and design required for larger projects [Appendix A, "Stormwater Management Design Assistance Manual for Minor Land Development Activities"]. [*Ord. 2014-01*]

Special management areas–those areas outlined in Chapter 7 of the *BMP Manual*. Special management areas include: brownfields, highways and roads, karst areas, mined lands, water supply well areas, surface water supplies and special protection waters.

Spillway–a depression in the embankment of a pond or basin which is used to pass peak discharge greater than the maximum design storm controlled by the pond or basin.

State water quality requirements–the regulatory requirements to protect, maintain, reclaim, and restore water quality under Title 25 of the Pennsylvania Code and the Clean Streams Law, 35 P.S. §691.1 *et seq*.

Storm sewer–a pipe or conduit, or a system of pipes or conduits, which intercepts and carries surface stormwater runoff, but excludes sewage, industrial wastes and similar discharges.

Stormwater–drainage runoff from the surface of the land resulting from precipitation or snow or ice melt.

Stormwater management facility–any structure, natural or man-made, that, due to its condition, design, or construction, conveys, stores, or otherwise affects stormwater runoff. Typical stormwater management facilities include, but are not limited to, detention and retention basins, open channels; storm sewers, pipes, and infiltration facilities.

Stormwater Management Plan (the Plan)–parts and/or elements of the Adams County Integrated Water Resources Plan which incorporate the requirements of the Act of October 4, 1978, P.L. 864, (Act 167), as amended, and known as the "Storm Water Management Act," 32 P.S. §680.1 *et seq*.

Stormwater management best management practices–abbreviated as BMPs or SWM BMPs throughout this Chapter.

Stormwater management site plan (SWM site plan)–the plan prepared by the

developer or his representative indicating how stormwater runoff will be managed at the development site in accordance with this Chapter. Stormwater management site plan will be designated as SWM site plan throughout this Chapter. For all NPDES permitted sites, the stormwater management site plan shall include, and be consistent with, the erosion and sediment control plan as submitted to the Adams County Conservation District (ACCD) and/or DEP.

Subdivision–the division or re-division of a lot, tract or parcel of land by any means into two or more lots, tracts or parcels or other divisions of land including changes in existing lot lines for the purpose, whether immediate or future, of lease, partition by the court for distribution to heirs or devisees, transfer of ownership or building or lot development; provided, however, that the subdivision by lease of land for agricultural purposes into parcels of more than 10 acres, not involving any new street or easement of access or any residential dwelling, shall be exempted.

Swale–a low-lying stretch of land which gathers and/or carries surface water runoff.

SWM–stormwater management.

Township–Reading Township, Adams County, Pennsylvania.

Tract–all contiguous land in common ownership at the date of the enactment of this Chapter. Land shall be considered contiguous even though separated by public or private roads or by utility rights-of-way, irrespective of whether the right-of-way is owned in fee or is an easement, and land adversed from the original tract after June 18, 2012.

USDA–United States Department of Agriculture.

Waters of this Commonwealth–any and all rivers, streams, creeks, rivulets, impoundments, ditches, watercourses, storm sewers, lakes, dammed water, wetlands, ponds, springs, and all other bodies or channels of conveyance of surface and underground water, or parts thereof, whether natural or artificial, within or on the boundaries of this Commonwealth.

Watershed–a region or area drained by a river, watercourse, or other surface water of this Commonwealth. Reading Township watersheds are defined by the corporate limits of Reading Township.

Wetland–areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs, and similar areas.

(*Ord. 2012-01*, 10/15/2012, §201; as amended by *Ord. 2014-01*, 4/21/2014)

Part 3

Stormwater Management Standards

§23-301. General Requirements.

1. For all regulated activities, unless preparation of an SWM site plan is specifically exempted in §23-302:

A. Preparation and implementation of an approved SWM site plan is required.

B. No regulated activities shall commence until Reading Township issues written approval of an SWM site plan which demonstrates compliance with the requirements of this Chapter.

C. All Regulated Activities shall provide notification of approval from the applicable State and Federal agencies for any proposed encroachment into wetland area(s).

2. SWM site plans approved by Reading Township, in accordance with §23-406, shall be on site throughout the duration of the regulated activity.

3. Reading Township may, after notifying DEP and receiving a favorable response, approve measures for meeting the state water quality requirements other than those in this Chapter; provided, that they meet the minimum requirements of, and do not conflict with, State law including, but not limited to, the Clean Streams Law, 35 P.S. §691.1 *et seq*. The Township shall maintain a record of correspondence with DEP pursuant to this subsection. If no response is received from DEP within 45 days of notification, the Township may approve such measures without DEP approval.

4. For all regulated earth disturbance activities, erosion and sediment control BMPs shall be designed, implemented, operated, and maintained during the regulated earth disturbance activities, i.e., during construction, to meet the purposes and requirements of this Chapter and to meet all requirements under Title 25 of the Pennsylvania Code and the Clean Streams Law. Various BMPs and their design standards are listed in the *Erosion and Sediment Pollution Control Program Manual* (*E&S Manual*) 2, No. 363-2134-008 (March, 2012), as amended and updated. Approval of the SWM site plan by Reading Township shall be conditioned on the applicant obtaining erosion and sedimentation control approval from the appropriate agency or agencies, when applicable.

5. For all regulated activities, implementation of the volume controls in §23-303 is required, unless specifically exempted under this Section or §23-302 or exempted by an approved modification request as specified in §23-408 of this Chapter.

6. All regulated activities shall be performed in such manner as to:

A. Protect health, safety, and property.

B. Meet the water quality goals of this Chapter, as stated in §23-103, "Purpose," by implementing measures to:

(1) Minimize disturbance to floodplains, wetlands, wooded areas, and existing vegetation.

(2) Maintain or extend riparian buffers.

(3) Avoid erosive flow conditions in natural flow pathways.

(4) Minimize thermal impacts to waters of this Commonwealth.

(5) Disconnect impervious surfaces by directing runoff to pervious areas, wherever possible.

(6) Minimize soil disturbance and compaction. Topsoil, if removed from the property, shall be replaced so that there is at least the same depth of topsoil as prior to removal; provided, however, if the depth prior to removal was less than 4 inches, the replacement depth must be at least 4 inches and if the depth prior to removal was greater than 8 inches, the replacement depth need not exceed 8 inches, except when the design requires greater depth.

C. To the maximum extent practicable, incorporate the techniques for low impact development practices described in the *Pennsylvania Stormwater Best Management Practices Manual* (*BMP Manual*).

7. Infiltration BMPs shall be spread out, made as shallow as practicable, and located to maximize use of natural on-site infiltration features while still meeting the other requirements of this Chapter. In addition, infiltration BMPs shall include pre-treatment BMPs where appropriate. All proposed stormwater control measures which rely upon infiltration type processes shall provide adequate site evaluation and soil testing in accordance, with the PA DEP Stormwater Best Management Practices Manual (Appendix C) or as may be most recently revised.

8. Normally dry, open-top storage facilities, designed as such, shall completely drain both the volume control and rate control capacities over a period of time not more than 96 hours from the end of the design storm. Infiltration facilities shall be designed to infiltrate in not less than 24 hours, however, any designed infiltration at such facilities is exempt from the minimum 24-hour standard, i.e., may infiltrate in a shorter period of time, so long as none of the stormwater flowing into the infiltration facility is discharged directly into the surface waters of the Commonwealth. (Inordinately rapid infiltration rates may indicate the presence of large fractures or other conditions for which an additional soil buffer or organic layer may be required.)

9. The design storm volumes and precipitation intensities to be used in the analysis of discharge or runoff shall be obtained from the *Precipitation-Frequency Atlas of the United States*, Atlas 14, Volume 2, Version 3.0, U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) Atlas 14 website at http://hdsc.nws.noaa.gov/hdsc/pfds/. National Weather Service, Hydrometeorological Design Studies Center, Silver Spring, Maryland, utilizing the version in effect at the time of the application.

10. For all regulated activities, SWM BMPs shall be designed, implemented, operated, and maintained to meet the purposes and requirements of this Chapter and to meet all requirements under Title 25 of the Pennsylvania Code, the Clean Streams Law, 35 P.S. §691.1 *et seq*., and the Storm Water Management Act, 32 P.S. §680.1 *et seq*.

11. Various BMPs and their design standards are listed in the *BMP Manual*.

12. *Special Management Areas*. SWM site plans involving regulated activities within special management areas shall be prepared in a manner consistent with the guidance provided in Chapter 7 of the *BMP Manual*. The SWM site plan submission shall include design details for SWM BMPs within said special management area.

13. A SWM site plan may propose that stormwater related to the proposed regulated activities be accommodated by existing stormwater management facilities on adjoining or nearby properties provided that the SWM site plan documents the following:

A. The use of stormwater management facilities located on said adjoining or nearby property is approved in writing by the owner of the property.

B. The stormwater management facilities located on the adjoining or nearby property were designed in a manner that can accommodate the stormwater management needs of the regulated activity in a manner consistent with all requirements of this Chapter. The SWM site plan shall include all documentation necessary for Reading Township to confirm such compliance.

14. Stormwater management facilities that involve a State highway shall be subject to the approval of PennDOT.

15. *Easements*.

A. Easements shall be provided where stormwater or surface water drainage facilities are proposed, whether located within or beyond the boundaries of the property. Although normal lot grading does not require easements, swales which receive runoff from more than one other lot or from more than ½ acre must be provided with an easement.

B. Easements shall have a minimum width of 10 feet from the top of the bank of a watercourse or body of water or each side of a drainage structure and shall be adequately designed to provide area for:

(1) Collection and discharge of water.

(2) Maintenance, repair and reconstruction of the drainage facilities.

(3) Passage of machinery for such work.

C. Easements shall include a description of an ownership and maintenance program, in a recordable form, that clearly sets forth responsibility for all temporary and permanent stormwater management facilities.

D. Easements that are not along the center line of a described property line shall be located by a center-line bearing and distance from a known point.

E. Where a development is traversed by watercourses, drainage easements shall be provided conforming to the line of such watercourses. The terms of the easement shall prohibit excavation, the placing of fill or structures and any alterations that may adversely affect the flow of stormwater within any portion of the easement.

(*Ord. 2012-01*, 10/15/2012, §301)

16. If diffused flow is proposed to be directed onto adjacent property, the developer must document that adequate downstream conveyance facilities exist to safely transport the discharge, or otherwise prove that no erosion, sedimentation, or flooding will result from the discharge.

17. The existing points of concentrated discharge that flow onto adjacent property shall not be altered without permission of the adjacent property owner(s) and shall be subject to any applicable discharge criteria as specified in this Section.

18. Any stormwater management facilities regulated by this Section that would be located in or adjacent to waters of the Commonwealth or wetlands shall be subject to approval by PA DEP through the appropriate Chapter 1O'5 permitting process. If there is a question as to whether wetlands may be involved, it is the responsibility of the developer (or his agent) to prove that the land in question is not classified as wetlands.

§23-302. Exemptions.

1. A property owner or developer of any regulated activity that meets the following exemption criteria is, upon approval from Reading Township, exempt from the formal SWM plan submission requirements of this Chapter as specified herein. However, the property owner or developer shall be subject to all other requirements of this Chapter other than the formal SWM plan submission requirements for which an exemption or exemptions have been authorized. The criteria for exemption in this Section apply to the total development proposed, including instances in which the development is proposed to take place in phases. The date of enactment of this Chapter shall be the starting point from which future development and the respective exemption criteria shall be cumulatively considered and regulated.

A. Regulated activities that involve equal to or less than 1,000 square feet of impervious surface may be exempted from the peak rate control, volume control and the SWM plan/site plan preparation and submission requirements of this Chapter. The applicant shall complete page 1 of the Municipal Stormwater Management Worksheet from the *Stormwater Management Design Assistance Manual* (see Appendix A) and file said worksheet with Reading Township. [*Ord.*

2014-01]

B. Regulated activities that involve greater than 1,000 square feet and equal to or less than 10,000 square feet of impervious area, and where the all the proposed impervious area can be entirely disconnected, may be exempted from the peak rate control, volume control, and the SWM plan/site plan preparation and submission requirements of this Chapter. The applicant shall complete the Stormwater Management Worksheets from the *Stormwater Management Design Assistance Manual* (see Appendix A) and file said worksheets with Reading Township. [*Ord. 2014-01*]

C. Regulated activities that involve greater than 1,000 square feet and equal to or less than 5,000 square feet of impervious area may be exempted from the peak rate control and volume control preparation and submission requirements of this Chapter. A minor stormwater site plan, as detailed in the *Stormwater Management Design Assistance Manual* (see Appendix A), shall be submitted to Reading Township instead of the submission of a full SWM plan/site plan in accordance with Part 4 of this Chapter. [*Ord. 2014-01*]

D. Forest management and timber operations are exempted from the rate control, volume control and SWM plan/site plan preparation and submission requirements of this Chapter provided the forest management and timber operations are performed in accordance with the requirements of 25 Pa.Code, Chapter 102.

E. Regulated activities involving domestic gardening for single-family consumption shall be exempted from volume control, rate control, and SWM plan/site plan preparation and submission requirements of this Chapter, and shall not be subject to the exemption approval process of subsection .2 of this Chapter.

F. In kind repair, in kind replacement, and maintenance of existing surfaces, and structures shall be exempted from volume control, rate control, and SWM plan/site plan preparation and submission requirements of this Chapter, and shall not be subject to the exemption approval process of subsection .2 of this Chapter.

G. Agricultural activity, as defined in this Chapter, is exempt from the SWM site plan preparation, rate and volume control requirements of this Chapter, provided the activities are performed with no adverse impacts to downstream property owners due to stormwater runoff and do not cause erosion and are performed according to the requirements of 25 Pa.Code, Chapter 102.

2. *Authorization of Exemptions*. Reading Township shall determine, in accordance with the following requirements and process, whether a proposed regulated activity may be exempted from any of the requirements of this Chapter.

A. The property owner or developer proposing the regulated activity shall submit, in writing on a form supplied by Reading Township, a request for said proposed regulated activity to be exempted from allowable requirements of this Chapter pursuant to subsections .1 and .2 above. The written request shall identify the project and shall indicate the specific exemption criteria, as listed in subsection .1 and .2, that apply to the project.

B. Upon receipt of the exemption request form, the Board of Supervisors or its designee shall either approve or deny the exemption request. If the exemption request is denied, the Board of Supervisors or its designee shall direct the property

owner or developer to submit the information required to demonstrate that the proposed regulated activity complies with the requirements of this Chapter or meets the exemption criteria.

C. Exemption request submitted to Reading Township shall be subject to the following:

(1) Reading Township will deny any exemption request or suspend or revoke any approved exemption request at any time for any project where Reading Township the proposed regulated activity poses a threat to public health, safety, property, or the environment.

(2) Approval of an exemption request does not relieve the property owner or developer from other applicable requirements of this Chapter or of other Reading Township ordinance or regulations.

(3) Reading Township will deny an exemption request if a drainage problem is known or identified by Reading Township to exist downstream from the proposed Regulated Activity.

D. Reading Township will utilize the provisions of the "*Simplified Approach and Design Assistance Manual*" (Appendix A).

(*Ord. 2012-01*, 10/15/2012, §302; as amended by *Ord. 2014-01*, 4/21/2014)

§23-303. General Design Standards.

1. *Impervious Area*.

A. The measurement of impervious areas shall include all of the impervious areas in the total proposed development, even if development is to take place in phases.

B. For development taking place in phases, the total proposed impervious area within the SWM plan/site plan must be used in determining conformance with this Chapter.

C. For projects that add impervious area to a parcel, the total impervious area on the parcel is subject to the requirements of this Chapter; except that the volume controls in §23-304 and the peak rate controls of §23-305 do not need to be retrofitted to existing impervious areas that are not being altered by the proposed regulated activity.

2. Normally dry, open-top storage facilities, designed as such, shall completely drain both the volume control and rate control capacities over a period of time not less than 24 hours and not more than 72 hours from the end of the design storm. However, any designed infiltration volume at such facilities is exempt from the minimum 24-hour standard, i.e., may infiltrate in a shorter period of time, so long as none of the stormwater intended for infiltration is discharged into the surface waters of the Commonwealth. Inordinately rapid infiltration rates may indicate the presence of large fractures or other conditions for which an additional soil buffer/organic layer may be required.

3. Infiltration BMP's shall be spread out, made as shallow as practicable, and located to maximize use of natural on-site infiltration features while still meeting the other requirements of this Chapter. In addition, infiltration BMP's shall include pre-treatment BMP's where appropriate.

4. *Additional Criteria.* Under certain conditions, the Township, upon recommendation by the Township Engineer, may impose the following additional restrictions on stormwater discharges:

A. Peak discharge may be further restricted when it can be shown that a probable risk to downstream structures or unique natural areas exists or that existing, severe flooding could be further aggravated.

B. Measures shall be imposed to protect against groundwater or surface water pollution where the type of activity may result in significant nonpoint source pollution or the nature of the soils or bedrock underlying a stormwater management structure constitutes substantial risk of contamination, such as might be the case in limestone formations. Special provisions to be followed in these cases will be submitted by the designer and reviewed/approved by the Township Engineer.

(*Ord. 2012-01*, 10/15/2012, §303)

§23-304. Volume Controls.

The low impact development practices provided in the *BMP Manual* shall be utilized for all regulated activities to the maximum extent practicable. Water volume controls shall be implemented using the design storm method in paragraph .A or the simplified method in paragraph .B below. For regulated activity areas equal or less than 1 acre that do not require hydrologic routing to design the stormwater facilities, this Chapter establishes no preference for either methodology; therefore, the applicant may select either methodology on the basis of economic considerations, the intrinsic limitations on applicability of the analytical procedures associated with each methodology, and other factors. Acknowledgment that an NPDES, DEP or other soil erosion and sediment pollution control approval is not required by law, or if such approval is required by law, then a true and accurate copy of such approval shall be provided to the Township.

A. The design storm method (CG-1 in the *BMP Manual*) is applicable to any size of regulated activity. This method requires detailed modeling based on site conditions.

(1) Do not increase the post-development total runoff volume for all storms equal to or less than the 2-year 24-hour duration precipitation to more than the pre-development total runoff volume.

(2) For modeling purposes:

(a) Existing (pre-development) non-forested pervious areas must be considered meadow.

(b) Twenty percent of the existing impervious area of a project site, when present, shall be considered meadow in the model for existing conditions, if the existing impervious area is being altered by the proposed regulated activity.

B. The simplified method (CG-2 in the *BMP Manual*) provided below is independent of site conditions and should be used if the design storm method is not followed. This method is not applicable to regulated activities greater than 1 acre or for projects that require design of stormwater storage facilities. For new impervious surfaces:

(1) Stormwater facilities shall capture at least the first 2 inches of runoff from all new impervious surfaces.

(2) At least the first 1 inch of runoff from new impervious surfaces shall be permanently removed from the runoff flow, i.e., it shall not be released into the surface waters of this Commonwealth. Removal options for the first 1 inch of runoff include reuse, evaporation, transpiration, and infiltration.

(3) Wherever possible, infiltration facilities should be designed to accommodate infiltration of the entire permanently removed runoff; however, in all cases at least the first 0.5 inch of the permanently removed stormwater runoff shall be infiltrated.

(*Ord. 2012-01*, 10/15/2012, §304)

§23-305. Rate Controls.

1. For computation of pre-development peak discharge rates, 20 percent of the existing impervious area of a project site, when present, shall be considered meadow, if the existing impervious area is being altered by the proposed regulated activity.

2. Post-development discharge rates shall not exceed the pre-development discharge rates for the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year 24-hour storms. If it is shown that the peak rates of discharge indicated by the post-development analysis are less than or equal to the peak rates of discharge indicated by the pre-development analysis for 1-, 2-, 5-, 10-, 25-, 50-and 100-year, 24-hour storms, then the requirements of this section have been met. Otherwise, the applicant shall provide additional controls as necessary to satisfy the peak rate of discharge requirement.

(*Ord. 2012-01*, 10/15/2012, §305)

§23-306. Riparian Buffers/Riparian Forest Buffers.

Where an applicant proposes to utilize riparian buffers as the means to meet the requirements of this Chapter, said riparian buffers shall be established and/or maintained in accordance with the *BMP Manual* or the publication *Riparian Forest Buffer Guidance*, published November 2011, by the Pennsylvania Department of Environmental Protection, and as may be amended or updated.

(*Ord. 2012-01*, 10/15/2012, §306)

§23-307. Phasing Plans.

When applications are submitted in phases, and if temporary facilities are required for construction of a phase, such facilities shall be included in the submitted plans. All phases of development must comply with the provisions of this Chapter. In the event temporary measures cannot adequately handle the stormwater runoff; the main outfall line shall be included as part of the construction of the proposed phase.

(*Ord. 2012-01*, 10/15/2012, §307)

§23-308. Erosion and Sedimentation Control.

The following principles (at a minimum) shall be applied to the design plan and construction schedule to minimize soil erosion and sedimentation. Stripping of vegetation, grading or other soil disturbance shall be done in a manner which will minimize soil erosion:

A. Natural vegetation shall be retained and protected, whenever feasible.

B. The extent of the disturbed area and the duration of its exposure shall be kept to a minimum, within practical limits.

C. Either temporary seeding, mulching or other suitable stabilization measures shall be used to protect exposed critical areas during construction.

D. Drainage provisions shall accommodate the stormwater runoff, both during and after construction.

E. Soil erosion and sedimentation facilities shall be installed before any on-site grading.

F. All earthmoving activities shall be conducted in such a way as to minimize accelerated erosion and resulting sedimentation. Measures to control erosion and sedimentation shall, at a minimum, meet the standards of the Adams County Conservation District and Chapter 102 (Erosion and Sediment Control) of Title 25, Pa.Code, Rules and Regulations of PA DEP.

G. The erosion and sedimentation control plan must be available at all times at the project site. When required, a permit allowing earthmoving activity shall be obtained by the developer before any construction on the project site shall begin.

H. Approval of an erosion and sedimentation control plan by the Township shall not be construed as an indication that the plan complies with the standards of any agency of the Commonwealth.

I. The erosion and sedimentation control plan shall be submitted to the Adams County Conservation District for its review and approval. Building permits will not be issued and construction shall not start until an NPDES permit is received (if applicable).

(*Ord. 2012-01*, 10/15/2012, §308)

§23-309. Coordination with Adjacent Lands.

1. Consideration shall be given to the relationship of the subject property to the drainage pattern of the watershed. The proposed stormwater discharge at the perimeter of the site shall not be beyond the capacity of any existing, immediately contiguous, stormwater management facility into which it flows, unless the existing flow at the perimeter of the site already exceeds the capacity of the existing facilities into which it flows and the discharge does not alter the calculated pre-development discharge characteristics.

2. Stormwater shall not be transferred from one watershed to another, unless:

A. The watersheds are sub-watersheds of a common watershed which join together within the perimeter of the property.

B. The effect of the transfer does not alter the peak discharge onto adjacent lands.

C. Easements from the affected downstream landowners are provided.

3. Stormwater runoff from the subject property shall flow directly into a:

A. Natural watercourse.

B. Existing storm sewer system.

C. Adjacent properties in a manner similar to the runoff characteristics of the

predevelopment flow.

(*Ord. 2012-01*, 10/15/2012, §309)

§23-310. Roof Drains, Sump Pumps and Footer Drains.

Roof drains, sump pumps, and footer drains should discharge to infiltration or vegetative BMP's and, to the maximum extent practicable, satisfy the criteria for DIAs. Discharges of each should be conveyed in such a manner as to not cause water problems for adjoining property owners.

(*Ord. 2012-01*, 10/15/2012, §310)

§23-311. Alteration of SWM BMP's.

No person shall modify, remove, fill, landscape, or alter any SWM BMP's, facilities, areas, or structures in a manner, without the written approval of Reading Township, with the exception of necessary maintenance activities such as mowing.

(*Ord. 2012-01*, 10/15/2012, §311)

§23-312. Facility Design Criteria.

1. *Stormwater Management Facilities for PennDOT and Associated Facilities*.

A. For the purposes of this Section, design policy pertaining to stormwater management facilities for Pennsylvania Department of Transportation (PennDOT) roadways and associated facilities is provided in §13.7, "Antidegradation and Post Construction Stormwater Management Policy," of PennDOT Publication No. 13M, *Design Manual*, Part 2 (August 2009), as developed, updated, and amended in consultation with the Pennsylvania Department of Environmental Protection (DEP). As stated in DM-2.13.7.D, 'Act 167 and Municipal Ordinances," PennDOT roadways and associated facilities shall be consistent with Act 167 Plans. DM-2.13.7.B, "Policy on Antidegradation and Post Construction Stormwater Management," was developed as a cooperative effort between PennDOT and DEP. DM 2.13.7.0, "Project Categories," discusses the anticipated impact on the quality, volume, and rate of stormwater runoff.

B. Where standards in this Section are impractical, PennDOT may request assistance from DEP, in consultation with the County, to develop an alternative strategy for meeting State water quality requirements and the goals and objectives of this Section.

C. For the purposes of this Section, road maintenance activities are regulated under 25 Pa.Code, Chapter 102.

2. *Method of Calculations*. Runoff calculations for on-site stormwater conveyance facilities shall be based upon the rational method or an acceptable engineering design method, subject to Township approval. Hydraulic grade line calculations shall be provided to demonstrate that inlet surcharging does not occur. When conveyance facilities discharge directly to a basin, the basin shall be assumed to be one-third full for the purpose of computing the hydraulic grade line for the collection system.

3. *Criteria, Methodology and Assumptions*. Appropriate values for time of concentration, and rainfall intensity shall be from the latest edition of the PennDOT Publication 584. Use of other criteria, methodology, assumptions, references, calculation

methods, and/or computer modeling may be accepted, provided detailed design information and programming with references are submitted and approved by the Township.

4. *Design Storm for Stormwater Management Collection Facilities.*

A. The design of stormwater management collection facilities that service drainage areas within the site shall be based upon the peak flow from a 25-year storm frequency event. Stormwater management facilities that convey off-site stormwater through the site must be designed to convey a 50-year event.

B. All developments shall include design provisions that allow for the overland conveyance of the post development 100-year peak flows through the site without damage to any private or public property.

5. *Basin Facility Design Criteria.*

A. Permanent detention and retention basins shall be designed to store the stormwater runoff of the 100-year post-development storm event minus the water discharged, if any, from the basin by any primary and/or secondary outlets. The storage volume shall be calculated from the beginning of the storm event until such time as the inflow rate equals the outflow rate that is discharged through outlets from the basin.

B. All basins shall be structurally sound and shall be constructed of sound and durable materials.

C. The completed structure and the foundation of all basins shall be stable under all probable conditions of operation and shall be capable of discharging the peak discharge of a post-development 100-year storm event through the emergency spillway facilities and all other outlets combined in a manner which will not damage the integrity of the facility or the downstream drainage areas.

D. Emergency spillways shall not be considered in the design of primary and secondary outlet controls. The emergency spillway minimum elevation shall be established at a minimum of 0.1 foot above the water surface elevation of the 100-year storm event, when routed through the primary and secondary outlet controls. The emergency spillway shall be designed by routing the 100-year storm event through the spillway, assuming no storage below the emergency spillway elevation.

E. The effect on downstream areas, if the basin embankment fails, shall be considered in the design of all basins. Where possible, the basin shall be designed to minimize the potential damage caused by such failure of the embankment.

F. Basins which are not designed to release all stormwater shall be specifically identified as retention basins or wet pond basins. All other basins shall include provisions for dewatering, particularly the bottom, and shall not create swampy and/or unmaintained conditions unless supporting documentation is provided to justify the facility as a best management practice.

G. An outlet structure must be provided to permit draining the basin to a completely dry position within 24 hours, unless designed/approved otherwise.

H. Discharge structures shall be designed to eliminate the possibility of blockage during operation (i.e., trash racks).

I. All outlet structures and emergency spillways shall include a satisfactory means of dissipating the energy of flow at its outlet to assure conveyance of flow,

without endangering the safety and integrity of the basin and the downstream drainage area.

J. Detention basins and/or retention basins which are designed with earth fill dams shall incorporate the following minimum standards:

(1) The maximum water depth shall not exceed 6 feet.

(2) The minimum top width of all dams shall be 5 feet.

(3) The side slopes of earth fill dams shall not be less than 3 horizontal to 1 vertical, unless specific geotechnical analysis/evidence is provided and approved which would justify a steeper slope.

(4) Fencing, or other acceptable devices that restrict access, shall be provided for basins with slopes greater than 5 horizontal to one vertical when the water surface area is greater than 1 acre and/or more than 5 feet deep during a 100-year storm event. However, the Township, based upon the type and proximity of adjacent land use, may require appropriate access restrictions to avoid a hazardous condition.

(5) A key trench of compacted, relatively impervious material (Unified Soil Classification CL or ML) at a depth of at least 2 feet, or extending down to stable subgrade, whichever is deeper. Minimum bottom widths for the key trench shall be 4 feet. Maximum side slopes for the key trench shall be 1 horizontal to 1 vertical. A compacted impervious core, at least 8 feet wide at the top, having a maximum side slope of 1 horizontal to 1 vertical, shall extend for the full length of the embankment, and the top elevation shall be set at the 25-year design water surface elevation.

(6) All pipes and culverts through dams shall be reinforced concrete and have properly spaced concrete cutoff collars or anti-seep collars.

(7) All riser pipes shall be reinforced cement concrete, unless otherwise specifically approved by the Township Engineer.

(8) A minimum of 1 foot of freeboard shall be provided above the maximum design water surface elevation at the emergency spillway. The freeboard is required through the emergency spillway above the calculated water surface elevation for the entire 100-year post-development flow condition through the emergency spillway. The freeboard should be determined based on the calculated depth of flow through the emergency spillway, in accordance with the emergency spillway calculation.

(9) Minimum finished floor elevations for all buildings that adjoin a basin, other temporary impoundments, or open conveyance systems shall be 2 feet above the water surface of a 100-year storm event. If a basement is proposed below the bottom elevation of the basin, detailed calculations addressing the effects of stormwater ponding on the building and waterproofing and/or floodproofing design information consistent with the floodplain standards in Chapter 27, "Zoning," shall be submitted.

(10) The downstream toe of any embankments shall be located outside of any designated floodway. In the absence of a designated floodway the toe of the embankment shall be located a minimum, of sixty (60) feet from the top of any stream bank.

(11) Where the embankment of any stormwater management facility is shown to be located within a designated floodplain. as indicated on the Township Flood Insurance Rate Map, the following additional in for/nation

shall be provided;

a. Calculations shall be submitted to verify that the emergency spillway will be capable of passing the 100 year flood flows associated with the floodplain as referenced from the Flood Insurance Rate Map as prepared by the Federal Emergency Management Agency or in the absence of detailed flow data in the Federal Emergency Management Agency Study, the applicant shall submit calculations, as prepared by a registered Professional Engineer, to substantiate such design. The calculations shall be reviewed by the Township Engineer. If determined to be necessary by the Township to protect downstream property, such calculations shall include a dam breach analysis prepared in accordance with criteria established by the Pennsylvania Department of Environmental Protection, Bureau of Waterways Engineering. In addition, the Township may refer such design to the Pennsylvania Department of Environmental Protection where determined to be necessary.

b. Design drawings sealed by a registered Professional Engineer which indicate protection from flood flows associated with the 100 year flood plain.

c. All requirements of the Township Subdivision and Land Development Ordinance relating to structures within flood plains shall be met.

d. Calculations to indicate that the embankment will not cause an increase in 100 year flood water surface elevation.

e. Slope protection shall be incorporated into all embankments, for earthen embankments this may include keyed rip-rap, geogrid, or other approved method. Design of such stabilization shall be certified asa registered geotechnical engineer.

K. Stormwater management basins shall not be located closer than 100 feet to the rim of sinkholes or closed depressions, nor within 100 feet from disappearing streams, nor shall these basins be located closer than 50 feet to lineaments or fracture traces, nor shall these basins be located closer than 25 feet to surface or

identified subsurface pinnacles.

(1) Where retention basins, seepage pits, seepage tanks, seepage trenches and/or french drains are located in an area that is suspected to contain sinkholes, closed depressions, fracture traces, or caverns, the applicant shall include an analysis of the potential for accelerated sinkhole development in the specific geology of the site due to the concentration of water introduction to the subsurface.

(2) This information shall include a seepage report containing a test pit soils analysis, prepared by a soil scientist or similarly qualified professional, and percolation test results in accordance with PA DEP regulations, 25 Pa.Code §73.15. The bottom of the test pits shall be no less than 30 inches below the elevation at which the soil/seepage interface is designed (i.e., the bottom of the trench, pit, etc.).

L. Retention basins must provide enough capacity to store the entire runoff volume created by a 100-year, 24-hour storm event. If supporting documentation is provided for a reduction based upon percolation, the applicant may:

(1) Reduce the required volume by 20 percent.

(2) Determine the volume required using 20 percent of the percolation rate to perform routing calculations, whichever volume is greater.

M. Retention basins shall incorporate the following minimum design standards:

(1) Infiltration systems greater than 3 feet deep shall be located no less than 30 feet from basement walls or the drain field of a sanitary sewer system. Information addressing the effects of the infiltration system on the building and waterproofing shall be submitted.

(2) Infiltration systems designed to handle runoff from commercial or industrial impervious parking areas shall be no closer than 100 feet to any water supply.

(3) Infiltration systems may not receive runoff until the entire contributory drainage area to the infiltration system has received final stabilization.

(4) The stormwater management facility design shall provide an emergency overflow system with measures to provide a nonerosive velocity of flow along its length and at the outfall.

N. A liner of impervious material must be provided in all wet ponds. In lieu of an impervious liner, the applicant may supply sufficient information to the Township, prepared by a soil scientist, which includes an analysis of the potential for sinkhole development and demonstrates to the Township that sinkholes will not develop.

6. *Additional Design Criteria.*

A. *Capacities.* The capacities of the pipes, gutters, inlets, culverts, outlet structures, and swales shall consider all possible hydraulic conditions. The following are minimum design standards.

B. Grass swales and roadside gutters shall consider both the channel velocity

and stability based upon a low degree of retardant ("n" of 0.03), and the channel capacity based upon a high degree of retardant ("n" of 0.05) unless otherwise justified or deemed appropriate by Township Engineer.

C. The "n" factors to be used for paved or rip-rap swales or gutters shall be based on the latest edition of the PennDOT Publication 584.

D. The velocity to be used in the design of any piped stormwater conveyance system shall be a minimum of 2½ feet per second.

E. Inlets, culverts, and basin discharge systems shall be designed for the worst case condition.

F. Pipe sizes with nominal diameters greater than 48 inches shall require structural design submittals for approval.

G. All culvert structures shall require submission of construction drawings, to assure compliance to HS-25 loading, flow design capacity, and calculated life cycle of proposed structures.

H. Inlet capacity shall be based on design standards provided by the latest edition of the PennDOT Publication 584. If acceptable information is not available, inlets in non-ponding areas shall be designed for a maximum capacity of 5 cubic feet per second. Where ponding occurs, inlet capacity shall be based on accepted engineering design practices.

I. Culvert design shall consider either inlet/outlet control or a combination of hydraulic losses through the system, whichever is greater.

J. Basin discharge systems shall be designed to the same standards as culverts. If it cannot be readily determined which hydraulic condition controls, the basin discharge rate shall be based on the highest possible discharge rating curve with the basin capacity sized to store the excessive storm runoff based on the lowest possible discharge rating curve.

7. *Stormwater Flow Along Streets and Access Drives*.

A. Inlets shall be along the curb line and are not permitted along the curb radius at an intersection. When possible, inlets shall be located away from the side lot property line to avoid conflicts with driveways. For the purpose of inlet placement, curb, gutter, or roadside swale, the 10-year storm frequency with a 5-minute time-of-concentration shall be used. Gutter spread shall not exceed one-half the travel lane.

B. Calculations shall be provided demonstrating the peak flow for the 10-year frequency storm crossing the centerline of a local road or driveway intersection. The total top width of flow, including the spread into the driveway or local road, shall not exceed 8 feet.

C. In no case shall inlets be spaced more than 500 feet apart and function at less than 65 percent efficiency based on the criteria in the PennDOT *Design Manual*.

8. *Collection System Criteria.*

A. Manholes shall not be spaced more than 400 feet apart for pipes that are less than a 36-inch diameter and 600 feet apart for all pipes of greater than a 36-inch diameter. Additionally, manholes shall be placed at points of abrupt changes

in the horizontal or vertical direction of storm sewers and all convergence of two or more stormwater lines. Inlets may be substituted for manholes where they will serve a useful purpose.

B. *Alignment Requirements*. If less than a 48-inch pipe diameter, curves in pipes or box culverts, without an inlet or manhole are prohibited. Tee joints, elbows, and wyes are also prohibited.

C. *Minimum Pipe Size*. Stormwater management pipe collection and conveyance systems shall have a minimum diameter of 15 inches and shall be installed on sufficient slope to provide a minimum velocity of 3 feet per second when flowing full. No double piping shall be permitted.

D. All storm sewer pipes and culverts shall be laid to a minimum depth of 1 foot from subgrade of streets, access drives, driveways, or parking areas to the crown of pipe.

E. *Material Specifications*. All pipes shall be either concrete or polyethylene (smooth lined) unless otherwise specifically approved by the Township Engineer. Installations must comply with the manufacturers minimum recommendations as supplemented by PennDOT Pub. 408.

9. *Surface Flow Characteristics*. The maximum swale, gutter, or curb velocity of stormwater runoff shall be maintained at levels which result in a stable condition both during and after construction. The following are considered characteristics of a stable condition:

A. It neither aggrades nor degrades beyond tolerable limits.

B. The channel banks do not erode to the extent that the channel cross section is changed appreciably.

C. Sediment bars do not develop.

D. Erosion does not occur around culverts and bridges or elsewhere.

E. Gullies do not form or enlarge due to the entry of uncontrolled stormwater runoff.

10. Grass-lined channels shall be considered stable if the calculated velocity does not exceed the allowable velocities shown below:

A. Three feet per second where only sparse vegetation can be established and maintained because of shade or soil condition.

B. Four feet per second where normal growing conditions exist and vegetation is to be established by seeding.

C. Five feet per second where a dense, vigorous sod can be quickly established or where water can be temporarily diverted during establishment of vegetation. Netting and mulch or other equivalent methods for establishing vegetation shall be used.

D. Six feet per second where there exists a well established sod of good quality.

E. Where swale bends occur, the following maximum allowable velocities shall be maintained:

Severity of Bend (Degrees)	Maximum Velocity (Feet Per Second)
0–30	1.50
30–60	1.75
60–90	2.00
Exceeding 90	2.50

F. Grass-lined channel flows may be exceeded if the designer can provide acceptable supportive design criteria as proof of erosion prevention.

G. Where the velocity of stormwater runoff exceeds the allowable velocity, erosion protection must be provided. The method of erosion protection proposed must be supported by the appropriate design information and/or references. The design of erosion protection shall be in accordance with the requirements of the latest edition of the Pennsylvania Department of Environmental Protection *Erosion and Sediment Control Best Management Practice (BMP) Manual*.

H. Sump pump discharges and similarly, roof drains will be directed to lawn areas away from residences, into areas that will surface drain to conveyance structures (e.g., swales and storm sewer collection systems).

I. Sump pump discharges and roof drains shall not discharge directly into collection systems located within a public right-of-way.

(*Ord. 2012-01*, 10/15/2012, §313)

Part 4

Stormwater Management (SWM) Site Plan Requirements

§23-401. Plan Requirements.

1. Although not a requirement of this Chapter, prior to proceeding with SWM site plan preparation and submission, the applicant is encouraged to request a pre-application meeting with Reading Township's Engineer and a staff member of the Adams County Conservation District to discuss the plan concept and responsibility for submission of required documents and information.

2. Where the regulated activity for which a SWM site plan is being submitted is also subject to subdivision and/or land development plan review in accordance with Reading Township Subdivision and Land Development Ordinance [Chapter 22], the SWM site plan shall be submitted as a component of the subdivision or land development plan submission for the project and shall include the following information. The following items shall be included in the SWM site plan:

A. Appropriate Sections of Reading Township's Subdivision and Land Development Ordinance [Chapter 22], and other applicable ordinances of Reading Township regarding subdivision and land development plan preparation and applicable plan requirements shall be followed in preparing all SWM site plans, regardless of whether or not a SWM site plan involves a subdivision and/or land development plan.

B. Reading Township shall not approve any SWM site plan that is deficient in meeting the requirements of this Chapter. At its sole discretion, and in accordance with this Part, when a SWM site plan is found to be deficient, the Township may either disapprove the submission, or, in the case of minor deficiencies, the Township may accept the submission of a revised SWM site plan as noted in §23-404 of this Chapter.

C. Provisions for permanent access and/or maintenance easements for all physical SWM BMPs, such as ponds and infiltration structures, as necessary to implement the operation and maintenance (O&M) plan discussed below.

D. The following signature blocks for the Township Engineer and design engineer:

"(*Township Engineer*), on this date (*date of signature*), has reviewed the SWM site plan and finds it to be consistent with the design standards and criteria of Reading Township Stormwater Management Ordinance."

"(*Design Engineer*), on this date (*date of signature*), hereby certifies that the SWM site plan meets all design standards and criteria of Reading Township Stormwater Management Ordinance."

E. If not required by the Township Subdivision and Land Development Ordinance [Chapter 22], as specified in §23-401.A of this Chapter, the SWM site plan shall also provide the following information where applicable:

(1) The name of the development, the name and address of the owner of the property, and the name and address of the individual or firm preparing the

plan. Also to be included are the name, address, signature and seal of any registered surveyor (attesting the accuracy of the boundary survey), professional engineer, landscape architect, or professional geologist (for geomorphological assessments) contributing to and/or with a responsibility for any aspect of the plan where applicable.

(2) Preferred graphic and written scale of 1 inch equals no more than 50 feet. Dependent upon site conditions, an alternative scale proposed by the applicant or his designee may be accepted by Reading Township.

(3) North point (arrow).

(4) Existing and proposed land uses within the project boundary plus 25 feet outside the project boundary.

(5) The location of existing and proposed utilities, stormwater facilities, sanitary sewers, and water lines within the project boundaries and for the entire area within the first 50 feet beyond the project boundary.

(6) Significant physical features and associated boundary limits including flood hazard areas, sinkholes, existing drainage courses, and areas of natural vegetation.

(7) Existing and proposed features, such as: structures, buildings, streets, driveways, access drives, and parking areas.

(8) The SWM site plan shall show the locations of existing and proposed on-lot wastewater facilities and water supply wells.

(9) The location of the proposed regulated activity relative to streets, municipal boundaries, and other significant man-made features for the entire area within the first 25 feet beyond the project boundary.

(10) A determination of site conditions in accordance with the *BMP Manual*. A detailed site evaluation shall be completed for projects proposed in environmentally sensitive areas, whether natural or man-made, including but not limited to floodplains, streams, lakes, ponds, hydric soils, wetlands, brownfields and wellhead protection zones.

(11) Stormwater runoff design computations, and documentation as specified in this Chapter, or as otherwise necessary to demonstrate that the maximum practicable measures have been taken to meet the requirements of the Chapter, including the recommendations and general requirements in §23-301.

(12) The overall stormwater management concept for the project, including any additional information required for a post-construction stormwater management plan (PCSWMP) as applicable.

(13) A description of permanent stormwater management techniques, including the construction specifications of the materials to be used for stormwater management facilities.

(14) Plan and profile drawings of all SWM BMPs, including, but not limited to, drainage structures, pipes, open channels, and swales.

(15) Horizontal and vertical cross-sections of all open channels/pipes, including hydraulic capacity and grade lines.

(16) Proposed changes to the land surface and vegetative cover, and the type and amount of existing and proposed impervious area.

(17) Contour intervals of 2 feet or less. Dependent upon site conditions, alternative contour intervals proposed by an applicant or his designee may be accepted by Reading Township.

(18) Drainage flow pathways.

(19) The effect of the project in terms of runoff volumes, water quality, and peak flows on surrounding properties and aquatic features, and on any existing stormwater conveyance system that may be affected by the project.

(20) The effect of the proposed regulated activity in terms of runoff volumes and peak flows on adjacent properties and/or any existing municipal stormwater collection system that may receive runoff from the project site.

(21) A map showing all existing man-made features beyond the subject parcel's boundary lines that will be affected by the proposed regulated activities.

(22) Expected project time schedule.

(23) A soil erosion and sediment control plan in accordance with the following:

(a) Earth disturbance, 0–5,000 square feet, implement erosion and sediment control measures on site, a written erosion and sediment control plan and Adams County Conservation District approval is not required unless required by State and/or Federal permit(s) or is deemed necessary by Reading Township. If earth disturbance is in a high quality or exceptional value watershed then a written erosion and sediment control plan and ACCD approval is required.

(b) Earth disturbance, 5,001 square feet to less than 1 acre, a written erosion and sediment control plan and implementation of plan on site is required. ACCD approval may be required by Reading Township or State and/or Federal permit(s). If earth disturbance is in a high quality or exceptional value watershed than ACCD approval is required.

(c) Earth disturbance, 1 acre or greater, a written erosion and sediment control plan, ACCD approval and implementation of plan on site is required.

(d) In addition, under 25 Pa.Code, Chapter 92, an individual or general, as applicable, DEP "NPDES Construction Activities" permit is required for regulated earth disturbance activities of 1 acre or greater.

(24) An NPDES permit application, including PCSM plan, where applicable, as administratively reviewed and approved by the Adams County Conservation District.

(25) The SWM site plan shall include an operation and maintenance (O&M) plan for all existing and proposed physical stormwater management facilities. This plan shall address long-term ownership and responsibilities for O&M as well as schedules and costs for O&M activities.

(26) A notarized signature of the owner of the parcel for which the SWM

site plan is proposed.

(27) A note on the plan indicating the location, and responsibility for maintenance of, SWM facilities and/or easements that would be located on adjoining properties as a result of proposed regulated activities, and the location of such facilities and/or easements.

(28) Once the SWM plan and supporting documents are finalized and approved, digital copies shall be provide to Reading Township and its Engineer.

F. *Simplified SWM Site Plan*.

(1) The simplified site plan shall require a drawing showing:

(a) The location and dimensions of the proposed new impervious surface, property lines, significant natural and man-made features within the project site.

(b) The approximate location and dimensions of all other impervious surfaces within the project site identifying those placed after the date of the enactment of this Chapter.

(c) The location of all wells and sewage disposal systems located within the project site.

(d) The direction of stormwater flow from the existing impervious surfaces within the project site and the direction of stormwater flow from the proposed impervious surface and across the project site.

(2) The simplified site plan shall require a proposal to manage the stormwater flow from the proposed impervious surface. The proposal may involve:

(a) The maintenance of a pervious flow area constructed consistent with the requirements of Appendix "A" of this Chapter.

(b) The construction and maintenance of a stormwater management facility as outlined in the Design Assistance Manual, which by reference is made part of this Chapter.

(c) Construction of a detention basin approved by the Township engineer as designed and sized to manage proposed increases in stormwater flow from the project site brought about by the proposed impervious surface. Prior to approval, there must be probe hole analysis and infiltration tests to establish the size of basins necessary to achieve the required infiltration. Tests shall be performed by a Township designee at the depth and location of the proposed basin.

(d) Any other proposal approved by the Township Engineer or the Township Enforcement Officer as sufficient to manage the increase in stormwater brought about by the proposed impervious surface.

(*Ord. 2012-01*, 10/15/2012, §401)

§23-402. Plan Submission.

1. When a property owner or developer proposes a regulated activity, the property owner or developer shall submit a SWM site plan to demonstrate compliance with the

stormwater management provisions of this Chapter. The submission shall be required by Reading Township unless the regulated activity is exempted from SWM site plan submission in accordance with the exemption criteria and exemption approval process established in §23-302 of this Chapter. Where Reading Township determines that the property owner or developer proposing the regulated activity is eligible to employ the process established in the *Stormwater Management Design Assistance Manual* (SWM plan Appendix A) to address the stormwater management needs of a site, the submission of the required documentation from the Manual shall substitute for the SWM site plan requirements of this Part. [*Ord. 2014-01*]

2. Copies of the SWM site plan shall be distributed as follows:

A. Three copies to the Township. (Two for the Township and one for the Township Engineer).

B. One copy to the Adams County Planning Commission when a SWM site plan accompanies a subdivision/land development plan application.

C. One copy to the Adams County Conservation District, if an NPDES permit is required.

3. Additional copies shall be submitted as requested by Reading Township or DEP.

4. Reading Township may establish a fee schedule for the review of SWM Plans, the amount of which shall be set by resolution of the Township's Board of Supervisors. Payment of the required fee shall be considered a component of the SWM site plan submission. The SWM site plan submission shall not be considered to be complete until such time that any required fee is paid.

(*Ord. 2012-01*, 10/15/2012, §402; as amended by *Ord. 2014-01*, 4/21/2014)

§23-403. Plan Review and Approval Procedure.

1. SWM site plans and supporting information shall be reviewed by the Township for consistency with the provisions of this Chapter.

2. *SWM Site Plan Review and Approval Procedure*.

A. If a SWM site plan and supporting information does not involve a subdivision and/or land development, the review of the SWM site, recommendations, approval, approval with conditions, or disapproval, i.e., the review and decision period, shall occur within 45 days of submission to Reading Township. However, the Township, in its sole discretion, may extend the review and decision period another 45 days due to the nature of the application and/or site conditions. If an extension of another 45 days is imposed or granted by the Township beyond the first 45-day review and decision period designated by this paragraph, the Township shall notify the applicant in writing and deliver such notice to said applicant within 15 days of the decision to extend the review and decision period by the Township. If no extension is imposed or granted by the Township beyond the first 45-day review and decision period, and no decision has been rendered by the Township within that period, the SWM site plan shall be deemed approved. Similarly, if after a 45-day extension of the review and decision period has been imposed or granted by the Township, and no decision has been rendered by the Township within that period, the SWM site plan shall be deemed

approved.

B. If a SWM site plan involves a subdivision and/or land development plan, the period of time from the submission to Reading Township of the subdivision and/or land development plan application which includes the SWM plan and the approval, approval with conditions, or disapproval, i.e., review and decision period, shall be in accordance with the procedure for approval of plats in §508 of the Pennsylvania Municipalities Planning Code, 53 P.S. §10508.

C. From the time an application for approval of a plat involving a subdivision or land development plan, whether preliminary or final, which includes a SWM site plan, is duly filed with Reading Township, no change or amendment of this Chapter or other governing ordinance or plan shall affect the decision on such application in accordance with the provisions of the governing ordinances or plans as they stood at the time the application was duly filed, as specified in §508(4) of the Pennsylvania Municipalities Planning Code, 53 P.S. §10508(4).

D. *NPDES Permits and E & S Plans*. Where the project for which an SWM site plan is submitted is subject to NPDES permitting or the submission of an E & S plan, or both, any final approval of the SWM site plan by the Township shall be conditioned on the applicant's receipt of the required NPDES permit or E & S plan approval, as appropriate.

3. *Decision Notification Procedure*. In all cases, the decision of Reading Township to approve or disapprove the SWM site plan shall be in writing and shall be delivered to the applicant no later than 15 days following the decision. If the SWM site plan is disapproved, the written decision by the Township shall specify the defects in the application, describe the requirements which were not met, and shall cite the provisions of the Chapter relied upon. If the SWM site plan is approved with conditions, the notification to the applicant shall state the acceptable conditions for approval and the time limit for satisfying such conditions. The time limit for satisfying conditions of approval shall be the time limit prescribed for conditional approval of subdivision and land development plans as stated in the Township's Subdivision and Land Development Ordinance [Chapter 22], where applicable.

(*Ord. 2012-01*, 10/15/2012, §403)

§23-404. Revision of Plans.

A revision to a previously submitted SWM site plan that involves a change in SWM BMPs, stormwater management facilities, or changes in analytical techniques, or that involves the relocation or redesign of SWM BMPs, or that is necessary because soil or other conditions are not as stated on the SWM site plan, as determined by Reading Township, shall require a resubmission of the revised SWM site plan in accordance with this Part, including applicable fees. For NPDES permitted sites, any revised SWM site plan shall also be re-submitted to the Adams County Conservation District for review. In the case of a SWM site plan which contains minor deficiencies, such as a missing label, omission of a required note or minor construction detail, as determined by Reading Township, the Township may accept a re-submission of such SWM site plan without the requirement of a review fee, or for a lesser fee as provided for in the Township's fee schedule.

(*Ord. 2012-01*, 10/15/2012, §404)

§23-405. Re-submission of Disapproved SWM Site Plans.

A disapproved SWM site plan may be resubmitted, with the revisions addressing Reading Township's concerns as stated regarding the original submission, to the Township in accordance with this Part. The applicable review fee must accompany the submission of a revised SWM site plan, unless such fee is waived by the Township. (See §23-404)

(*Ord. 2012-01*, 10/15/2012, §405)

§23-406. Authorization to Construct and Term of Validity.

1. *SWM Site Plans Independent of Subdivision and Land Development Plans*. Reading Township's approval of a SWM site plan, when such plan is submitted independent of a subdivision and/or land development plan, authorizes the regulated activities contained in the SWM site plan for a maximum term of validity of 5 years following the date of approval. The Township may, in its sole discretion, specify a term of validity shorter than 5 years in the approval for any specific SWM site plan, particularly if the nature of the proposed SWM facilities require more frequent maintenance and/or short-term replacement of certain components. Terms of validity shall commence on the date the Township signs the approval for an SWM site plan. If an approved SWM site plan is not completed according to §23-407 within the term of validity, then the Township may consider the SWM site plan disapproved and may revoke any and all permits. SWM site plans that are considered disapproved by the Township may be resubmitted in accordance with §23-405 of this Chapter.

2. *SWM Site Plans Included in a Subdivision and/or Land Development Plan*. Reading Township's approval of a SWM site plan, which is a part of a subdivision and/or land development plan, authorizes that plan and the regulated activities therein so that no subsequent change or amendment in this Chapter or other governing ordinances or plans shall be applied to affect adversely the right of the applicant to commence and to complete any aspect of the approved development in accordance with the terms of such approval within 5 years from such approval, as specified in §508(4)(ii)–(vii) of the Pennsylvania Municipalities Planning Code, 53 P.S. §508(4)(ii)–(vii).

(*Ord. 2012-01*, 10/15/2012, §406)

§23-407. As-Built Plans, Completion Certificate, and Final Inspection.

1. The developer shall be responsible for providing as-built plans of all SWM BMPs included in the approved SWM site plan. The as-built plans and an explanation of any discrepancies with the construction plans shall be submitted to Reading Township.

2. The as-built submission shall include a certification of completion signed by a Township designee or other qualified person approved by the Township verifying that all permanent SWM BMPs have been constructed according to the approved plans and specifications. If any licensed qualified person contributed to the construction plans, then a licensed qualified person must sign the completion certificate.

3. After receipt of the completion certification by Reading Township, the Township may conduct a final inspection to verify compliance with, and accuracy of, the as-built plans.

4. Once the as-built plans are approved by Reading Township, digital copies of the

as-built plans and executed certification of completion shall be provided to the Township and its Engineer.

(*Ord. 2012-01*, 10/15/2012, §407)

§23-408. Modification/Waiver Requests.

1. If a SWM site plan is not submitted as a component of a subdivision and/or land development plan, Reading Township, may accept a request for modification/waiver of one or more of the requirements of this Chapter if the literal enforcement will enact undue hardship because of the peculiar conditions pertaining to the land in question, provided that Reading Township determines that such waiver will not be contrary to the public interest and that the purpose and intent of the Chapter is observed. All requests for modifications/waivers from an applicant shall be in writing and shall accompany and be part of the application for approval of a SWM site plan. The request shall state in full the grounds and facts of unreasonableness or hardship on which the request is based, the provision or provisions of the ordinance involved, and the minimum modification/waiver necessary to afford relief. If no response is received from DEP within 30 days of notification, the Township may approve such measures without DEP approval.

2. The governing body of Reading Township shall keep a written record of all action on requests for modifications / waivers. The response of any consultation and/or review by DEP shall be included as an original report if available or otherwise documented in the required written record.

(*Ord. 2012-01*, 10/15/2012, §408)

Part 5

Operation and Maintenance

§23-501. Responsibilities of Developers and Landowners.

1. Reading Township shall make the final determination on the continuing maintenance responsibilities prior to final approval of the SWM site plan. Reading Township may require a dedication of such facilities as part of the requirements for approval of the SWM site plan. Such a requirement is not an indication that Reading Township will accept the facilities. Reading Township reserves the right to accept or reject the ownership, maintenance, and operating responsibility for any portion of the stormwater management facilities and controls.

2. If Reading Township accepts dedication of any or all stormwater management facilities associated with a project, the Township shall operate and maintain the facilities in accordance with the approved O & M plan.

3. If Reading Township does not accept dedication of some or all stormwater management facilities associated with a project, the property owner shall sign an O & M agreement in accordance with §23-502 of this Chapter. The Township shall not approve the SWM site plan before the owner signs the O & M agreement.

4. The operation and maintenance (O & M) plan shall be recorded as a restrictive deed covenant that runs with the land.

5. Reading Township may take enforcement actions against an owner for any failure to satisfy provisions of this Part.

(*Ord. 2012-01*, 10/15/2012, §501)

§23-502. Operation and Maintenance Agreements.

1. Prior to final approval of the SWM site plan, the property owner may be required to sign and record an operation and maintenance (O&M) agreement satisfactory to Reading Township covering the maintenance or operation of all stormwater control facilities which are to be privately owned. The property owner shall provide to the Township easements to ensure access for periodic inspection and maintenance. The property owner shall keep on file with the Township the name, address, and telephone number of the person or company responsible for maintenance activities. In the event of a change, new information shall be submitted by the property owner to the Township within 10 working days of the change.

2. The owner of the property where stormwater management facilities are located is responsible for operation and maintenance of all stormwater management facilities. If the owner fails to properly maintain such facilities, the Township may perform the maintenance required and assess the cost of such maintenance upon the owner of the land where such facilities are located and upon failure of the owner to pay such assessment place a municipal lien upon the property in the amount of such assessment together with costs, including reasonable attorney fees. If the owner of the property where stormwater management facilities are located is a homeowners association, that association shall have primary responsibility for the required maintenance and all of the owners of property within the subdivision or development shall have joint and

secondary responsibility. In the event those responsible fail to properly maintain such facilities, the Township may perform the maintenance required and assess the cost of such maintenance upon one or more of the properties within the subdivision or development with no duty to apportion. Upon failure of the owner or owners of such properties to pay such assessment, the Township may place a municipal lien upon such property or properties in the amount of such assessment together with cost of collection, including reasonable attorney fees.

3. Reading Township is exempt from the requirement to sign and record an operation and maintenance agreement.

(*Ord. 2012-01*, 10/15/2012, §502)

§23-503. Performance Guarantee.

For SWM site plans that involve subdivision and land development, the applicant shall provide a financial guarantee to Reading Township for the timely installation and proper construction of all stormwater management controls as required by the approved SWM site plan and this Chapter in accordance with the provisions of §§509, 510, and 511 of the Pennsylvania Municipalities Planning Code, 53 P.S. §§10509, 10510, 10511.

(*Ord. 2012-01*, 10/15/2012, §503)

Part 6

Fees and Expenses

§23-601. General.

1. Reading Township may establish by resolution a schedule of fees which shall be sufficient to reimburse the Township for all costs including engineer and legal fees incurred in connection with the project.

2. The applicant shall be responsible for the payment of all fees, costs, and other expenses incurred in the submission, review, and decision on the SWM site plan and/or other submissions pursuant to this Chapter.

(*Ord. 2012-01*, 10/15/2012, §601)

§23-602. Expenses Covered by Fees.

The fee(s) may include, but are not limited to, costs for the following:

A. Engineering, administrative/clerical, and legal costs.

B. Review of the SWM site plan and reports by Reading Township and representatives or counselors of the Township.

C. Attendance at meetings including pre-application meetings as set forth in Part 4.

D. Various inspections (such as during construction and after construction) by the Township or its representatives.

E. Any additional work required to enforce any provision regulated by this Chapter, correct violations, and ensure proper completion of stipulated remedial actions, including the preparation of necessary agreements.

(*Ord. 2012-01*, 10/15/2012, §602)

Part 7

Prohibitions

§23-701. Prohibited Discharges and Connections.

1. Any drain or conveyance, whether on the surface or subsurface, that allows any non-stormwater discharge including sewage, process wastewater, and wash water to enter the waters of this Commonwealth is prohibited.

2. No person shall allow, or cause to allow, discharges into surface waters of this Commonwealth which are not composed entirely of stormwater, except (A) as provided in subsection .3 below and (B) discharges allowed under a State or Federal permit.

3. No person may alter existing drainage or topography in any way so as adversely affect adjoining property by increasing stormwater flow upon such property or otherwise damaging such property.

4. The following discharges are authorized unless they are determined to be significant contributors to pollution of the waters of this Commonwealth:

Discharges from firefighting activities	Flows from riparian habitats and wetlands
Potable water sources including water line flushing	Uncontaminated water from foundations or from footing drains
Irrigation drainage	Lawn watering
Air conditioning condensate	De-chlorinated swimming pool discharges
Springs	Uncontaminated groundwater
Water from crawl space pumps	Water from individual residential car washing
Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spill material has been removed) and where detergents are not used	Routine external building wash-down (which does not use detergents or other compounds)
Diverted stream flows	Water discharged in well testing for potable

5. In the event that Reading Township or DEP determines that any of the discharges identified in subsection .3 significantly contribute to pollution of the waters of this Commonwealth, the Township or DEP will notify the responsible person(s) to cease the discharge.

(*Ord. 2012-01*, 10/15/2012, §701)

§23-702. Roof and Driveway Drains and Sump Pump Discharges.

Roof drains, driveway drains and sump pumps shall discharge to infiltration or vegetative BMPs and to the maximum extent practicable satisfy the criteria for DIAs. Where the discharge is not to vegetative BMPs, roof and driveway drain infiltration facilities must be protected by filter fabric, provide for sediment filtering either at the roof or elsewhere above ground level and provide for a cleanout at ground level.

(*Ord. 2012-01*, 10/15/2012, §702)

§23-703. Alteration of SWM BMPs.

No person shall modify, remove, fill, landscape, or alter any SWM BMPs, facilities, areas, or structures in any manner without the written approval of Reading Township, with the exception of necessary maintenance activities such as mowing.

(*Ord. 2012-01*, 10/15/2012, §703)

Part 8

Enforcement and Penalties

§23-801. Right-of-Entry.

1. Upon presentation of proper credentials, Reading Township may enter at reasonable times upon any property within the Township to inspect the condition of the stormwater structures and facilities in regard to any aspect regulated by this Chapter.

2. Inspections regarding compliance with the SWM site plan may be conducted by Reading Township at any time when there may be a question of compliance with the approved SWM site plan, the approved O & M plan, or when any condition exists that may threaten public health, safety or welfare.

(*Ord. 2012-01*, 10/15/2012, §801)

§23-802. Inspection.

1. Reading Township or its designee may inspect all phases of the construction, operation, maintenance and any other implementation of SWM BMPs.

2. SWM BMPs shall be inspected by the landowner, or the owner's designee, including the Township for dedicated and owned facilities, as needed to insure the SWM BMP is functioning as designed.

3. Reading Township shall be entitled to inspect any SWM BMP upon observation, report, or information, of lack of maintenance, a defect, or a failure, of such SWM BMP, or at such other times as the Township deems necessary and appropriate. In such instance, the landowner or other responsible party shall pay the cost of such inspections.

4. In the case of a subdivision or land development which is being administered under the Subdivision and 'Land Development Ordinance, inspection shall be coordinated with the inspection of other improvements.

5. Inspections shall be required prior to the start of construction, during installation of materials and structures, and upon the completion of all improvements. Prior to the initiation of construction, the developer shall arrange a pre-construction meeting with the Township Engineer so that an inspection schedule can be coordinated with the construction schedule. The Township Engineer shall be notified a minimum of two (2) working days in advance of any intended date of construction or as a final inspection of the construction. The Township shall inspect all phases of the Land Disturbance Activity including, but not limited to, the following:

a. Prior to the start of any Land Disturbance Activity.

b. During construction the permanent stormwater management facilities at such times as specified by the Township.

c. Upon installation of permanent stormwater management facilities.

d. Upon completion of any final grading, vegetative control measures or other site restoration work done in accordance with the permit.

e. At other times as deemed necessary by the Township Engineer.

6. No work shall begin on a subsequent phase until the preceding phase has been inspected and approval has been noted on the permit.

7. Any portion of 'the work which does not comply with the approved plan must be corrected by the applicant. No work may proceed on any subsequent phase until the required corrections have been made.

8. Inspection shall occur during the first year of operation and periodically thereafter at the discretion of the Township.

9. No person shall interfere with or obstruct the ingress or egress to or from any site or premises by an authorized agent of the Township engaged in the inspection of work for compliance with the approved Stormwater Management Plan.

(*Ord. 2012-01*, 10/15/2012, §802)

§23-803. Enforcement.

1. It shall be unlawful for a person to undertake any regulated activity except as provided in an approved SWM site plan, unless specifically exempted.

2. It shall be unlawful to violate any Section of this Chapter.

3. Inspections regarding compliance with the SWM site plan are a responsibility of Reading Township.

4. Reading Township may institute injunctive, mandamus, or any other appropriate action or proceeding at law or in equity for the enforcement of this Chapter when Reading Township determines that a property owner or developer has initiated a regulated activity without receiving SWM site plan approval, that a property owner or developer has failed to comply with an approved SWM site plan or approved O & M plan, or that a property owner or developer has violated any other provision of this Chapter. Any court of competent jurisdiction shall have the right to issue restraining orders, temporary or permanent injunctions, mandamus or other appropriate forms of remedy or relief.

(*Ord. 2012-01*, 10/15/2012, §803)

§23-804. Suspension and Revocation.

1. Any approval or permit issued by Reading Township pursuant to this Chapter may be suspended or revoked for:

A. Noncompliance with or failure to implement any provision of the approved SWM site plan or O&M agreement.

B. A violation of any provision of this Chapter or any other applicable law, ordinance, rule, or regulation relating to the regulated activity.

C. The creation of any condition or the commission of any act during the regulated activity which constitutes or creates a hazard, nuisance, pollution, or endangers the life or property of others.

2. A suspended approval shall be reinstated by Reading Township when:

A. Reading Township has inspected and approved the corrections to the violations that caused the suspension.

B. Reading Township is satisfied that the violation has been corrected.

3. A SWM site plan approval that has been revoked by Reading Township cannot be reinstated. The applicant may apply for a new approval under the provisions of this Chapter.

4. If a violation causes no immediate danger to life, public health, or property, at its sole discretion, Reading Township may provide a limited time period for the owner to correct the violation. In these cases, the Township will provide the owner, or the owner's designee, with a written notice of the violation and the time period allowed for the owner to correct the violation. If the owner does not correct the violation within the allowed time period, the Township may revoke or suspend any, or all, applicable approvals and permits pertaining to any provision of this Chapter.

(*Ord. 2012-01*, 10/15/2012, §804)

§23-805. Penalties.

1. Any person, partnership, corporation, or other entity who or which has violated the provisions of this Chapter shall commit a summary offense, and shall, upon conviction, pay a penalty in the amount of $1,000. Each day that a violation continues shall constitute a separate violation, unless the district justice determining that there has been a violation further determines that there has been a good faith basis for the person, partnership, corporation or other entity violating the Chapter to have believed that there was no such violation, in which event there shall be deemed to have been only one such violation.

2. Reading Township may institute civil, injunctive, mandamus, or any other appropriate action or proceeding at law or in equity for the enforcement of this Chapter. Any court of competent jurisdiction shall have the right to issue restraining orders, temporary or permanent injunctions, mandamus or other appropriate forms of remedy or relief.

(*Ord. 2012-01*, 10/15/2012, §805)

§23-806. Appeals.

1. Any person aggrieved by any action of the Township enforcement officer or its

designee, relevant to the provisions of this Chapter, may appeal to Reading Township within 30 days of that action.

2. Any person aggrieved by any decision of Reading Township, relevant to the provisions of this Chapter, may appeal to the Adams County Court of Common Pleas within 30 days of the Township's decision.

(*Ord. 2012-01*, 10/15/2012, §806)

Part 9

References

§23-901. References.

1. Pennsylvania Department of Environmental Protection. No. 363-0300-002 (December 2006), as amended and updated. *Pennsylvania Stormwater Best Management Practices Manual*. Harrisburg, PA.

2. Pennsylvania Department of Environmental Protection. No. 363-2134-008 (April 15, 2000), as amended and updated. *Erosion and Sediment Pollution Control Program Manual*. Harrisburg, PA.

3. U.S. Department of Agriculture, National Resources Conservation Service (NRCS). National Engineering Handbook. Part 630: Hydrology, 1969-2001. Originally published as the *National Engineering Handbook*, §4: Hydrology. Available from the NRCS online at: http://www.nrcs.usda.gov/

4. U.S. Department of Agriculture, Natural Resources Conservation Service. 1986. Technical Release 55: *Urban Hydrology for Small Watersheds*, 2nd Edition. Washington, D.C.

5. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Hydrometeorological Design Studies Center. 2004-2006. Precipitation-Frequency Atlas of the United States, Atlas 14, Volume 2, Version 3.0, Silver Spring, Maryland. Internet address: http://hdsc.nws.noaa.gov/hdsc/pfds/.

6. Act of July 31, 1968, P.L. 85, No.247, the Pennsylvania Municipalities Planning Code, 53 P.S. §10101 *et seq.,* as amended.

(*Ord. 2012-01*, 10/15/2012)

STORMWATER MANAGEMENT DESIGN ASSISTANCE MANUAL

Guide to Choosing Stormwater BMPs

Simplified Approach

STORMWATER MANAGEMENT DESIGN ASSISTANCE MANUAL

Guide to Choosing Stormwater BMPs

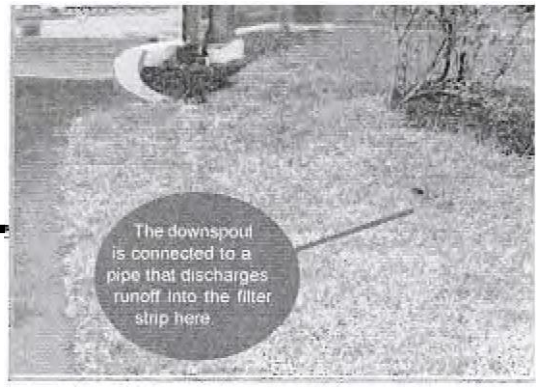
The information in this guide has been complied from several sources including the Pennsylvania Handbook of Best Management Practices for Developing Areas (PA Association of Conservation Districts) and is intended to help homeowners select an appropriate stormwater best management practice (BMP) for qualifying minor projects. These printouts represent facilities that have been deemed to be of a nature and cost that will accomplish the goals of the Adams County Stormwater Management Plan, while not unduly burdening the residents.

Additional information may also be found in Chapter 6 & Chapter 7 of the Pennsylvania Stormwater Best Practices Manual (DEP):

http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-8305
or http://www.stormwaterpa.org/43

Best Management Practices Fact *Sheet*

Filter Strip



PURPOSE: Filter strips remove sediment and other pollutants from runoff before they are carried into storm sewer systems or streams. Filter strips also aid with reducing the flow rate of runoff and allowing runoff to infiltrate Into the soil to recharge the groundwater supply.

Filter strips are gently sloping, densely vegetated areas used to treat stormwater runoff, acting as a buffer between impervious areas and storm sewer systems or streams.

The filter strip's ability to increase water quality depends on the varieties and mix of vegetation (grass, shrubs or trees) selected. It is important to note that filter strips are only effective when runoff flows in sheets; concentrated flow leads to erosion, which will result in failure of the filter strip. Level spreading devices, such as a gravel-filled trench, curb stops, or berms, are recommended to convert runoff into sheetflow that washes evenly over the filter strip. As runoff flows across the filter strip, its vegetated top layer filters sediment and pollutants, such as pesticides, from runoff. Vegetatloh also slows the rate of runoff, which allows for increased absorption into the underlying soil for additional filtering and some infiltration to the groundwater supply.

Filter strips can be designed to collect and convey filtered runoff to other types of BMPs, such as vegetated swales, infiltration basins and natural buffer areas.

NOTE: Roof drainage discharged to filter strips should be at least ten feet from the building foundation to prevent water damage

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- Length of filter strip is a function of the slope, vegetated cover and soil type
- Effective for areas with slope less than 8%; grades more than 5% will require more dense vegetation to effectively dissipate energy from flow
- Recommended for drainage areas of less than 5 acres
- For every acre of drainage, filter strip width should be 100 feet perpendicular to flow of runoff and 50 **feet** long
- Design for wooded areas should include a healthy layer of mulch
- Ratio of drainage area to filter strip area must not exceed 6:1
- Lateral slope of filter strip is 1%
- Use of a level spreading device is recommended to provide sheet flow conditions
- Filter strips should be protected against pedestrian and vehicular traffic
- Length and slope of contributing dralnage should be considered to avoid erosion of filter strip
- Minimize excessive soil compaction and land disturbance during construction
- Follow erosion control procedures
- Inspect regularly for clogging, rills or gullies caused by erosion, damage by foot traffic

Ben:efits and Uses

- Filters eontaminants from runoff prior to its dlscharge to the storm sewer system
- Reduces peak velocity and volume of stormwater runoff deHvered to storm sewer system or stream
- Provldes some recharge to groundwater supply
- Can be used to treat runoff along residential streets, stream corridors, and small parking lots
- Provides an ideal habitat for wildlife, depending on vegetation seletrted
- Inexpensive to install and maintain
- Enhances aesthetics of local landscape
- Area can be used for snow storage during winter
- Applicable to all types of sites (residential/ commercial flndustrial)

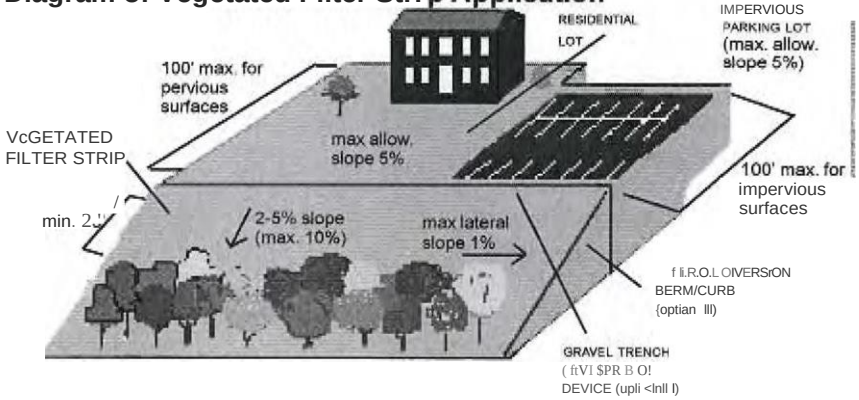
Additional Resources

PA Deparlment of Environmental Protection
- www.dep.state,pa.us
- Pennsylvania Stormwater Best Management Practices Manual

US Environmental Protection Agency
www.epa.gov

Stormwater Manager's Resource Center
www.stormwatsrcenter.net

Diagram of Vegetated Filter Strip Application



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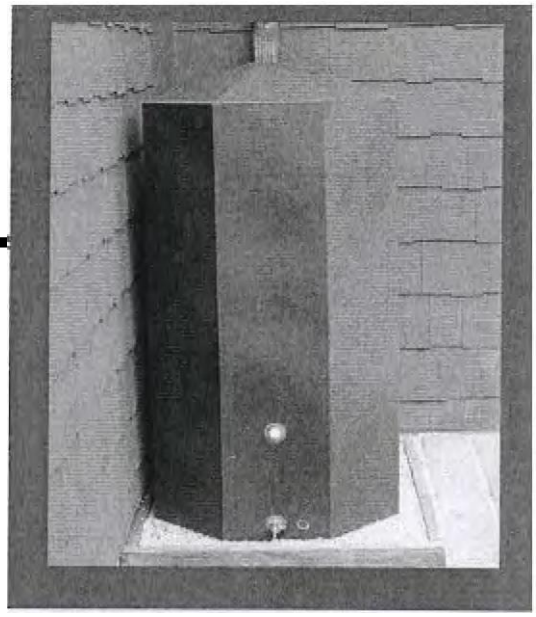
Best Management Practices Fact *Sheet*

Rain Barrel

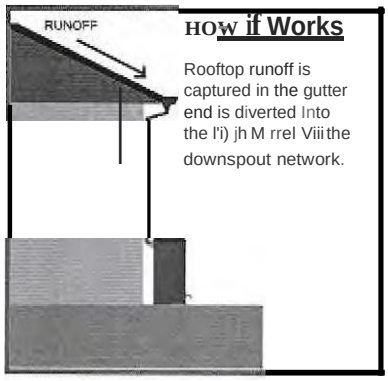


PURPOSE: Rain barrels reduce the amount of stormwater runoff flowing to an area by collecting roof runoff and storing the water for future use.

Rain barrels are an effective means of capturing and storing runoff collected from roofs of any size and function (commercial or residentia.l)Manufactured containers range from units as small as 20 gallons to units capable of holding 600 gallons. Cisterns and polymer storage units with pumps are other types of storage that function the same as rain barrels.

The rain barrel is placed near a roof downspout outlet on a base of compacted dirt, pre-treated wood, or a concrete pad. The barrel is then connected to the downspout by a section of elbow pipe. Runoff is diverted into the rain barrel via the downspout.

Units specifically designed to function as rain barrels feature a cover for preventing animals, mosquitoes, dust, and light from contaminating stored water. A drain valve located near the base of the barrel releases collected runoff that can be used to water gardens or wash cars, reducing the consumption of tap water for this purpose. Some models include a mesh screen near the intake trough for filtering leaves and other rooftop debris. Rain barrels should feature a diverter that allows large quantities of runoff to bypass the unit during major storm events. Some units are designed to be connected in a series to increase capacity.



NOTE: water collected in a rain barrel contains pollutants and is unfit for human consumption.

Benefits and Uses

- Cost-effective alternative to using tap water for watering yards and gardens
- Reduces peak volume and velocity of stormwater runoff to streams=and storm sewer systems
- Helps to reduce peakwater demand during summer months
- Applicable to all types of sites (residential/ commercial/industrial)
- Takes advartage of already exjstingsource of fresh rainwater
- Inexpensive to install and maintain

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- Calculate roof area to select rain ba1rel size to accommodate runoff volume
- During winter, open drain valve or disconnect system to prevent stored water tram ice expansion, which could damage the container
- Positionthe rain barrelclose to the downspou,t where land slopes away from the foundation
- Collected water must be used or discharged before the next storm event unless a diverted unit is installed to allow excess water to bypass the unit
- Do not connect rain barrel system to any drinking water system
- Pipes or storage units should be marked "Caution: Do Not Drink"
- First flush runoff may be diverted **away** from storage to minimize sediment
- Storage tank should be protecetd from direct sunlight to minimize algae growth
- Cover should fit tight
- Unit should include a dlverter to allow excess stormwater to bypass the rain barrel
- Containers should be flushed periodically to remove sediment
- Keep lid closed to reduce evaporation and prevent mosquito breeding

Additional Resources

PA Department of Environmental Protection
www,depweb;state.pa.us- search Pennsylvania Stormwater Best Management Practices Manual

US Environmental Protection Agency
www.epa.gov

Chesapeake Bay Foun ati011
www.cbf.org

l ow Impact Development Center
- www.lld-stormwater.ne-t click on Site Map and select Rain Barrels and Cisterns
- www.lowimpactdevelopment.org

Maryland Department of N11tur,/ Resources
www.dnr.state.rnd.us/ed/rainbarrel.html

Stormwater Manager's* Resource *Center
www.stormwatercenter.net

Rain Barrel Gulde Online
www.rainbarrelguide,com

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SIMPLE COMPUTATION FOR SIZING OF RAIN BARRELS FOR COLLECTION AND REUSE

ONE INCH OF RAIN THAT FALLS OVER ONE SQUARE FOOT OF IMPERVIOUS SURFACE CREATES 0.6 GALLONS OF WATER.

EXAMPLE: A ROOF OF 2000 SQUARE FEET WOULD PRODUCE 1200 GALLONS OF WATER PER ONE INCH STORM. (2000 X 0.6 = 1200 GALLONS).

Best Management Practices Fact Sheet

Vegetative Stabilization

PURPOSE: Permanent vegetation can prevent erosion by wind or water, and improves wildlife habitat and aesthetics. Vegetation reduces velocity and volume of runoff, and protects bare soil from the impact of rain.

Vegetative stabilization Is the practice of preserving existing vegetation at a site during construction. Traditionally, sites are cleared of vegetation in preparation for construction activities. More vegetation is often removed than is necessary, which leads to a greater amount of exposed soil that is prone to erosion by wind and rain.

To prevent damage to the trees selected to remain during construction and their root systems, protective rneasures must be Implemented. Following Is a list of guidelines for assessing a site to determine the most effective implementation of this practice.

- ***Design to protect vegetated areas*** - consider protecting wooded areas, vegetated slopes, etc. as site development plans are prepared
- ***Mark construction zone boundaries*** - on the site development plan, identify areas of disturbance, including the location of proposed buildings, pavement, material storage areas and paths used by construction equipment. Use stakes and string to mark boundaries at the site: clearly mark trees to be preserved.
- ***Inventory tree health and select trees to be saved*** - remove diseased trees; consider alternative site designs to maximize retention of healthy trees.
- ***Designate areas that are off limits*** - use bright colored polypropylene tape to mark a boundary around the area that is not to be disturbed, including room for root systems; photograph the area before construction begins
- ***Prepare trees for construction disturbance*** - address water and nutrient deficiencies prior to construction to aid with tree survival after construction.
- ***Protect soil for future tree planting*** • apply a six-inch layer of wood chips on areas used for materials storage or equipment paths to alleviate soil compaction.
- ***Monitor tree health during construction*** - irrigate trees regularly and inspect for any darnage to branches, trunks and roots.
- ***Final site inspection*** - remove protective tape/fencing after all work is complete; continue regular maintenance , i.e. watering, pruning, fertilization, etc.

General Design Considerations

- Vegetation is effective for stabilizing flow with a stream channel velocity of up to 5 feet per second
- May be used in conjunction with structural measures to provide effective erosion control
- Young, small trees tend to survive disturbance better than large trees
- Use erosion control measures around perimeter of preserved area to maintain adequate water flow and drainage conditions
- Disturb no more than 25% of roots within each tree's dripline
- Heavily wooded sites should be thinned over a period of time to prevent stress
- Avoid changes in soil pH
- Avoid disruptions to lhe site's natural contour
- Cut exposed roots cleanly to promote quick wound closure

Benefits and Uses

- Prevents erosion at construction site
- Applicable to all types of sites, including floodplains; wetlands and steep-sloped areas
- Enhances aesthetics of local landscape
- Provides habitat for wildlife
- Able to handle higher quantities of runoff than newly seeded areas
- Immediately effective
- Requires less maintenance than newly planted vegetation
- P.rovides noise buffer and screens construction activity

Additional Resources

PA Department of Environmental Protection
- www.dep.state.pa.us
- Pennsylvaina Stormwater Best Management Practices Manual

US f *nvlronmenta/ Protection Agency*
www.epa.gov

Cah/11 Assoqiates
www.thcahill.com - click on "Technoloiges" for project examples and general Information

Low Impact Development Center
www.lowlmpactdevelopment.org

University of Minnesota Extension Service
"Homeowne'rs Guide to Protecting Trees from Construction Damage" - www.extension.umn.edu/distribution/housingandctlholng/DK6135.html

Stormwater Manager's Resource Center
www.stormwatercente.nret

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Vegetated Swale

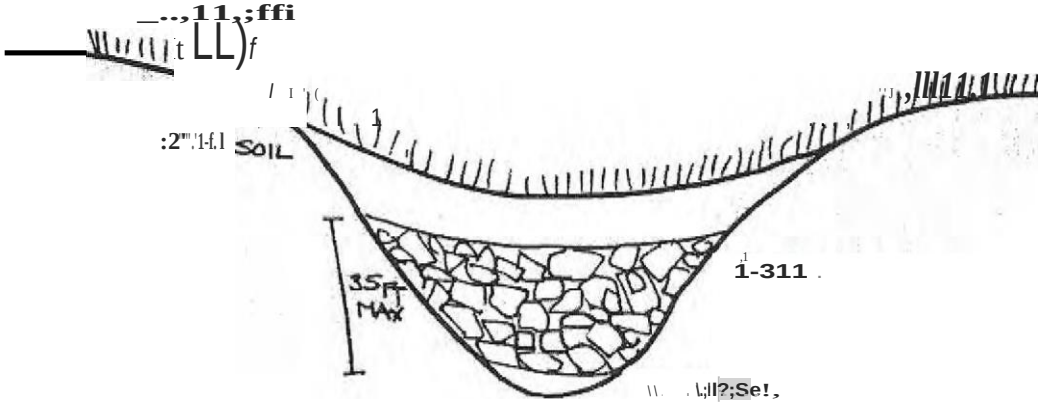
A vegetated swale Is a planted channel that infiltrates runoff and filters pollutants. They handle impervious surfaces like driveways, patios, and walkways. Vegetated swales can be simple, purely bioretention systems (like a rain garden), or they can include an infiltration trench.

Sizing

Sizing a vegetated swale Is similar to sizing an Infiltration Trench (Page 15).
Determine Volume of stormwater Swale must handle (Step 2), use this value as the Swale Required Dimensions.

1. Swale Required Dimensions"' Swale Void Volume/ 40%, Void Ratio (result of gaps in gravel)
1/z of driveway stormwater volume (161.25 ft cu) - Swale Required Dimensions
161.25ft cu= Swale Void Volume/40%
Swale Void Volume c 64.5 ft cu

2. Swale Void Volume - width (.5ft - 1.5ft) x length x depth (max 3.5ft) x ½ (Triangle shape)
64.5 ft cu "' 1 ft (width) x length x 3.5 ft (depth) x ½
Length= 36.9 **ft**
Final Swale Dimensions are 36.9' x **1'** x 3 .5 '



Installation

Dig swale pit. Triangularshapes are most affective. Swale depth should be 2'-5' from surface. Simple veg. swales should be filled with well-drained soils, planted like a rain garden, and mulched.
If you would like to add an infiltration system to your vegetated swale, as st1own above, line bottom of pit with course sand or finely crushed stone. Fill **1**'-2' with 1-3" cliameter stone aggregate. Lay over 2-4' of permeable soil, and plant.
When planting vegetation, consult planting tips in raln garden section, and use the plant list supplement in this pamphlet (p21). Grasses are particul arly effective at purifying and Infiltrating stormwater runoff .

Maintenance

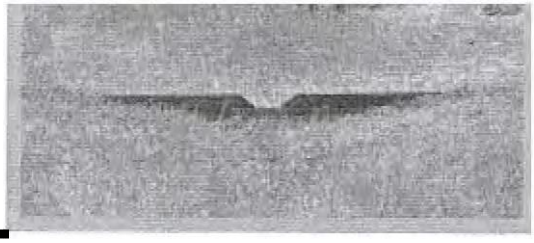
Vegetation must be maintained, and checked regularly for health. Inspect swale for litter and debris, and mow or weed when necessary. Be sure to water swale during dry periods, especially after initial planting.

rCosts

Swal es are a much cheaper and longer-lasting option than traditional curbs and gutters. Costs for grass swales range 30-70 cents per square foot, but vary greatly with plant choice. Grassed swales are cheaper than swales vegetated with shrubs and wildflowers.

Best Management Practices Fact Sheet

Vegetated Swale



PURPOSE Vegetated swales are an alternative to traditional storm sewer systems that use pipes to convey stormwater runoff. Vegetation planted along the swale enhances infiltration of runoff into the soil, and can aid in the settling and filtering of pollutants from runoff.

The swale itself is an open; Li-shaped channel, planted with grass, shrubs or trees along the base and sides of the swale. Vegetation provides an initial filter, as well as a means for slowing the rate of runoff. The vegetated or grassed top layer is underlain by a thick layer of highly organic, permeable soil, which further filters runoff. An additional layer of aggregate laid under the soil layer can significantly reduce the peak volume and conveyance rate of stormwater.

In areas with steeper slopes (greater than three percent), the addition of a check dam to a swale works to slow or "check" the speed of runoff as It courses through the swale, which allows for increased infiltration . Placing the dam near the source of runoff vastly reduces its speed. The ponding area created on the back side of the dam enables sediment to settle out of runoff. Check dams can be placed in series to increase their effectivenessMaterials suitable for check dams include wood, concrete, stone, and earth.

NOTE: Grass-only swales provide less infiltration and pollutant removal capabilities than swales planted with a mix of shrub and tree vegetation. Swales should be located at least 100 feet from drinking water sources to avoid contamination.

Benefits and Uses

- Filters some contaminants from runoff prior to s discharge to streams and storm sewer systems
- Provides some recharg,ftO groundwater supply
- Reduces peak volume and velocity of stormwater runoff to streams and stor-msewersystems
- Helps alleviate fl90dlng aod erosion downstream
- Applicable to all lypesofsites (residential/ commerqial/ingustliaQ
- Inexpensive to install and niaihtain
- Enhances aesthetics of locallandscape
- Can be Incorporated along roadways and parking lots as an alternative to curbs

Additional Resources

PA Deparlmeflt of EnvironmentalProtection
- www.dep.state.pa.us
- Pennsylvania Stonnwater Best Management Practices Manual

US *£nvironmental Protection Agency*
www.epa.gov

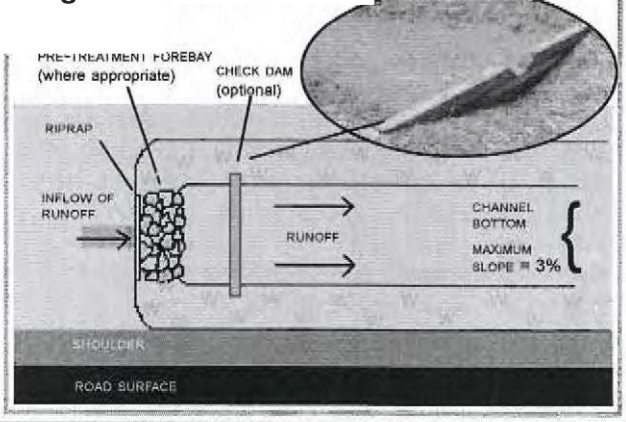
Stormwater Manager's Resource *Center*
www.stormwatecenter.net

General Design Considerations

- Design should incorporate existing site features, land use, size of drainage area, soil type and slope to maximize effectiveness
- Minimum infiltrationrate ofpermeable soil media should be at least 0.5inch per hour
- Slope for length of swale should be 2% to 6%; side slope should be 3:1 or4:1
- Bottom width of swale from 2 to 8 feet
- Design for maximum ponding depth of 18 inches; maximum ponding time of 48 hours
- Construct swales in areas of uncompacted soil where possible
- Soil media should contain a high level of organic material toassist with pollutant removal
- Permeable soil layershould be at least 30 inches deep within the ponding area created by the check dam
- Allow for a 12 to 24.inch base layer of stone aggregate to reduce peak rate and volume
- Height of check dam can be designed for various frequency storms (ex.10-year)
- Maximum amount of filtering occurs for water depths below six inches
- Select dense, low-growing native vegetation that is tolerant of varying water level condrrions
- Vegetation should not be submerged for prolonged periods of time
- Mature *tree* cover should allow light to pass through to other vegetation
- Follow guidelines for erosion control and runoff velocity/flow depth
- Incorporating a swale with an infiltration trench or weUand aids with pollutant removal; follow design guidelines for constructing each specific type of BMP
- Consider pretreatment options, such as a filter strip, if a swale is the sole means of lreatmentfor runoff
- Routinely inspect for pooling water, eroded vegetation, litter and blockages
- Reseed sparse areas as necessary

Cro s Section of Vegeta:: Swale

Vegetated Swale from Toi?,



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Bio-retention BMPs: The following BMPs utllize blo-retantion to mange stormwater on your site.

Rain Garden

Rain gardens are a shallow depression planted with native vegetation that capture, filter, and infiltrate stormwater. They work well infiltrating rooftop, driveway, path, and patio runoff. Rain gardens are versatile and attractive, and can take a variety of shapes and forms.

Sizing

1. Determine Total Impervious Surfaces
   ie ¼ Rooftop runoff: 12.5 ft x 37.5 ft -- 468.75 ft sq

2. Using a loading ratio of **5:1(Impervious to rain garden),** determine minimum size of rain garden Bed:
   (Impervious Area)/5 - (468.75)/5=93.75 ft sq
   Size of Rain Garden Bed '" 93.75 ft sq
   This means, the rain garden 's dimensions can be 9.7ft x 9.7ft, or 3ft by 31 ft, or any dimension that contains 93.75 ft sq

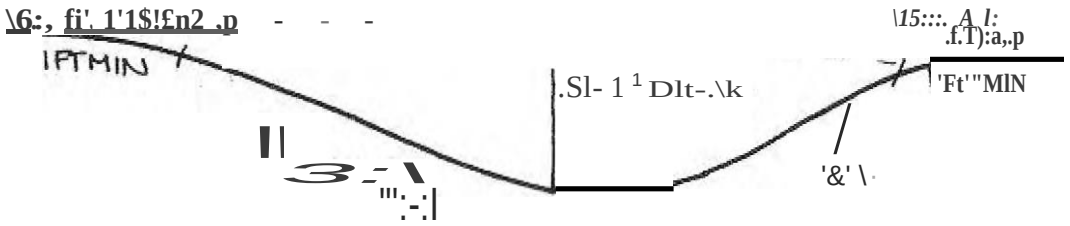
3. . Sizing of Rain Garden
Total Volume of rain garden = Surface storage + soil storage

   a. Surface Storage Volume (ft3) '" Bed Area (fl2) X Average Design Water Depth (12")
   Surtace Storage Volume (ft3) - 93.75 ft sq x 1 ft '" 93.75 ft cu

   b. Soil Storage Volume (ft3) = Bed Area (ft2) x Depth of Amended Soil (ft) X Holding Capacity (typically 10-20% can be greater if soils amended with organic matter)

   Soil Storage Volume (ft3) :,:: 93 .75 ft sq x 2.5 ft x 15% "" 35.16 ft cu

Total Volume of rain garden - Surface storage + soil storage ,
Total Volume of rain garden .. 93.75 ft cu+ 35.16 ft cu= 128.91 ft cu



Installation

Select an area at least i O feet from your house, ideally in a naturally occurrlng low spot. The rain garden st1ould have full to partial sun.

Mark out the size of your garden, and start to dig, Try to create a level area around the outer edge of the rain garden, to create sheet flow and act as a filter strip. You can use some of the cut soll to create a small berm around the garden. The slopes of the sides should be fairly gradual, *or* a bout 3 :1 .

Crea te the ponding area. Avoid creating a surtace ponci depth lower than 12"s, for safety and maintenance reasons , The ponding area should meet the required storage volume without exceeding 12"s.

Planting soil depth should be about 18"s, *or* deeper with different tree species. Planting soil should be loan,. and 20-30¾ organic material/compost. Planting soil st10uld be about 4" deaper than the bottom·of the largest root ball.

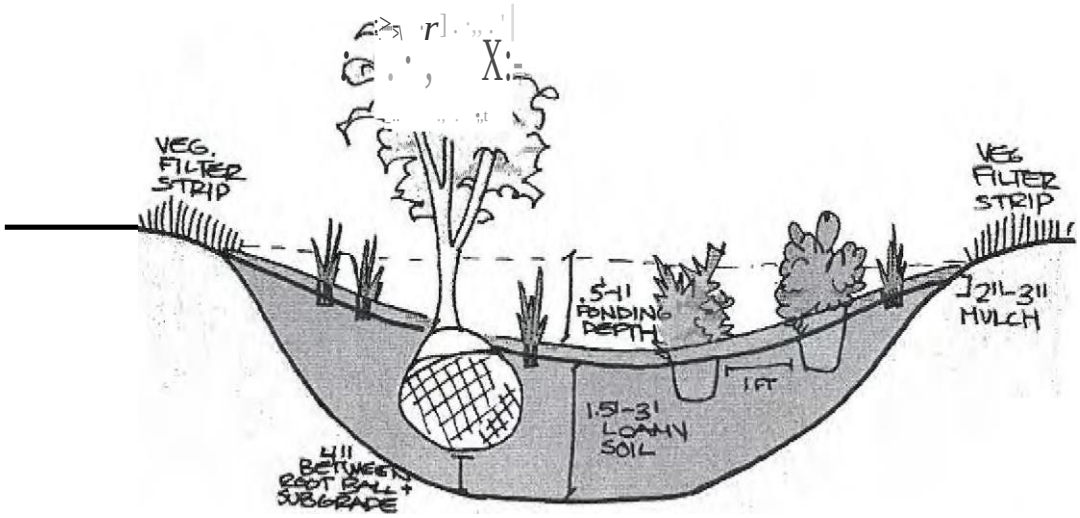
Planting

Plant a vegetated filter strip around the slopes of the ponding area to keep the rain garden healthy (see page 13)

Select native floodplafn species to make up tt)e rain garden area. See the recommended plant list (p 21) for trps about plant selection. A mix of trees and shrubs is recommended, with about one tree for every three shrubs. Plants native to Pennsylvania are most effective, as they are lower maintenance and resist disease. Get creatfve with your plant palette, and select different plants with interesting textures and colors.

Plant trees and shrubs first, about a foot apart, and till in with plugs of grasses and flowers. Seeding isn't effective in rain gardens, so plugs are recomm ended.

Mulch helps filter pollutants and protect soil. Compost or leaf mulch is preferred, and wood mulch should be shredded. Mulch layer should be no thicker than 2 3".



Maintenance

Rain gardens require a little initial maintenance to stay healthy. For the first 2 weeks , water the garden every ott1er day (unless it rains). For the first year, the garden requires weeding, and about an Inch of water a week.

A rain garden also needs robe re•mulched annually, and raked regularly, to prevent weed-growth. Once durfng spring and fall dead vegetation should also be removed from the rain garden, and replacement plants should be planted.

Costs

Rain gardens are a fairly low-cost BMP, with their simple installation and maintenance. Most of U1e costs come from the price of plants.

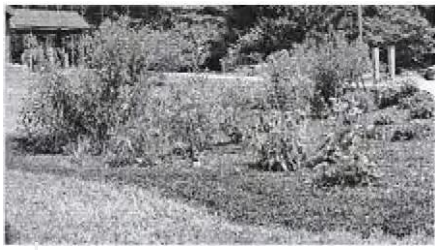
Creating your own rain garden costs $3 to $5 per square toot, but if a landscaper is hired to do everything, it will cost $10 to $12 per square foot.

Building the example rain garden yourself would cost $280 to $470, while hiring a landscaper to install it would cost $940 to $1100.

See the plant chart in the back for individua l plants price estimates.

Stormwater Best **Management** *Practices* **Fact** *Sheet*

Rain Garden



PURPOSE:: Rain gardens are small-scale bioretention areas that benefit water quality by removing pollutants from runoff. They also reduce the speed of runoff and promote infiltration of runoff into the groundwater supply.

Rain gardens are designed to mimic the layered conditions of a forest floor, which naturally filters pollutants from water. The rain garden consists of a vegetated or stone ponding area, a mulch layer, a planting soil layer, a sand bed, and a gravel base. The multiple layers work together to filter pollutants from water, allowing it to infiltrate into the groundwater supply uncontaminated.

Rain gardens are well-suited tor use on individual resldential **sites,** as they provide for stormwater management on a lot by-lot basis. The vegetated or stone surface layer initially slows the velocity of runoff and provides temporary storage for runoff before water either evaporates or infiltrates the soiL Plant material aids with evapotranspiration of water, and plant roots create pathways for water to infiltrate soil. Water retained in the ponding area is absorbed into the mulch layer, where bacteria that live among plant roots digest pollutants, even petroleum-based solvents. Mulch also aids with preventing erosion, protects underlying soil from drying, and provides a medium for biological growth and decomposition of organic matter. The soil layer provides water and nutrients to plants. Voids within the soil *are* where runoff is stored prior to infiltration to deeper ground. Addition of a subsurface infiltration bed will help to move water from the surface ponding area into the ground, and will aid with aerating the soil layers in order to enable them to absorb additional runoff. Runoff then filters through a layer of nonwoven geotextile material before seeping into a bed of sand for additional filtering. Lastly, water is received into a stone base, which allows the water to drain into the ground below.

Unlike bioretention areas, rain gardens traditionally do not include an underdrain feature to convey water to a storm sewer system because their purpose is to allow runoff to infiltrate the groundwater supply.

Rain gardens can *be* used in conjunction with porous paved parking areas, infiltration trenches, and filter strips for pretreatment of stormwater runoff.

Benefitsand *Uses*

- Filters contaminarils from runoff prior to its discharge to the storm sewer system or streams
- Reduces peak velocity and volume of stormwater nmoff delvered to storm sewer system or streams
- Alleviates flooding and erosion downstream
- Inexpensive to lnstalLand maintain
- Enhances aesthetics of locallandscape
- Recharges groundwater supply
- Applicable to alltypes of sites (residential' commercial/industrial)
- Can be used to treat runoff from streets, P!irkl g lots and drivew_ays
- Provides habitatfor wildlife
- Reduces mosq ito breeding by removing standing-water in yards
- Reduces potential of home flooding

Additional Resources

PA Department* of *Environmental Protection
www.depwe state.pa.us- seamh Pennsylvania Stormwater Be st Management Practices Manual

Alliance for·th, Chesapeake Say
www.AllianceChesBayorg

Cah/11 Associates
www.thcahlll.com - click on "Technologies" for project examples and general lnformauon

Rain Garden Network
www.raingardennetwork:corn

Stormwater Manager's Resource Center
www.storrnwatercenter.net

General Qesfgp Co1tsiJJJ11atk!ns

- Effective for draining areas of less than 5 acres
- Effective for nearly all types of soils and topograph;ybest suited for areas with moderate permeability, more than 0.25 inch per hour
- Allow space between basin bottom and water table and bedrocKtoprevent groundwater contamination
- Design should Include overflow drainage to remove excess stormwater
- Not suitable for receiving runoff with high levels of sediment
- Underdrains should not be used in rain garden design (see *bioretention area* for drainage)
- Recommended side slope is 3:1, or 2:1 in areas where space is limited
- Select native vegetation that is tolerant of varying water conditions (see reverse side)
- Plant depth should be at least 24 inches for herbaceousplants
- Soil should be a loam, loam/sand rni:x or sandy loam capable of supporting vegetative cover; modify soil with compost If needed
- Use a maximum of 2 to 3 inches of mulch
- Replace mulch annually, Restrict ponding depth to 6 inches or less
- Pruning and weeding should be performed as necessary
- Rain gardens may require watering during dry periods
- Follow erosion control procedures
- Inspectregularly for clogging, litter, or rills or gullies caused by erosion

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Dauphin County Conservation District
1451 Peters Mountain Road Dauphin, PA 17018
www.dauphincd.org p: (717) 921.8100

Native Vegetation

Native vegetation refers to plants, shrubs and trees that have existed in an area before it was settled by European. More than 2,100 native plant species grow in Pennsylvania.

Using native plants is beneficial as they are acclimated to the local climate and therefore, require **less** maintenance than introduced species. Native plants also contribute to the preservation of Pennsylvania's plant heritage.

Cultivars are varieties of native plants bred for a particular characteristic (size, color, etc.). Cultivars may be used in place of a native species.

Other Native Plants

Examples of some other types of native plants include:

Flowers

Wild Columbine	Jack-in-the-pulpit
Wood Geranium	Common Milkweed
Phlox	Snowdrops
Common Blue Violet	Partridge-berry
Virginia Bluebell	May-apple
Cardinal Flower	Trillium

Grasses

Virginia Wild Rye	Switch Grass
Indian Grass	Bottlebrush Grass
Lurid Sedge	Big Bluestem

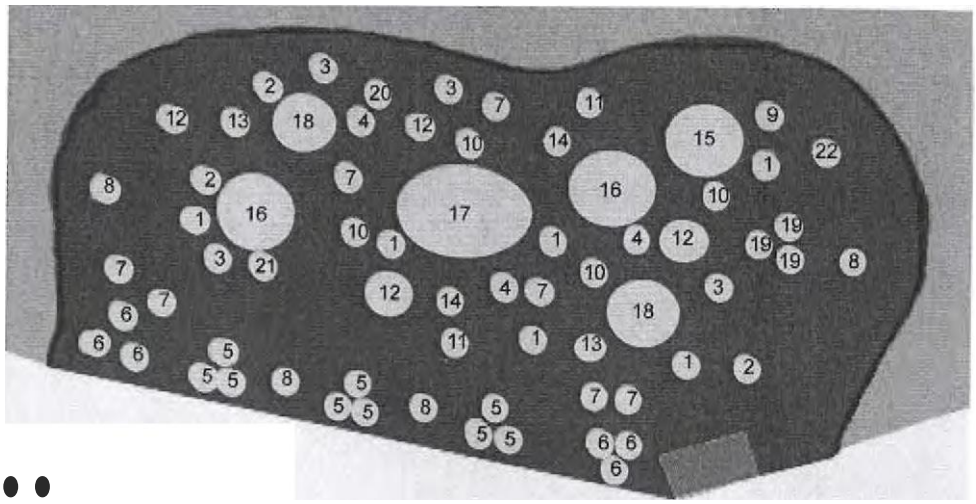
Shrubs

Red Chokeberry	Silky Dogwood
Black Chokeberry	Flowering Dogwood
Winterberry	Wild Hydrangea
Fragrant Sumac	Virginia creeper
Mountain Laurel	Redbud

Trees

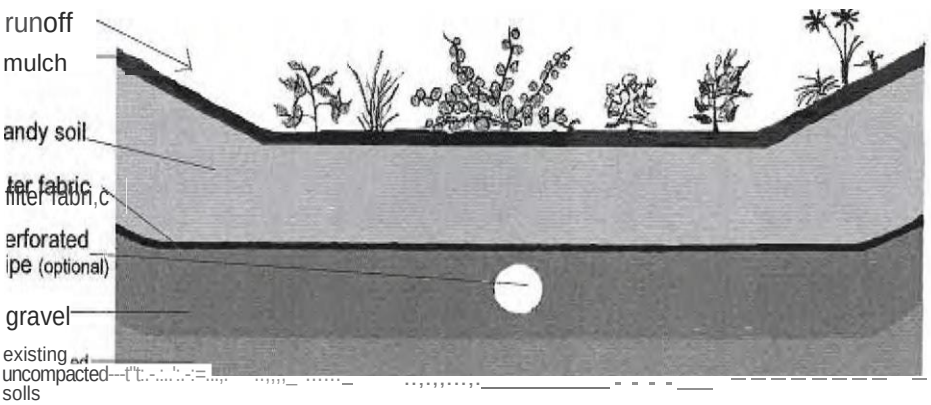
Red Maple	Sugar Maple
Tulip Poplar	Eastern White Pine
American Beech	Sycamore
Swamp White Oak	Chestnut Oak
White Oak	Red Oak
Black Birch	Yellow Birch

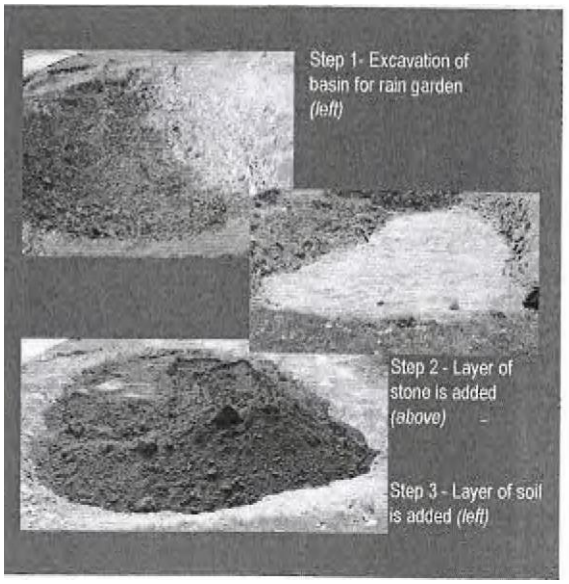
Native Vegetation planted in the BMP Tour Rain Garden



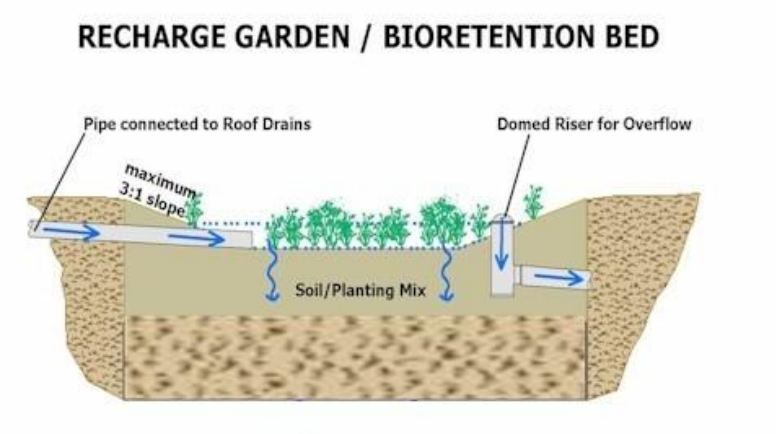
	Key Flowers/Shrubs	Latin Name	Flowering time
1	Foxglove Beardtongue	*Penstemon digitalis*	May-July
2	Swamp Sunflower	*Helianthus angustifolium*	Aug-Oct
3	Swamp Milkweed	*Asclepias incarnata*	July-Oct
4	Dogtooth Daisy/Sneezeweed	*Helenium autumnale*	Aug-Nov
5	Mouse-eared tickseed cultivar	*Coreopsis auriculata* 'Nana'	May-Sept
6	Black-eyed Susan cultivar	*Rudbeckia speciosa* 'Goldsturm'	Aug-Oct
7	Marsh Blazing Star	*Liatris spicata*	July-Sept
8	Stout Blue-eyed Grass	*Sisyrinchium angustifolium*	May-July
9	Evening primrose cultivar	*Oenothera fruitioosa* 'Lemondrops'	May-Aug
10	New England Aster	Aster *novi-angliae*	Aug-Oct
11	New England Aster cultivar	*Aster novi-angliae* 'PurpleDome'	Aug-Oct
12	Spiderwort cultivar	*"raclescantia ohiensis* 'Mrs. Loewer'	June-July
13	Simler's Joy/Blue Vervain	*Verbena hastata*	June-Oct
14	Boneset	*Eupatorium perfolatum*	July-Sept
15	Elderberry	*Sambucus canadensis*	June
16	Virginia Sweet Spire cultivar	*Itea virginioa* 'Henry's Garnet'	June-July
17	Red Osier Dogwood	*Comus sericea*	June-July
18	Summer Sweet cultivar	*Clethra alnifolia* 'Ruby Spice'	July Sept
19	Goldenrod cultivar	*Solidago sphacelata* 'Golden Fleece'	Aug-Oct
20	Great Blue Lobelia	*Lobelia siphilitica*	Aug-Oct
21	Eastern Joe-pye Weed	*Eupatorium dubium*	June-Sept
22	Narrow leaf Echinacea	*Echinacea angustifolia*	June--Aug

A Closer Look at the Layers of a Rain Garden





BMP 6.4.5: Rain Garden/Bioretention



A Rain Garden (also called Bioretention) is an excavated shallow surface depression planted with specially selected native vegetation to treat and capture runoff.

Key Design Elements

- Flexible in terms of size and infiltration
- Ponding depths generally limited to 12 inches or less for aesthetics, safety, and rapid draw down. Certain situations may allow deeper ponding depths.
- Deep rooted perennials and trees encouraged
- Native vegetation that is tolerant of hydrologic variability, salts and environmental stress
- Modify soil with compost.
- Stable inflow/outflow conditions
- Provide positive overflow
- Maintenance to ensure long-term functionality

Potential Applications

Residential: Yes
Commercial: Yes
Urban: Industrial: Yes
Retrofit: Yes
Highway/Road: Yes

Stormwater Functions

Volume Reduction: Medium
Recharge: Med./High
Peak Rate Control: Low/Med.
Water Quality: Med./High

Water Quality Functions

TSS: 85%
TP: 85%
NO3: 30%

Other Considerations

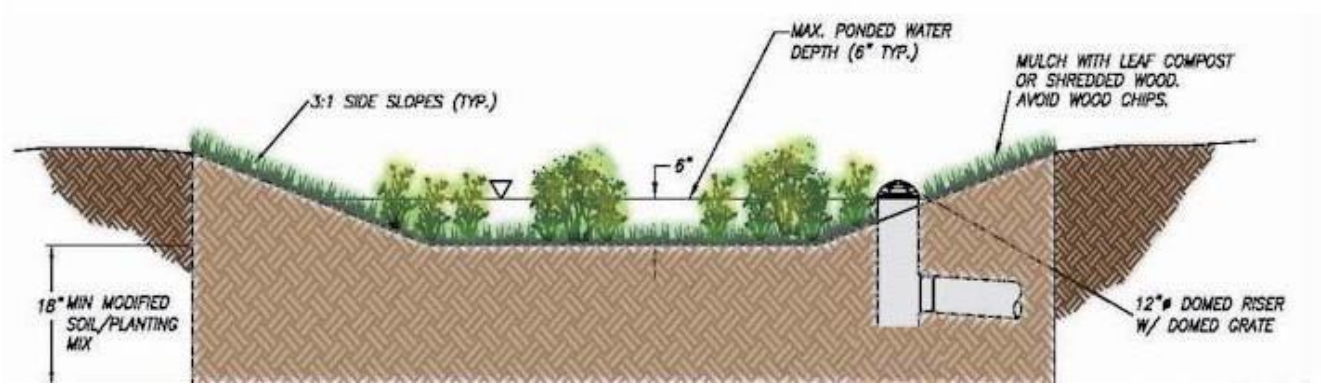
- **Protocol 1. Site Evaluation and Soil Infiltration Testing** and **Protocol 2. Infiltration Systems Guidelines** should be followed, see Appendix C

Description

Bioretention is a method of treating stormwater by pooling water on the surface and allowing filtering and settling of suspended solids and sediment at the mulch layer, prior to entering the plant/soil/microbe complex media for infiltration and pollutant removal. Bioretention techniques are used to accomplish water quality improvement and water quantity reduction. Prince George's County, Maryland, and Alexandria, Virginia have used this BMP since 1992 with success in many urban and suburban settings.

Bioretention can be integrated into a site with a high degree of flexibility and can balance nicely with other structural management systems, including porous asphalt parking lots, infiltration trenches, as well as non-structural stormwater BMPs described in Chapter 5.

The vegetation serves to filter (water quality) and transpire (water quantity) runoff, and the root systems can enhance infiltration. The plants take up pollutants; the soil medium filters out pollutants and allows storage and infiltration of stormwater runoff; and the bed provides additional volume control. Properly designed bioretention techniques mimic natural ecosystems through species diversity, density and distribution of vegetation, and the use of native species, resulting in a system that is resistant to insects, disease, pollution, and climatic stresses.



Rain Gardens / Bioretention function to:

- Reduce runoff volume
- Filter pollutants, through both soil particles (which trap pollutants) and plant material (which take up pollutants)
- Recharge groundwater by infiltration
- Reduce stormwater temperature impacts
- Enhance evapotranspiration
- Enhance aesthetics
- Provide habitat

Primary Components of a Rain Garden/Bioretention System

The primary components (and subcomponents) of a rain garden/bioretention system are:

Pretreatment (optional)

- Sheet flow through a vegetated buffer strip, cleanout, water quality inlet, etc. prior to entry into the Rain Garden

Flow entrance

- Varies with site use (e.g., parking island versus residential lot applications)
- Water may enter via an inlet (e.g., flared end section)
- Sheet flow into the facility over grassed areas
- Curb cuts with grading for sheet flow entrance
- Roof leaders with direct surface connection
- Trench drain
- Entering velocities should be non-erosive.

Ponding area

- Provides temporary surface storage of runoff
- Provides evaporation for a portion of runoff
- Design depths allow sediment to settle
- Limited in depth for aesthetics and safety

Plant material

- Evapotranspiration of stormwater
- Root development and rhizome community create pathways for infiltration
- Bacteria community resides within the root system creating healthy soil structure with water quality benefits
- Improves aesthetics for site
- Provides habitat for animals and insects
- Reinforces long-term performance of subsurface infiltration
- Should be tolerant of salts if in a location that would receive snow melt chemicals

Organic layer or mulch

- Acts as a filter for pollutants in runoff
- Protects underlying soil from drying and eroding
- Simulates leaf litter by providing environment for microorganisms to degrade organic material
- Provides a medium for biological growth, decomposition of organic material, adsorption and bonding of heavy metals
- Wood mulch should be shredded - compost or leaf mulch is preferred.

Planting soil/volume storage bed

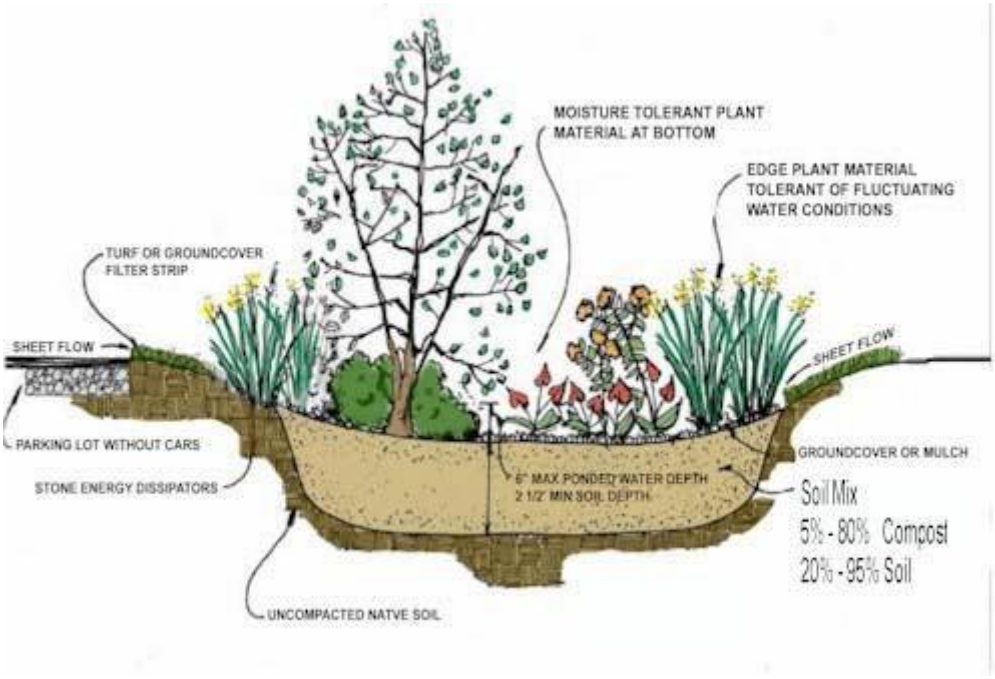
- Provides water/nutrients to plants
- Enhances biological activity and encourages root growth
- Provides storage of stormwater by the voids within the soil particles

Positive overflow

- Will discharge runoff during large storm events when the storage capacity is exceeded.

Examples include domed riser, inlet, weir structure, etc.

- An underdrain can be included in areas where infiltration is not possible or appropriate.



Variations

Generally, a Rain Garden/Bioretention system is a vegetated surface depression that provides for the infiltration of relatively small volumes of stormwater runoff, often managing stormwater on a lot-by-lot basis (versus the total development site). If greater volumes of runoff need to be managed or stored, the system can be designed with an expanded subsurface infiltration bed or the Bioretention area can be increased in size.

The design of a Rain Garden can vary in complexity depending on the quantity of runoff volume to be managed, as well as the pollutant reduction objectives for the entire site. Variations exist both in the components of the systems, which are a function of the land use surrounding the Bioretention system.

The most common variation includes a gravel or sand bed underneath the planting bed. The original intent of this design, however, was to perform as a filter BMP utilizing an under drain and subsequent discharge. When a designer decides to use a gravel or sand bed for volume storage under the planting bed, then additional design elements and changes in the vegetation plantings should be provided.

Flow Entrance: Curbs and Curb Cuts

Flow Entrance: Trench Drain

Positive Overflow: Domed Riser

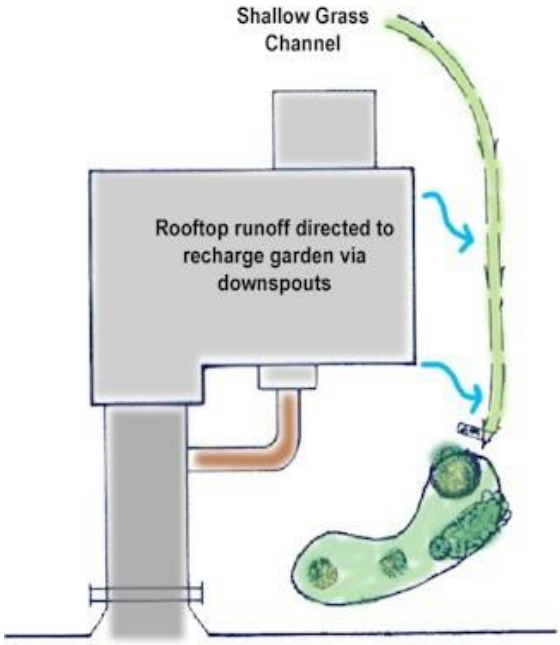
Positive Overflow: Inlet

Applications

Bioretention areas can be used in a variety of applications: from small areas in residential lawns to extensive systems in large parking lots (incorporated into parking islands and/or perimeter areas).

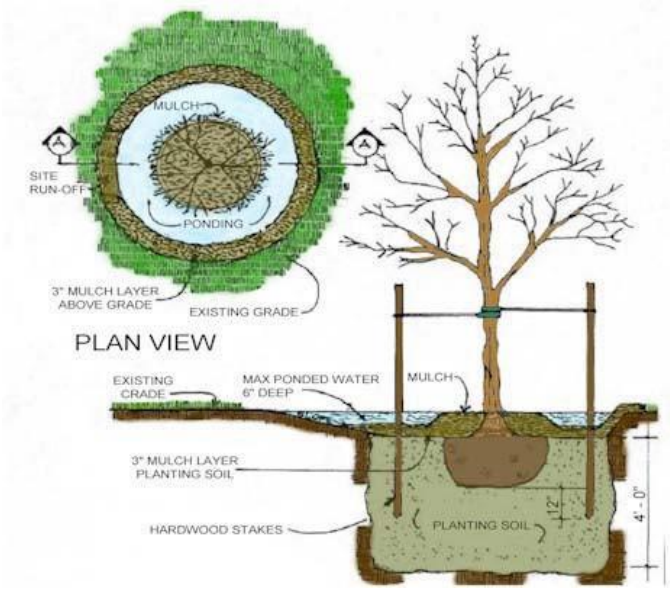
- **Residential On-lot**

  Rain Garden (Prince George's County)
  Simple design that incorporates a planting bed in the low portion of the site

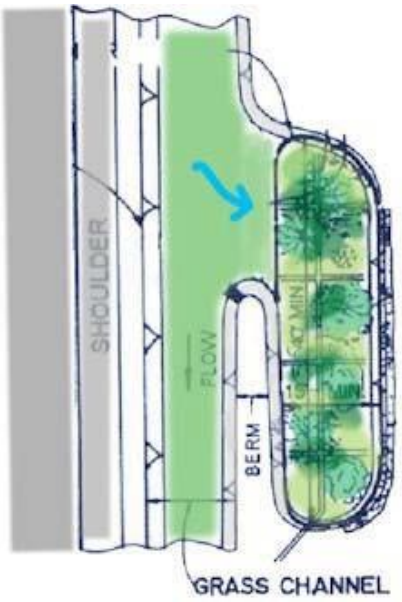


- **Tree and Shrub Pits**
  Stormwater management technique that intercepts runoff and provides shallow ponding in a dished mulched area around the tree or shrub.

  Extend the mulched area to the tree dripline



- **Roads and highways**



- **Parking Lots**
- **Parking Lot Island Bioretention**

- **Commercial/Industrial/Institutional**

In commercial, industrial, and institutional situations, stormwater management and greenspace areas are limited, and in these situations, Rain Gardens for stormwater management and landscaping provide multifunctional options.

- **Curbless (Curb cuts) Parking Lot Perimeter Bioretention**
  The Rain Garden is located adjacent to a parking area with no curb or curb cuts , allowing stormwater to sheet flow over the parking lot directly into the Rain Garden. Shallow grades should direct runoff at reasonable velocities; this design can be used in conjunction with depression storage for stormwater quantity control.

- **Curbed Parking Lot Perimeter Bioretention**

- **Roof leader connection from adjacent building**

Design Considerations

Rain Gardens are flexible in design and can vary in complexity according to water quality objectives and runoff volume requirements. Though Rain Gardens are a structural BMP, the initial siting of bioretention areas should respect the Integrating Site Design Procedures described in Chapter 4 and integrated with the preventive non-structural BMPs.

It is important to note that bioretention areas are not to be confused with constructed wetlands or wet ponds which permanently pond water. Bioretention is best suited for areas with at least moderate infiltration rates (more than 0.1 inches per hour). In extreme situations where permeability is less than 0.1 inches per hour, special variants may apply, including under drains, or even constructed wetlands.

Rain Gardens are often very useful in retrofit projects and can be integrated into already developed lots and sites. An important concern for all Rain Garden applications is their long-term protection and maintenance, especially if undertaken in multiple residential lots where individual homeowners provide maintenance. In such situations, it is important to provide some sort of management that insures their long-term functioning (deed restrictions, covenants, and so forth).

1. Sizing criteria

a. Surface area is dependent upon storage volume requirements but should generally not exceed a maximum loading ratio of 5:1 (impervious drainage area to infiltration area; see Protocol 2. Infiltration Systems Guidelines (Appendix C) for additional guidance on loading rates.)

b. Surface Side slopes should be gradual. For most areas, maximum 3:1 side slopes are recommended, however where space is limited, 2:1 side slopes may be acceptable.

c. Surface Ponding depth should not exceed 6 inches in most cases and should empty within 72 hours.

d. Ponding area should provide sufficient surface area to meet required storage volume without exceeding the design ponding depth. The subsurface storage/infiltration bed is used to supplement surface storage where feasible.

e. Planting soil depth should generally be at least 18” where only herbaceous plant species will be utilized. If trees and woody shrubs will be used, soil media depth may be increased, depending on plant species.

2. **Planting Soil** should be a loam soil capable of supporting a healthy vegetative cover. Soils should be amended with a composted organic material. A typical organic amended soil is combined with 20-30% organic material (compost), and 70-80% soil base (preferably topsoil). Planting soil should be approximately 4 inches deeper than the bottom of the largest root ball.

3. **Volume Storage Soils** should also have a pH of between 5.5 and 6.5 (better pollutant adsorption and microbial activity), a clay content less than 10% (a small amount of clay is beneficial to adsorb pollutants and retain water), be free of toxic substances and unwanted plant material and have a 5 –10% organic matter content. Additional organic matter can be added to the soil to increase water holding capacity (tests should be conducted to determine volume storage capacity of amended soils).

4. Proper **plant selection** is essential for bioretention areas to be effective. Typically, native floodplain plant species are best suited to the variable environmental conditions encountered. If shrubs and trees are included in a bioretention area (which is recommended), at least three species of shrub and tree should be planted at a rate of approximately 700 shrubs and 300 trees per acre (shrub to tree ratio should be 2:1 to 3:1). An experienced landscape architect is recommended to design native planting layout.

5. **Planting periods** will vary, but in general trees and shrubs should be planted from mid-March through the end of June, or mid-September through mid-November

6. A maximum of 2 to 3 inches of shredded **mulch** or leaf compost (or other comparable product) should be uniformly applied immediately after shrubs and trees are planted to prevent erosion, enhance metal removals, and simulate leaf litter in a natural forest system. Wood chips should be avoided as they tend to float during inundation periods. Mulch / compost layer should not exceed 3" in depth so as not to restrict oxygen flow to roots.

7. Must be designed carefully in areas with **steeper slopes** and should be aligned parallel to contours to minimize earthwork.

8. Under drains should not be used except where in-situ soils fail to drain surface water to meet the criteria in Chapter 3.

Detailed Stormwater Functions

Infiltration Area

Volume Reduction Calculations

The storage volume of a Bioretention area is defined as the sum total of 1. and the smaller of 2a or 2b below. The surface storage volume should account for at least 50% of the total storage. Inter-media void volumes may vary considerably based on design variations.

1. Surface Storage Volume (CF) = Bed Area (ft^2) x Average Design Water Depth

2a. Infiltration Volume = Bed Bottom area (sq ft) x infiltration design rate (in/hr) x infiltration period (hr) x 1/12.
2b. Volume = Bed Bottom area (sq ft) x soil mix bed depth x void space.

Peak Rate Mitigation

See Chapter 8 for Peak Rate Mitigation methodology, which addresses link between volume reduction and peak rate control.

Water Quality Improvement

See Chapter 8 for Water Quality Improvement methodology, which addresses pollutant removal effectiveness of this BMP.

Construction Sequence

The following is a typical construction sequence; however, alterations might be necessary depending on design variations.

1. Install temporary sediment control BMPs as shown on the plans.
2. Complete site grading. If applicable, construct curb cuts or other inflow entrance but provide protection so that drainage is prohibited from entering construction area.
3. Stabilize grading within the limit of disturbance except within the Rain Garden area. Rain garden bed areas may be used as temporary sediment traps provided that the proposed finish elevation of the bed is 12 inches lower than the bottom elevation of the sediment trap.
4. Excavate Rain Garden to proposed invert depth and scarify the existing soil surfaces. Do not compact in-situ soils.
5. Backfill Rain Garden with amended soil as shown on plans and specifications. Overfilling is recommended to account for settlement. Light hand tamping is acceptable if necessary.
6. Presoak the planting soil prior to planting vegetation to aid in settlement.
7. Complete final grading to achieve proposed design elevations, leaving space for upper layer of compost, mulch or topsoil as specified on plans.
8. Plant vegetation according to planting plan.
9. Mulch and install erosion protection at surface flow entrances where necessary.

Maintenance Issues

Properly designed and installed Bioretention areas require some regular maintenance.

- While vegetation is being established, pruning and weeding may be required.
- Detritus may also need to be removed every year. Perennial plantings may be cut down at the end of the growing season.
- Mulch should be re-spread when erosion is evident and be replenished as needed. Once every 2 to 3 years the entire area may require mulch replacement.
- Bioretention areas should be inspected at least two times per year for sediment buildup, erosion, vegetative conditions, etc.
- During periods of extended drought, Bioretention areas may require watering.
-
- Trees and shrubs should be inspected twice per year to evaluate health.

Cost Issues

Rain Gardens often replace areas that would have been landscaped and are maintenance-intensive so that the net cost can be considerably less than the actual construction cost. In addition, the use of Rain Gardens can decrease the cost for stormwater conveyance systems at a site. Rain Gardens cost approximately $5 to $7 (2005) per cubic foot of storage to construct.

Specifications

The following specifications are provided for informational purposes only. These specifications include information on acceptable materials for typical applications, but are by no means exclusive or limiting. The designer is responsible for developing detailed specifications for individual design projects in accordance with the project conditions.

1Vegetation - See Appendix B

2 Execution

a. Subgrade preparation

1. Existing sub-grade in Bioretention areas shall NOT be compacted or subject to excessive construction equipment traffic.
2. Initial excavation can be performed during rough site grading but shall not be carried to within one feet of the final bottom elevation. Final excavation should not take place until all disturbed areas in the drainage area have been stabilized.
3. Where erosion of sub-grade has caused accumulation of fine materials and/or surface ponding in the graded bottom, this material shall be removed with light

equipment and the underlying soils scarified to a minimum depth of 6 inches with a York rake or equivalent by light tractor.

4. Bring sub-grade of bioretention area to line, grade, and elevations indicated. Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction. All bioretention areas shall be level grade on the bottom.
5. Halt excavation and notify engineer immediately if evidence of sinkhole activity or pinnacles of carbonate bedrock are encountered in the bioretention area.

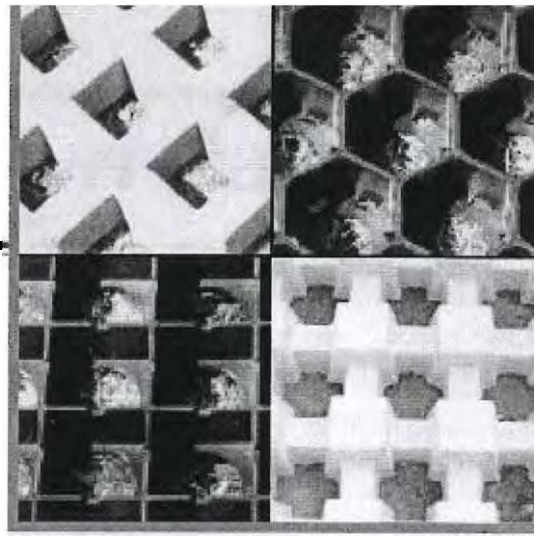
b. Rain Garden Installation

1. Upon completion of sub-grade work, the Engineer shall be notified and shall inspect at his/her discretion before proceeding with bioretention installation.
2. For the subsurface storage/infiltration bed installation, amended soils should be placed on the bottom to the specified depth.
3. Planting soil shall be placed immediately after approval of sub-grade preparation/bed installation. Any accumulation of debris or sediment that takes place after approval of sub-grade shall be removed prior to installation of planting soil at no extra cost to the Owner.
4. Install planting soil (exceeding all criteria) in 18-inch maximum lifts and lightly compact (tamp with backhoe bucket or by hand). Keep equipment movement over planting soil to a minimum – **do not over compact**. Install planting soil to grades indicated on the drawings.
5. Plant trees and shrubs according to supplier's recommendations and only from mid-March through the end of June or from mid-September through mid-November.
6. Install 2-3" shredded hardwood mulch (minimum age 6 months) or compost mulch evenly as shown on plans. Do not apply mulch in areas where ground cover is to be grass or where cover will be established by seeding.
7. Protect Rain Gardens from sediment at all times during construction. Hay bales, diversion berms and/or other appropriate measures shall be used at the toe of slopes that are adjacent to Rain Gardens to prevent sediment from washing into these areas during site development.
8. When the site is fully vegetated and the soil mantle stabilized the plan designer shall be notified and shall inspect the Rain Garden drainage area at his/her discretion before the area is brought online and sediment control devices removed.
9. Water vegetation at the end of each day for two weeks after planting is completed.

Contractor should provide a one-year 80% care and replacement warranty for all planting beginning after installation and inspection of all plants.

Best Management Practices Fact Sheet

Turf Pavers



PURPOSE:: Turf pavers used In place of traditional impervious paving materials reduqe the total amount of Impervious surface area, promote infiltration of runoff into the ground, and can aid with reducing peak runoff velocity and volume.

Turf pavers are an innovative alternative to conventional Impervious paving which contributes a significant amount of runoff to storm sewers and waterways, especially in urban areas. This type of paver is a matrix of polymer, concrete or cement blocks designed to form a void space that is filled with grass, sand, or gravel, which allows runoff to infiltrate into the soil. The material used for the paver itself is resistant to weathering and the effects of prolonged sunlight.

Turf pavers are well-suitedfor areas that receive pedestrian and light vehicular traffic, such as walkways, bike paths, overflow parking lots, fire lanes and golf cart paths. The paver grid provides extra support to prevent vegetated areas from being destroyed by tires.

Installation of pavers beglhs with a level base of existing soil. A layer of crushed gravel may be spread over the soil base to provide a reservoir for holding runoff prior to infiltration. Incorporating a gravel base will add the benefits of reducing peak runoff velocity and volume. Next, a layer of sand or sand/gravel mix is placed and compacted to the required depth. The pavers are laid in place, then filled with another layer of compacted concrete sand or sand/soil mix to the depth called for in the paver manufacture'rs specifications. Finally, a cover of turf or grass seed Is spread on top of the paver cells. *Manufacturers speoifications should be followedas to th@ materials used for the base and* surface

NOTE:: Sand-filled openings provide greater infiltration rates than grass openings. Some turf pavers are designed for use on sloped areas: consult the product specifications to determine the type of paver suitable for sloped site conditions.

Genetal l:Jes,gn *Conside,a :t lons*

- Use in areas with soil permeability between 0.5 and 3.0 inches per hour
- Existingsoil and/or stone reservoir base must be graded flat
- Install at least two to five feet above seasonal high groundwater table to prevent contamination of groundwater
- Location should be at least 1DO feet from drinking water wells to avoid contamination
- Thickness of gravel base may vary accordingto designated use of area (ex, a thicker base may be required tosustain weight of fire trucks)
- Design should include overflow drainage to remove excess stormwater
- Gravel used In sand/gravel mix should be no larger than 3/4 Inch In diameter
- Follow manufactruer's specifications for depthof sand underneathpavers
- Pavers should be swept clean of fllll prior to adding grass seed or turf
- Remove any invasive vegetation, including small tree seedlings, from paver grids
- Maintenance includes regular mowing
- Use snow plows, sand and salt with caution during snow removal
- Installation in areas of high traffic or heavy contamination not recommended (ex. service stations)

Benefits and Uses

- Reduces total £tmount of Impervious cover
- Enhances ae.sthetcls of local landscape
- Recharges groundwater supply
- Reduces peak velocity and Volume of stormwater runoff delivered to storm sewer system
- Alleviates flooding and erosioh downstream
- Prevents soil compaction by vehicle weight and promotes healthy raotgrowth
- Appflcable to a11 types of sites

Additional Resourees

PA D@parlment of Environmental Protection
- www.dep.statepa;Us
- Pennsylvania Stormwater Best.Management Practices Manual

US Environmental Protection Agency
www.epa.gov

Cahill Associates
www.thcahll.com - click on "Technologies· for project examples and-generalInformation

Low Impact Development Canter
www.lid-stormwater.net• click on Site Map and select Permeable Paving

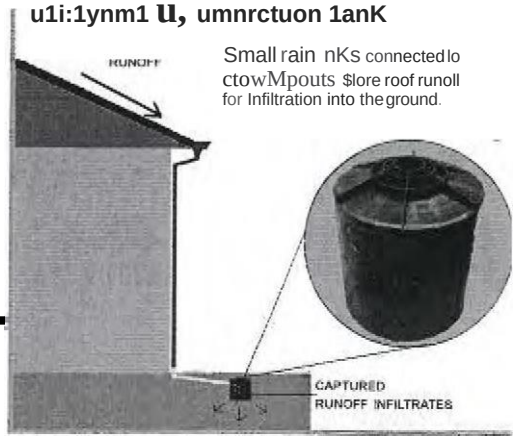
Metropolitan Council Environmental Services
www.metrocouncil.org- click on"Environmental Services" to find thelink to the *Urban Small Sites BMPManual*

Stormwater Manager's Resource Center
www.stormwatercenter.net

Produced by:
Dauphin County Conservation District
1451 Peters Mountain Road Dauphin, PA 17018
www.dauphincd.org p: (717) 921.8100

Best **Management** *Practices Fact Sheet*

Sub-Surface Infiltration Areas

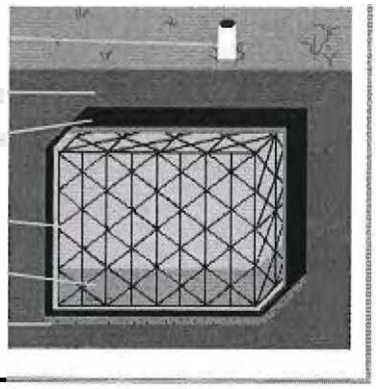


PURPOSE: Sub-surface infiltration areas reduce the volume of stormwater runoff leaving a site by capturing runoff for storage undergroun.dOver time, the stored runoff percolates down through the soil to recharge the groundwater supply.

Sub-surface infiltration applications range from simple tanks that are suited to individualhouse sites to large-scale, high-techcommercial and industrial installations. Some of the products and materials used for underground storrnwater storage are manufactured polymer cells and tanks; arched chambers, pipes, and stone. Storage capacities for these products range from 95% of the total storage area for polymer units to 40% or less for crushed stone.

Construction consists of excavating a trench or pit, placing the storage media, then covering the storage area with soil. Polymer cell units are wrapped with geotextile material to keep dirt from filling in the storage area. Stormwater can be directed to the infiltration area from roofs, paved areas, or any other impenrieable surface. Infiltration rates vary from site to site, dependent upon soils, depth to groundwatre, and other site conditions.

Diagram of Infiltration Area using Polymer Storage Cells



Benefits and Uses

- Recharges groundwater supply
- Reduces peak velocity and volume of stormwater runoff to streams andstorm sewer systems
- Alleviates flooding and erosion downstream
- Reduces space required for stormwater detention/retention basins
- Minimal to moderatecost to Install and maintain
- Space above infiltration bed is usable as lawn, landscaped area courtyard, etc.
- Applicable to all types of sites (residential/ commercial/industrial)
- Small tank units (featured above) are easily adapted to most existing Individual home sites

General Design Considerations

- Excavate bottom of infiltration bed level to slope of less than 1%
- Sub-grade should not be compacted to permit maximum infiltration
- Soil should consist of less than 20% clay content, and less than 40% clay/silt QOntent
- Infiltration areas work best in porous soils, and do not function as efficiently in areas of dense day soils, as they are prone to dogging
- Allow threefeet of vertical buffer between the bed bottom and seasonal high-water table to prevent contamination of groundwater; allow two feet of vertical buffer above bedrock
- Design should include overflow drainage to remove excess stormwater
- Large residential/commercial/industrial site installationsshould be designed by a design professional
- A homeowner doing a single retrofit installation would not need to hire a design professional as long as overflow drainage is included
- Do not install infiltration bed within 1O feet of basement walls or where sub-surface drainage may run toward a basement
- Space above the infiltration bed can be paved or planted with vegetation
- Regular maintenance is required to prevent the system from clogging

Additional Resources

PA Department of invJronmental Protection
www.depweb.state.pa.us search for Pennsylvania Stormwater Best Management Practices Manual

US Environmental Protection Agency
www.epa.gov

Cahill Associates
www.thcahill.corn - click on "Technologies" for project examples and general"information

Low Impact Development Center
www.lowimpactdevelopment.org

Stormwater Manager's Resource Center
www.stormwatercenter.net

Metropolitan Council Environmental Services
www.metrocouncil.org - click on "Environmental Services" to find the link to the *Urban Small Sites BMP Manual*

Produced by:
Dauphin County Conservation District
1451 Peters Mountain Road Dauphin, PA 17018
www.dauphincd.org p: (717) 921.8100

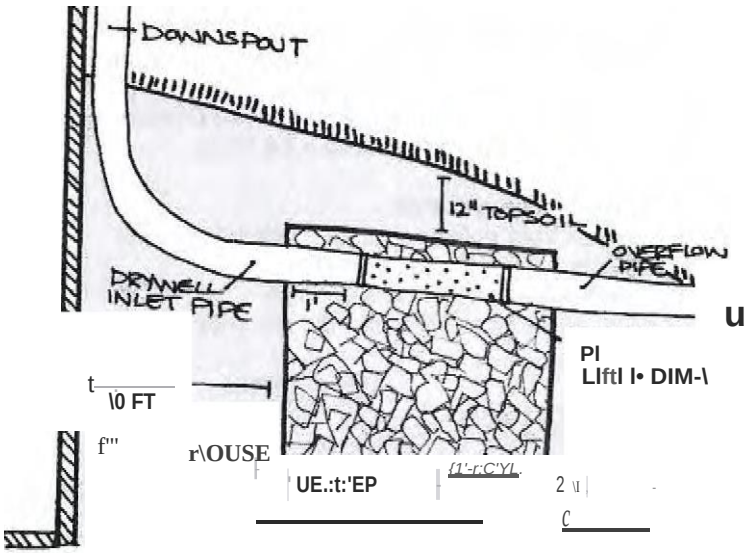
Infiltration BMPs: The following BMPs infiltrate Storrnwater on site.

Dry Well

Dry wells are an infiltration type Best Management Practice, and effective at infiltratingroof runoff. A drywell can be either a preconstructed chamber, or a dug pit filled with aggregate.

Sizing

First, calculate the amount of impervious surface on site, and then the cubic volume of storm water you need to manage. (See "calculate stormwater volume"). We'll call this the Drywell Required Volume.



If the drywall is filled with stone, use a 40% void ratio

1. Divide drywell required volume by 40%

   Ex required volume - 75ft cu
   75ft cu/40%;; **190ft cu**

2. A drywell's Actual Volume is calculated by (width x length x depth)

   (Remember L x W / D - < 4)

3. Since depth can be 3.5 ft max, calculate the drywell area

   190 ft oubed/3.Sft= 54.3 ft2

So the example drywell dimensions are 3'6" depth, 7'4"1enth, 7'4"width

Installation

Excavate drywall bottom to a uniform level. Select a location at least 1O feet from your home, to avoid flooding. Avoid compaction of soil during construction, and know that drywells deeper than 3 1/2 feet aren't recommended. Remember to dig 12" deeper than your measurements for the depth of your drywell, so you have space to cover the drywell in 12" of topsoil.

Cover dryweH floor with 2" sand or finely crushed stone. Install drywell inlet pipe and perforated pipe, which connect to roof downspout.slnlet pipes run underground, and overtlow pipes run horizontally until they emerge above ground, and they should have a cap on the end. Overflow pipes allow for easier maintenance and help avoid flooding damage during very large storms.

Fill the dry well with stone aggregate. Aggregate fill should be 1" to 3" diamete.r Cover with a layer of topsoil (12"s) , and seed and vegetate topsoil to stabilize and aid infiltration .

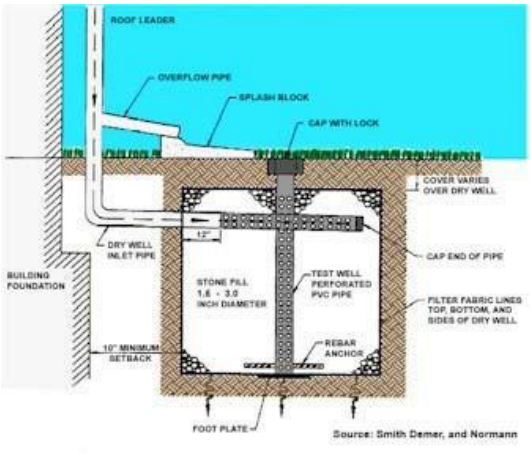
Maintenance

Drywalls should be inspected seasonally and after large-stormsfor debris build-up The builder may want to install a monitoring pipe.

Costs

Drywells typically cost from $4 to $9 per cubic foot, and most drywell costs are associated with the amount of gravel. The example drywell from this section would cost $800 to $1500 .
Drywell installation kits for pre-sized drywells are also available. Online, prices are around $150 to $200 .

BMP 6.4.6: Dry Well / Seepage Pit



A Dry Well, or Seepage Pit, is a variation on an Infiltration system that is designed to temporarily store and infiltrate rooftop runoff.

Key Design Elements

- Fllow Infiltration System Guidelines in Appendix C
- Maintain minimum distance from building foundation (typically 10 feet)
- Provide adequate overflow outlet for large storms
- Depth of Dry Well aggregate should be between 18 and 48 inches
- At least one observation well; clean out is recommended
- Wrap aggregate with nonwoven geotextile
- Maintenance will require periodic removal of sediment and leaves from sumps and cleanouts
- Provide pretreatment for some situations

Potential Applications

Residential: Yes
Commercial: Yes
Ultra Urban: Yes
Industrial: Limited
Retrofit: Yes
Highway/Road: No

Stormwater Functions

Volume Reduction: Medium
Recharge: High
Peak Rate Control: Medium
Water Quality: Medium

Water Quality Functions

TSS: TP: 85% 85%
NO3: 30%

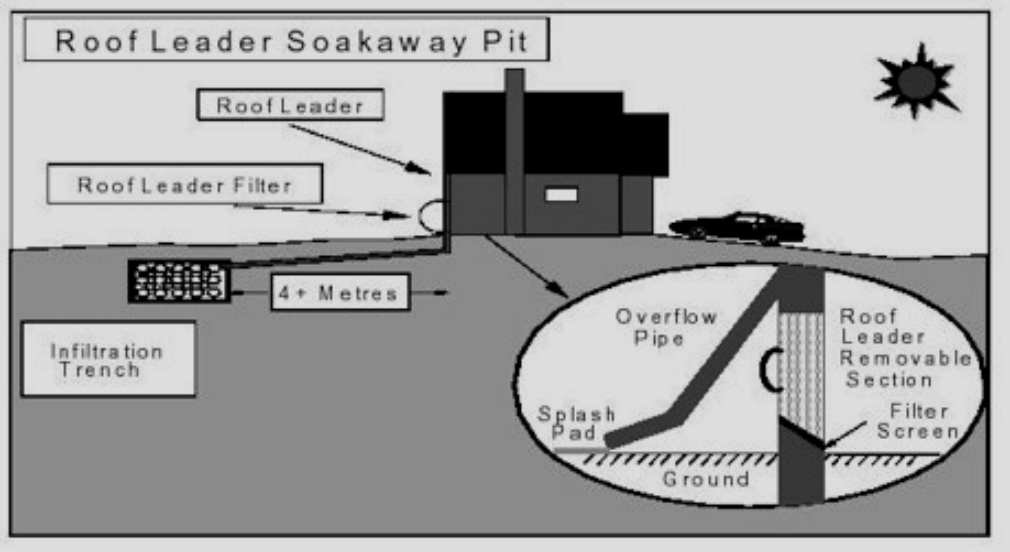
Other Considerations

- **Protocol 1. Site Evaluation and Soil Infiltration Testing** and **Protocol 2. Infiltration Systems Guidelines** should be followed, see Appendix C

Description

A Dry Well, sometimes called a Seepage Pit, is a subsurface storage facility that temporarily stores and infiltrates stormwater runoff from the roofs of structures. Roof leaders connect directly into the Dry Well, which may be either an excavated pit filled with uniformly graded aggregate wrapped in geotextile or a prefabricated storage chamber or pipe segment. Dry Wells discharge the stored runoff via infiltration into the surrounding soils. In the event that the Dry Well is overwhelmed in an intense storm event, an overflow mechanism (surcharge pipe, connection to larger infiltration area, etc.) will ensure that additional runoff is safely conveyed downstream.

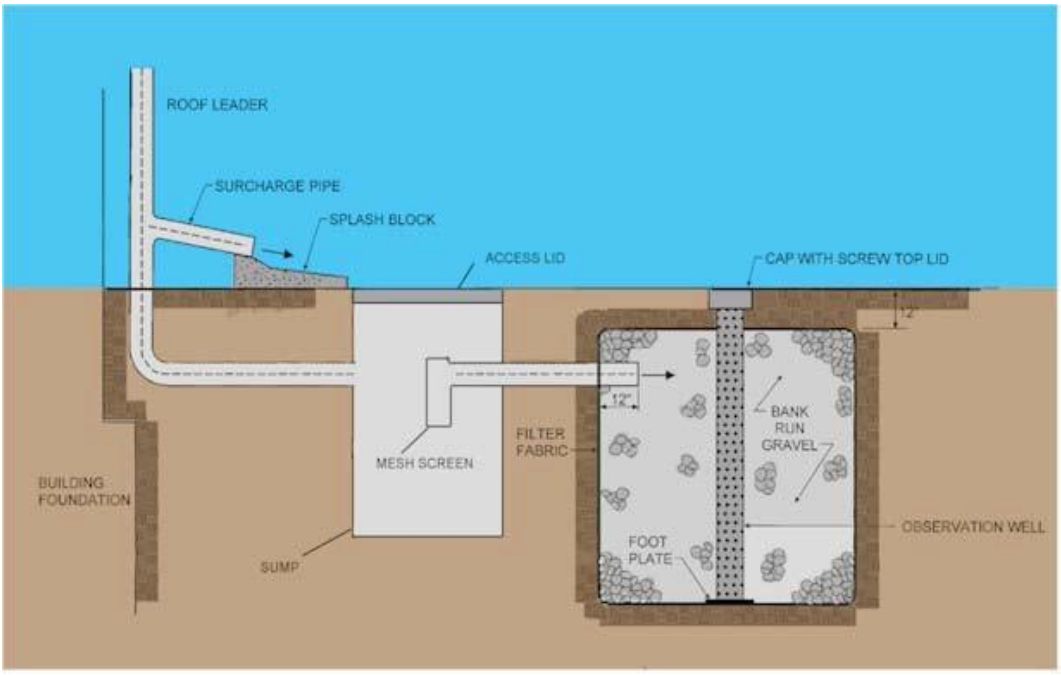
By capturing runoff at the source, Dry Wells can dramatically reduce the increased volume of stormwater generated by the roofs of structures. Though roofs are generally not a significant source of runoff pollution, they are still one of the most important sources of new or increased runoff volume from developed areas. By decreasing the volume of stormwater runoff, Dry Wells can also reduce runoff rate and improve water quality. As with other infiltration practices, Dry Wells may not be appropriate for "hot spots" or other areas where high pollutant or sediment loading is expected without additional design considerations. Dry Wells are not recommended within a specified distance to structures or subsurface sewage disposal systems. (see Appendix C, Protocol 2)



Variations

Intermediate "Sump" Box – Water can flow through an intermediate box with an outflow higher to allow the sediments to settle out. Water would then flow through a mesh screen and into the dry well.

Drain Without Gutters – For structures without gutters or downspouts, runoff is designed to sheetflow off a pitched roof surface and onto a stabilized ground cover (surface aggregate, pavement, or other means). Runoff is then directed toward a Dry Well via stormwater pipes or swales.



Prefabricated Dry Well – There are a variety of prefabricated, predominantly plastic subsurface storage chambers on the market today that can replace aggregate Dry Wells. Since these systems have significantly greater storage capacity than aggregate, space requirements are reduced and associated costs may be defrayed. Provided the following design guidelines are followed and infiltration is still encouraged, prefabricated chambers can prove just as effective as standard aggregate Dry Wells.

Applications

Any roof or impervious area with relatively low sediment loading

Design Considerations

1. Dry Wells are sized to temporarily retain and infiltrate stormwater runoff from roofs of structures. A dry well usually provides stormwater management for a limited roof area. Care should be taken not to hydraulically overload a dry well based on bottom area and drainage area. (See Appendix C, Protocol 2 for guidance)

2. Dry Wells should drain-down within the guidelines set in Chapter 3. Longer drain-down times reduce Dry Well efficiency and can lead to anaerobic conditions, odor and other problems.

3. Dry Wells typically consist of 18 to 48 inches of clean washed, uniformly graded aggregate with 40% void capacity (AASHTO No. 3, or similar). Dry Well aggregate is wrapped in a nonwoven geotextile, which provides separation between the aggregate and the surrounding soil. At least 12 inches of soil is then placed over the Dry Well. An alternative form of Dry Well is a subsurface, prefabricated chamber. A variety of prefabricated Dry Wells are currently available on the market.

4. Dry Wells are not recommended when their installation would create a significant risk for basement seepage or flooding. In general, 10 feet of separation is recommended between Dry Wells and building foundations. However, this distance may be shortened at the discretion of the designer. Shorter separation distances may warrant an impermeable liner to be installed on the building side of the Dry Well.

5. All Dry Wells should be able to convey system overflows to downstream drainage systems. System overflows can be incorporated either as surcharge (or overflow) pipes extending from roof leaders or via connections to more substantial infiltration areas.

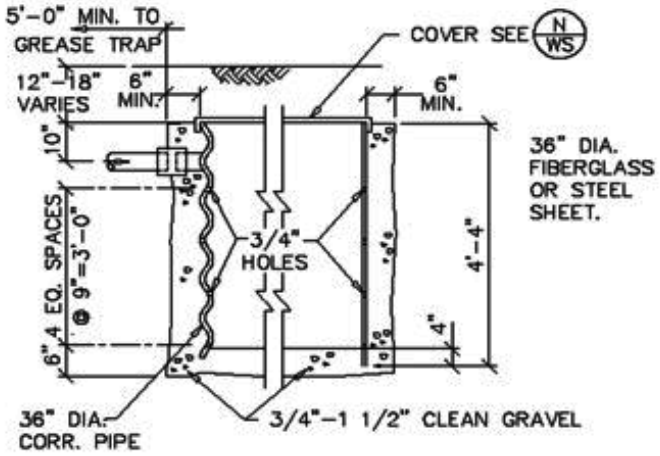
6. The design depth of a Dry Well should take into account frost depth to prevent frost heave.

7. A removable filter with a screened bottom should be installed in the roof leader below the surcharge pipe in order to screen out leaves and other debris.

8. Adequate inspection and maintenance access to the Well should be provided. Observation wells not only provide the necessary access to the Well, but they also provide a conduit through which pumping of stored runoff can be accomplished in case of slowed infiltration.

9. Though roofs are generally not a significant source of runoff pollution, they can still be a source of particulates and organic matter, as well as sediment and debris during construction. Measures such as roof gutter guards, roof leader clean-out with sump, or an intermediate sump box can provide pretreatment for Dry Wells by minimizing the amount of sediment and other particulates that may enter it.

NOTE:
1. FABRICATE FROM 12 GA. STEEL SHEET, 12 GA. CORR. PIPE (STEEL OR ALUM.) OR 1/4" FIBERGLASS.
2. STEEL OPTIONS SHALL BE GALV. AFTER FABRICATION.
3. MIN. PERFORATIONS – 4 ROWS OF 3/4" HOLES, 8 HOLES PER ROW, ALL OPTIONS.



SEEPAGE PIT F WS 51-120 3-28-88
SCALE: 1"=1'-0"

Detailed Stormwater Functions

Volume Reduction Calculations
The storage volume of a Dry Well is defined as the volume beneath the discharge invert. The following equation can be used to determine the approximate storage volume of an aggregate Dry Well:

Dry Well Volume = Dry well area (sf) x Dry well water depth (ft) x 40% (if stone filled)

Infiltration Area: A dry well may consider both bottom and side (lateral) infiltration according to design.

Peak Rate Mitigation Calculations
See Chapter 8 for corresponding peak rate reduction.

Water Quality Improvement
See Chapter 8

Construction Sequence

1. Protect infiltration area from compaction prior to installation.

2. If possible, install Dry Wells during later phases of site construction to prevent sedimentation and/or damage from construction activity.

3. Install and maintain proper Erosion and Sediment Control Measures during construction as per the Pennsylvania Erosion and Sediment Pollution Control Program Manual (March 2000, or latest edition).

4. Excavate Dry Well bottom to a uniform, level uncompacted subgrade free from rocks and debris. Do NOT compact subgrade. To the greatest extent possible, excavation should be performed with the lightest practical equipment. Excavation equipment should be placed outside the limits of the Dry Well.

5. Completely wrap Dry Well with nonwoven geotextile. (If sediment and/or debris have accumulated in Dry Well bottom, remove prior to geotextile placement.) Geotextile rolls should overlap by a minimum of 24 inches within the trench. Fold back and secure excess geotextile during stone placement.

6. Install continuously perforated pipe, observation wells, and all other Dry Well structures. Connect roof leaders to structures as indicated on plans.

7. Place uniformly graded, clean-washed aggregate in 6-inch lifts, lightly compacting between lifts.

8. Fold and secure nonwoven geotextile over trench, with minimum overlap of 12-inches.

9. Place 12-inch lift of approved Topsoil over trench, as indicated on plans.

10. Seed and stabilize topsoil.

11. Connect surcharge pipe to roof leader and position over splashboard.

12. Do not remove Erosion and Sediment Control measures until site is fully stabilized.

Maintenance Issues

As with all infiltration practices, Dry Wells require regular and effective maintenance to ensure prolonged functioning. The following represent minimum maintenance requirements for Dry Wells:

- Inspect Dry Wells at least four times a year, as well as after every storm exceeding 1 inch.
- Dispose of sediment, debris/trash, and any other waste material removed from a Dry Well at suitable disposal/recycling sites and in compliance with local, state, and federal waste regulations.
- Evaluate the drain-down time of the Dry Well to ensure the maximum time of 72 hours is not being exceeded. If drain-down times are exceeding the maximum, drain the Dry Well via pumping and clean out perforated piping, if included. If slow drainage persists, the system may need replacing.
- Regularly clean out gutters and ensure proper connections to facilitate the effectiveness of the dry well.
- Replace filter screen that intercepts roof runoff as necessary.
- If an intermediate sump box exists, clean it out at least once per year.

Cost Issues

The construction cost of a Dry Well/Seepage Pit can vary greatly depending on design variability, configuration, location, site-specific conditions, etc. Typical construction costs in 2003 dollars range from $4 - $9 per cubic foot of storage volume provided (SWRPC, 1991; Brown and Schueler, 1997). Annual maintenance costs have been reported to be approximately 5 to 10 percent of the capital costs (Schueler, 1987). The cost of gutters is typically included in the total structure cost, as opposed

Specifications

The following specifications are provided for information purposes only. These specifications include information on acceptable materials for typical applications, but are by no means exclusive or limiting. The designer is responsible for developing detailed specifications for individual design projects in accordance with the project conditions.

1. Stone for infiltration trenches shall be 2-inch to 1-inch uniformly graded coarse aggregate, with a wash loss of no more than 0.5%, AASHTO size No. 3 per AASHTO Specifications, Part I, 19th Ed., 1998, or later and shall have voids 40% as measured by ASTM-C29.

2. Nonwoven Geotextile shall consist of needled nonwoven polypropylene fibers and meet the following properties:

a. Grab Tensile Strength (ASTM-D4632) ³ 120 lbs
b. Mullen Burst Strength (ASTM-D3786) ³ 225 psi
c. Flow Rate (ASTM-D4491) ³ 95 gal/min/ft^2
d. UV Resistance after 500 hrs (ASTM-D4355) ³ 70%
e. Heat-set or heat-calendared fabrics are not permitted
Acceptable types include Mirafi 140N, Amoco 4547, and Geotex 451.

3. Topsoil See Appendix C

4. Pipe shall be continuously perforated, smooth interior, with a minimum inside diameter of 4-inches. High-density polyethylene (HDPE) pipe shall meet AASHTO M252, Type S or AASHTO M294, Type S. 12 gauge aluminum or corrugated steel pipe may be used in seepage pits.

5. Gutters and splashboards shall follow Manufacturer's specifications.

References

New Jersey Department of Environmental Protection. *New Jersey Stormwater Best Management Practices Manual*. 2004.

New York Department of Environmental Conservation. *New York State Stormwater Management Design Manual.* 2003.

French Drains. http://www.unexco.com/french.html . 2004.

SWRPC, The Use of of Best Management Practices(BMPs) in Urban Watersheds, US Environmental Protection Agency,1991.

Brown and Schueler, *Stormwater Management Fact Sheet: Infiltration Trench.* 1997.

Schueler, T., 1987. *Controlling urban runoff: a practical manual for planning and designing urban BMPs*, Metropolitan Washington Council of Governments, Washington, DC

Infiltration Trench

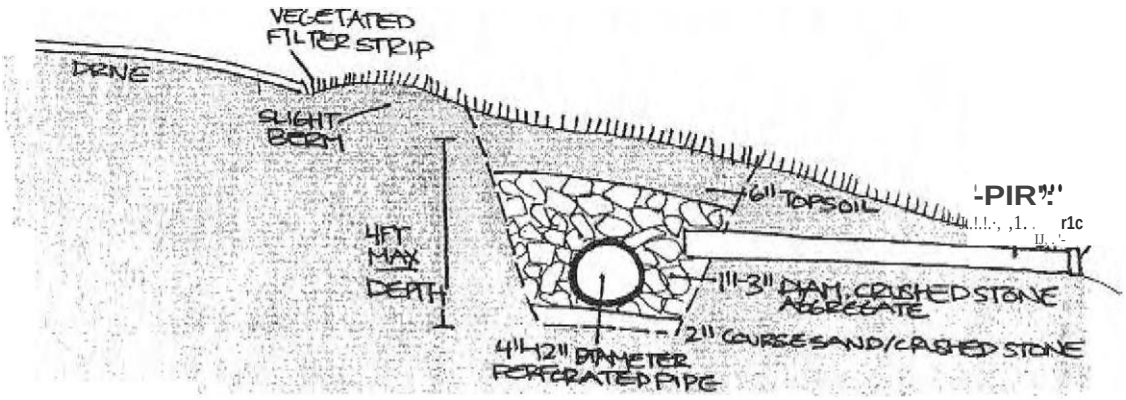
An infiltratfon trench is a stone tilled trench that stores, infiltrates, and cleans stormwater runoff. Infiltration trenches work well *tor* catching water from small impervious areas, such as a discon nected patio, path, driveway, or even rooftop. Infiltration trenches MUST be adjacent to a vegetated filter strip, to help purify water .

Sizing

1. Find the Stormwater Runoff Volume (Step 2). Use this number to determine how much stormwater you rnust manage. We'll call this volume Trench Required Dimensions"

2. "Trench Required Dimensions" "' Trench Void Volume/ 40"'/o void ratior
w(void ratio is a result of the gaps between stone aggregate)
161.25ft cu= storrnwater volume of half of the example driveway.
161.25 ft cu (Trench Requir t'!Jd Dim ensions)- Trench Void Volume /40'7,;,
Trench Void Volume "' 64.5ft cu

3 _ Sizing **of** the Trench
Trench Vold Volume "' width•.. x length x depth"'
--maximum depth should be 3.5'
**average trench width is about .5'
64.5ft cu (Trench Void Volume) "' 1ft width X 3.5 ft depth X 18.42 ft length



Installation

Avoid soil compaction during the construction process. Excavate the trench, according to calculated sizing, creating a level un-compactedbottom. It is very important that tt, e bottom of the trench is very flat.
Line the trench with 2" sand or finely crushed stone. Place inslde a level pertorated pipe, and consider overflow pipe that nms horizontally until above ground, like one on a drywell. The overflow outlet pipe should have a cap on the end.
=-ill witt1 ston e aggregate. Aggregate fill should be 1" to 3" dia.rnater . Place 6" of topsoil on top of trench, and rn-seed the topsoil.

Maintenance

Veget ation along the surface of the trench, and on the filter strip; should be maintained. Avoid driving on or compacting soil on top of an infiltratlon trench. Inspect the overllow pipe regularly to check for leakage .

Cost

Typical constructi on costs tend to be $4 to $9 per cubic foot. Costs are associated with the labor (if used} and m ateria ls.
he cost of t11e example trench would be $650 to $1400.

BMP 6.4.3: Subsurface Infiltration Bed

Subsurface Infiltration Beds provide temporary storage and infiltration of stormwater runoff by placing storage media of varying types beneath the proposed surface grade. Vegetation will help to increase the amount of evapotranspiration taking place.

Key Design Elements

- Maintain a minimum 2-foot separation to bedrock and seasonally high water table, provide distributed infiltration area (5:1 impervious area to infiltration area - maximum), site on natural, uncompacted soils with acceptable infiltration capacity, and follow other guidelines described in Protocol 2: Infiltration Systems Guidelines
- Beds filled with stone (or alternative) as needed to increase void space
- Wrapped in nonwoven geotextile
- Level or nearly level bed bottoms
- Provide positive stormwater overflow from beds
- Protect from sedimentation during construction
- Provide perforated pipe network along bed bottom for distribution as necessary
- Open-graded, clean stone with minimum 40% void space
- Do not place bed bottom on compacted fill
- Allow 2 ft. buffer between bed bottom and seasonal high groundwater table and 2 ft. for bedrock.

Potential Applications

Residential: Yes
Commercial: Yes
Ultra Urban: Yes
Industrial: Yes
Retrofit: Yes
Highway/Road: Limited

Stormwater Functions

Volume Reduction: High
Recharge: High
Peak Rate Control: Med./High
Water Quality: High

Water Quality Functions

TSS: 85%
TP: 85%
NO3: 30%

Other Considerations

- **Protocol 1. Site Evaluation and Soil Infiltration Testing** and **Protocol 2. Infiltration Systems Guidelines** should be followed, see Appendix C

Description

A Subsurface Infiltration Bed generally consists of a vegetated, highly pervious soil media underlain by a uniformly graded aggregate (or alternative) bed for temporary storage and infiltration of stormwater runoff. Subsurface Infiltration beds are ideally suited for expansive, generally flat open spaces, such as lawns, meadows, and playfields, which are located downhill from nearby impervious areas. Subsurface Infiltration Beds can be stepped or terraced down sloping terrain provided that the base of the bed remains level. Stormwater runoff from nearby impervious areas (including rooftops, parking lots, roads, walkways, etc.) can be conveyed to the subsurface storage media, where it is then distributed via a network of perforated piping.

The storage media for subsurface infiltration beds typically consists of clean-washed, uniformly graded aggregate. However, other storage media alternatives are available. These alternatives are generally variations on plastic cells that can more than double the storage capacity of aggregate beds, at a substantially increased cost. Storage media alternatives are ideally suited for sites where potential infiltration area is limited.

If designed, constructed, and maintained as per the following guidelines, Subsurface Infiltration features can stand-alone as significant stormwater runoff volume, rate, and quality control practices. These systems can also maintain aquifer recharge, while preserving or creating valuable open space and recreation areas. They have the added benefit of functioning year-round, given that the infiltration surface is typically below the frost line.

Variations

As its name suggests, Subsurface Infiltration is generally employed for temporary storage and infiltration of runoff in subsurface storage media. However, in some cases, runoff may be temporarily stored on the surface (to depths less than 6 inches) to enhance volume capacity of the system. The overall system design should ensure that within the criteria in Chapter 3, the bed is completely empty.

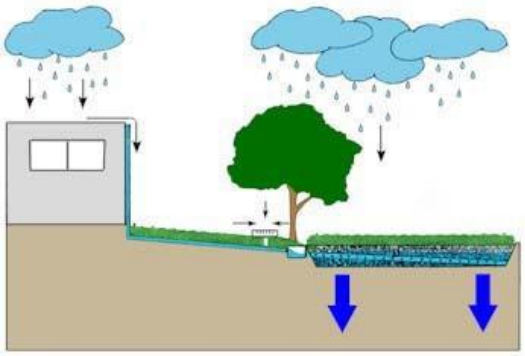
Applications

Connection of Roof Leaders

Runoff from nearby roofs may be directly conveyed to subsurface beds via roof leader connections to perforated piping. Roof runoff generally has relatively low sediment levels, making it ideally suited for connection to an infiltration bed. However, cleanout(s) with a sediment sump are still recommended between the building and infiltration bed.

Connection of Inlets

Catch Basins, inlets, and area drains may be connected to Subsurface Infiltration beds. However, sediment and debris removal should be provided. Storm structures should therefore include sediment trap areas below the inverts of discharge pipes to trap solids and debris. In areas of high traffic or excessive generation of sediment, litter, and other similar materials, a water quality insert or other pretreatment device may be needed.



Under Recreational Fields

Subsurface Infiltration is very well suited below playfields and other recreational areas. Special consideration should be given to the engineered soil mix in those cases.

Under Open Space

Subsurface Infiltration is also appropriate in either existing or proposed open space areas. Ideally, these areas are vegetated with native grasses and/or vegetation to enhance site aesthetics and landscaping. Aside from occasional clean-outs or outlet structures, Subsurface Infiltration systems are essentially hidden stormwater management features, making them ideal for open space locations (deed-restricted open space locations are especially desirable because such locations minimize the chance that Subsurface Infiltration systems will be disturbed or disrupted accidentally in the future).

Other Applications

Other applications of Subsurface Infiltration beds may be determined by the Design Professional as appropriate.

Design Considerations

1. Soil Investigation and Infiltration Testing is needed (Appendix C).

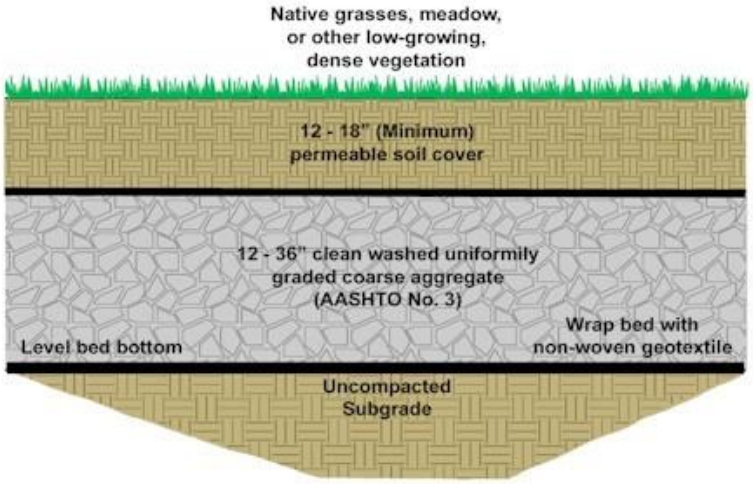
2. Guidelines for Infiltration Systems should be met (Appendix C).

3. The overall site should be evaluated for potential Subsurface Infiltration areas early in the design process, as effective design requires consideration of existing site characteristics (topography, natural features/drainage ways, soils, geology, etc.).

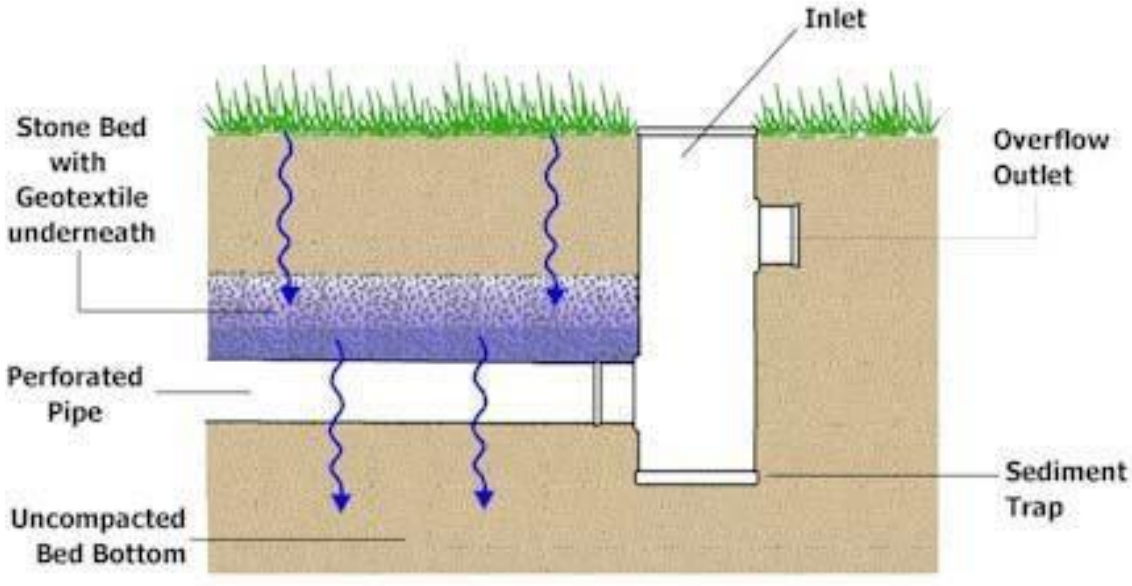
4. Control of Sediment is critical. Rigorous installation and maintenance of erosion and sediment control measures is needed to prevent sediment deposition within the stone bed. Nonwoven geotextile may be folded over the edge of the bed until the site is stabilized.

5. The Infiltration bed should be wrapped in non-woven geotextile filter fabric.

6. Subsurface Infiltration areas should not be placed on areas of recent fill or compacted fill. Any grade adjustments requiring fill should be done using the stone subbase material, or alternative. Areas of historical fill (>5 years) may be considered if other criteria are met.



7. The subsurface infiltration bed is typically comprised of a 12 to 36 inch section of aggregate, such as AASHTO No.3, which ranges 1-2 inches in gradation. Depending on local aggregate availability, both larger and smaller size aggregate has been used. The critical requirements are that the aggregate be uniformly graded, clean-washed, and contain at least 40% void space. The depth of the bed is a function of stormwater storage requirements, frost depth considerations, and site grading. Infiltration beds are typically sized to mitigate the increased runoff volume from the design storm.



8. Water Quality Inlet or Catch Basin with Sump is needed for all surface inlets, should be designed to avoid standing water for periods greater than the criteria in Chapter 3.

9. Infiltration beds may be placed on a slope by benching or terracing infiltration levels. The slope of the infiltration bed bottom should be level or with a slope no greater than 1%. A level bottom assures even water distribution and infiltration.

10. Perforated pipes along the bottom of the bed can be used to evenly distribute runoff over the entire bed bottom. Continuously perforated pipes may connect structures (such as cleanouts and inlet boxes). Pipes should lay flat along the bed bottom and provide for uniform distribution of water. Depending on size, these pipes may provide additional storage volume.

11. Cleanouts or inlets should be installed at a few locations within the bed and at appropriate intervals to allow access to the perforated piping network and or storage media.

12. All infiltration beds should be designed with an overflow for extreme storm events. Control in the beds is usually provided in the form of an outlet control structure. A modified inlet box with an internal concrete weir (or weir plate) and low-flow orifice is a common type of control structure. The specific design of these structures may vary, depending on factors such as rate and storage requirements, but it must always include positive overflow from the system. The overflow structure is used to maximize the water level in the stone bed, while providing sufficient cover for overflow pipes. Generally, the top of the outlet pipe should be 4 inches below the top of the aggregate to prevent saturated soil conditions in remote areas of the bed. As with all

infiltration practices, multiple discharge points are recommended. These may discharge to the surface or a storm sewer system.

13. Adequate soil cover (generally 12 - 18 inches) should be maintained above the infiltration bed to allow for a healthy vegetative cover.

14. Open space overlying infiltration beds can be vegetated with native grasses, meadow mix, or other low-growing, dense vegetation. These plants have longer roots than traditional grass and will likely benefit from the moisture in the infiltration bed, improving the growth of these plantings and, potentially increasing evapotranspiration.

15. Fertilizer use should be minimized.

16. The surface (above the stone bed) should be compacted as minimally as possible to allow for surface percolation through the engineered soil layer and into the stone bed.

17. When directing runoff from roadway areas into the beds, measures to reduce sediment should be used.

18. Surface grading should be relatively flat, although a relatively mild slope between 1% and 3% is recommended to facilitate drainage.

19. In those areas where the threat of spills and groundwater contamination exists, pretreatment systems, such as filters and wetlands, may be needed before any infiltration occurs. In Hot Spot areas, such as truck stops and fueling stations, the suitability of Subsurface Infiltration must be considered.

20. In areas with poorly-draining soils, Subsurface Infiltration areas may be designed to slowly discharge to adjacent wetlands or bioretention areas.

21. While most Subsurface Infiltration areas consist of an aggregate storage bed, alternative subsurface storage products may also be employed. These include a variety of proprietary, interlocking plastic units that contain much greater storage capacity than aggregate, at an increased cost.

22. The subsurface bed and overflow may be designed and evaluated in the same manner as a detention basin to demonstrate the mitigation of peak flow rates. In this manner, detention basins may be eliminated or significantly reduced in size.

23. During Construction, the excavated bed may serve as a Temporary Sediment Basin or Trap. This can reduce overall site disturbance. The bed should be excavated to at least 1 foot above the final bed bottom elevation for use as a sediment trap or basin. Following construction and site stabilization, sediment should be removed and final grades established. In BMPs that will be used for infiltration in the future, use of construction equipment should be limited as much as possible.

Detailed Stormwater Functions

Infiltration Area

Loading rate quidelines in Appendix C should be consulted**.**

The Infiltration Area is the bottom area of the bed, defined as:

Length of bed x Width of bed = Infiltration Area (if rectangular)

Volume Reduction Calculations

Volume = Depth* (ft) x Area (sf) x Void Space

*Depth is the depth of water stored during a storm event, depending on the drainage area and conveyance to the bed.

Infiltration Volume = Bed Bottom Area (sf) x Infiltration design rate (in/hr) x Infiltration period* (hr) x (1/12)

*Infiltration Period is equal to 2 hours or the time of concentration, whichever is larger.

Additional storage/volume reduction can be calculated for the overlying soil as appropriate.

Peak Rate Mitigation Calculations

See in Chapter 8 for Peak Rate Mitigation methodology which addresses link between volume reduction and peak rate control.

Water Quality Improvement: See in Chapter 8 for Water Quality Improvement methodology, which addresses pollutant removal effectiveness of this BMP.

Construction Sequence

1. Due to the nature of construction sites, Subsurface Infiltration should be installed toward the end of the construction period, if possible. (Infiltration beds may be used as temporary sediment basins or traps as discussed above).

2. Install and maintain adequate Erosion and Sediment Control Measures (as per the Pennsylvania Erosion and Sedimentation Control Program Manual) during construction.

3. The existing subgrade under the bed areas should NOT be compacted or subject to excessive construction equipment traffic prior to geotextile and stone bed placement.

4. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, this material should be removed with light equipment and the underlying soils scarified to a minimum depth of 6 inches with a York rake (or equivalent) and light tractor. All fine grading should be done by hand. All bed bottoms should be at level grade.

5. Earthen berms (if used) between infiltration beds should be left in place during excavation. These berms do not require compaction if proven stable during construction.

6. Install upstream and downstream control structures, cleanouts, perforated piping, and all other necessary stormwater structures.

7. Geotextile and bed aggregate should be placed immediately after approval of subgrade preparation and installation of structures. Geotextile should be placed in accordance with manufacturer's standards and recommendations. Adjacent strips of geotextile should overlap a minimum of 16 inches. It should also be secured at least 4 feet outside of bed in order to prevent any runoff or sediment from entering the storage bed. This edge strip should remain in place until all bare soils contiguous to beds are stabilized and vegetated. As the site is fully stabilized, excess geotextile along bed edges can be cut back to the edge of the bed.

8. Clean-washed, uniformly graded aggregate should be placed in the bed in maximum 8-inch lifts. Each layer should be lightly compacted, with construction equipment kept off the bed bottom as much as possible.

9. Approved soil media should be placed over infiltration bed in maximum 6-inch lifts.

10. Seed and stabilize topsoil.

11. Do not remove inlet protection or other Erosion and Sediment Control measures until site is fully stabilized.

Maintenance Issues

Subsurface Infiltration is generally less maintenance intensive than other practices of its type. Generally speaking, vegetation associated with Subsurface Infiltration practices is less substantial than practices such as Recharge Gardens and Vegetated Swales and therefore requires less maintenance. Maintenance activities required for the subsurface bed are similar to those of any infiltration system and focus on regular sediment and debris removal. The following represents the recommended maintenance efforts:

- All Catch Basins and Inlets should be inspected and cleaned at least 2 times per year.

- The overlying vegetation of Subsurface Infiltration features should be maintained in good condition, and any bare spots revegetated as soon as possible.

- Vehicular access on Subsurface Infiltration areas should be prohibited, and care should be taken to avoid excessive compaction by mowers. If access is needed, use of permeable, turf reinforcement should be considered.

Cost Issues

The construction cost of Subsurface Infiltration can vary greatly depending on design variations, configuration, location, desired storage volume, and site-specific conditions, among other factors. Typical construction costs are about $5.70 per square foot, which includes excavation, aggregate (2.0 feet assumed), non-woven geotextile, pipes and plantings.

Specifications

The following specifications are provided for information purposes only. These specifications include information on acceptable materials for typical applications, but are by no means exclusive or limiting. The designer is responsible for developing detailed specifications for individual design projects in accordance with the project conditions.

1. **Stone** for infiltration beds shall be 2-inch to 1-inch uniformly graded coarse aggregate, with a wash loss of no more than 0.5%, AASHTO size number 3 per AASHTO Specifications, Part I, 19th Ed., 1998, or later and shall have voids 40% as measured by ASTM-C29.

2. **Non-Woven 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/ft^2
   d. UV Resistance after 500 hrs (ASTM-D4355) 70%
   e. Heat-set or heat-calendared fabrics are not permitted
      Acceptable types include Mirafi 140N, Amoco 4547, and Geotex 451.

3. **Topsoil** may be amended with compost (See soil restoration BMP 6.7.2)

4. **Pipe** shall be continuously perforated, smooth interior, with a minimum inside diameter of 6-inches. High-density polyethylene (HDPE) pipe shall meet AASHTO M252, Type S or AASHTO M294, Type S.

5. **Storm Drain Inlets and Structures**
   a. Concrete Construction: Concrete construction shall be in accordance with Section 1001, PennDOT Specifications, 1990 or latest edition.
   b. Precast Concrete Inlets and Manholes: Precast concrete inlets may be substituted for cast-in-place structures and shall be constructed as specified for cast-in-place.

      Precast structures may be used in only those areas where there is no conflict with existing underground structures that may necessitate revision of inverts. Type M standard PennDOT inlet boxes will be modified to provide minimum 12 inch sump storage and bottom leaching basins, open to gravel sumps in sub-grade, when situated in the recharge bed.
   c. All PVC Catch Basins/Cleanouts/Inline Drains shall have H-10 or H-20 rated grates, depending on their placement (H-20 if vehicular loading).
   d. Steel reinforcing bars over the top of the outlet structure shall conform to ASTM A615, grades 60 and 40.
   e. Permanent turf reinforcement matting shall be installed according to manufacturers' specifications.

6. **Alternative storage media:** Follow appropriate Manufacturers' specifications.

7. **Vegetation** see Local Native Plant List and Appendix B.

BMP 6.4.4: Infiltration Trench

An Infiltration Trench is a “leaky” pipe in a stone filled trench with a level bottom. An Infiltration Trench may be used as part of a larger storm sewer system, such as a relatively flat section of storm sewer, or it may serve as a portion of a stormwater system for a small area, such as a portion of a roof or a single catch basin. In all cases, an Infiltration Trench should be designed with a positive overflow.

Key Design Elements

- Continuously perforated pipe set at a minimum slope in a stone filled, level-bottomed trench
- Limited in width (3 to 8 feet) and depth of stone (6 feet max. recommended)
- Trench is wrapped in nonwoven geotextile (top, sides, and bottom)
- Placed on uncompacted soils
- Minimum cover over pipe is as per manufacturer.
- A minimum of 6" of topsoil is placed over trench and vegetated
- Positive Overflow always provided

Deed restrictions recommended

Not for use in hot spot areas without pretreatment

Potential Applications

Residential: Yes
Commercial: Yes
Ultra Urban: Yes
Industrial: Yes
Retrofit: Yes
Highway/Road: Yes

Stormwater Functions

Volume Reduction: Medium
Recharge: High
Peak Rate Control: Medium
Water Quality: High

Water Quality Functions

TSS: 85%
TP: 85%
NO3: 30%

Other Considerations

- **Protocol 1. Site Evaluation and Soil Infiltration Testing** and **Protocol 2. Infiltration Systems Guidelines** should be followed, see Appendix C

Description

An Infiltration Trench is a linear stormwater BMP consisting of a continuously perforated pipe at a minimum slope in a stone-filled trench (Figure 6.4-1). Usually an Infiltration Trench is part of a **conveyance system** and is designed so that large storm events are conveyed through the pipe with some runoff volume reduction. During small storm events, volume reduction may be significant and there may be little or no discharge. All Infiltration Trenches are designed with a **positive overflow** (Figure 6.4-2).

An Infiltration Trench differs from an Infiltration Bed in that it may be constructed without heavy equipment entering the trench. It is also intended to convey some portion of runoff in many storm events.

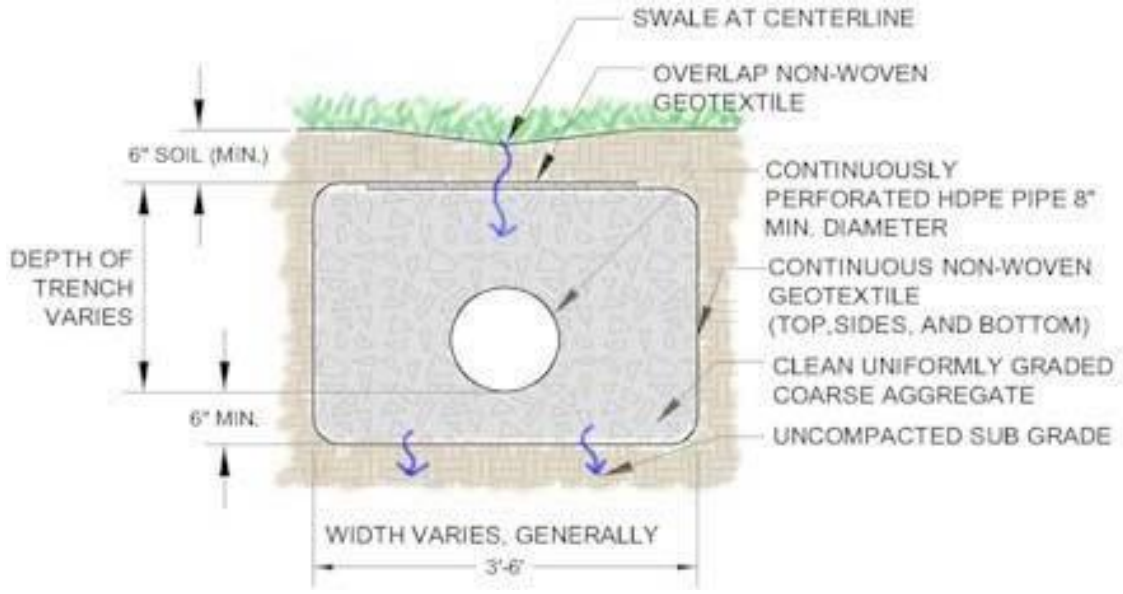


Figure 6.4-1

Figure 6.4-2

All Infiltration Trenches should be designed in accordance with Appendix C. Although the width and depth can vary, it is recommended that Infiltration Trenches be limited in depth to not more than six (6)

feet of stone. This is due to both construction issues and Loading Rate issues (as described in the Guidelines for Infiltration Systems). The designer should consider the appropriate depth.

Variations

Infiltration Trenches generally have a vegetated (grassed) or gravel surface. Infiltration Trenches also may be located alongside or adjacent to roadways or impervious paved areas with proper design. The subsurface drainage direction should be to the downhill side (away from subbase of pavement), or located lower than the impervious subbase layer. Proper measures should be taken to prevent water infiltrating into the subbase of impervious pavement.

Infiltration Trenches may also be located down a mild slope by “stepping” the sections between control structures as shown in Figure 6.4-3. A level or nearly level bottom is recommended for even distribution.

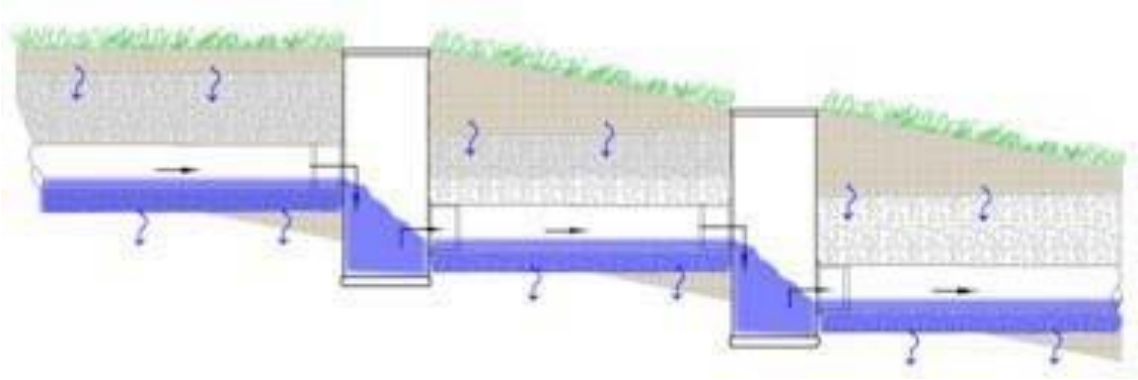


Figure 6.4-3

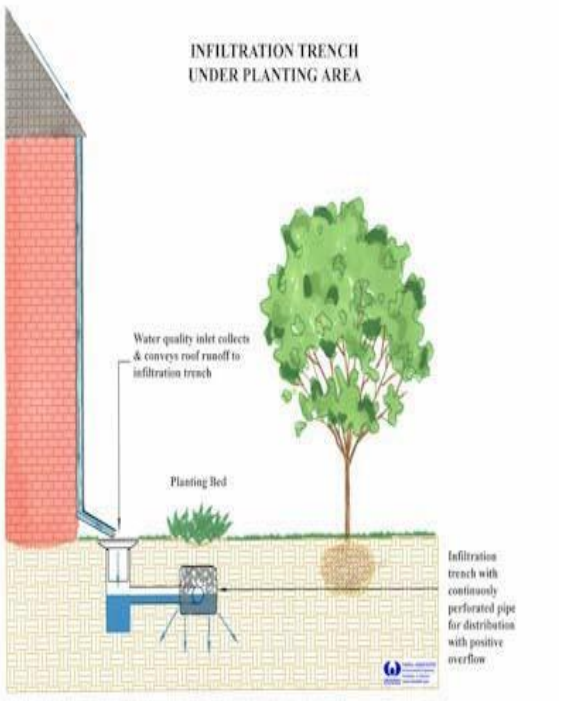
Applications

- **Connection of Roof Leaders**

Roof leaders may be connected to Infiltration Trenches. Roof runoff generally has lower sediment levels and often is ideally suited for discharge through an Infiltration Trench. A cleanout with sediment sump should be provided between the building and Infiltration Trench.

- **Connection of Inlets**

Catch Basins, inlets and area drains may be connected to Infiltration Trenches, however sediment and debris removal should be addressed. Structures should include a sediment trap area below the invert of the pipe for solids and debris. In areas of high traffic or areas where excessive sediment, litter, and other similar materials may be generated, a water quality insert or other pretreatment device is needed.



- **In Combination with Vegetative Filters**

An Infiltration Trench may be preceded by or used in combination with a Vegetative Filter, Grassed Swale, or other vegetative element used to reduce sediment levels

from areas such as high traffic roadways. Design should ensure proper functioning of vegetative system.

- **Other Applications**

Other applications of Infiltration Trenches may be determined by the design professional as appropriate.

Design Considerations

1. Soil Investigation and Percolation Testing is required (see Appendix C, Protocol 2)
2. Guidelines for Infiltration Systems should be met (i.e., depth to water table, setbacks, Loading Rates, etc. See Appendix C, Protocol 1)
3. Water Quality Inlet or Catch Basin with Sump (see Section 6.6.4) recommended for all surface inlets, designed to avoid standing water for periods greater than the criteria in Chapter 3.
4. A continuously perforated pipe should extend the length of the trench and have a positive flow connection designed to allow high flows to be conveyed through the Infiltration Trench.
5. The slope of the Infiltration Trench bottom should be level or with a slope no greater than 1%. The Trench may be constructed as a series of “steps” if necessary. A level bottom assures even water distribution and infiltration.
6. Cleanouts or inlets should be installed at both ends of the Infiltration Trench and at appropriate intervals to allow access to the perforated pipe.
7. The discharge or overflow from the Infiltration Trench should be properly designed for anticipated flows.

Detailed Stormwater Functions

Infiltration Area

The Infiltration Area is the bottom area of the Trench*, defined as:

Length of Trench x Width of Trench = Infiltration Area (Bottom Area)

This is the area to be considered when evaluating the Loading Rate to the Infiltration Trench.
* Some credit can be taken for the side area that is frequently inundated as appropriate.

Volume Reduction Calculations

Volume = Depth* (ft) x Area (sf) x Void Space

*Depth is the depth of the water surface during a storm event, depending on the drainage area and conveyance to the bed.

Infiltration Volume = Bed Bottom Area (sf) x Infiltration design rate (in/hr)
x Infiltration period* (hr) x (1/12)

*Infiltration Period is the time when bed is receiving runoff and capable of infiltration. Not to exceed 72 hours.

The void ratio in stone is approximately 40% for AASTO No 3. If the conveyance pipe is within the Storage Volume area, the volume of the pipe may also be included. All Infiltration Trenches should be designed to infiltrate or empty within 72 hours.

Peak Rate Mitigation Calculations

See Chapter 8 for Peak Rate Mitigation methodology which addresses link between volume reduction and peak rate control.

Water Quality Improvement

See Chapter 8 for Water Quality Improvement methodology which addresses pollutant removal effectiveness of this BMP.

Construction Sequence

1. Protect Infiltration Trench area from compaction prior to installation.
2. If possible, install Infiltration Trench during later phases of site construction to prevent sedimentation and/or damage from construction activity. After installation, prevent sediment laden water from entering inlets and pipes.
3. Install and maintain proper Erosion and Sediment Control Measures during construction.
4. Excavate Infiltration Trench bottom to a uniform, level uncompacted subgrade free from rocks and debris. Do NOT compact subgrade.
5. Place nonwoven geotextile along bottom and sides of trench*. Nonwoven geotextile rolls should overlap by a minimum of 16 inches within the trench. Fold back and secure excess geotextile during stone placement.
6. Install upstream and downstream Control Structures, cleanouts, etc.
7. Place uniformly graded, clean-washed aggregate in 8-inch lifts, lightly compacting between lifts.
8. Install Continuously Perforated Pipe as indicated on plans. Backfill with uniformly graded, clean-washed aggregate in 8-inch lifts, lightly compacting between lifts.
9. Fold and secure nonwoven geotextile over Infiltration Trench, with minimum overlap of 16-inches.
10. Place 6-inch lift of approved Topsoil over Infiltration Trench, as indicated on plans.
11. Seed and stabilize topsoil.
12. Do not remove Inlet Protection or other Erosion and Sediment Control measures until site is fully stabilized.
13. Any sediment that enters inlets during construction is to be removed within 24 hours.

(from left to right) Installation of Inlets and Control Structure; Non-woven Geotextile is folded over Infiltration Trench; Stabilized Site

(Clockwise from top left) Infiltration Trench is on downhill side of roadway; Infiltration Trench is installed; Infiltration Trench is paved with standard pavement material

Maintenance and Inspection Issues

- Catch Basins and Inlets should be inspected and cleaned at least 2 times per year.
- The vegetation along the surface of the Infiltration Trench should be maintained in good condition, and any bare spots revegetated as soon as possible.
- Vehicles should not be parked or driven on a vegetated Infiltration Trench, and care should be taken to avoid excessive compaction by mowers.

Cost Issues

The construction cost of infiltration trenches can vary greatly depending on the configuration, location, site-specific conditions, etc. Typical construction costs in 2003 dollars range from $4 - $9 per cubic foot of storage provided (SWRPC, 1991; Brown and Schueler, 1997). Annual maintenance costs have been reported to be approximately 5 to 10 percent of the capital costs (Schueler, 1987).

Specifications

The following specifications are provided for information purposes only. These specifications include information on acceptable materials for typical applications, but are by no means exclusive or limiting. The designer is responsible for developing detailed specifications for individual design projects in accordance with the project conditions.

1. Stone for infiltration trenches shall be 2-inch to 1-inch uniformly graded coarse aggregate, with a wash loss of no more than 0.5%, AASHTO size number 3 per AASHTO Specifications, Part I, 19th Ed., 1998, or later and shall have voids 40% as measured by ASTM-C29.

2. Non-Woven Geotextile shall consist of needled nonwoven polypropylene fibers and meet the following properties:

a. Grab Tensile Strength (ASTM-D4632)
b. Mullen Burst Strength (ASTM-D3786)
c. Flow Rate (ASTM-D4491)
d. UV Resistance after 500 hrs (ASTM-D4355) 70%
e. Heat-set or heat-calendared fabrics are not permitted
Acceptable types include Mirafi 140N, Amoco 4547, and Geotex 451.

3. Pipe shall be continuously perforated, smooth interior, with a minimum inside diameter of 8-inches. High-density polyethylene (HDPE) pipe shall meet AASHTO M252, Type S or AASHTO M294, Type S.

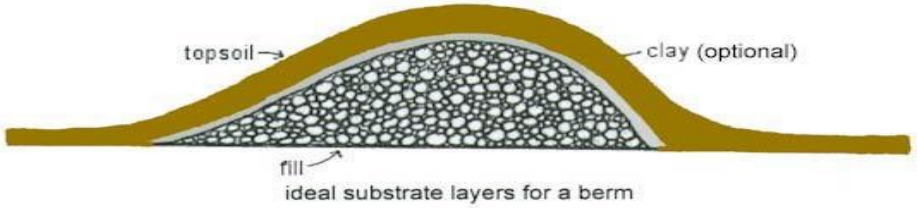
References

Brown and Schueler, *Stormwater Management Fact Sheet: Infiltration Trench.* 1997.

Schueler, T., 1987. *Controlling urban runoff: a practical manual for planning and designing urban BMPs*, Metropolitan Washington Council of Governments, Washington, DC

SWRPC, The Use of of Best Management Practices (BMPs) in Urban Watersheds, US Environmental Protection Agency,1991.

BMP 6.4.10: Infiltration Berm & Retentive Grading



An Infiltration Berm is a mound of compacted earth with sloping sides that is usually located along a contour on relatively gently sloping sites. Berms can also be created through excavation/removal of upslope material, effectively creating a Berm with the original grade. Berms may serve various stormwater drainage functions including: creating a barrier to flow, retaining flow and allowing infiltration for volume control, and directing flows. Grading may be designed in some cases to prevent rather than promote stormwater flows, through creation of "saucers" or "lips" in site yard areas where temporary retention of stormwater does not interfere with use.

Key Design Elements

- Maintain a minimum 2-foot separation to bedrock and seasonally high water table, provide distributed infiltration area (5:1 impervious area to infiltration area - maximum), site on natural, uncompacted soils with acceptable infiltration capacity, and follow other guidelines described in Protocol 2: Infiltration Systems Guidelines
- Berms should be relatively low, preferably no more than 24 inches in height.
- If berms are to be mowed, the berm side slopes should not exceed a ratio of 4:1 to avoid "scalping" by mower blades.
- The crest of the berm should be located near one edge of the berm, rather than in the middle, to allow for a more natural, asymmetrical shape.
- Berms should be vegetated with turf grass at a minimum, however more substantial plantings such as meadow vegetation, shrubs and trees are recommended.

Potential Applications

Residential: Yes
Commercial: Yes Ultra
Urban: Limited
Industrial: Yes
Retrofit: Yes
Highway/Road: Yes

Stormwater Functions

Volume Reduction: Low/Med.
Recharge: Low
Peak Rate Control: Medium
Water Quality: Med./High

Water Quality Functions

TSS: 60%
TP: 50%
NO3: 40%

Other Considerations

- **Protocol 1. Site Evaluation and Soil Infiltration Testing** and **Protocol 2. Infiltration Systems Guidelines** should be followed, see Appendix C

Description

Infiltration Berms are linear landscape features located along (i.e. parallel to) existing site contours in a moderately sloping area. They can be described as built-up earthen embankments with sloping sides, which function to divert, retain and promote infiltration, slow down, or divert stormwater flows. Berms are also utilized for reasons independent of stormwater management, such as to add interest to a flat landscape, create a noise or wind barrier, separate land uses, screen undesirable views or to enhance or emphasize landscape designs. Berms are often used in conjunction with recreational features, such as pathways through woodlands. Therefore, when used for stormwater management, berms and other retentive grading techniques can serve multifunctional purposes and are easily incorporated into the landscape.

Infiltration Berms create shallow depressions that collect and temporarily store stormwater runoff, allowing it to infiltrate into the ground and recharge groundwater. Infiltration berms may be constructed in series along a gradually sloping area.

1. Infiltration berms can be constructed on disturbed slopes and revegetated as part of the construction process. Infiltration berms should not be installed on slopes where soils having low shear strength (or identified as “slip prone” or “landslide prone”, etc.) have been mapped.
2. They can be installed along the contours within an existing woodland area to slow and infiltrate runoff from a development site.
3. May be constructed in combination with a subsurface infiltration trench at the base of the berm.

Infiltration Berms can provide runoff rate and volume control, though the level to which they do is limited by a variety of factors, including design variations (height, length, etc.), soil permeability rates, vegetative cover, and slope. Berms are ideal for mitigating runoff from relatively small impervious areas with limited adjacent open space (e.g. roads, small parking lots). Systems of parallel berms have been used to intercept stormwater from roadways or sloping terrain. Berms can sometimes be threaded carefully along contour on wooded hillsides, minimally disturbing existing vegetation and yet still gaining stormwater management credit from the existing woodland used. Conversely, berms are often incapable of controlling runoff from very large, highly impervious sites. Due to their relatively limited volume capacity, the length and/or number of berms required to retain large quantities of runoff make them impractical as the lone BMP in these cases. In these situations, berms are more appropriately used as pre- or additional-treatment for other more distributed infiltration systems closer to the source of runoff (i.e. porous pavement with subsurface infiltration).

Retentive grading may be employed in portions of sites where infiltration has been deemed to be possible and where site uses are compatible. Ideally, such retentive grading will serve to create subtle “saucers,” which contain and infiltrate stormwater flows. The “lip” of such saucers effectively function as a very subtle berm, which can be vertically impervious when vegetated and integrated into the overall landscape.

Variations

Diversion Berms

Diversion Berms can be used to protect slopes from erosion and to slow runoff rate. They can also be used to direct stormwater flow in order to promote longer flow pathways, thus increasing the time of concentration. Diversion berms often:

1. Consist of compacted earth ridges usually constructed across a slope in series to intercept runoff.
2. Can be incorporated within other stormwater BMPs to increase travel time of stormwater flow by creating natural meanders while providing greater opportunity for pollutant removal and infiltration.

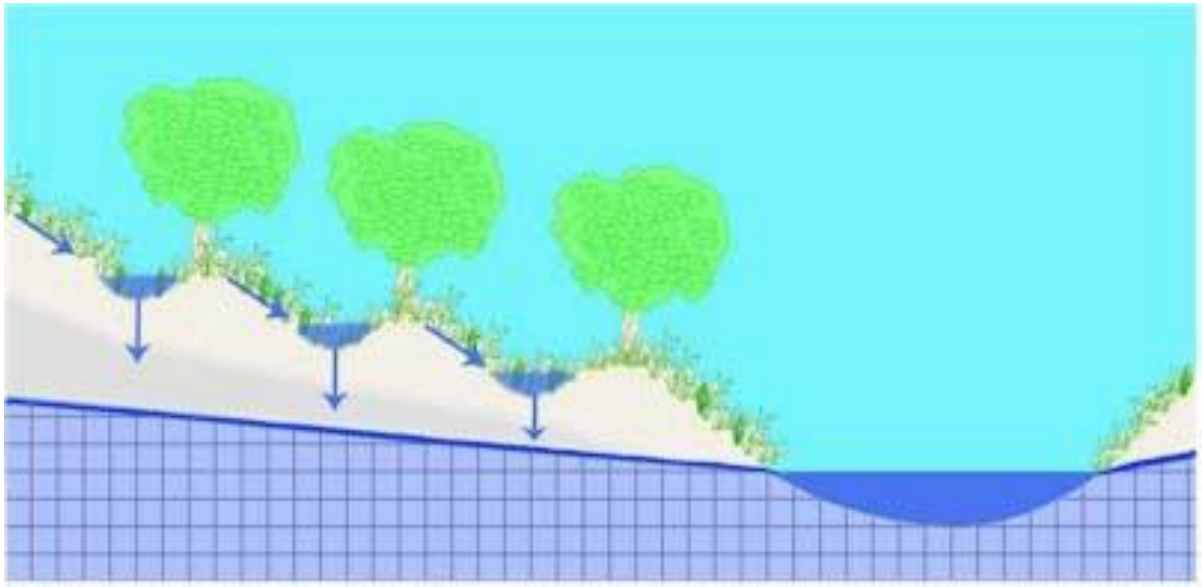
Applications

- **Meadow/Woodland Infiltration Berms**
  Infiltration Berms effectively control both the rate and volume of stormwater runoff. The berms are constructed along the contours and serve to collect and retain stormwater runoff, allowing it to infiltrate through the soil mantle and recharge the groundwater. Depressed areas adjacent to the berms should be level so that concentrated flow paths are not encouraged. Infiltration berms may have a variety of vegetative covers but meadow and woodland are recommended in order to reduce maintenance. If turf grass is used, berms in series should be constructed with enough space between them to allow access for maintenance vehicles. Also, berm side slopes should not exceed a 4:1 ratio. Woodland infiltration berms can sometimes be installed within existing wooded areas for additional stormwater management. Berms in wooded areas can even improve the health of existing vegetation, through enhanced groundwater recharge. Care should be taken during construction to ensure minimum disturbance to existing vegetation, especially tree roots.

- **Slope Protection**
  Diversion Berms can be used to help protect steeply sloping areas from erosion. Berms may divert concentrated discharge from a developed area away from the sloped area. Additionally, berms may be installed in series down the slope to retain flow and spread it out along multiple level berms to discourage concentrated flow.

- **Flow Pathway Creation**
  Berms may be utilized to create or enhance stormwater flow pathways within existing or proposed BMPs, or as part of an LID (Low Impact Development) strategy. Berms can be installed such that vegetated stormwater flow pathways are allowed to "meander" so that stormwater travel time is increased. For example, berms can be utilized within existing BMPs as part of a retrofit strategy to eliminate short-circuited inlet/outlet situations within detention basins provided care is taken to ensure the required storage capacity of the basin is maintained. Flow pathway creation can be utilized as part of an LID strategy to disconnect roof leaders and attenuate runoff, while increasing pervious flow pathways within developed areas. Berms should be designed to compliment the landscape while diverting runoff across vegetated areas and allowing for longer travel times to encourage pollutant removal and infiltration.

- **Constructed Wetland Berms**
  Berms are often utilized within constructed wetland systems in order to create elongated flow pathways with a variety of water depths. See BMP 6.6.1 – Constructed Wetlands.



Design Considerations

1. Sizing criteria are dependent on berm function, location and storage volume requirements.
   a. Low **berm height** (less than or equal to 24 inches) is recommended to encourage maximum infiltration and to prevent excessive ponding behind the berm. Greater heights may be used where berms are being used to divert flow or to create "meandering" or lengthened flow pathways. In these cases, stormwater is designed to flow adjacent to (parallel to), rather than over the crest of the berm. Generally, more berms of smaller size are preferable to fewer berms of large size.

b. **Berm length** is dependent on functional need and site size. Berms installed along the contours should be level and located across the slope. Maximum length will depend on width of the slope. Generally speaking, diversion berm length will vary with the size and constraints of the site in question.

2. **Infiltration Berms** should be constructed along (parallel to) contours at a constant elevation.

3. **Soil**. A berm may consist entirely of high quality topsoil. To reduce cost, only the top foot needs to consist of high quality Topsoil, with well-drained soil making up the remainder of the berm. The use of gravel is not recommended in the layers directly underneath the topsoil because of the tendency of the soil to wash through the gravel. In some cases, the use of clay may be required due to its cohesive qualities (especially where the berm height is high or relatively steeply sloped). However, well-compacted soil usually is sufficient provided that the angle of repose (see below) is not exceeded for the soil medium used.

   A more sustainable alternative to importing berm soil from off-site is to balance berm cut and fill material as much as possible, provided on-site soil is deemed suitable as per the Specifications below. Ideally, the concave segment (infiltration area) of the berm is excavated to a maximum depth of 12 inches and then used to construct the convex segment (crest of berm).

4. The **Angle of Repose of Soil** is the angle at which the soil will rest and not be subject to slope failure. The angle of repose of any soil will vary with the texture, water content, compaction, and vegetative cover. Typical angles of repose are given below:

   a. Non-compacted clay: 5-20%
   b. Dry Sand: 33%
   c. Loam: 35-40%
   d. Compacted clay: 50-80%

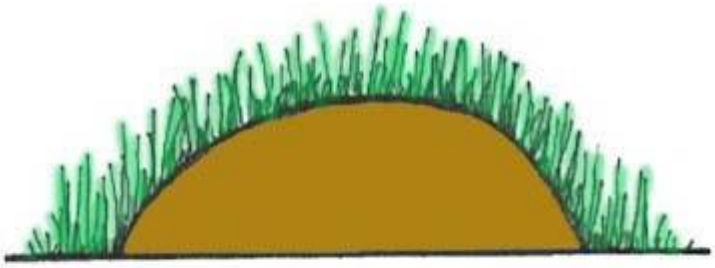
5. **Side Slopes**. The angle of repose for the soil used in the berm should determine the maximum slope of the berm with additional consideration to aesthetic, drainage, and maintenance needs. If a berm is to be mowed, the slope should not exceed a 4:1 ratio (horizontal to vertical) in order to avoid “scalping” by mower blades. If trees are to be planted on berms, the slope should not exceed a 5:1 ratio. Other herbaceous plants, which do not require mowing, can tolerate slopes of 3:1. Berm side slopes should not exceed a 2:1 ratio.

6. **Plant Materials.** It is important to consider the function and form of the berm when selecting plant materials. If using trees, plant them in a pattern that appears natural and accentuates the berm’s form. Consider tree species appropriate to the proposed habitat. If turf will be combined with woody and herbaceous plants, the turf should be placed to allow for easy maneuverability while mowing. Low maintenance plantings, such as trees and meadow plants, rather than turf and formal landscaping, are encouraged.

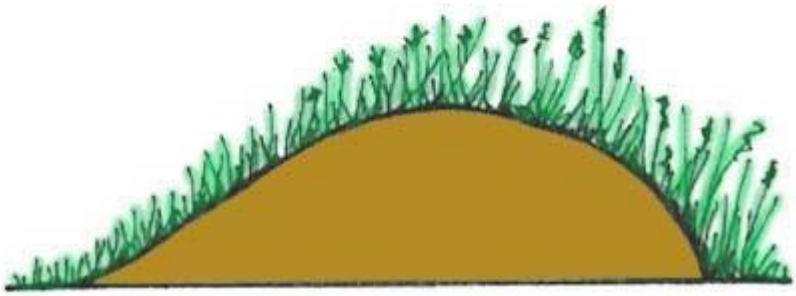
7. **Infiltration Design.** Infiltration berms located along slopes should be composed of low berms (less than 12 inches high) and should be vegetated. Subsurface soils should be uncompacted to encourage infiltration behind the berms. Soil testing is not required where berms are located within an existing woodland, but soil maps/data should be consulted when siting the berms. Where feasible, surface soil testing should be conducted in order to estimate potential infiltration rates.

8. **Infiltration Trench Option.** Soil testing is recommended for infiltration berms that will utilize a subsurface infiltration trench. Infiltration trenches are not recommended in existing woodland areas as excavation and installation of subsurface trenches could damage tree root systems. See BMP 6.4.4 – Infiltration Trench, for information on infiltration trench design.

9. **Aesthetics.** To the extent possible, berms should reflect the surrounding landscape. Berms should be graded so that the top of the berm is smoothly convex and the toes of the berms are smoothly concave. Natural, asymmetrical berms are usually more effective and attractive than symmetrical berms. The crest of the berm should be located near one end of the berm rather than in the middle.



undesirable shape for a berm



desirable shape for a berm

Detailed Stormwater Functions

Infiltration Area

The Infiltration Area is the ponding area behind the berm, defined as:
Length of ponding x Width ponding area = Infiltration Area (Ponding Area)

Volume Reduction Calculations

Storage volume can be calculated for Infiltration Berms. The storage volume is defined as the ponding area created behind the berm, beneath the discharge invert (i.e. the crest of the berm). Storage volume can be calculated differently depending on the variations utilized in the design.

Surface Storage Volume is defined as the volume of water stored on the surface at the ponding depth. This is equal to:
Cross-sectional area of ponded water x Berm length = Surface Storage Volume

Peak Rate Mitigation:

See Section 8 for Peak Rate Mitigation methodology which addresses link between volume reduction and peak rate control.

Water Quality Improvement:

See Section 8 for Water Quality Improvement methodology which addresses pollutant removal effectiveness of this BMP.

Construction Sequence

The following is a typical construction sequence for a infiltration berm without a subsurface infiltration trench, though alterations will be necessary depending on design variations.

1. Install temporary sediment and erosion control BMPs as per the Pennsylvania Erosion and Sediment Pollution Control Program Manual.

2. Complete site grading and stabilize within the limit of disturbance except where Infiltration Berms will be constructed; make every effort to minimize berm footprint and necessary zone of disturbance (including both removal of exiting vegetation and disturbance of empty soil) in order to maximize infiltration.

3. Lightly scarify the soil in the area of the proposed berm before delivering soil to site.

4. Bring in fill material to make up the major portion of the berm. Soil should be added in 8-inch lifts and compacted after each addition according to design specifications. The slope and shape of the berm should graded out as soil is added.

5. Protect the surface ponding area at the base of the berm from compaction. If compaction of this area does occur, scarify soil to a depth of at least 8 inches.

6. Complete final grading of the berm after the top layer of soil is added. Tamp soil down lightly and smooth sides of the berm. The crest and base of the berm should be at level grade.

7. Plant berm with turf, meadow plants, shrubs or trees, as desired.

8. Mulch planted and disturbed areas with compost mulch to prevent erosion while plants become established.

Maintenance Issues

Infiltration Berms have low to moderate maintenance requirements, depending on the design.

Infiltration Berms

- Regularly inspect to ensure they are infiltrating; monitor drawdown time after major storm events
- Inspect any structural components, such as inlet structures to ensure proper functionality
- If planted in turf grass, maintain by mowing. Other vegetation will require less maintenance. Trees and shrubs may require annual mulching, while meadow planting requires annual mowing and clippings removal.
- Avoid running heavy equipment over the infiltration area at the base of the berms. The crest of the berm may be used as access for heavy equipment when necessary to limit disturbance.
- .
- Routinely remove accumulated trash and debris.
- Remove invasive plants as needed
- Inspect for signs of flow channelization; restore level gradient immediately after deficiencies are observed

Diversion Berms

- Regularly inspect for erosion or other failures.
- Regularly inspect structural components to ensure functionality.
- Maintain turf grass and other vegetation by mowing and re-mulching.
-
- Remove invasive plants as needed.
- Routinely remove accumulated trash and debris.

Cost Issues

Infiltration berms can be less expensive than other BMPs options because extensive clearing and grubbing is not necessary. Cost will depend on height, length and width of berms as well as desired vegetation.

Specifications

The following specifications are provided for information purposes only. These specifications include information on acceptable materials for typical applications, but are by no means exclusive or limiting. The designer is responsible for developing detailed specifications for individual design projects in accordance with the project conditions.

1. **Soil Materials**
   a. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP.
   b. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.
   c. Topsoil: Topsoil stripped and stockpiled on the site should be used for fine grading. Topsoil is defined as the top layer of earth on the site, which produces heavy growths of crops, grass or other vegetation.

d. Soils excavated from on-site may be used for berm construction provided they are deemed satisfactory as per the above recommendations or by a soil scientist.

2. Placing and Compacting of Berm Area Soil

a. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fill. Plow strip, or break up sloped surfaces steeper than I vertical to 4 horizontal so that fill material will bond with existing surface.

b. When existing ground surface has a density less than that specified under g. (below) for particular area classification, break up ground surface, pulverize, bring the moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

c. Place backfill and fill materials in layers not more than 8 inches in loose depth for material to be compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material to be compacted by hand-operated tampers.

d. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

e. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or same elevation in each lift.

f. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts if soil density tests indicate inadequate compaction.

g. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557:

- Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 85 percent maximum density.
- Under infiltration areas no compaction shall be permitted.

3. Grading

a. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances; compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

b. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.

c. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

4. Temporary Seeding

a. Temporary seeding and mulching shall be required on all freshly graded areas immediately following earth moving procedures. Seed-free straw or salt hay mulch shall be applied at a rate of 75 lbs. per 1,000 square feet over temporary seeded areas. Straw bale barriers shall be placed in swale areas until vegetation is established.

b. Should temporary seeding not be possible or not establish itself properly, mulch as described above, pending fine grading or permanent seeding.

5. Finish Grading

a. Spreading of topsoil and finish grading shall be coordinated with the work of the Landscape Contractor.
b. Verify that the rough grades meet requirements for tolerances, materials, and compaction.
c. Surface of subgrades shall be loosened and made friable by cross-discing or harrowing to a depth of 2 inches. Stones and debris more than 1-1.5 inches in any dimension shall be raked up and grade stakes and rubbish removed.
d. Topsoil shall be uniformly spread to minimum depths after settlement of 6 inches on areas to be seeded and 4 inches on areas to be sodded. Correct any surface irregularities to prevent formation of low spots and pockets that would retain water.
e. Topsoil shall not be placed when the subgrade is frozen, excessively wet, or extremely dry and no topsoil shall be handled when in a frozen or muddy condition. During all operations following topsoil spreading, the surface shall be kept free from stones over 1-1.5 inches in size or any rubbish, debris, or other foreign material.
f. After placing topsoil rake soil to a smooth, even-draining surface and compact lightly with an empty water roller. Leave finish graded areas clean and well raked, ready for lawn work.

References

AMEC Earth and Environmental Center for Watershed Protection et al. *Georgia Stormwater Management Manual*. 2001.

Harris, C. and Dines, N. *Time Saver Standards for Landscape Architecture, 2nd Edition*. New York, NY: McGraw-Hill, 1998.

University of Minnesota. “Building Soil Berms.” *Sustainable Urban Landscape Information Series (SULIS)*. 1998. <http://www.sustland.umn.edu/implement/soil_berms.html>

Chester County Conservation District. *Chester County Stormwater BMP Tour Guide-Infiltration Trenches (Infiltration Berms).* 2002.

Williams, G.P. *Canadian Building Digest - Drainage and Erosion at Construction Sites*. National Research Council Canada. 2004. <http://irc.nrc-cnrc.gc.ca/cbd/cbd183e.html>

BMP 6.7.2: Landscape Restoration

Landscape Restoration is the general term used for actively sustainable landscaping practices that are implemented outside of riparian (or other specially protected) buffer areas. Landscape Restoration includes the restoration of forest (i.e. reforestation) and/or meadow and the conversion of turf to meadow. In a truly sustainable site design process, this BMP should be considered only after the areas of development that require landscaping and/or revegetation are minimized. The remaining areas that do require landscaping and/or revegetation should be driven by the selection and use of vegetation (i.e., native species) that does not require significant chemical maintenance by fertilizers, herbicides, and pesticides..

- Minimize traditional turf lawn area
- Maximize landscape restoration area planted with native vegetation
- Protect landscape restoration area during construction
- Prevent post-construction erosion through adequate stabilization
- Minimize fertilizer and chemical-based pest control programs
- Creates and maintains porous surface and healthy soil.
- Minimize mowing (two times per year)
- Reduced maintenance cost compared to lawn

Commercial: Yes Ultra
Urban: Limited
Industrial: Yes
Retrofit: Yes
Highway/Road: Yes

Stormwater Functions

Volume Reduction: Low/Med.
Recharge: Low/Med.
Peak Rate Control: Low/Med.
Water Quality: Very High

Water Quality Functions

TSS: 85%
TP: 85%
NO3: 50%

Other Considerations

- Soil investigation recommended
- Soil restoration may be necessary

Description

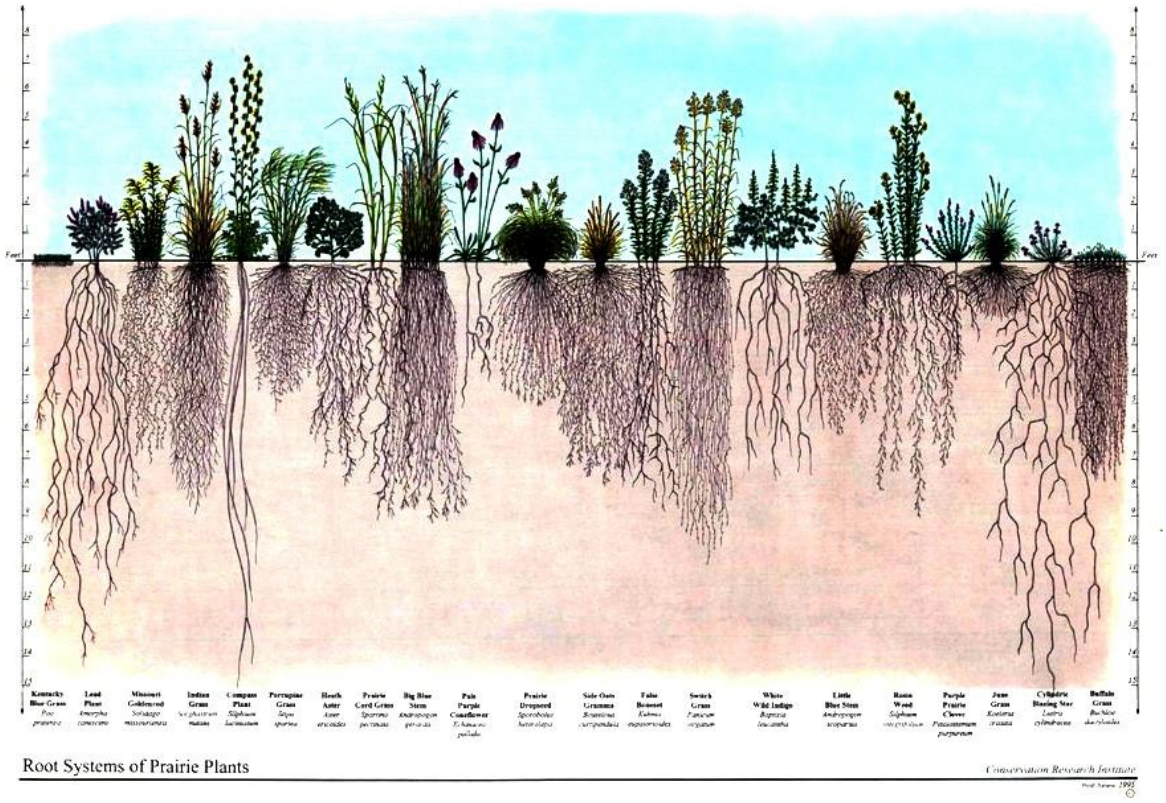
In an integrated stormwater management plan, the landscape is a vital factor, not only in sustaining the aesthetic and functional resources of a site, but also in mitigating the volume and rate of stormwater runoff. Sustainable landscaping, or Landscape Restoration, is an effective method of improving the quality of site runoff. This often overlooked BMP includes the restoration of forest and/or meadow or the conversion of turf to meadow.

Landscape Restoration involves the careful selection and use of vegetation that does not require significant chemical maintenance by fertilizers, herbicides and pesticides. Implicit in this BMP is the assumption that native species have the greatest tolerance and resistance to pests and require less fertilization and chemical application than do nonnative species. Furthermore, since native grasses and other herbaceous materials often require less intensive maintenance efforts (i.e. mowing or trimming), their implementation on a site results in less biomass produced.

Native species are customarily strong growers with stronger and denser root and stem systems, thereby generating less runoff. If the objective is revegetation with woodland species, the longer-term effect is a significant reduction in runoff volumes, with increases in infiltration, evapotranspiration, and recharge, when contrasted with a conventional lawn planting. Peak rate reduction also is achieved. Similarly, meadow reestablishment is also more beneficial than a conventional lawn planting, although not so much as the woodland landscape. Again, these benefits are long term in nature and will not be forthcoming until the species have had an opportunity to grow and mature (one advantage of the meadow is that this maturation process requires considerably less time than a woodland area). Native grasses also tend to have substantially deeper roots and more root mass than turf grasses, which results in:

- A greater volume of water uptake (evapotranspiration)
- Improved soil conditions through organic material and macropore formation
- Provide for greater infiltration

Landscape architects specializing in the local plant community are usually able to identify a variety of species that meet these criteria. Other sources of advice may be county conservation districts, watershed associations and other conservation groups. As the selection of such materials begins at the conceptual design stage, where lawns are eliminated or avoided altogether and landscaping species selected, Landscape Restoration can generally result in a site with reduced runoff volume and rate, as well as significant nonpoint source load reduction/prevention.



Landscape Restoration can improve water quality by minimizing application of fertilizers and pesticides/herbicides. Given the high rates of chemical application which have been documented at newly created lawns for both residential and nonresidential land uses, eliminating the need for chemical application is important for water quality. Of special importance here is the reduction in fertilization and nitrate loadings. For example, Delaware's *Conservation Design for Stormwater Management* lists multiple studies that document high fertilizer application rates, including both nitrogen and phosphorus, in newly created landscapes in residential and nonresidential land developments. Expansive lawn areas in low density single-family residential subdivisions as well as large office parks typically receives intensive chemical application, both fertilization and pest control, which can exceed application rates being applied to agricultural fields. Avoidance of this nonpoint pollutant source is an important water quality objective.

Variations

- Meadow
- No-mow lawn area
- Woodland restoration
- Removal of existing lawn to reduce runoff volume
- Buffers between lawn areas and wetlands or stream corridors
- Replacement of "wet" lawn areas difficult to mow
- Replacement of hard to maintain lawns under mature trees

Applications

- Forested Landscape/Restoration
- Suburban / Developing Landscape
- Urban Landscape
- Meadow Restoration
- Conversion of Turf to Meadow

Design Considerations

1. The recommended guidelines for Landscape Restoration are very closely related to those of Riparian Buffer Restoration (RBR) (BMP 6.7.1). Specifically, Landscape Restoration overlaps with the guidelines for Zones 2 and 3 in typical RBR. As with RBR, it is essential for successful Landscape Restoration that site conditions be well understood, objectives of the landowner considered, and the appropriate plants chosen for the site. These are all tasks that should be completed in the early planning stages of a project. For a summary of the nine steps recommended for the planning stages of a restoration project, see BMP 6.7.1- Riparian Buffer Restoration. Included in this nine-step process are: analysis of site soils/natural vegetative features/habitat significance/topography/etc., determination of restoration suitability, and site preparation.

2. In those sites where soils have been disturbed or determined inadequate for restoration (based on analysis), soil amendments are needed. Soil amendment and restoration is the process of restoring compromised soils by subsoiling and/or adding a soil amendment, such as compost, for the purpose of reestablishing its long-term capacity for infiltration and pollution removal. For more information on restoring soils, see BMP 6.7.3 Soil Amendments and Restoration.

3. “Native species” is a broad term. Different types of native species landscapes may be created, from meadow to woodland areas, obviously requiring different approaches to planting. A native landscape may take several forms in Pennsylvania, ranging from reestablishment of woodlands with understory plantings to reestablishment of meadow. It should be noted that as native landscapes grow and mature, the positive stormwater benefits relating to volume control and peak rate control increase. So, unlike highly maintained turf lawns, these landscapes become much more effective in reducing runoff volumes and nonpoint source pollutants over time.

4. Minimizing the extent of lawn is one of the easiest and most effective ways of improving water quality. Typical (i.e. compacted) lawns on gentle slopes can produce almost as much runoff as pavement. In contrast to turf, “natural forest soils with similar overall slopes can store up to 50 times more precipitation than neatly graded turf.” (Arendt, Growing Greener, pg. 81)
   The first step in sustainable site design is to limit the development footprint as much as possible, preserving natural site features, such as vegetation and topography. If lawn areas are desired in certain areas of a site, they should be confined to those areas with slopes less than 6%.

5. Meadow restoration may be used alone or in combination with a forest restoration. The native meadow landscape provides a land management alternative that benefits stormwater management by reducing runoff volume and nonpoint source pollutant transport. Furthermore, meadow landscapes vastly reduce the need for maintenance, as they do not require frequent mowing during the growing season. Because native grasses and flowers are almost exclusively perennials, properly installed meadows are a self-sustaining plant community that will return year after year.

   Meadows can be constructed as a substitute to turf on the landscape, or they can be created as a buffer between turf and forest. In either situation, the meadow restoration acts to reduce runoff as well as reduce erosion and sedimentation. Meadow buffers along forests also help reduce off-trail pedestrian traffic in order to avoid creating paths which can further concentrate stormwater.

   The challenge in restoring meadow landscapes is a lack of effective establishment and maintenance methods. Native grasses and flowers establish more slowly than weeds and turf grass. Therefore, care must be taken when creating meadow on sites where weed or other vegetative communities are well established. It may take a year or more to prepare the site and to get weeds under control before planting. Erosion prone sites should be planted with a nurse crop (such as annual rye) for quick vegetation establishment to prevent seed and soil loss. Steep slopes and intermittent water courses should be stabilized with erosion blankets, selected to mitigate expected runoff volumes and velocities. Additionally, seed quality is extremely important to successful establishment. There is tremendous variation among seed suppliers, seeds should be chosen with a minimum percent of non-seed plant parts.

6. Conversion of turf grass areas to meadow is relatively simple and has enormous benefits for stormwater management. Though turf is inexpensive to install, the cost of maintenance to promote an attractive healthy lawn is high (requiring mowing, irrigation, fertilizer, lime and

herbicides) and its effects are detrimental to water quality. Turf areas are good candidates for conversion to meadow as they typically have lower density of weed species. The conversion of turf to meadow requires that all turf be eliminated before planting, and care must be taken to control weed establishment prior to planting.

7. Forest restoration includes planting of appropriate tree species (small saplings) with quick establishment of an appropriate ground cover around the trees in order to stabilize the soil and prevent colonization of invasive species. Reforestation can be combined with other volume control BMPs such as retentive berming, vegetated filter strips and swales.

   Plant selection should mimic the surrounding native vegetation and expand on the native species composition already found on the site. A mixture of native trees and shrubs is recommended and should be planted once a ground cover is established.

8. In terms of woodland areas, DCNR's *Conservation Design for Stormwater Management* states, "…a mixture of young trees and shrubs is recommended…. Tree seedlings from 12 to 18 inches in height can be used, with shrubs at 18 to 24 inches. Once a ground cover crop is established (to offset the need for mowing), trees and shrubs should be planted on 8-foot centers, with a total of approximately 430 trees per acre. Trees should be planted with tree shelters to avoid browse damage in areas with high deer populations, and to encourage more rapid growth." (p.3-50). Initial watering and weekly watering during dry periods may be necessary during the first growing season. As tree species grow larger, both shrubs and ground covers recede and yield to the more dominant tree species. The native tree species mix of small inexpensive saplings should be picked for variety and should reflect the local forest communities. Annual mowing to control invasives may be necessary, although the quick establishment of a strong-growing ground cover can be effective in providing invasive control. Native meadow planting mixes also are available. A variety of site design factors may influence the type of vegetative community that is to be planned and implemented. In so many cases, the "natural" vegetation of Pennsylvania's communities is, of course, woodland.

9. Ensure adequate stabilization. Adequate stabilization is extremely important as native grasses, meadow flowers, and woodlands establish more slowly than turf. Stabilization can be achieved for forest restoration by establishing a ground cover before planting of trees and shrubs. When creating meadows, it may be necessary to plant a fast growing nurse crop with meadow seeds for quick stabilization. Annual rye can be planted in the fall or spring with meadow seeds and will establish quickly and usually will not present a competitive problem. Erosion prone sites should be planted with a nurse crop and covered with weed-free straw mulch, while steep slopes and areas subject to runoff should be stabilized with erosion control blankets suitable for the expected volume and velocity of runoff.

Volume Reduction Calculations and Peak Rate Mitigation
Areas designated for landscape restoration should be considered as “Meadow, good condition” in stormwater calculations.

Water Quality Improvement
See Section 8 for Water Quality Improvement methodology, which addresses pollutant removal effectiveness of this BMP.

Construction Sequence

Forest restoration installation follows closely the procedure outlined in BMP 6.7.1- Riparian Buffer Restoration. Refer to BMP 6.7.1 for detailed information, with the understanding that species selection for upland forest restoration will differ from that for riparian restoration.

Meadow installation should proceed as follows:

1. SELECT SITE
- Confirm site is suitable for restoration, should be sunny, open and well-ventilated. Meadow plants require at least a half a day of full sun.
- Obtain landowner permission

2. ANALYZE SITE
- Evaluate site’s physical conditions (soil attributes, geology, terrain)
- Evaluate site’s vegetative features (desirable and undesirable species, native species, sensitive habitats). Good candidates for meadow plantings include areas presently in turf, cornfields, soybean fields, alfalfa fields and bare soils from new construction.
- Areas with a history of heavy weed growth may require a full year or longer to prepare for planting.
- Beware of residual herbicides that may have been applied to agricultural fields. Always check the herbicide history of the past 2-3 years and test the soils if in doubt.

3. PLANT SELECTION
- Select plants that are well adapted to the specific site conditions. Meadow plants must be able to out compete weed species in the first few years as they become established.

4. PREPARE SITE
- All weeds or existing vegetation must be eliminated prior to seeding.
- Perennial weeds may require year long smothering, repeated sprayings with herbicides, or repeated tillage with equipment that can uproot and kill perennial weeds.

5. PLANTING DAY
- Planting can take place from Spring thaw through June 30 or from September 1 through soil freeze-up (“dormant seeding”)
- Planting in July and August is generally not recommend due to the frequency of drought during this time.
- Seeding can be accomplished by a variety of methods: no-till seeder for multi-acre planting; broadcast seeder; hand broadcast for small areas of one acre or less.
- Seed quality is critical and a seed mix should be used with a minimum percentage of non-seed plant parts.

6. SITE MAINTENANCE (additional information below)

- Assign responsibilities for watering, weeding, mowing, and maintenance
- Monitor site regularly for growth and potential problems

Maintenance Issues

Meadows and Forests are low maintenance but not “no maintenance”. They usually require more frequent maintenance in the first few years immediately following installation.

Forest restoration areas planted with a proper cover crop can be expected to require annual mowing in order to control invasives. Application of a carefully selected herbicide (Roundup or similar glyphosate herbicide) around the protective tree shelters/tubes may be necessary, reinforced by selective cutting/manual removal, if necessary. This initial maintenance routine is necessary for the initial 2 to 3 years of growth and may be necessary for up to 5 years until tree growth and tree canopy begins to form, naturally inhibiting weed growth (once shading is adequate, growth of invasives and other weeds will be naturally prevented, and the woodland becomes self-maintaining). Review of the new woodland should be undertaken intermittently to determine if replacement trees should be provided (some modest rate of planting failure is usual).

Meadow management is somewhat more straightforward; a seasonal mowing or burning may be required, although care must be taken to make sure that any management is coordinated with essential reseeding and other important aspects of meadow reestablishment. In the first year weeds must be carefully controlled and consistently mowed back to 4-6 inches tall when they reach 12 inches in height. In the second year, weeds should continue to monitored and mowed and rhizomatous weeds should be hand treated with herbicide. Weeds should not be sprayed with herbicide as the drift from the spray may kill large patches of desirable plants, allowing weeds to move in to these new open areas. In the beginning of the third season, the young meadow should be burned off in mid-spring. If burning is not possible, the meadow should be mowed very closely to the ground instead. The mowed material should be removed from the site to expose the soil to the sun. This helps encourage rapid soil warming which favors the establishment of “warm season” plants over “cool season” weeds.

Cost Issues

Landscape restoration cost implications are minimal during construction. Seeding for installation of a conventional lawn is likely to be less expensive than planting of a “cover” of native species, although when contrasted with a non-lawn landscape, “natives” often are not more costly than other nonnative landscape species. In terms of woodland creation, somewhat dated (1997) costs have been provided by the *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers*:

$860/acre trees with installation
$1,600/acre tree shelters/tubes and stakes
$300/acre for four waterings on average

In current dollars, these values would be considerably higher, well over $3,000/acre for installation costs. Costs for meadow reestablishment are lower than those for woodland, in part due to the

elimination of the need for shelters/tubes. Again, such costs can be expected to be greater than installation of conventional lawn (seeding and mulching), although the installation cost differences diminish when conventional lawn seeding is redefined in terms of conventional planting beds.

Cost differentials grow greater when longer term operating and maintenance costs are taken into consideration. If lawn mowing can be eliminated, or even reduced significantly to a once per year requirement, substantial maintenance cost savings result, often in excess of $1,500 per acre per year. If chemical application (fertilization, pesticides, etc.) can be eliminated, substantial additional savings result with use of native species. These reductions in annual maintenance costs resulting from a native landscape reestablishment very quickly outweigh any increased installation costs that are required at project initiation. Unfortunately, because developers pay for the installation costs and longer term reduced maintenance costs are enjoyed by future owners, there is reluctance to embrace native landscaping concepts.

Specifications

The following specifications are provided for information purposes only. These specifications include information on acceptable materials for typical applications, but are by no means exclusive or limiting. The designer is responsible for developing detailed specifications for individual design projects in accordance with the project conditions.

Vegetation – See Appendix B

References

Bowman's Hill Wildflower Preserve, Washington Crossing Historic Park, PO Box 685, New Hope, PA 18938-0685, Tel (215) 862-2924, Fax (215) 862-1846, Native plant reserve, plant sales, native seed, educational programs, www.bhwp.org

Morris Arboretum of the University of Pennsylvania; 9414 Meadowbrook Avenue, Philadelphia, PA 19118, Tel (215) 247-5777, www.upenn.edu/morris, PA Flora Project Website: Arboretum and gardens (some natives), educational programs, PA Flora Project, www.upenn.edu/paflora

Pennsylvania Department of Conservation and Natural Resources; Bureau of Forestry; PO Box 8552, Harrisburg, PA 17105-8552, Tel (717)787-3444, Fax (717)783-5109, Invasive plant brochure; list of native plant and seed suppliers in PA; list of rare, endangered, threatened species.

Pennsylvania Native Plant Society, 1001 East College Avenue, State College, PA 16801 www.pawildflower.org

Western Pennsylvania Conservancy; 209 Fourth Avenue, Pittsburgh, PA 15222, Tel (412) 288-2777, Fax (412) 281-1792, www.paconserve.org

Conservation Design for Stormwater Management (DNREC and EMC)

Stream ReLeaf Plan and Toolkits

The Once and Future Forest – Leslie Sauer

Forestry Best Management Practices for Water Quality – Virginia Department of Forestry

Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers (1997)

Arendt, R. *Growing Greener.* Island Press, November 1999.

Diboll, Neil. Five Steps to Successful Prairie Meadow Establishment. Windstar Wildlife Institute.

Penn State College of Agricultural Sciences, Agricultural Research and Cooperation Extension. " Pennsylvania Wildlife No. 12: Warm-season Grasses and Wildlife" and "Pennsylvania Wildlife No. 5: Meadows and Prairies: Wildlife-friendly Alternatives to Lawn"

Appendix C
Simplified Approach

STORMWATER MANAGEMENT DESIGN ASSISTANCE MANUAL

For Minor Land Development Activities in Adams County, Pennsylvania

Simplified Approach

TABLE OF CONTENTS

Introduction

This design manual has been created as a tool to help property owners manage stormwater on their property and streamline the process of designing on-site stormwater management facilities for new, relatively minor residential and accessory structure projects. Through the use of this manual, residents have the ability to determine the appropriate facilities for their property, project and budget. This design method is not intended to be used with large-scale subdivision/ land development or activities that include infrastructure such as roadways.

The best management practices (BMPs) listed in this manual should be used as a guide and are not a comprehensive list of options. Residents should contact the municipality or Conservation District to discuss alternative solutions for site specific applications.

Importance of Stormwater Management

Stormwater is the runoff produced by precipitation, snow melt, or ice melt. When land is developed or changed, the flow patterns of water and quality of water are also changed. Land development activities can affect characteristics of stormwater runoff, including the rate of runoff, volume of runoff, and quality of runoff. When runoff is not managed, the increased volume may aggravate flooding.

The objective of stormwater management is to prevent or mitigate the adverse impacts of the increase in rate and volume of stormwater runoff, while also protecting health, safety, and property. Stormwater Best Management Practices aim to maintain water quality, encourage infiltration in appropriate areas, promote groundwater recharge, maintain the natural drainage characteristics of the site to the maximum extent practicable, and protect stream banks and beds.

Standard Terms Used in the Manual

Best Management Practice (BMP) - Activities, facilities, designs, measures, or procedures used to manage stormwater impacts from regulated activities, to meet state water quality requirements, to promote groundwater recharge, and to otherwise meet the purposes of this Ordinance.

Disconnected Impervious Area (DIA) - An impervious or impermeable surface that is disconnected from any stormwater drainage or conveyance system and is redirected or directed to a pervious area, which allows for infiltration, filtration, and increased time of concentration.

Disturbed Area - An unstabilized land area where an earth disturbance activity is occurring or has occurred.

Flow Path – The path that stormwater flows from the discharge point to the nearest property line or channelized flow (ie stream, drainage ditch, etc.). The length of the path is measured along the ground slope.

Impervious Surface (Impervious Area) - A surface that prevents the infiltration of water into the ground. Impervious surfaces and areas include but are not limited to roofs, additional indoor living spaces, patios and decks, garages, storage sheds and similar structures, streets, driveways, access drives, parking areas, and sidewalks. Any areas designed to be covered by loose surfacing materials such as gravel, stone and/or crushed stone, and intended for storage of and/or travel by vehicles, or pedestrians shall be considered impervious. Surfaces or areas designed, constructed and maintained to permit infiltration may be considered pervious.

Karst - A type of topography or landscape characterized by surface depressions, sinkholes, rock pinnacles/uneven bedrock surface, underground drainage, and caves. Karst is formed on carbonate rocks, such as limestone or dolomite.

Minor Stormwater Site Plan – A site plan prepared and submitted to the municipality for proposed projects which qualify to use the Simplified Approach. The plan depicts existing conditions on the property, proposed impervious areas, and, if required, the location of proposed BMPs.

Regulated Activit(ies)y - Any earth disturbing activity or any activity that involves the alteration or development of land in a manner that may affect stormwater runoff.

Runoff - Any part of precipitation that flows over the land.

Determining What Type of Stormwater Management Plan is Needed

The chart on the following page provides a guide to determine what type of stormwater plan is needed. Some projects will be exempt from preparing a stormwater management plan, but documentation of the project must still be filed with the municipality. Completion of the **Municipal Stormwater Management Worksheets** will determine what type of documentation is required for each project.

This manual is designed to assist those with projects that qualify for the use of a minor stormwater site plan. If a formal stormwater management plan is required, **please consult a qualified person (ex. Engineer, Surveyor)!**

SMP Plan Requirement	Impervious Area	Disturbed Area*	Next Steps
Exempt	Up to 1,000 ft²	Less than 1 acre	File Municipal Stormwater Management Worksheet with municipality
May be Exempt	1,000 to ≤ 10,000 ft², if disconnected from impervious areas	Less than 1 acre	File Municipal Stormwater Management Worksheet with municipality
Minor Stormwater Site Plan	1,000 ft² to ≤ 5,000 ft² IF connected to impervious areas	Less than 1 acre	Prepare a Minor Stormwater Site Plan
Formal Stormwater Management Plan	Greater than 5,000 ft²	Greater than 1 ac.	Consult a Qualified Person

Using Municipal Stormwater Management Worksheets

Determining the impervious area of a proposed project is the first step in using this Manual. Municipal Stormwater Management Worksheets have been included in the Simplified Approach, which will assist the property owner, or applicant, and municipality determine the impervious area of a proposed project and provide guidance through the next steps.

Step 1 of the Municipal Stormwater Management Worksheet provides a table and directions on how to figure out the impervious area created. If the total proposed surface area is up to 1,000 square feet, the project may be exempt from the requirements in this guide. The owner will sign the Acknowledgement at the top of the sheet and file it with the municipality. The municipality will use this as a record of exempt projects and keep a running total of proposed impervious area since the adoption of the Stormwater Management Ordinance.

If the proposed impervious area is between 1,000 square feet and 10,000 square feet, the applicant will go on to Step 2 to determine the Disconnected Impervious Area (DIA). DIA is explained on page C-6. The applicant will need to prepare a minor stormwater site plan to show how far the proposed project is from things like property lines and existing impervious surfaces. If DIA requirements can be met, projects of this size may be exempt from the requirement to prepare and submit a formal stormwater management (SWM) site plan. The applicant should take the worksheets and plan to the municipality for review and approval.

If stormwater runoff needs to be managed on the property, Best Management Practices (BMPs) will have to be installed if the project is between 1,000 square feet and 5,000 square feet. If the project is between 5,000 and 10,000 square feet and the entire volume of stormwater runoff cannot be managed within the property without using BMPs, then the project is not qualified to use the Simplified Approach. The applicant should fill out the rest of the worksheets and determine which BMPs will be used. The size and location

of proposed BMPs will be added to the minor stormwater site plan. The worksheets, site plan, and Owner Acknowledgement are brought to the municipality for approval. Each municipality has an approval process for exemptions and the minor stormwater site plans. The municipality may also require the submission of the Stormwater Management/ BMP Facilities & Maintenance Agreement.

Minor Stormwater Site Plan Requirements

A minor stormwater site plan depicts the existing conditions of a property and the location of proposed impervious surfaces. Depicting the relationship between the proposed activities and distances to things like property lines, streams, and vegetated areas will help determine if the stormwater runoff created by the proposed project can be managed naturally within the property or if additional best management practices (BMPs) are needed to accommodate the stormwater runoff.

If a project qualifies for use of a minor stormwater site plan, the applicant may prepare and submit to the Municipality a minor stormwater site plan and the Municipal Stormwater Management Worksheet. The Adams County GIS Office can also provide assistance to applicants to obtain property maps of existing features. A minor stormwater site plan depicting the key features of the site must be drawn, or depicted, to scale to show the following:

- Property boundary.
- Location of all existing and proposed structures (house, shed, addition, etc.) and any proposed downspouts. Include the dimensions of proposed structures.
- Site conditions (grassed areas, agricultural fields, direction of slope and stormwater flow on the property).
- Distance from proposed downspouts to property line.
- All existing and proposed driveways and impervious areas (stone and gravel driveways are considered impervious).
- Natural features such as streams, wetlands, tree lines and other vegetation on the property and within 50 feet of the property line for lots smaller than 5 acres.
- Distance from proposed structures or downspouts along the stormwater flow path to any stream or wooded area.
- Any other pertinent information that may be significant to the project site (existing drainage ways, steep slopes, etc.).
- Wells and on-site septic systems.

If BMPs are required, the following information must also be shown on the plan:

- Location and size of proposed stormwater BMPs.

Other Considerations for Minor Plans:

- While soil testing is not mandatory for the simplified approach, soil testing is highly recommended to select and apply the appropriate stormwater BMPs. The use of soil maps, infiltration tests, and/ or perc tests may provide the applicant basic information about soil characteristics.

- Proposed stormwater management facilities must be designed to handle flows from the contributing area.

- The site shall not have any pre-existing stormwater drainage-related problems (as verified by the municipality), at the discretion of the Municipality.

- Water quality shall be protected per Chapter 93 of PA Code.

- The municipality may inspect all BMPs during and after construction/ installation.

- Infiltration BMPs should not be constructed nor receive runoff until the entire contributory drainage area has achieved final stabilization.

- Ensure that infiltration in geologically susceptible areas such as, but not limited to, carbonate geology/ karst topography do not cause adverse effects. The minor stormwater site plan should incorporate steps to ensure that salt or chloride will not contaminate the groundwater.

- Selected BMPs shall be designed, constructed, and maintained in accordance with the manufacturer's recommendation, the BMP Manual, or other written guidance acceptable to the municipality.

- Proposed sump pumps shall discharge to infiltration or vegetative BMPs to the maximum extent practicable.

DISCONNECTED IMPERVIOUS AREA (DIA)

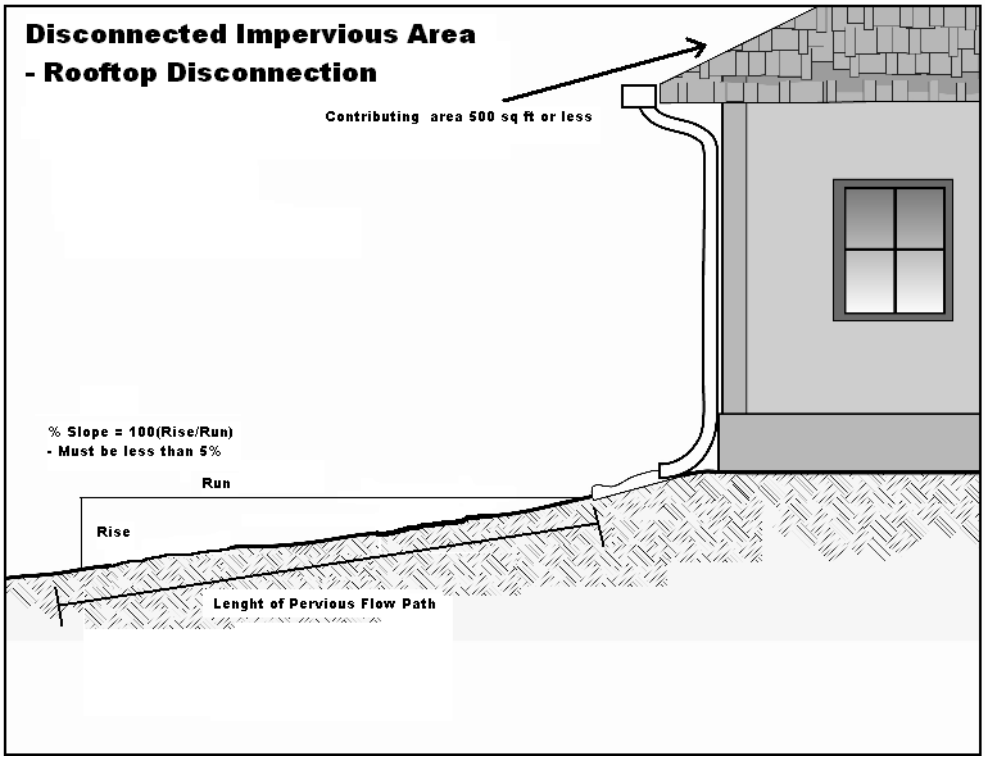
When impervious surface areas like rooftops and paved areas are directed to a pervious area that allows for infiltration, filtration, and increased time of concentration, the impervious surface areas may qualify to be treated as Disconnected Impervious Area (DIAs).

Impervious Area is defined as: A surface that prevents the infiltration of water into the ground. Impervious surfaces and areas shall include roofs, home additions, patios and

decks, garages, storage sheds and similar structures, driveways, access drives, parking areas, walkways and sidewalks. Any areas designed to be covered by loose surfacing materials such as gravel, stone and/or crushed stone, and intended for storage of and/or travel by vehicles, or pedestrians shall be considered impervious. Surfaces or areas designed, constructed and maintained to permit infiltration may be considered pervious.

Rooftop Disconnection A rooftop is considered to be completely disconnected if it meets the requirements listed below:

- Õ The contributing area of rooftop to each disconnected discharge (downspout) is 500 square feet or less.
- Õ The overland flow path from roof runoff discharge point has a positive slope of five percent (5%) or less.
- Õ The length of the overland flow path is greater than 75 feet.
- Õ Soils along the overland flow path are not classified as hydrologic group "D" (See Plan Appendix B). i.e. infiltration is at least 1 inch per 24-hour day.
- Õ The receiving pervious area shall not include another person's property unless written permission has been obtained from the affected property owner.



Note: Downspout not required.

Determining Status of DIA

Step 1: Determine contributing area of the roof to each disconnected discharge (downspout). If it's 500 ft^2 or less, continue to step 2. If it's greater than 500 ft^2, the area does not qualify as DIA.

Step 2: Determine the length of down slope pervious flow path available for each disconnected discharge.

Step 3: Determine the % slope of the pervious flow path, % slope = (rise/ run) x 100. Must be 5% or less.

Step 4: See the table on the next page to determine the percentage of the area that can be treated as disconnected. If the available length of the flow path is equal to or greater than 75 ft, the discharge qualifies as entirely disconnected.

Partial Rooftop Disconnection		
Length of Pervious Flow Path* (ft) Lots 10,000 ft^2 and Under	**Length of Pervious Flow Path* (ft)**	**Roof Area Treated as Disconnected**
0 – 7.9	0 – 14	0%
8 – 15.9	15 – 29	20%
16 – 22.9	30 – 44	40%
23 – 29.9	45 – 59	60%
30 – 34.9	60 – 74	80%
35 or more	75 or more	100%
*Pervious flow path must be at least 15 feet from any impervious surface and cannot include impervious surfaces.		

Paved Disconnection When runoff from paved surfaces is directed to a pervious area that allows for infiltration, filtration, and increased time of concentration, the contributing pavement area may qualify as disconnected. This applies generally to only small or narrow pavement structures such as driveways and walkways. Paved surfaces can be considered disconnected if they, or the adjacent areas, meet the following requirements:

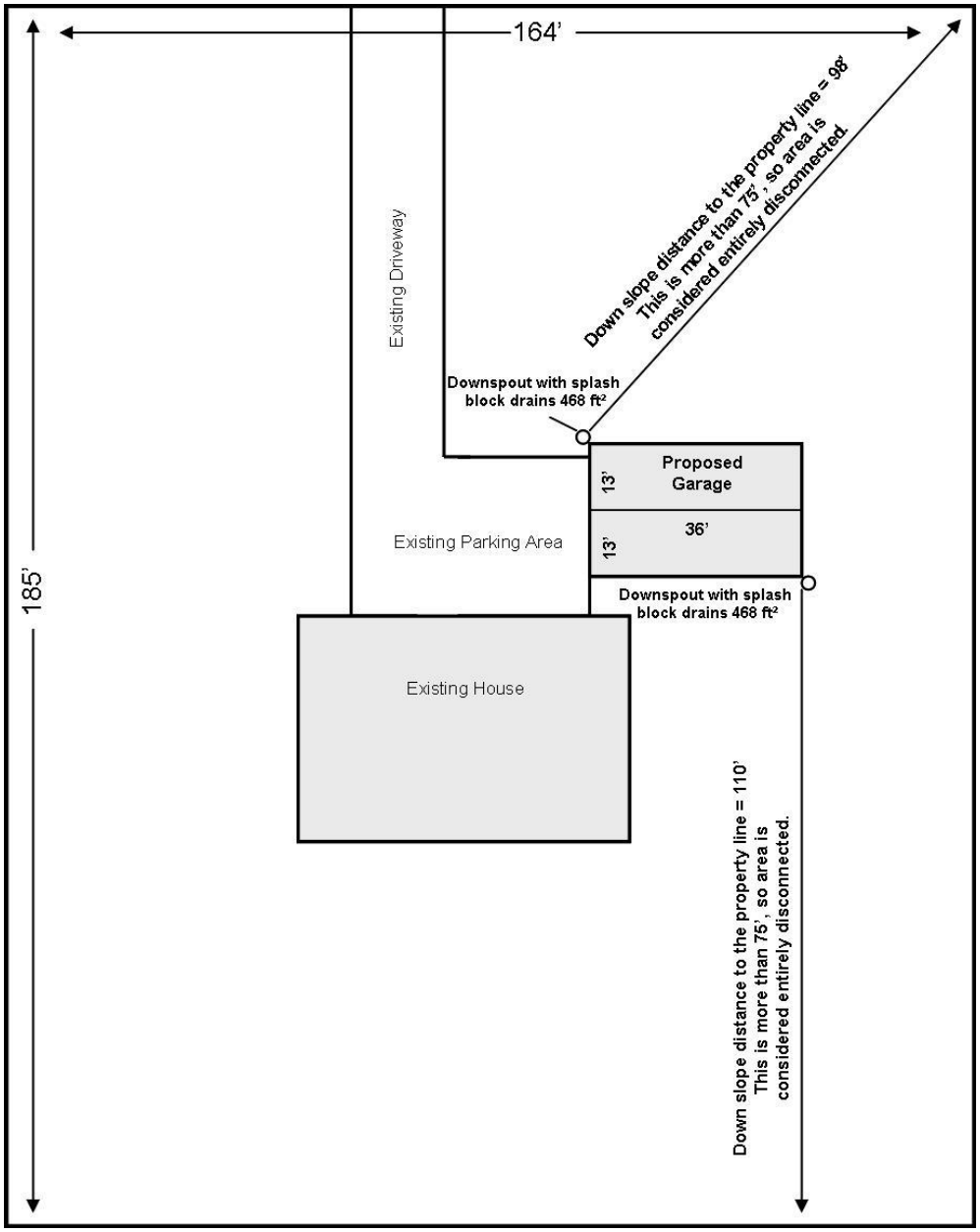
- The contributing flow path over the impervious area is not more than 75 feet
- The length of overland flow is greater than or equal to the maximum length of flow over the impervious area
- The slope of the contributing impervious area is five percent (5%) or less
- The slope of the overland flow path is five percent (5%) or less

- If discharge is concentrated at one or more discrete points, no more than 500 ft² may discharge to any one point. In addition, a gravel strip or other spreading device is required for concentrated discharges. For non-concentrated discharges along the entire edge of paved surface, a level spreader is not required; however, there must be provisions for the establishment of vegetation along the paved edge and temporary stabilization of the area until the vegetation is established.

REFERENCE: Philadelphia Water Department. 2006 & 2011. Stormwater Management Guidance Manual. Section 4: Integrated Site Design. Philadelphia, PA.

The following example determines the status of DIA for a proposed 936 ft² garage.

This example meets the criteria to use the Simplified Approach.



Step 1: Determine the area to each disconnected discharge. The area draining to each downspout is 468 ft^2. This is less than 500 ft^2, proceed to step 2.

Step 2: The discharge on the north side of the garage has a 98 ft pervious flow path available. The south discharge has 110 ft pervious flow path available.

Step 3: The rise of the north discharge is 2 ft and the run is 75 ft for a slope of 2.6%. This is 5% or less so it qualifies. For the south discharge the rise is 4 ft and the run is 100 ft equaling a slope of 4%. This is 5% or less, so it qualifies.

Step 4: Both of these discharges have pervious flow paths greater than 75 ft, so they qualify as entirely disconnected.

Selecting BMPs

If BMPs are required, the Owner/ Designer should review the compiled information in the enclosed "Guide to Choosing Stormwater BMPs", as taken from the *PA Handbook of Best Management Practices for Developing Areas* and the *PA Stormwater Management BMP Manual*. These documents identify stormwater BMPs that have been deemed to be of a nature and cost that will accomplish the goals of the Adams County Stormwater Management Plan, while not unduly burdening the residents. It will then be the Owner's responsibility to select a facility, determine the appropriate size and agree to construct and maintain that facility or facilities. The property owner is encouraged to utilize both multiple and hybrid versions of the facilities, as outlined in the documents mentioned above.

Municipal Stormwater Management Worksheets

Municipal Stormwater Management Worksheet

For Municipal Use and Record of Project Area

Property Owner's Name _____

Address of Property _____

Parcel ID # _____ Municipality _____

Phone Number _____ New Impervious Area Associated with this Project _____

Stormwater Project Type: _____ Exempt _____ Minor Plan _____ Project Requires Formal SWM Plan

Total New Impervious Area Since Adoption of SWM Plan _____

Acknowledgement - I declare that I am the property owner, or representative of the owner, and that the information provided is accurate to the best of my knowledge. I understand that stormwater may not adversely affect adjacent properties or be directed onto another property without written permission. I also understand that false information may result in a stop work order or revocation of permits. Municipal representatives are also granted reasonable access to the property for review and/ or inspection of this project if necessary.

Signature _____ Date _____

Step 1: Determine the amount of new impervious area created by the proposed project. This includes any new surface areas that prevent infiltration of stormwater into the ground. New stone and gravel areas are considered impervious. Impervious areas existing before November 23, 2011 are not included in this calculation. Use additional sheets if necessary

Calculate new impervious area by completing this table.

Surface	Length (ft)	x	Width (ft)	=	Impervious Area (ft²)
Buildings		x		=	
Driveway		x		=	
Parking Areas		x		=	
Patios/ walkways		x		=	
Other		x		=	
			Total Proposed Impervious Surface Area (Sum of all impervious areas)		

- If the total new impervious surface area is **up to 1,000 ft²**, the project is exempt from the requirement to submit a plan for approval. Sign Acknowledgement and file this sheet with municipality.
- If total impervious surface area is **1,001 ft² to 10,000 ft²**, continue to Step 2.

  - If project area can be entirely disconnected, sign Acknowledgement and file worksheets with municipality.
  - If project is between 1,000 ft² and 5,000 ft² and requires BMPs, complete step 3.
  - If project area is 5,000 ft² - 10,000 ft² and can't be disconnected, the project does not qualify for the Simplified Approach.

Municipal Stormwater Management Worksheet

Step 2: Determine Disconnected Impervious Area (DIA). All or parts of proposed impervious surfaces may qualify as Disconnected Impervious Area if runoff is directed to a pervious area that allows for infiltration, filtration, and increased time of concentration. The volume of stormwater that needs to be managed could be reduced through DIA. Prepare a minor stormwater site plan (see pg C-5 for requirements).

Criteria

- Overland flow path from the discharge area or impervious area has a positive slope of 5% or less.
- Contributing area to each rooftop discharge (downspout) is 500 ft² or less.
- Soils are not classified as hydrologic soil group "D".
- The receiving pervious area shall not include another person's property unless written permission has been obtained from the affected property owner.

Partial Rooftop Disconnection		
Length of Pervious Flow Path (ft) Lots ≤ 10,000 ft²	**Length of Pervious Flow Path (ft)**	**DIA Credit Factor**
35 or more	75 or more	0
30 – 34.9	60 – 74	0.2
23 – 29.9	45 – 59	0.4
16 – 22.9	30 – 44	0.6
8 – 15.9	15 – 29	0.8
0 – 7.9	0 - 14	1.0
Pervious flow path must be at least 15 feet from any impervious surface		

Paved Disconnection Criteria: Paved surfaces (driveways, walkways, etc.) and gravel can be considered disconnected if it meets the criteria above and:

- Runoff does not flow over impervious area for more than 75 feet.
- The length of overland flow is greater than or equal to the contributing flow path.
- The slope of the contributing impervious areas is 5% or less.
- If discharge is concentrated at one or more discrete points, no more than 1,000 ft² may discharge to any one point. In addition, a gravel strip or other spreading device is required for concentrated discharges. Non-concentrated discharges along the entire edge of paved surface must include provisions for the establishment of vegetation along the paved edge and temporary stabilization of the area until the vegetation is established.
- If these criteria can be met, the DIA credit = 0

Using the calculations from Step 1, complete the table below. This will determine the impervious area that may be excluded from the area that needs to be managed through stormwater BMPs. If the total impervious area to be managed =0, the area can be considered entirely disconnected.

Surface	Proposed Impervious Area	x	DIA Credit	=	Impervious Area (ft²) to be Managed
Buildings (area to each downspout)		x		=	
Driveway		x		=	
Parking Areas		x		=	
Patios/ walkways		x		=	
Other		x		=	
Total Proposed Impervious Surface Area to be managed (Sum of all impervious areas)					

If total surface area to be managed if greater than 0, continue to Step 3.

Municipal Stormwater Management Worksheet

Step 3: Calculate the volume of stormwater runoff created by proposed impervious surfaces or see Simple BMP Sizing in Step 4.

Impervious Area (ft^2) to be Managed (Sum of Step 2)	X	3.0 in/12 in = 0.25 (3.0 in is 2-year 24-hour rainfall amount)	=	Amount of Stormwater to be Managed (ft^3)
	X	0.25	=	

Best Management Practices need to be used to manage the volume of stormwater created by the proposed impervious areas. The cubic feet of stormwater that need to be managed may also be further reduced by planting new trees. If the criteria below can be met, the amount of stormwater to be managed can be reduced per the following:

Deciduous Trees = 6 ft^3 per tree **Evergreen Trees = 10 ft^3 per tree**

Criteria:

- Trees must be PA native species (See PA Stormwater BMP Manual for a list)
- Trees shall be a minimum 1" caliper tree and 3 feet tall shrub (min)
- Trees shall be adequately protected during construction
- No more than 25% of the required capture volume can be mitigated through the use of trees
- Dead trees shall be replaced by the property owner within 12 months
- Please consider the specifications for each tree species when determining location and spacing

Amount of Stormwater to be Managed (ft^3) (Sum of Step 3)	-	Tree Planting Credit (ft^3)	=	Amount of Stormwater to be Managed (ft^3)
	-		=	

Step 4: Select BMPs and size according to the volume of stormwater that needs to be managed. The Guide to Choosing Stormwater BMPs, included in the Simplified Approach, includes sizing calculations for specific techniques. ***Simple BMP Sizing*** **-** Sizing BMPs may also be simplified through the use of this chart. Take the sum of Step 2 and match it to the "Amount of New Impervious Area to be Managed" in white boxes in the table below (rounding **up** to the next value if the number is between two values). Then look in the light grey box to determine the cubic footage based on the type of BMP (bioretention or infiltration). For example, if a proposed 1,000 square foot impervious area must handle 240 cubic feet of stormwater in a bioretention system, a 13'x 13'x 1.5' rain garden or a 36'x 2'x 3.5' vegetated swale could be used. Show the location and size of proposed BMPs on the minor stormwater site plan. (The following was based on a chart from the Lycoming Co. Planning Dept)

BMP Type		Simple BMP Sizing - Amount New Impervious Area to be Managed (ft^2)											
		250	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000
Bioretention	Ex. Rain garden, Vegetated swale	60 ft^3 or	120 ft^3 or	180 ft^3 or	240 ft^3 or	360 ft^3 or	480 ft^3 or	600 ft^3 or	720 ft^3 or	840 ft^3 or	960 ft^3 or	1,080 ft^3 or	1,200 ft^3 or
Infiltration	Ex. Dry well, Infiltration trench	180 ft^3	360 ft^3	540 ft^3	720 ft^3	1,080 ft^3	1,440 ft^3	1,800 ft^3	2,160 ft^3	2,520 ft^3	2,880 ft^3	3,240 ft^3	3,600 ft^3

Bring the worksheets, plan, Owner Acknowledgement, and BMP Facilities and Maintenance Agreement (if applicable) to your municipality. If an area greater than 5,000 square feet of earth is disturbed, an erosion and sedimentation (E & S) control plan must be prepared. The municipality may require that the E&S plan be submitted to, reviewed, and approved by the Adams County Conservation District.

Municipal Stormwater Management Worksheet

The minor stormwater site plan assists the owner / applicant in preparing the necessary information for the municipality to review and approve.

OWNER ACKNOWLEDGMENT

(Municipality may decide if the Owner Acknowledgement should be notarized and/ or recorded, based on municipal process)

- Development activities shall begin only after the municipality approves the plan.
- The installed BMPs will not adversely affect any property, septic systems, or drinking water wells on this or any other property.
- If a stormwater management alternative to the approved minor stormwater site plan is used, the applicant will submit a revised plan to the municipality for approval. If a site requires a more complex system or if problems arise, the applicant may need the assistance of a licensed professional.
- The applicant acknowledges that the proposed stormwater management BMPs will be a permanent fixture of the property that can not be altered or removed without approval by the Township.

I (we)_____, hereby acknowledge the above statements and agree to assume full responsibility for the implementation, construction, operation, and maintenance of the proposed stormwater management facilities. Furthermore, I (we) also acknowledge that the steps, assumptions, and guidelines provided in this simplified approach package (minor stormwater site plan & Municipal Stormwater Worksheet(s)) will be adhered to.

Signature:_____ Date: _____

Signature:_____ Date: _____

STORMWATER MANAGEMENT/ BMP FACILITIES & MAINTENANCE AGREEMENT

STORMWATER MANAGEMENT/ BMP

FACILITIES & MAINTENANCE AGREEMENT

THIS AGREEMENT, made and entered into this_____day of_____, 20___, by and between _____ hereinafter called the "Landowner", and < Municipality>, Adams County, Pennsylvania, hereinafter called the "Municipality".

WHEREAS, the Landowner is the owner of certain real property described as (Adams County tax Map/Parcel Identification Number)_____as recorded by deed in the land records of Adams County, Pennsylvania, Book_____Page_____, hereinafter called the "Property".

WHEREAS, the Landowner is proceeding to build on and develop the property; and WHEREAS, the minor stormwater site plan hereinafter called the "Plan", which is expressly made a part hereof, as approved or to be approved by the Municipality, provides for detention of stormwater within the confines of the property through the use of Best Management Practices (BMPs); and

WHEREAS, the Municipality and the Landowner, its successors and assigns, agree that the health, safety, and welfare of the residents of Adams County, Pennsylvania, require that on-site stormwater management/ BMP facilities be constructed and maintained on the Property; and

WHEREAS, the Municipality requires that on-site stormwater management/ BMP facilities as shown on the Plan be constructed and adequately maintained by the Landowner, its successors and assigns. Any additional requirements imposed by the Municipality are considered part of the Plan.

NOW, THEREFORE, in consideration of the foregoing premises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The Landowner in accordance with the specifications identified within the Plan shall construct the onsite BMP facilities.

2. The Landowner, its successors and assigns, shall adequately maintain the BMP facilities. This includes all pipes and channels built to convey stormwater to the facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater. Adequate maintenance is herein defined as good working condition so that these facilities are performing their design functions.

3. The Landowner, its successors and assigns, shall inspect the BMP facility after all rainfall events exceeding one inch of precipitation in a 24-hour period.

4. The Landowner, its successors and assigns, hereby grant permission to the Municipality, its authorized agents and employees, to enter upon the Property without prior notification at reasonable times and upon presentation of proper identification to inspect the BMP facilities whenever the Municipality deems necessary.

5. In the event the Landowner, its successors and assigns, fails to maintain the BMP facilities as shown on the Plan and in good working condition, the Municipality may enter upon the Property and take whatever action is deemed necessary to maintain said BMP facilities and to charge the costs of such repairs to the Landowner, its successors and assigns. This provision shall not be construed to allow the Municipality to erect any structure of permanent nature on the land of the Landowner unless such structures were part of the approved Plan. It is expressly understood and agreed that the Municipality is under no obligation to routinely maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the Municipality.

6. In the event the Municipality, pursuant to this Agreement, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner shall reimburse the Municipality within thirty (30) days of receipt of invoice for all expenses incurred. The municipality has the right to file a municipal lien for unpaid costs and expenses that have not been reimbursed thirty (30) days after receipt of invoice.

7. The intent and purpose of this Agreement is to ensure the proper maintenance of the BMP facilities by the Landowner. This Agreement shall not be deemed to create any additional liability of any party for damage alleged to result from or be caused by nonpoint source pollution runoff. This Agreement imposes no liability of any kind whatsoever on the Municipality and the Landowner agrees to hold the Municipality harmless from any liability in the event the stormwater management BMP facilities fail to operate properly. In the event that a claim is asserted against the municipality, its designated representatives or employees, the municipality shall promptly notify the Landowner and the Landowner shall defend, at his own expense, any suit based on the claim. If any judgment or claims against the municipality shall be allowed, the Landowner shall pay all costs and expenses regarding said judgment.

8. This Agreement shall be binding to the Landowner, its administrators, executors, assigns, heirs and any other successors in interests, in perpetuity.

Landowner signatures:

_____

(Print Landowner Name)

_____ _____

(Print Landowner Name)

Witnessed By:

_____ _____

(Municipal Representative)

Guide to Choosing Stormwater BMPs