

Small Projects Stormwater Management Design Assistance Manual

Simplified Approach to Stormwater Management for Small Projects

Handbook

Errata Notes:

The following corrections are noted for Figure 6:

1. Label for BMP #1 Cistern – should read “(166 Gallons)”
2. Label for BMP #2 Infiltration Trench – should read “(20’L x 3’W x 3.5’D)”

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for

Drumore Township
as part of the
County-wide Act 167 Stormwater Management Plan for Lancaster County, PA

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All revisions made by **Drumore Township** were completed without consultation with Borton-Lawson and were completed at the sole discretion of Solanco Engineering Associates, LLC.

STORMWATER MANAGEMENT PROCEDURES FOR MEETING THE SIMPLIFIED APPROACH REQUIREMENTS

Introduction

This Handbook has been developed to allow homeowners or applicants for small projects to comply with stormwater management requirements of the Stormwater Management Ordinance of the Township, including sizing, designing, locating and installing on-lot measures, referred to herein as “Best Management Practices” (BMPs). **Only projects that meet the size thresholds specified in the Township’s Stormwater Management Ordinance may use this Simplified Approach** and are then not required to submit a formal Stormwater Management Site plan to the Township. However, these projects are still required to address certain requirements, such as stormwater quality, infiltration, rate and volume management goals as outlined in this Simplified Approach Handbook.

Pennsylvania Act 167 (PA Stormwater Management Act) was authorized on October 4, 1978 (32 P.S., P.L. 864) and gave Pennsylvania Municipalities the power to regulate activities that affect flooding, streambank erosion, stormwater runoff and surface and groundwater quantity and quality. The Township’s Stormwater Management Ordinance was prepared to comply with the PA Act 167 requirements and includes provisions allowing this Simplified Approach to be used for small projects as specified in their Ordinance.

If the guidelines presented in this Handbook are followed, the applicant may not require professional engineering services to comply with these stormwater management goals. This Handbook is organized into five sections:

- Section 1 describes requirements and a simplified approach for designing a suitable BMP, and a description of what needs to be included on the simplified stormwater management (SWM) site plan (i.e. sketch plan).
- Section 2 presents definitions of key terms.
- Section 3 presents options of BMPs that can be considered for on-lot stormwater management.
- Section 4 illustrates an example of how to obtain the size and dimensions of a BMP(s) for a sample project.

The Simplified Approach requires:

- The applicant to submit the following to the Township for review and approval prior to beginning construction:
 - A Simplified Stormwater Management (SWM) Site Plan (i.e. sketch plan) and accompanying Worksheet
- The first 1-inch of rainfall runoff from proposed impervious surfaces (as defined by the Township’s Ordinance) must be captured and removed from the stormwater runoff leaving the applicant’s property.

The purpose of requiring effective stormwater management from small projects is to help reduce stormwater runoff in the community, to maintain groundwater recharge, to prevent degradation of surface and groundwater quality, and to otherwise protect water resources and public safety.

What needs to be submitted to the Township?

- Simplified Approach Worksheet (Table 4)
- Simplified SWM site plan (i.e. sketch plan), containing the features described in Section 1, Step 1

If the applicant is using a contractor to construct the project, the worksheet and sketch plan must be shared with the contractor to ensure the BMP(s) are properly installed.

1. Determination of Simplified Approach Volume Requirements

All proposed impervious areas (as required by the Township's Ordinance) must be included in the determination of the amount of new impervious areas and the size of proposed BMPs needed to manage stormwater. Proposed impervious areas on an individual residential lot generally include, but are not limited to: roof area, pavement, sidewalks, driveways, patios, porches, permanent pools, or parking areas, etc. See the definitions provided in Section 2 and check with the Municipal Engineer to confirm what features of the proposed project must be included in the calculation of new impervious areas. Sidewalks, driveways, or patios that are constructed with gravel or pervious pavers and will not be disturbed or altered in the future may not need to be included in this calculation (check with the Municipal Engineer). In these cases, the amount of proposed impervious area may be reduced for proposed driveways, patios, and sidewalks through the use of gravel, pervious pavement, and turf pavers. All proposed impervious areas must be constructed so that runoff is conveyed to a BMP(s); no runoff may be directed to storm sewers, inlets or other impervious areas (i.e. street) without effective stormwater management from a site.

In addition, the use of low impact development is recommended to further minimize the effect of the new construction on water, land, and air. Low impact development is a method of development that incorporates design techniques that include: minimizing the amount of land disturbance, reducing the amount of impervious cover, disconnecting gutters and directing stormwater runoff to vegetated areas to infiltrate, and redirecting the flow of stormwater runoff from impervious surfaces to vegetated areas instead of the street or gutter.

Below are the steps that must be undertaken to meet the Ordinance requirements. The size and description of the proposed construction as well as important aspects related to the design of the BMP(s) must be documented in the Simplified Approach Worksheet found in Table 4. All individuals planning on using the Simplified Approach are encouraged to review the planned project with the Municipal Engineer prior to initiating the Simplified Approach to confirm the following:

- That the proposed project is not otherwise exempt from the stormwater management control and engineered Stormwater Management Site Plan requirements of the Township's Stormwater Management Ordinance;
- That the proposed project size is within the range eligible to use this Simplified Approach;
- To determine which components of the proposed project must be included in the calculation of "impervious areas"; and

- Whether any local conditions are known to the Municipal Engineer that would preclude the use of any of the techniques included in this Simplified Approach.

Step 1 - Prepare the Simplified SWM Site Plan (i.e. sketch plan) that includes:

- Name and address of the owner of the property, and name and address of individual preparing the plan (if different than the property owner), along with the date of submission.
- Location of all existing structures including buildings, driveways, and roads within fifty (50) feet of the project site.
- Location of proposed structures, driveways, or other paved areas with approximate size in square feet.
- Location, and distance, of any existing surface water features, such as streams, lakes, ponds, wetlands or other natural water bodies, within fifty (50) feet of the project site and/or BMPs. Depending upon the Township's requirements, the following may also be required (check with the Municipal Engineer):
 - The project and/or BMPs cannot cause earth disturbance within fifty (50) feet from a perennial or intermittent stream, wetland or water body. Protecting this area from non-disturbance along the aforementioned features helps protect the applicant's land from erosion, the flood carrying capacity of streams, and the water quality of the water body. Where the applicant cannot meet the 50-foot non-disturbance width, the applicant should work with the Municipal Engineer to determine if a reduced width is acceptable, however a minimum of at least a 10 foot non-disturbance area width should be maintained.
 - If an existing buffer is legally prescribed (i.e., deed, covenant, easement, etc.) and it exceeds this requirements, the existing buffer must be maintained.
- Location, orientation, and dimensions of all proposed BMPs. For all rain gardens/bioretention, infiltration trenches, and dry wells the length, width, and depth must be included on the plan. For rain barrels or cisterns the volume must be included.
- Location of any existing or proposed on-lot septic system and potable water wells showing rough proximity to infiltration facilities. See Section 3. Description of BMPs, for the appropriate setbacks for on-lot septic systems and potable water wells.

Step 2 – Determine the Impervious Area to be Managed

- Determine the total area of all proposed impervious surfaces that will need to drain to one or more BMP(s).
- Also determine the total area for proposed earth disturbance to complete the project and install the BMP(s). The total earth disturbance to complete a project is often greater than the project area to allow for access from construction vehicles, stock piling of materials and excavation. The total area of earth disturbance must account for all of the construction activities necessary to construct the project.
- Determine locations where BMP(s) need to be placed so that the appropriate amount of stormwater runoff from the proposed impervious surfaces can be captured and managed.

Step 3 – Select the BMP(s) to be Used and Determine Appropriate Sizing Criteria

- Select the BMP(s) to be used and determine the requirements of each from Section 3, Description of BMPs.
 - For instance, the back half of a garage may drain to a rain barrel and the front half of the garage and a driveway may drain to a bioretention area. Each BMP will be sized differently, manage stormwater runoff and will need to be designed to be consistent with Section 3.
- Then obtain the required storage volume and surface area needed for each of the proposed BMP(s) from the appropriate heading below.
- Complete Table 4 Simplified Approach Worksheet.

For Rain Barrels/Cisterns:

Step 3A – Select the proposed impervious area value in Column 1 of Table 1 that is closest to, but not less than the determined value.

Step 3B – Determine the volume that needs to be provided in cubic feet and gallons to satisfy the volume requirements using Columns 2 and 3 in Table 1.

For Rain Gardens/Bioretention or Dry Well #1:

Step 3A – Select the proposed impervious area value in Column 1 of Table 2 that is closest to, but not less than the determined value.

Step 3B - Determine the volume that needs to be provided in cubic feet to satisfy the volume requirements using Column 2 in Table 2.

Step 3C – Using the value from Column 2 determined above, and the depth (D) of the proposed BMP, simply determine the surface area needed from Column 3 of Table 2.

Note: The arrows under Column 3 in Table 2 indicate which range of depths is appropriate for each BMP. To determine the depth based on the area, select an area that corresponds to the required volume, and is closest to, but not more than the area to be used. To determine the area based on the depth, select a depth that is closest to, but not less than the depth that is to be used.

For Infiltration Trench or Dry Well #2:

Step 3A – Select the proposed impervious area value in Column 1 of Table 3 that is closest to, but not less than the determined value.

Step 3B - Determine the volume that needs to be provided in cubic feet to satisfy the volume requirements using Column 2 in Table 3.

Step 3C – Using the value from Column 2 determined above, and the depth (D) of the proposed BMP, simply determine the surface area needed from Column 3 of Table 3.

Note: The arrows under Column 3 in Table 3 indicate which range of depths is appropriate for each BMP. To determine the depth based on the area, select an area that corresponds to the required volume, and is closest to, but not less than the area to be used. To determine the area based on the depth, select a depth that is closest to, but not less than the depth that is to be used.

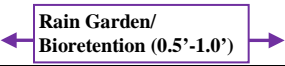
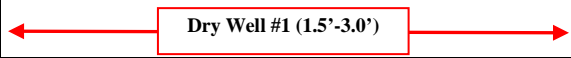
Step 4 – Submit the final SWM Site Plan and Simplified Approach Worksheet. Construction can begin only after the Township has issued its approval of the proposed project to the applicant.

Table 1: Simplified Approach - Calculating Cistern Storage Volume for 1” Rainfall

Column 1	Column 2	Column 3
Proposed Impervious Area (square feet)	Volume of Cistern¹ (cubic feet)	Volume of Cistern (gallons)
<i>I</i>	V_{RBcf}	V_{RBgal}
Sum of all Proposed Impervious Areas	$(1*(1/12)*I)/0.75=V_{RBcf}$	$V_{RBcf} * 7.48=V_{RBgal}$
1,000	111	831
1,100	122	913
1,200	133	995
1,300	144	1,077
1,400	156	1,167
1,500	167	1,249
1,600	178	1,331
1,700	188	1,406
1,800	200	1,496
1,900	211	1,578
1,999	222	1,661

¹It is assumed that the cistern is 25% full prior to receiving runoff.

Table 2: Simplified Approach - Calculating Rain Garden/Bioretenion and Dry Well #1 Storage Volume and Surface Area for 1 Inch Rainfall

Column 1	Column 2	Column 3					
Total Proposed Impervious Area (square feet)	Volume of Rain Garden/Bioretenion or Dry Well #1 ¹ (cubic feet)	Surface Area of Rain Garden/Bioretenion or Dry Well #1 Acceptable Depths for Each BMP are indicated by the arrows below (square feet)					
		Area Required for a BMP with a Depth(D) of 0.5'	Area Required for a BMP with a Depth(D) of 1.0'	Area Required for a BMP with a Depth(D) of 1.5'	Area Required for a BMP with a Depth(D) of 2.0'	Area Required for a BMP with a Depth(D) of 2.5'	Area Required for a BMP with a Depth(D) of 3.0'
							
<i>I</i>	<i>V</i>	<i>A(sf)</i>					
Sum of all Proposed Impervious Areas	1*(1/12)*I= V	V/D=A					
1,000	83	166	83	55	42	33	28
1,100	92	184	92	37	46	37	31
1,200	100	200	100	67	50	40	33
1,300	108	216	108	72	54	43	36
1,400	117	234	117	78	59	47	39
1,500	125	250	125	83	63	50	42
1,600	133	266	133	89	67	53	44
1,700	142	284	142	95	71	57	47
1,800	150	300	150	100	75	60	50
1,900	158	316	158	105	79	63	53
1,999	166	332	166	111	83	66	55

¹ It is assumed that the rain garden/bioretenion or the dry well #1 are empty prior to receiving runoff (i.e. 0% full)

Table 3: Simplified Approach - Calculating Infiltration Trench and Dry Well #2 Storage Volume and Surface Area for 1 Inch of Rainfall

Column 1	Column 2	Column 3			
Total Proposed Impervious Area (square feet)	Volume of Infiltration Trench or Dry Well #2 ¹ (cubic feet)	Surface Area of Infiltration Trench or Dry Well #2			
		Acceptable Depths for Each BMP are indicated by the arrows below (square feet)			
		Area Required for a BMP with a Depth(D) of 1.5'	Area Required for a BMP with a Depth(D) of 2.0'	Area Required for a BMP with a Depth(D) of 2.5'	Area Required for a BMP with a Depth(D) of 3.0'
		<p>Infiltration Trench (1.5' - 3.0')</p> <p>Dry Well #2 (1.5' - 3.0')</p>			
<i>I</i>	<i>V</i>	<i>A(sf)</i>			
Sum of all Proposed Impervious Areas	$(1*(1/12)*I) / (0.4)^1 = V$	$V/D=A$			
1,000	208	139	104	83	69
1,100	230	153	115	92	77
1,200	250	167	125	100	83
1,300	270	180	135	108	90
1,400	293	195	147	117	98
1,500	313	209	157	125	104
1,600	333	222	167	133	111
1,700	355	237	178	142	118
1,800	375	250	188	150	125
1,900	395	263	198	158	132
1,999	415	277	208	166	138

¹ Assumes a percent void volume of 40%

Table 4: Simplified Approach Worksheet

Name of Property Owner(s):		Date:			
Name of Applicant(s) [if different than Owner(s)]:					
Contact Phone #:			Email Address:		
Address of Project:					
Description of Project:					
<input type="checkbox"/> Met with Municipal Engineer to discuss proposed project. Date:					
Distance from earth disturbance to nearest surface water feature (stream, pond, wetland, etc.)					
(circle one): 50 feet or less		More than 50 feet			
<input type="checkbox"/> Step 1: Attach Simplified SWM Site Plan (i.e. sketch plan), per Section 1, Step 1					
Step 2: Determine the Impervious Area to be Managed					
Total Proposed Impervious Area (square feet):					
Total Earth Disturbance (square feet):					
Step 3: Select the BMP(s) to be Used and Appropriate Sizing Criteria					
Cistern					
Proposed Impervious Surface from Column 1 in Table 1		Volume from Column 3 in Table 1			
Rain Garden/Bioretenion or Dry Well #1					
Proposed Impervious Surface from Column 1 in Table 2		Volume of BMP from Column 2 in Table 2	Area Dimensions of BMP - Column 3 in Table 2	Depth of BMP from Column 3 in Table 2	Types of Materials to be Used
Infiltration Trench					
Proposed Impervious Surface from Column 1 in Table 3		Volume of BMP from Column 2 in Table 3	Area Dimensions of BMP - Column 3 in Table 3	Depth of BMP from Column 3 in Table 3	Types of Materials to be Used

Note: For additional BMPs, use additional sheet(s).

2. Definitions

These definitions apply only to this Simplified Approach to Stormwater Management for Small Projects Handbook. The definitions included in the Township's Stormwater Management Ordinance also apply.

Best Management Practice (BMP) – As defined in the Township's Stormwater Management Ordinance, but generally including activities, facilities, designs, measures or procedures used to manage stormwater impacts from land development and earth disturbance activities to meet stormwater quality, runoff control and groundwater recharge protection requirements. BMPs include, but are not limited to, a wide variety of practices and devices such as: infiltration facilities (dry wells and infiltration trenches), filter strips, low impact design, bioretention (rain gardens), permeable paving, grassed swales, and manufactured devices (cisterns and rain barrels). Structural stormwater BMPs are permanent appurtenances to the project site.

Geotextile - A fabric manufactured from synthetic fibers which provides a separation between different types of media (i.e., soil and stone), and is used to achieve specific objectives, including infiltration or filtration.

Hotspot - Areas where land use or activities generate highly contaminated runoff, with concentrations of pollutants that are higher than those that are typically found in stormwater (e.g. vehicle salvage yards, recycling facilities, vehicle fueling stations, fleet storage areas, vehicle equipment and cleaning facilities, and vehicle service and maintenance facilities).

Impervious Surface - As defined in the Township's Stormwater Management Ordinance, but generally including **any** surface that prevents the infiltration of water into the ground. Impervious surfaces generally include, but are not limited to, streets, sidewalks, pavements, driveway areas, or roofs. The applicant should review the Township's Stormwater Management Ordinance or consult with the Municipal Engineer to confirm what components of the proposed project are considered "impervious surfaces". Decks, swimming pools, compacted soils or stone surfaces (such as for vehicle movement or parking), among other features, may be included in the Township's definition of "impervious surfaces".

Infiltration - Movement of surface water into the soil, where it is absorbed by plant roots, transpired or evaporated into the atmosphere, or percolated downward to recharge groundwater.

Low Impact Development - A land development and construction approach that uses various land planning, design practices, and technologies to simultaneously conserve and protect natural resource systems, and reduce infrastructure costs.

Percent Void Volume – The volume of void space, expressed as a percentage, of the total volume of the storage facility (void volume + volume of solid materials providing structural support for the storage facility).

Pervious Surface - Any area not defined as impervious surface.

Potable – A water supply that is either absent of contaminants or contains contaminant levels that are below a given threshold level that makes the water as suitable for drinking.

Runoff - Any part of precipitation that flows over the land surface.

Stormwater - Drainage runoff from the surface of the land resulting from precipitation, or snow or ice melt.

3. Description of BMPs

The following is a description of several types of BMPs that could be implemented. The requirements of each BMP as described below are taken directly from the PA Stormwater BMP Manual (December, 2006). Refer to the PA BMP Manual (latest version) which can be found on the PA Department of Environmental Protection's website.

Rain Barrels/Cisterns

Rain Barrels are large containers that collect drainage from roof leaders and temporarily store water to be released to lawns, gardens, and other landscaped areas after the rainfall has ended. Rain Barrels are typically between 50 to 200 gallons in size. The stored water can also be used as a non-potable water supply. Cisterns are larger than rain barrels having volumes of 200 gallons or more, and can be placed either on the surface or underground. Figures 1 and 2 show examples of rain barrels and cisterns, respectively, that could be used to manage stormwater from a project. Rain barrels and cisterns are manufactured in a variety of shapes and sizes. All of these facilities must make provisions for the following items:

- There must be a means to release the water stored in the container between storm events in order for the necessary storage volume to be available for the next storm.
- Stormwater must be kept from entering other potable systems, and pipes and storage units must be clearly marked "Do Not Drink".
- An overflow outlet should be placed a few inches below the top of the storage container with an overflow pipe to divert flow away from structures once the storage containers are filled.
- Use screens to filter debris, and covers (lids) placed over the containers to prevent insects and debris from entering the storage chamber.
- Make sure cisterns are watertight and do not leak.
- Rain barrels are typically assumed to be 25% full to calculate volume since they are not always emptied before each storm. The tables contained in this Handbook were developed to account for the 25% increase in the required storage of a rain barrel or a cistern.



Source (picture on left): <http://www.rfcity.org/Eng/Stormwater/YourProperty/YourProperty.htm>
Source (picture on right): <http://www.floridata.com/tracks/transplantedgardener/Rainbarrels.cfm>

Figure 1: Rain Barrels



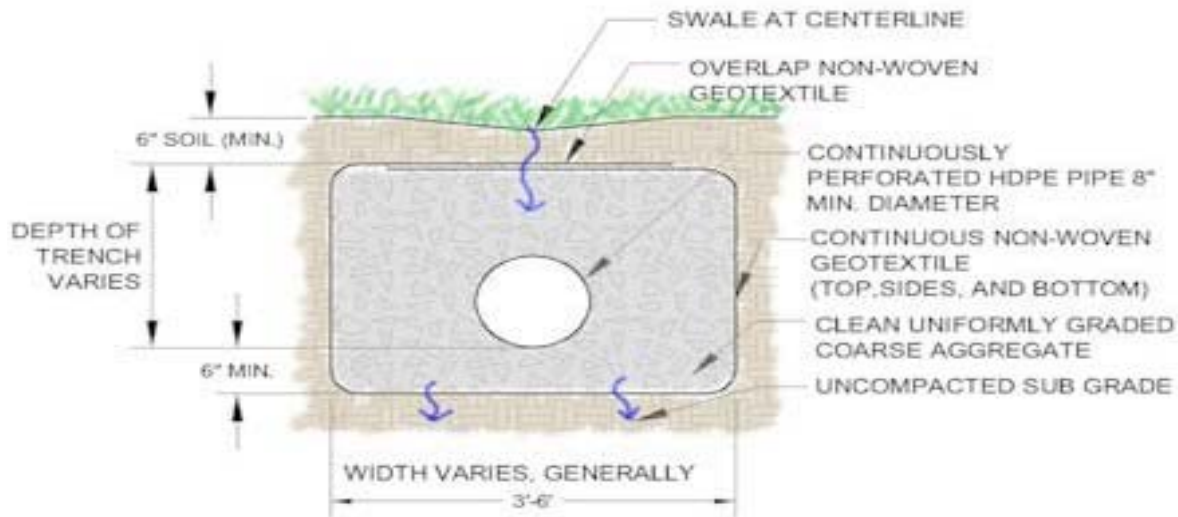
Source (for both pictures): Pennsylvania Stormwater BMP Manual (PADEP, 2006)

Figure 2: Cisterns

Infiltration Trench

An infiltration trench is a long, narrow, rock-filled trench, with or without a perforated pipe placed within the rock to distribute water evenly along the trench, that receives stormwater runoff, and has no outlet. Runoff is stored in the void space between the stones and in the pipe, and infiltrates through the bottom of the trench into the underlying soil matrix. Figure 3 shows a typical cross-section of an infiltration trench configuration. Infiltration trenches shall incorporate or make provisions for the following elements:

- These facilities should be located a minimum of twenty-five (25) feet (or as otherwise required by the Township) from the building foundation to avoid foundation seepage problems, and are not recommended if their installation would create a risk of flooding other structures constructed at or below grade.
- Perforated pipe placed within the rock is to be set level.
- The width is limited to between 3 to 8 feet, and the depth ranges from 1.5 to 3 feet.
- Trench should be wrapped in nonwoven geotextile (top, sides, and bottom).
- There should be a positive overflow that allows stormwater that cannot be stored or infiltrated to be discharged into a nearby vegetated area.
- Roof downspouts may be connected to infiltration trenches, but should contain a cleanout to collect sediment and debris before entering the infiltration area.
- Infiltration testing is recommended to ensure soil is capable of infiltrating stormwater.
- It is recommended that there be a 2 foot clearance above the regularly occurring seasonal high water table, and have a minimum depth to bedrock of 2 feet.
- The infiltration trench should be at least 50 feet from individual water supply wells, 100 feet from community or municipal water supply wells, and 50 feet from any septic system component. It should not be located near stormwater Hotspots (refer to B.2 Definitions).
- The infiltration trench should be located so that it presents no threat to sub-surface structures such as building foundations and basements.
- Protect infiltration areas from compaction by heavy equipment during and after construction.
- Infiltration trenches should be constructed after all earth disturbances associated with a given project or site is stabilized to avoid clogging.
- The ratio of the drainage area which stormwater runoff is collected from to the area of the footprint (bottom area) of the infiltration portion of the facility should be as small as possible with a ratio of less than 5:1 preferred.



Source: Pennsylvania Stormwater BMP Manual (PADEP, 2006)

Figure 3: Cross-Section of Typical Infiltration Trench

Rain Garden/Bioretention Area

A Rain Garden (Bioretention Area) is an excavated depression area on the surface of the land in which native vegetation is planted to filter and use stormwater runoff. Runoff ponds on top of the surface of the rain garden and then infiltrates into an enhanced soil/planting mix below the surface where plants can use the water to grow. Bioretention improves water quality, with the vegetation planted in the facility filtering the water, and the root systems encouraging or promoting infiltration. Figure 4 shows a cross-section of a typical rain garden. Key elements of a rain garden include:

- Recommended ponding depths not exceeding 1 foot.
- Native vegetation that can tolerate dry and wet weather.
- An overflow area where, if the bioretention area were to overflow, the overflow would flow over pervious surfaces (i.e. grass, meadow), and would not cause harm to property, or;
- An overflow, such as a domed riser, to allow excess flow from large storms to travel to other infiltration areas, pervious areas, or connected storm systems designed to receive the excess runoff.
- For most areas, slopes should be limited to 3:1, maximum; however, where space is limited, 2:1 side slopes may be acceptable with approval from the municipal engineer.
- The soil/planting mix depth should not be less than 1.5 feet deep and typically consist of a mixture of topsoil, sand and compost (i.e. mulch). The topsoil, sand and compost should be uniformly mixed by volume in a 50%, 30%, 20% mixture, respectively.



Source: Pennsylvania Stormwater BMP Manual (PADEP, 2006)

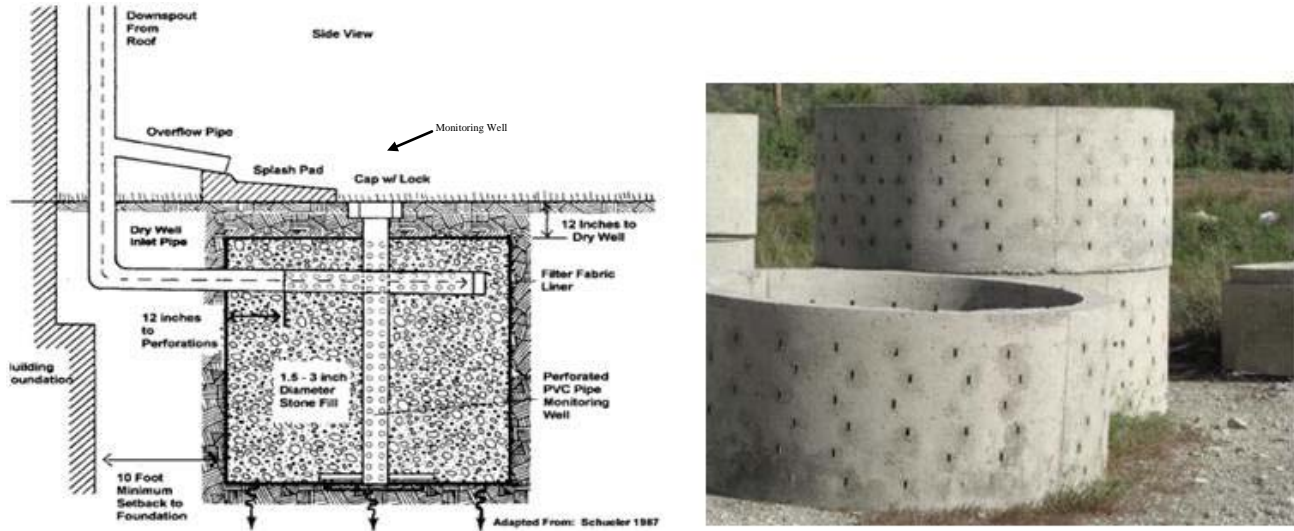
Figure 4: Cross-Section of Typical Rain Garden/Bioretention Area

Dry Wells

A dry well, also referred to as a seepage pit, is a subsurface storage facility that temporarily stores and infiltrates runoff from the roofs of buildings or other impervious surfaces. A dry well can be either a structural prefabricated chamber (Dry Well #1) or an excavated pit filled with stone fill (Dry Well #2). Dry Wells discharge the stored runoff via infiltration into the surrounding or underlying soils. Figure 5 shows a typical prefabricated dry well and a typical dry well configuration with stone fill. The following elements shall be incorporated into all dry well designs:

- These facilities should be located a minimum of twenty-five (25) feet (or as otherwise required by the Township) from the building foundation to avoid foundation seepage problems, and are not recommended if their installation would create a risk of flooding other structures constructed at or below grade.
- Dry well should be constructed after all earth disturbances associated with a given project or site is stabilized to avoid clogging.
- During construction, compaction of the subgrade soil in the bottom of the dry well should be avoided, and construction should be performed only with light machinery.
- For Dry Well #2 designs, the depth of dry well should be between **1.5 feet to 3 feet**. Gravel fill should consist of uniformly graded stone with an average diameter of between one and one half and two (1.5 –2.0) inches with the gravel fill wrapped in a nonwoven geotextile to separate the stone fill from the surrounding soil.
- At least 1 foot of soil must be placed over the top of the dry well.
- Dry wells should be inspected at least four (4) times annually as well as after large storm events.
- Dry wells should have overflow pipes to allow high volumes of runoff to overflow the facility and flow into a connected infiltration area, pervious area, or other connected storm sewer designed to receive the excess runoff.
- Every dry well must have at least one monitoring well to assist in the inspection of the dry well to determine how much water is retained within the well during dry weather periods.

- Infiltration testing is recommended to ensure the underlying soil is capable of infiltrating the needed volume of stormwater.



Source (for picture on left): <http://www.seagrant.sunysb.edu/pages/BMPsForMarinas.htm>
 Source (for picture on right): <http://www.copelandconcreteinc.net/1800652.html>

Figure 5: Typical Dry Well Configuration filled with Stone Fill (DRY WELL #2) (Left) and Structural Prefabricated Chamber (DRY WELL #1) (Right)

4. Example

Simplified Approach to Stormwater Management for a Residential Garage and Driveway addition

Joe Homeowner wants to build a 400 square foot two car garage, and a 540 square foot (30' long x 18' wide) impervious driveway that is graded so that the stormwater runoff drains to the grassy area along one edge of the driveway. (An annotated copy of Table 1 is provided below as Table 5 and an annotated copy of Table 3 is provided below as Table 6, and outlines the steps of this example) and a completed Table 4 is provided as Table 7.

STEP 1 – Make a sketch of the site plan as shown in Figure 6.

STEP 2 - Determine the total area of all proposed impervious surfaces to drain to each BMP:

Garage Roof (Front)	10 ft. x 20 ft.	=	200 sq. ft.
Garage Roof (Rear)	10 ft. x 20 ft.	=	200 sq. ft.
Driveway	30 ft. x 18 ft.	=	540 sq. ft.

Total Proposed Impervious Surface			940 sq. ft.
Total Proposed Earth Disturbance Area			2,500 sq. ft. (estimated)

Note: If the driveway used pervious pavement (i.e. paving blocks), then the total impervious area would only be 400 square feet, and no stormwater management practices would need to control runoff from the project.

STEP 3 – Select the BMP(s) to be Used and Appropriate Sizing Criteria

Select a BMP or combination of BMPs from Section 3 to be used to satisfy the volume requirement. Determine the length, width, depth and other requirements for the BMPs in Section 3. A BMP needs to be placed to catch runoff from the back of the garage, and a BMP needs to be placed to capture runoff from the front of the garage and the driveway. Figure 6 shows the direction the runoff flows and the locations where the BMPs are to be placed.

Joe Homeowner would like to use a rain barrel (BMP #1) to capture the runoff from the rear of the garage and an infiltration trench (BMP #2) to capture runoff from the front of the garage and the driveway.

BMP #1 (Rain Barrel/Cistern) – Steps 3A and 3B

STEP 3A - Select the proposed impervious area value for BMP #1, the rain barrel or cistern, in Column 1 that is closest to, but not less than 200 in Table 1:

The value in Column 1 that is closest to but is not less than 200 is 200.

STEP 3B - Determine the volume that BMP #1 must be to satisfy the volume requirements using Columns 2 and 3 in Table 1:

The volume in gallons of the rain barrel/cistern to be used as BMP #1, assuming the rain barrel/cistern is 25% full, is determined by finding the value in Column 3 for the same row that corresponds to the impervious area value determined in Step 1. Therefore, the volume of BMP #1, the rain barrel/cistern must be ≥ 166 gallons. Depending on the size of the rain barrel(s), a combination of rain barrels could be used in succession as shown in Figure 1, or a cistern could be used.

BMP #2 (Infiltration Trench) - Steps 3A through 3C

STEP 3A - Select the proposed impervious area value for BMP #2, the infiltration trench, using Column 1 in Table 6:

Find the row in Column 1 that is closest to but not less than 740 (200 from the front of the garage + 540 from the driveway). Therefore, the value selected is 750.

STEP 3B - Determine the volume that BMP #2, the infiltration trench must be to satisfy the volume requirements using Column 2 in Table 6:

The volume of the infiltration trench to be used as BMP #2, assuming a percent void volume of 40%, is determined by finding the value Column 2 that is in the same row as 750 square feet from Column 1 as described in Step 2. Therefore, the volume of BMP #2 must be 156 cubic feet.

STEP 3C - Utilizing the value from Column 2 determined above, and the surface area that the proposed BMP will occupy, determine the depth needed using Column 3 in Table 6:

Joe Homeowner would like to place the infiltration trench along the edge of the driveway so it would have a length of 20 feet. The smallest width that can be used, as stated in the infiltration trench requirements in Section 3, is 3 feet. Therefore, the area of the infiltration trench is:

$$20 \text{ feet} * 3 \text{ feet} = 60 \text{ square feet}$$

To find the minimum depth of the trench move toward the right side of the table from 156 cubic feet in Column 2 to Column 3, and find the column with a value of as close to but not more than 60 square feet, which is 52 square feet. Then obtain the minimum depth of the facility by reading the depth from the column heading at the top of the table. Therefore, the depth of the trench would need to be 3 feet.

Selected BMPs:

BMP #1: Rain barrel(s) that provides for at least 166 gallons, and

BMP #2: A 20' long x 3' wide x 3' deep infiltration trench

Table 5: Example – Calculating Storage Volume for Rain Barrel/Cistern

Column 1	Column 2	Column 3	
Proposed Impervious Area (square feet)	Volume of Rain Barrel/Cistern ¹ (cubic feet)	Volume of Rain Barrel/Cistern (gallons)	
/	V_{RBcf}	V_{RBgal}	
Sum of all Proposed Impervious Areas	$(1*(1/12)*I)/0.75=V_{RBcf}$	$V_{RBcf} * 7.48=V_{RBgal}$	
50	6	42	↑
100	11	83	Rain Barrel
150	17	125	↓
2	22	166	↓
250	28	208	↑
300	33	249	↑
350	39	291	↑
400	44	332	↑
450	50	374	↑
500	56	416	↑
550	61	457	↑
600	67	499	Cistern
650	72	540	↑
700	78	582	↑
750	83	623	↑
800	89	665	↑
850	94	706	↑
900	100	748	↑
950	106	790	↑
999	111	830	↓

¹Assume that the rain barrel/cistern is 25% full

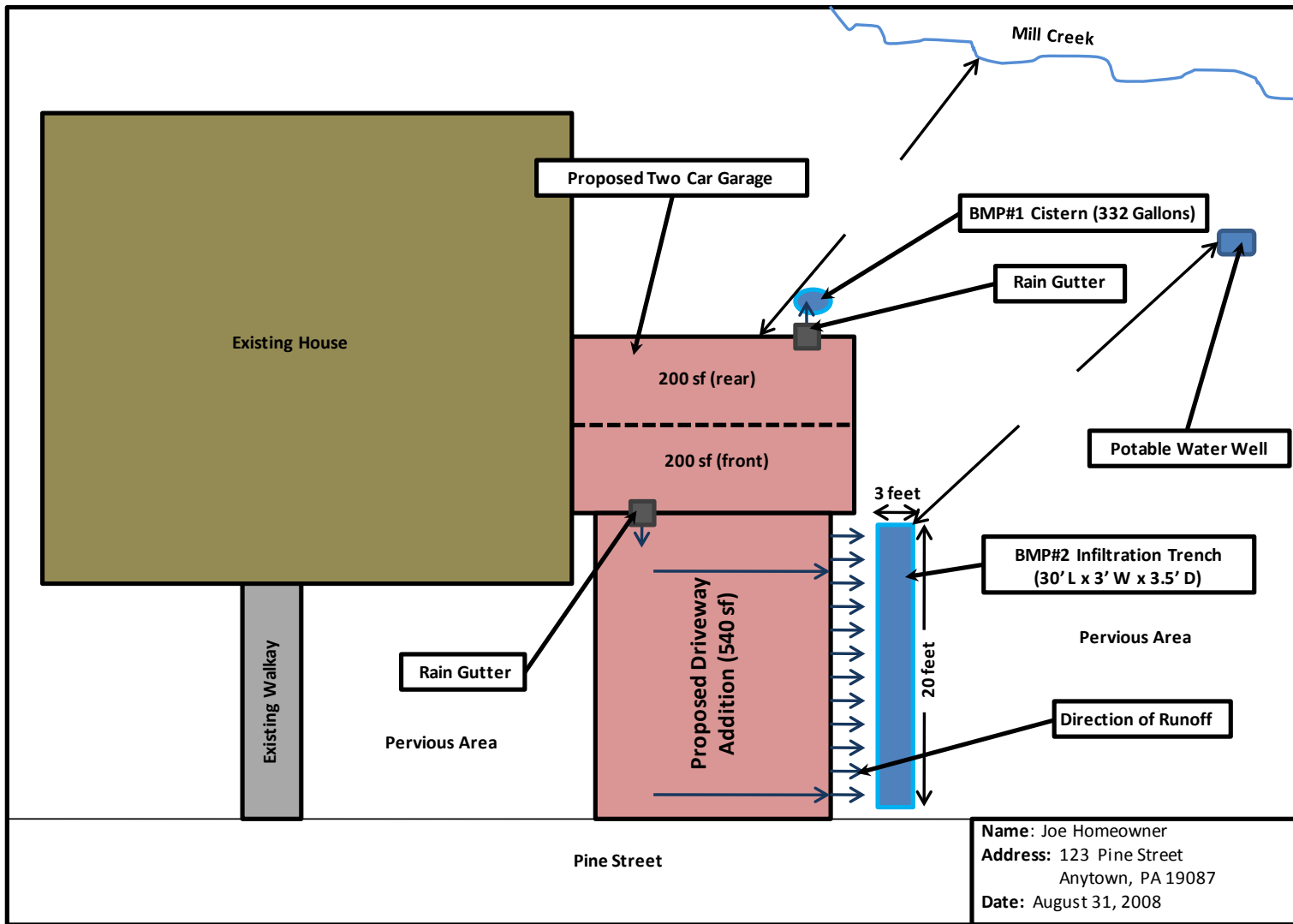


Figure 6: Example of Simplified Stormwater Management Site Plan for Joe Homeowner

Table 6: Example – Calculating Storage Volume Surface Area and Depth for Infiltration Trench

Column 1	Column 2	Column 3							
Total Proposed Impervious Area (square feet)	Volume of Infiltration Trench or Dry Well #2 ¹ (cubic feet)	Surface Area of Infiltration Trench or Dry Well #2							
		Acceptable Depths for Each BMP are indicated by the arrows below (square feet)							
		Area Required for a BMP with a Depth(D) of 1.5'	Area Required for a BMP with a Depth(D) of 2.0'	Area Required for a BMP with a Depth(D) of 2.5'	Area Required for a BMP with a Depth(D) of 3.0'	Area Required for a BMP with a Depth(D) of 3.5'	Area Required for a BMP with a Depth(D) of 4.0'	Area Required for a BMP with a Depth(D) of 4.5'	Area Required for a BMP with a Depth(D) of 5.0'
<i>I</i>	<i>V</i>	<i>A(sf)</i>							
Sum of all Proposed Impervious Areas	$(1*(1/12)*I) / (0.4)^1 = V$	$V/D=A$							
50	10	7	5	4	3	3	3	2	2
100	21	14	10	8	7	6	5	5	4
150	31	21	16	13	10	9	8	7	6
200	42	28	21	17	14	12	10	9	8
250	52	35	26	21	17	15	13	12	10
300	63	42	31	25	21	18	16	14	13
350	73	49	36	29	24	21	18	16	15
400	83	56	42	33	28	24	21	19	17
450	94	63	47	38	31	27	23	21	19
500	104	69	52	42	35	30	26	23	21
550	115	76	57	46	38	33	29	25	23
600	125	83	63	50	42	36	31	28	25
650	135	90	68	54	45	39	34	30	27
700	146	97	73	58	49	42	36	32	29
Step 3A 750	Step 3B 156	104	78	61	52	45	39	35	31
800	167	111	83	67	56	48	42	37	33
850	177	118	89	71	59	51	44	39	35
900	188	125	94	75	63	54	47	42	38
950	198	132	99	79	66	57	49	44	40
999	208	139	104	83	69	59	52	46	42

¹ Assumes a percent void volume of 40%

Table 7: Simplified Approach Worksheet – Example for Joe Homeowner

Name of Property Owner(s): Joe Homeowner		Date: 8/26/12			
Name of Applicant(s) [if different than Owner(s)]: N/A					
Contact Phone #: 610-555-1234		Email Address: joe@homeowner.com			
Address of Project: 123 Pine St., Anytown, PA 19355					
Description of Project: Add a 2-car garage and driveway					
<input type="checkbox"/> Met with Municipal Engineer to discuss proposed project. [date of meeting 6/1/12]					
Distance from earth disturbance to nearest surface water feature (stream, pond, wetland, etc.) (if required by the Township, circle one): 50 feet or less More than 50 feet					
<input checked="" type="checkbox"/> Step 1: Attach Simplified SWM Site Plan (i.e. sketch plan), per Section .1, Step 1					
Step 2: Determine the Impervious Area to be Managed					
Total Proposed Impervious Area (square feet): 940 sq. feet					
Total Earth Disturbance (square feet): ~ 2,500 sq. feet					
Step 3: Select the BMP(s) to be Used and Appropriate Sizing Criteria					
Rain Barrel or Cistern					
Proposed Impervious Surface from Column 1 in Table 1		Volume from Column 3 in Table 1			
200 sq. feet		166 gallons			
Rain Garden/Bioretenention or Dry Well #1					
Proposed Impervious Surface from Column 1 in Table 2		Volume of BMP from Column 2 in Table 2		Area Dimensions of BMP - Column 3 in Table 2	Depth of BMP from Column 3 in Table 2
N/A					Types of Materials to be Used
Infiltration Trench or Dry Well #2					
Proposed Impervious Surface from Column 1 in Table 3		Volume of BMP from Column 2 in Table 3		Area Dimensions of BMP - Column 3 in Table 3	Depth of BMP from Column 3 in Table 3
740 sq. feet		156 cubic feet		20 ft by 3 ft	3 ft
					Infiltration trench, uniformly graded aggregate, 8" HDPE pipe, geotextile, grass planted on top.
<input checked="" type="checkbox"/> Step 4: Complete, Sign & have Operation, Maintenance and Inspection Agreement Notarized and Recorded at the County Recorder of Deeds (when signed by the Township)					

Note: For additional BMPs, use additional sheet(s).

5. Simplified Approach Operation, Maintenance and Inspection Plan & Agreement

It is the property owner's responsibility to properly maintain BMPs. It is also the property owner's responsibility to inform any future buyers of the function, operation, and maintenance needed for any BMPs on the property prior to the purchase of the property. The accompanying sample "Simplified Approach Operation, Maintenance and Inspection Plan and Agreement" (see accompanying appendix) outlines the maintenance required for each type of BMP, the responsibilities of the property owner, and the rights of the Township in regards to inspection and enforcement of the maintenance requirements.

The "Simplified Approach Operation, Maintenance and Inspection Plan and Agreement" must be signed, notarized and submitted to the Township. Following the signature by the Township, the property owner must have the Agreement recorded at the County Recorder of Deeds, so that the Agreement will be applicable to future property owners.

SAMPLE AGREEMENT

SIMPLIFIED APPROACH STORMWATER BEST MANAGEMENT PRACTICES OPERATION, MAINTENANCE, AND INSPECTION PLAN AND AGREEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, 20____, by and between _____, (hereinafter the "Landowner"), and _____(City, Borough, Township), Lancaster County, Pennsylvania, (hereinafter "Township").

WITNESSETH

WHEREAS, the Landowner is the owner of certain real property by virtue of a deed of conveyance recorded in the office of the Recorder of Deeds, Lancaster County, Pennsylvania, at Deed Book _____ and Page _____, (hereinafter "Property"); and

WHEREAS, the Landowner recognizes that the stormwater management best management practices or BMPs (hereinafter referred to as "BMP" or "BMP(s)") located on the Property at _____ (address of Property where BMP is located) must be inspected and maintained; and

WHEREAS, the Township and the Landowner, for itself and for its administrators, executors, successors, heirs, and assigns, agree that the health, safety, and welfare of the residents of the Township and the protection and maintenance of water quality require that on-site BMP(s) be constructed and maintained on the Property; and

WHEREAS, for the purposes of this Agreement, the following definitions shall apply:

BMP – “Best Management Practice;” activities, facilities, designs, measures or procedures used to manage stormwater impacts from land development, to protect and maintain water quality and ground water recharge and to otherwise meet the purposes of the Township’s Stormwater Management Ordinance, including, but not limited to infiltration trenches, dry wells, bioretention, rain gardens, permeable paving, rain barrels and cisterns, etc. The BMP(s) are permanent appurtenances to the Property; and

Conveyance – As specifically identified in the Simplified Stormwater Management Site Plan (herein after “Plan”), a man-made, existing or proposed facility, structure or channel used for the transportation or transmission of stormwater from one place to another, including pipes, drainage ditches, channels and swales (vegetated and other), gutters, and like facilities or features. The conveyances identified in the Plan are permanent appurtenances to the Property; and

WHEREAS, the Township requires that the BMP(s) and conveyances as shown on Plan and in accordance with the sizing calculations found on the Simplified Method Worksheet (herein after “Worksheet”) be constructed by the Landowner; the BMP(s) shall further be maintained by the Landowner, its administrators, executors, successors, heirs, and assigns in accordance with the associated operation and maintenance requirements included herein. The Plan and Worksheet are attached hereto and incorporated herein together as Exhibit “A” hereto; and

WHEREAS, the Township requires that stormwater management BMP(s) be constructed and adequately inspected, operated and maintained by the Landowner, its administrators, executors, successors, heirs, and assigns, in accordance with the following maintenance requirements:

1. Infiltration Trenches

- a. At least twice a year and after significant rainfall events the Landowner is to inspect the infiltration trench and remove any accumulated debris, sediment and invasive vegetation.
- b. Vegetation along the surface of an infiltration trench is to be maintained in good condition, and any bare spots are to be revegetated as soon as possible.
- c. Vehicles are not to be parked or driven on an infiltration trench, and care is to be taken to avoid excessive compaction by mowers.
- d. Any debris, such as leaves blocking flow from reaching an infiltration trench, is to be routinely removed.

2. Bioretention/Rain Garden

- a. Any debris, such as leaves blocking flow from reaching a bioretention/rain garden, is to be routinely removed.
- b. Pruning and weeding are required as needed including removal of invasive species, especially while vegetation is being established for a bioretention/rain garden.
- c. Mulch cover is to be maintained in a bioretention/rain garden, re-spread and replaced as needed to prevent erosion, reduce weed growth and assist with plant survival, without restricting the infiltration of stormwater.
- d. At least twice a year the Landowner is to inspect the bioretention/rain garden for sediment buildup, ground cover and vegetative conditions and make any repairs as needed.
- e. Watering is required as needed, including during periods of extended dry weather and drought.
- f. Trees and shrubs in a bioretention/rain garden are to be inspected at least twice per year by the Landowner to evaluate their health. If they are in poor health they are to be replaced.

3. Dry Wells

- a. Dry wells are to be inspected by the landowner at least four (4) times a year and after significant rainfalls, and debris, trash, sediment, and any other waste material need to be removed and disposed of at suitable disposal or recycling sites and in compliance with local, state, and federal waste regulations.
- b. For dry wells, gutters are to be regularly cleaned out and ensure that proper connections are maintained to facilitate the effectiveness of the dry well.
- c. The filter screen for downspouts or roof gutters which intercepts roof runoff and conveys it to the dry well must be cleaned and replaced as necessary.
- d. Dry wells that are damaged are to be fixed or replaced within two (2) weeks of being damaged.
- e. If an intermediate sump box exists in conjunction with a dry well, it must be cleaned out at least once per year.

4. Rain Barrels and Cisterns

- a. Rain Barrels and Cisterns are to be cleared of debris routinely at least every three (3) months and after significant storms to allow stormwater from gutters to enter them.
- b. Gutters that directly convey rain water to dry wells, rain barrels, and cisterns are to be routinely cleared of trash and debris at least every three (3) months and after significant rainfall events.
- c. Rain Barrels and cisterns should be routinely emptied to allow for storage of additional rain water.
- d. Overflow outlets from rain barrels and cisterns must be kept free and clear of debris.
- e. Rain Barrels and cisterns that are damaged are to be fixed or replaced within two (2) weeks of being damaged.

NOW, THEREFORE, in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto, intending to be legally bound hereby, agree as follows:

- 1. The foregoing recitals to this Agreement are incorporated as terms of this Agreement and obligations of the Landowner as if fully set forth in the body of this Agreement.

2. The Landowner shall construct the BMP(s) in accordance with the specifications identified in the Plan and Worksheet.
3. The Landowner shall inspect, operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Township and in accordance with the specific inspection and maintenance requirements outlined in this Agreement.
4. The Landowner hereby grants permission to the Township, its authorized agents and employees, to enter upon the Property from the public right-of-way or roadway, at reasonable times and upon presentation of proper identification, to inspect the BMP(s) whenever it deems necessary for compliance with this Agreement and the Township's Stormwater Ordinance. Whenever possible, the Township shall notify the Landowner prior to entering the Property.
5. The Landowner acknowledges that, per the Township's Stormwater Ordinance, it is unlawful, without written approval of the Township, to:
 - a. Modify, remove, fill, landscape, alter or impair the effectiveness of any BMP or conveyance that is constructed as part of the Plan;
 - b. Place any structure, fill, landscaping, additional vegetation, yard waste, brush cuttings, or other waste or debris into a BMP or conveyance that would limit or alter the functioning of the BMP or conveyance;
 - c. Allow the BMP or conveyance to exist in a condition which does not conform to the Plan or this Agreement; and
 - d. Dispose of, discharge, place or otherwise allow pollutants including, but not limited to, deicers, pool additives, household chemicals and automotive fluids to directly or indirectly enter any BMP or conveyance.
6. In the event the Landowner fails to operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Township the Landowner shall be in violation of this Agreement and the Landowner agrees that the Township or its representatives may, in addition to and not in derogation or diminution of any remedies available to it under the Stormwater Ordinance or other statutes, codes, rules or regulations, or this Agreement, enter upon the Property and take whatever action is deemed necessary to maintain said BMP(s). It is expressly understood and agreed that the Township is under no obligation to maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the Township.

7. In the event the Township, 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 Township for all expenses (direct and indirect) incurred within 30 days of delivery of an invoice from the Township. Failure of the Landowner to make prompt payment to the Township may result in enforcement proceedings, which may include the filing of a lien against the Property, which filing is expressly authorized by the Landowner.

8. The intent and purpose of this Agreement is to ensure the proper maintenance of the onsite BMP(s) by the Landowner; provided, however, that this Agreement shall not be deemed to create or effect any additional liability of any party for damage alleged to result from or be caused by stormwater runoff.

9. The Landowner, its executors, administrators, assigns, heirs, and other successors in interests, hereby release and shall release the Township, its employees, agents and designated representatives from all damages, accidents, casualties, occurrences or claims which might arise or be asserted against the Township and/or its said employees, agents or representatives, arising out of the construction, presence, existence, or maintenance of the BMP(s) either by the Landowner or Township. In the event that a claim is asserted or threatened against the Township, its employees, agents or designated representatives, the Township shall notify the Landowner and the Landowner shall defend, at his own expense, any claim, suit, action or proceeding, or threatened claim, suit, action or proceeding against the Township or, at the request of the Township, pay the cost, including attorneys' fees, of defense of the same undertaken on behalf of the Township. If any judgment or claims against the Township, its employees, agents or designated representatives shall be allowed, the Landowner shall pay all damages, judgments or claims and any costs and expenses incurred by the Township, including attorney's fees, regarding said damages, judgment or claims.

10. The Township may enforce this Agreement in accordance with its Stormwater Ordinance, at law or in equity, against the Landowner for breach of this Agreement. Remedies may include fines, penalties, damages or such equitable relief as the parties may agree upon or as may be determined by a Court of competent jurisdiction. Recovery by the Township shall include its reasonable attorney's fees and costs incurred in seeking relief under this Agreement.

11. Failure or delay in enforcing any provision of this Agreement shall not constitute a waiver by the Township of its rights of enforcement hereunder.

12. The Landowner shall inform future buyers of the Property about the function of, operation, inspection and maintenance requirements of the BMP(s) prior to the purchase of the Property by said future buyer, and upon purchase of the Property the future buyer assumes all responsibilities as Landowner and must comply with all components of this Agreement.

13. This Agreement shall inure to the benefit of and be binding upon, the Township and the Landowner, as well as their heirs, administrators, executors, assigns and successors in interest.

This Agreement shall be recorded at the Office of the Recorder of Deeds of the County of Lancaster, Pennsylvania, and shall constitute a covenant running with the Property and/or equitable servitude, in perpetuity.

ATTEST:

WITNESS the following signatures and seals:

(SEAL)

For the Township:

(SEAL)

For the Landowner:

I, _____, a Notary Public in and for the County and State aforesaid, whose commission expires on the _____ day of _____, 20__, do hereby certify that _____ whose name(s) is/are signed to the foregoing Agreement bearing date of the _____ day of _____, 20__, has acknowledged the same before me in my said County and State.

GIVEN UNDER MY HAND THIS _____ day of _____, 20__.

NOTARY PUBLIC

OWNER ACKNOWLEDGMENT

- Development activities shall begin only after Bart Township approves the Small Project Stormwater Management Permit.
- The installed Stormwater BMPs will not adversely affect any property, septic systems, or drinking water wells on this or any other property.
- If, after approval of the Small Project by Bart Township, the applicant wishes to pursue alternative stormwater management measures in support of the project, the applicant will submit revised Small Project information and worksheets to Bart Township for approval. If a site requires a more complex system or if problems arise, the applicant may need the assistance of a licensed professional engineer, landscape architect or surveyor.
- The applicant acknowledges that the proposed Stormwater BMPs will be a permanent fixture of the property that cannot be altered or removed without approval by Bart 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 submission, including but not limited to the Bart Township Stormwater Worksheet, and the Stormwater Management / BMP Facilities and Maintenance Agreement (if applicable) will be adhered to.

Applicant Acknowledgement of Submission:

Signature: _____ Date: _____

Bart Township Acknowledgement of Receipt:

Signature: _____ Date: _____
 << Title >>