APPENDIX C

Optional Stormwater Management for Small Projects

Applicability: Stormwater management procedures for projects with between five hundred (500) square feet and (4,999) square feet of proposed impervious area. All of the proposed impervious area that is created by a regulated activity must be disconnected impervious area, otherwise the Applicant cannot use this document to meet stormwater management requirements, and is therefore responsible for meeting all stormwater management requirements of the Ordinance. Disconnected impervious area and regulated activities are defined in Section C.2 of this document.

Note: This small projects document is not to be used to plan for multiple lots without obtaining prior written approval from the Municipality. Approvals and actions associated with this document do not relieve the Applicant of the responsibility to secure required permits or approvals for activities regulated by any other code, law or ordinance.

STORMWATER MANAGEMENT PROCEDURES
FOR SMALL PROJECTS

Introduction

This handbook has been developed to allow homeowners to comply with stormwater management criteria for new projects to meet the requirements of the Act 167 Stormwater Management Ordinance of the Municipality including sizing, designing, locating, and installing on-lot measures, referred to herein as "Best Management Practices" (BMPs). Pennsylvania Act 167 was authorized on October 4, 1978 (32 P.S., P.L. 864) and gave Pennsylvania municipalities the power to regulate activities that affect stormwater runoff and surface and groundwater quantity and quality.

Individual home construction projects on single-family lots which result in between 500 square feet and 4,999 square feet of proposed impervious area (including the building footprint, driveway, sidewalks, and parking areas) are not required to submit formal stormwater management (SWM) site plans to the Municipality or County; however, they must attempt to address water quality and infiltration goals as outlined in this small projects document. If the guidelines presented in this brochure are followed, the individual homeowner will not require professional services to comply with these water quality and infiltration goals.

Section C.1 describes requirements and outlines the method for designing a suitable BMP, and a description of what needs to be included on the simple sketch plan. Section C.2 presents definitions of key terms. Section C.3 presents options of BMPs that can be considered for on-lot stormwater management. An example of how to obtain the size and dimensions of a BMP is explained in Section C.4.

The stormwater management method for small projects requires:

- The first 1" of rainfall runoff from proposed impervious surfaces to be captured (see definition of captured in Section C.2).

The purpose of this small projects document 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 sent to the Municipality?

Even though a formal SWM site plan is not required for individual lot owners, the small projects worksheet found in Table C-4 and a simple sketch plan containing the features described in Step 4 of Section C.1 needs to be submitted to the Municipality, and if applicable, the contractor prior to construction.

C.1 Determination of Simplified Approach Volume Requirements

All proposed impervious areas must be included in the determination of the amount of new impervious areas and the size of proposed BMPs needed to control stormwater. Proposed impervious areas on an individual residential lot include: roof area, pavement, sidewalks, driveways, patios, porches, permanent pools, or parking areas. Sidewalks, driveways, or patios that are constructed with gravel or pervious pavers that will not be converted to an impervious surface in the future need not be included in this calculation. Therefore, the amount of proposed impervious area can 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; no runoff can be directed to storm sewers, inlets, or other impervious areas (i.e., street).

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 impervious cover, disconnecting gutters and directing runoff to vegetated areas to infiltrate, and redirecting the flow of runoff from impervious driveways to vegetated areas instead of to the street or gutter.

The amount of impervious area that needs to be controlled may be reduced by disconnecting impervious areas as discussed below as a BMP and as found in Ordinance Appendix B.

Below are the steps that must be undertaken to meet the Ordinance requirements. The results obtained for each step must be included in the Small Projects Worksheet found in Table C-4:

STEP 1 – Determine the total area of all proposed impervious surfaces that will need to drain to one or more BMPs. Determine locations where BMPs need to be placed so that runoff from all of the proposed impervious surfaces can be captured. Select the BMPs to be used and determine the requirements of each from Section C.3. For instance, the back half of a garage may drain 200 square feet of roof to a rain barrel, and the front half of a garage may drain 200 square feet of roof and 540 square feet of driveway to an infiltration trench. Then, obtain the required storage volume and surface area needed for each of the proposed BMPs from the appropriate heading below.

For Rain Barrels/Cisterns

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

STEP 3 – 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 C-1.

Table C-1: Calculating Rain Barrel/Cistern Storage Volume for 1" Rainfall[1]

Column 1	Column 2	Column 3
Proposed Impervious Area (square feet)	**Volume of Rain Barrel/Cistern[2] (cubic feet)**	**Volume of Rain Barrel/Cistern (gallons)**
I	V_{RBcf}	V_{RBgal}
Sum of all Proposed Impervious Areas	$(1*(1/12)*I)/0.75=V_{RBcf}$	$V_{RBcf} * 7.48=V_{RBgal}$
50	6	42
100	11	83
200	22	166
300	33	249
400	44	332
500	56	416
600	67	499
700	78	582
800	89	665
900	100	748
1,000	111	831
1,100	122	914
1,200	133	997
1,300	144	1,081
1,400	156	1,164
1,500	167	1,247
1,600	178	1,330
1,700	189	1,413
1,800	200	1,496
1,900	211	1,579
2,000	222	1,662
2,100	233	1,745
2,200	244	1,829
2,300	256	1,912
2,400	267	1,995
2,500	278	2,078
2,600	289	2,161
2,700	300	2,244
2,800	311	2,327
2,900	322	2,410
3,000	333	2,494
3,100	344	2,577
3,200	356	2,660
3,300	367	2,743
3,400	378	2,826
3,500	389	2,909
3,600	400	2,992
3,700	411	3,075
3,800	422	3,158
3,900	433	3,242
4,000	444	3,325
4,100	456	3,408
4,200	467	3,491
4,300	478	3,574
4,400	489	3,657
4,500	500	3,740
4,600	511	3,823
4,700	522	3,906
4,800	533	3,990
4,900	544	4,073
4,999	556	4,155

[1]The typical volume of a rain barrel is between 50-200 gallons, so more than 1 rain barrel may be needed. Larger volumes may require a cistern.
[2]Assume that the rain barrel/cistern is 25% full

For Rain Gardens/Bioretention or Dry Well #1:

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

STEP 3 – Using the value from Column 1 determined in Step 2, select the depth (D) of the proposed BMP, and then simply determine the surface area needed for that depth from Column 2 of Table C-2.

Note: The arrows under Column 2 in Table C-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 value in Column 1 that 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.

Table C-2: Calculating Rain Garden/Bioretention and Dry Well #1 Storage Volume and Surface Area for 1" Rainfall

Column 1	Column 2							
Proposed Impervious Area (square feet)	**Surface Area of Rain Garden/Bioretention 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'*	*Area Required for a BMP with a Depth(D) of 3.5'*	*Area Required for a BMP with a Depth(D) of 4.0'*
	Rain Garden /Bioretention (0.5'-1.0')		**Dry Well #1 (1.5'-4.0')**					
I	*A(sf)*							
Sum of all Proposed Impervious Areas	A = Volume/D, where Volume[1] = (1/12)**I*							
100	17	8	6	4	3	3	2	2
200	33	17	11	8	7	6	5	4
300	50	25	17	13	10	8	7	6
400	67	33	22	17	13	11	10	8
500	83	42	28	21	17	14	12	10
600	100	50	33	25	20	17	14	13
700	117	58	39	29	23	19	17	15
800	133	67	44	33	27	22	19	17
900	150	75	50	38	30	25	21	19
1,000	167	83	56	42	33	28	24	21
1,100	183	92	61	46	37	31	26	23
1,200	200	100	67	50	40	33	29	25
1,300	217	108	72	54	43	36	31	27
1,400	233	117	78	58	47	39	33	29
1,500	250	125	83	63	50	42	36	31
1,600	267	133	89	67	53	44	38	33
1,700	283	142	94	71	57	47	40	35
1,800	300	150	100	75	60	50	43	38
1,900	317	158	106	79	63	53	45	40
2,000	333	167	111	83	67	56	48	42
2,100	350	175	117	88	70	58	50	44
2,200	367	183	122	92	73	61	52	46
2,300	383	192	128	96	77	64	55	48
2,400	400	200	133	100	80	67	57	50
2,500	417	208	139	104	83	69	60	52
2,600	433	217	144	108	87	72	62	54
2,700	450	225	150	113	90	75	64	56
2,800	467	233	156	117	93	78	67	58
2,900	483	242	161	121	97	81	69	60
3,000	500	250	167	125	100	83	71	63
3,100	517	258	172	129	103	86	74	65
3,200	533	267	178	133	107	89	76	67
3,300	550	275	183	138	110	92	79	69
3,400	567	283	189	142	113	94	81	71
3,500	583	292	194	146	117	97	83	73
3,600	600	300	200	150	120	100	86	75
3,700	617	308	206	154	123	103	88	77
3,800	633	317	211	158	127	106	90	79
3,900	650	325	217	163	130	108	93	81
4,000	667	333	222	167	133	111	95	83
4,100	683	342	228	171	137	114	98	85
4,200	700	350	233	175	140	117	100	88
4,300	717	358	239	179	143	119	102	90
4,400	733	367	244	183	147	122	105	92
4,500	750	375	250	188	150	125	107	94
4,600	767	383	256	192	153	128	110	96
4,700	783	392	261	196	157	131	112	98
4,800	800	400	267	200	160	133	114	100
4,900	817	408	272	204	163	136	117	102
4,999	833	417	278	208	167	139	119	104

[1]Assume that the rain garden/bioretention or the dry well #1 are 0% full

For Infiltration Trench or Dry Well #2:

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

STEP 3 – Using the value from Column 1 determined in Step 2, select the depth (D) of the proposed BMP, and then simply determine the surface area needed from Column 2 of Table C-3.

Note: The arrows under Column 2 in Table C-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 value in Column 1 that 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.

Table C-3: Calculating Infiltration Trench and Dry Well #2 Storage Volume and Surface Area for 1" Rainfall

Column 1	Column 2							
Total Proposed Impervious Area (square 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'*
	Infiltration Trench (2.0'-5.0') / **Dry Well #2 (1.5'-4.0')**							
I	*A(sf)*							
Sum of all Proposed Impervious Areas	A = Volume/D, where Volume[1] = ((1/12)**I*)/0.4							
100	14	10	8	7	6	5	5	4
200	28	21	17	14	12	10	9	8
300	42	31	25	21	18	16	14	13
400	56	42	33	28	24	21	19	17
500	69	52	42	35	30	26	23	21
600	83	63	50	42	36	31	28	25
700	97	73	58	49	42	36	32	29
800	111	83	67	56	48	42	37	33
900	125	94	75	63	54	47	42	38
1,000	139	104	83	69	60	52	46	42
1,100	153	115	92	76	65	57	51	46
1,200	167	125	100	83	71	63	56	50
1,300	181	135	108	90	77	68	60	54
1,400	194	146	117	97	83	73	65	58
1,500	208	156	125	104	89	78	69	63
1,600	222	167	133	111	95	83	74	67
1,700	236	177	142	118	101	89	79	71
1,800	250	188	150	125	107	94	83	75
1,900	264	198	158	132	113	99	88	79
2,000	278	208	167	139	119	104	93	83
2,100	292	219	175	146	125	109	97	88
2,200	306	229	183	153	131	115	102	92
2,300	319	240	192	160	137	120	106	96
2,400	333	250	200	167	143	125	111	100
2,500	347	260	208	174	149	130	116	104
2,600	361	271	217	181	155	135	120	108
2,700	375	281	225	188	161	141	125	113
2,800	389	292	233	194	167	146	130	117
2,900	403	302	242	201	173	151	134	121
3,000	417	313	250	208	179	156	139	125
3,100	431	323	258	215	185	161	144	129
3,200	444	333	267	222	190	167	148	133
3,300	458	344	275	229	196	172	153	138
3,400	472	354	283	236	202	177	157	142
3,500	486	365	292	243	208	182	162	146
3,600	500	375	300	250	214	188	167	150
3,700	514	385	308	257	220	193	171	154
3,800	528	396	317	264	226	198	176	158
3,900	542	406	325	271	232	203	181	163
4,000	556	417	333	278	238	208	185	167
4,100	569	427	342	285	244	214	190	171
4,200	583	438	350	292	250	219	194	175
4,300	597	448	358	299	256	224	199	179
4,400	611	458	367	306	262	229	204	183
4,500	625	469	375	313	268	234	208	188
4,600	639	479	383	319	274	240	213	192
4,700	653	490	392	326	280	245	218	196
4,800	667	500	400	333	286	250	222	200
4,900	681	510	408	340	292	255	227	204
4,999	694	521	417	347	298	260	231	208

[1]Assume a void ratio of 40%.

For Disconnected Rooftop Areas:

STEP 2 – Select the proposed impervious area value in Column 1 of Table C-4 that is closest to, but not less than, the determined value. Using the value from Column 1, select the corresponding soil group in column 2 determined from Map III-4, and corresponding slope in column 3 which is the slope of the path the stormwater from the roof travels along, from Table C-4.

STEP 3 – Using the value from Column 3 determined in Step 2, use column 4 to select the length of the flow path that is closest to, but not less than the value, and then simply determine the roof area treated as disconnected from Column 5 of Table C-4. Therefore, the value from Column 5 is the percentage of the total impervious area that can be excluded.

Table C-4: Calculating Rooftop Disconnected Impervious Area Percentage

Impervious Rooftop Area (square feet)	Soil Group	Slope (%)	Length of Flow Path (ft)*	Roof Area Treated as Disconnected (% of Contributing Area)
0-500	A, B, or C or equivalent	0-5	0-14	0
			15-29	20
			30-44	40
			45-59	60
			60-74	80
			≥75	100
		≥5	≥0	0
	D	≥0	≥0	0
≥500	A, B, C, D, or equivalent Soils	≥0	≥0	0

*Flow path cannot include impervious surfaces and must be at least 15 feet from any impervious surfaces.

For Pavement Disconnection:

STEP 2 – Select the contributing flow path value, which is the length of the impervious portion of the flow path that stormwater runoff from pavement travels along, in Column 1 of Table C-5 and the corresponding length of overland flow which is the total length that the stormwater runoff travels along the flow path, and the soil group determined from Map III-4, located in columns 2 and 3 respectively, from Table C-5.

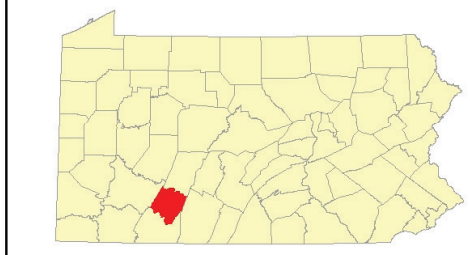
STEP 3 – Using the value from Column 3 determined in Step 2, select the slope of the contributing impervious area and slope of the overland flow path in Columns 4 and 5, respectively, and then simply determine if the pavement section is eligible for disconnection from Column 6. If the pavement is eligible for disconnection, then the area of the pavement may be excluded from the total impervious area.

Note: If the discharge is concentrated at one or more discrete points, no more than 1,000 square feet 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 edge of the pavement, this requirement is waived; however, there must be a provision for the establishment of vegetation along the pavement edge and temporary stabilization of the area until vegetation becomes stabilized.

Table C-5: Calculating Pavement Disconnection Eligibility

Contributing Flow Path (feet)	Length of Overland Flow (feet)	Soil Group	Slope of Contributing Impervious Area (%)	Slope of Overland Flow Path (%)	Eligible for Pavement Disconnection (Yes/No)
0-75	Length of Overland Flow Equal to or Greater Than Contributing Flow Path	A, B, or C or equivalent	0-5	0-5	Yes
			5+	5+	No
		D	0+	0+	No
	Length of Overland Flow less than Contributing Flow Path	A, B, C, D, or equivalent Soils	0+	0+	No
75+	0+	A, B, C, D, or equivalent Soils	0+	0+	No

STONYCREEK RIVER - CAMBRIA AND SOMERSET COUNTIES
ACT 167 STORMWATER MANAGEMENT PLAN



LOCATION MAP

Map III-4
HYDROLOGIC SOIL GROUPS

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Legend

- WATERSHED BOUNDARY
- STREAMS
- WATER BODIES
- COUNTY BOUNDARIES
- MUNICIPAL BOUNDARIES

Roads

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
Portions of this map were generated from existing data sources as listed below. This existing data was utilized for base mapping purposes and is shown on the maps for spatial reference only. This data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of this data and has corrected the data in locations where these discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the mapping data.

SOURCES:
Watershed Boundary - PADEP Modified by BLE
State Roads - PennDOT
County Boundaries - PennDOT
Municipal Boundaries - PennDOT
Streams - PaDEP
Water Bodies -Derived from USFWS NWI Wetlands data
Hydrologic Soil Groups - USDA/ NRCS Soil Survey Geographic (SSURGO) Database

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PREPARED BY: WSB CHECKED BY: SJD
DATE: 6/22/2006 PROJECT #: 2005-1719-00

FILE: \\WBData\Projects\2005\1719\00\DATA\GIS\FINAL_REPORT_MAPS\ArcMap\Stonycreek_Hydrologic_Soil_Groups.mxd

STEP 4 - Sketch a simple site plan as shown in Figure C-1 that includes:

- Name and address of the owner of the property, and or name and address of the individual preparing the plan, along with the date of submission.

- Location of proposed structures, driveways, or other paved areas with approximate size in square feet.

- 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-site septic system and/or potable water wells showing rough proximity to infiltration facilities.

- Location of any existing waterbodies such as; streams, lakes, ponds, wetlands, or other waters of the Commonwealth within fifty (50) feet of the project site, and the distance to the project site and/or BMPs. It is recommended that the project or BMPs be located at least than fifty (50) feet away from a perennial or intermittent stream. If an existing buffer is legally prescribed (i.e., deed, convenant, easement, etc.), the existing buffer shall be maintained.

- Location of all existing structures including buildings, driveways, and roads within fifty (50) feet of the project site.

Fill in the small projects worksheet found in Table C-4, then submit the worksheet and the simple site sketch to the Municipality.

Figure C-1: Typical Dry Well Configuration filled with Stone Fill (Left) and Structural Prefabricated Chamber (Right)

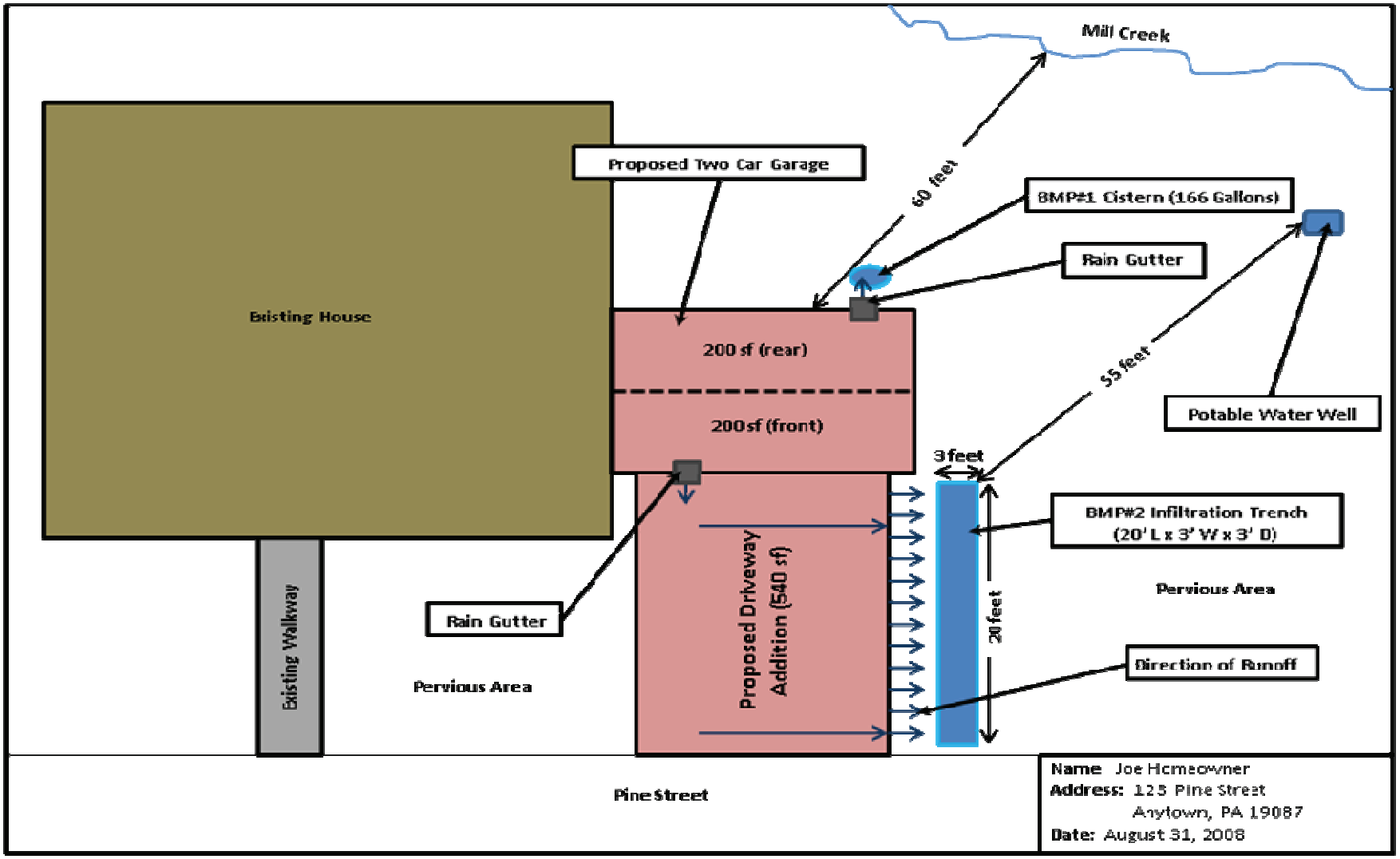


Table C-4: Small Projects Worksheet

Small Projects Worksheet			
STEP 1			
Proposed Impervious Surface for BMP #1	**Proposed Impervious Surface for BMP #2**	**Proposed Impervious Surface for BMP #3**	
STEPS 2&3			
Rain Barrel or Cistern			
Proposed Impervious Surface from Column 1 in Table C-1	**Volume from Column 2 or 3 in Table C-1**		
Rain Garden/Bioretention or Dry Well #1			
Proposed Impervious Surface from Column 1 in Table C-2	**Area of BMP from Column 2 in Table C-2**	**Depth of BMP from Column 2 in Table C-2**	**Types of Material to Be Used**
Infiltration Trench or Dry Well #2			
Proposed Impervious Surface from Column 1 in Table C-3	**Area of BMP from Column 2 in Table C-3**	**Depth of BMP from Column 2 in Table C-3**	**Types of Material to Be Used**
Note: For additional BMPs, use additional sheets			

C.2 Definitions

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. Stormwater BMPs are commonly grouped into one of two broad categories or measures: "structural" or "non-structural". In this Ordinance, non-structural 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.

Capture – Collecting runoff to be stored for reuse or allowed to slowly infiltrate into the ground.

Disconnected Impervious Area (DIA) - An impervious or impermeable surface which 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 B, Disconnected Impervious Area.

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; road maintenance; building construction; the moving, depositing, stockpiling, or storing of soil, rock or earth materials.

Geotextile - A fabric manufactured from synthetic fiber that is used to achieve specific objectives, including infiltration, separation between different types of media (i.e., between soil and stone), 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 and recycling facilities, vehicle fueling stations, fleet storage areas, vehicle equipment and cleaning facilities, and vehicle service and maintenance facilities).

Impervious Surface (Impervious Area) - A surface that prevents the infiltration of water into the ground. Impervious surfaces (or areas) shall include, but not be limited to, roofs, additional indoor living spaces, patios, garages, storage sheds and similar structures, and any new streets or sidewalks. Decks, parking areas, and driveway areas are not counted as impervious areas if they do not prevent infiltration.

Infiltration - Movement of surface water into the soil, where it is absorbed by plant roots, 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.

Pervious Surface (Pervious Area) - Any area not defined as impervious.

Regulated Activities - Any Earth Disturbances Activities or any activities that involve the alteration or development of land in a manner that may affect stormwater runoff.

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

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

Void Ratio - The ratio of the volume of void space to the volume of solid substance in any material.

C.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 Chapter 6 of the PA BMP Manual which can be found on the PA Department of Environmental Protection's website for specifications and steps for construction for the following BMPs. A list of routine maintenance for each of the BMPs described below is also included at the end of this section.

Disconnected Impervious Area (DIA)

Disconnected Impervious Area (DIA) may be used as a stormwater BMP for certain situations. When stormwater is disconnected from a rooftop by allowing the roof to drain to a pervious surface, and it meets certain conditions, then the initial impervious area may not be subtracted from the total impervious area. This applies specifically to rooftops and pavement. Reference Ordinance Appendix B for a more detailed description, and the requirements and applicability of DIA as a BMP.

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 and 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 on the surface or underground. Figures C-2 and C-3 show examples of rain barrels and cisterns, respectively, that could be used. 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 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 with an overflow pipe to divert flow away from structures.
- Use screens to filter debris, and covers (lids) to prevent mosquitoes.
- 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.*

Figure C-2: Rain Barrels

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

*This 25% has already been taken into account in Table 3.

Figure C-3: Cisterns

Source (for both pics): Pennsylvania Stormwater BMP Manual (2006)

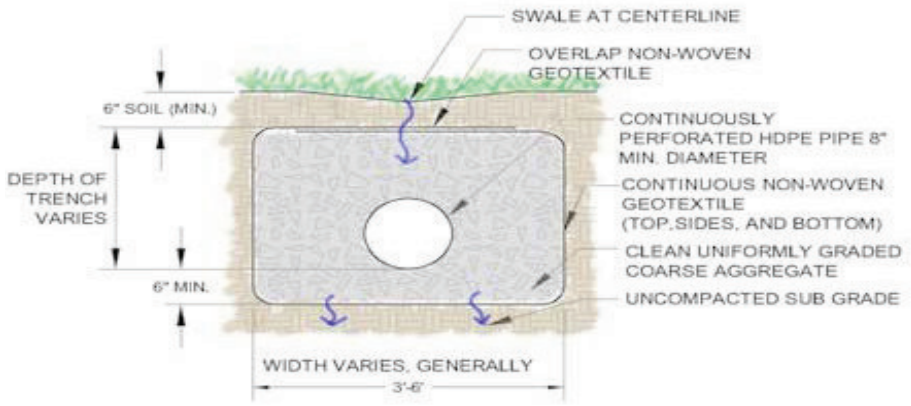
Infiltration Trench

An infiltration trench is a long, narrow, rock-filled trench with or without a perforated pipe 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 and into the underlying soil matrix. Infiltration trenches perform well for removal of fine sediment and associated pollutants. Figure C-4 shows a typical infiltration trench configuration. Infiltration trenches shall incorporate or make provisions for the following elements:

- Perforated pipe is to be set level.
- The width is limited to between **3 and 8 feet**, and the depth ranges from **2 to 5 feet**.
- Trench should be wrapped in nonwoven geotextile (see definition in Section C.2) on the 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 that the soil is capable of infiltrating stormwater. A description of how an infiltration test is performed is found in Appendix C of the *Pennsylvania Stormwater Best Management Practices Manual* (Document No. 363-0300-002), December 30, 2006.
- It is recommended that there be a 2-foot clearance above the regularly occurring seasonal high water table and 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 hotspots (see definition in Section C.2).
- 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.
- The ratio of the collected area to the footprint of the facility should be as small as possible with a ratio of less than 5:1 preferred.

Figure C-4: Typical Infiltration Trench



Source: Pennsylvania Stormwater BMP Manual (2006)

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 below the surface where plants can use the water to grow. Bioretention also improves water quality, vegetation filters the water, and the root systems encourage or promote infiltration. Figure C-5 shows a typical rain garden. Key elements of a rain garden include:

- Ponding depths of **1 foot** or less (recommended).
- A combination of native shrubs, grasses or mulch, trees, and flowers that can tolerate dry and wet weather also known as facultative plants (FAC). A list of

types of plants to use in the bioretention area is shown below in Table C-5. The plants shown below are taken from the PA Wildlands Conservancy plant list, and the plant list found in Appendix B of the PA BMP Manual. The PA Wildlands Conservancy plant list is found at: http://www.wildlandspa.org/TDE_CMS/database/UserFiles/File/weblist%202008.pdf, and the PA BMP Manual is found at: http://www.depweb.state.pa.us/watershedmgmt/cwp/view.asp?a=1437&q=529063&watershedmgmtNav=%7C. When using the PA BMP Manual plant list, check the Wetland indicator column for plants with a FAC designation. When using the PA Wildlands Conservancy list check the culture column for plants that can tolerate both wet and dry conditions, denoted by the abbreviations W and DR.

- Only shrubs, grasses, trees, and flowers should be used; vegetables should not be planted in the bioretention area.
- An overflow area where, if the bioretention area were to overflow, the water would flow over pervious area (i.e., grass, meadow), and would not cause harm to property
- An overflow such as a domed riser to allow excess flow from large storms to travel to other substantial infiltration areas or pervious areas.
- Typical side slopes of 3:1 are recommended, with 2:1 being the maximum.
- The soil/planting mix depth should be between 1.5 feet and 6 feet deep.

Figure C-5: Typical Rain Garden/Bioretention Area

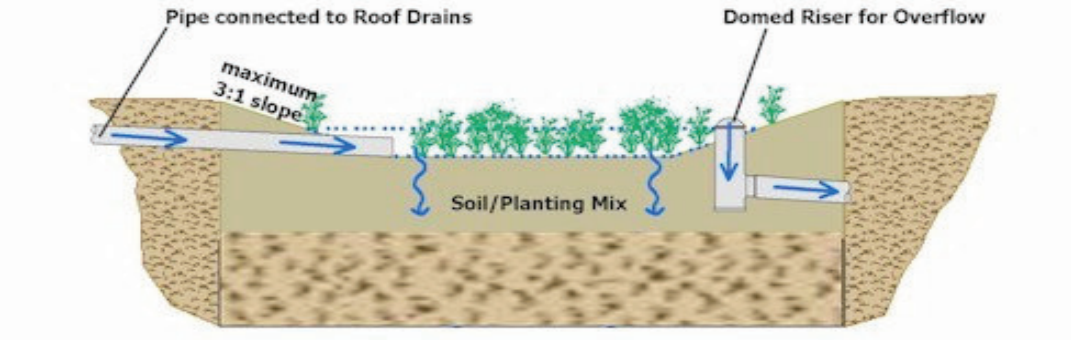


Table C-5: Plant List for Use in a Bioretention/Rain Garden

Common Name	Scientific Name	Plant Type	Photos
Red Maple	Acer rubrum	Tree	
Grey Birch	Betula populifolia	Tree	
Shadbush Serviceberry	Amelanchier canadensis	Tree	
Eastern Cotton-wood	Populus grandidentata	Tree	
Virginia Sweetspire	Itea virginica	Shrub	
Red-Twig Dogwood	Cornus sericea (stolonifera) 'Arctic Fire'	Shrub	

Southern Arrow-wood	Viburnum dentatum	Shrub	
Black Choke Berry	Aronia melanocarpa	Shrub	
Great Blue Lobelia	Lobelia siphilitica	Perennial	
Dwarf Pink false aster	Boltonia asteroides 'Nana'	Perennial	
White false aster	Boltonia asteroides 'Snowbank'	Perennial	
Switchgrass	Panicum virgatum	Grass	

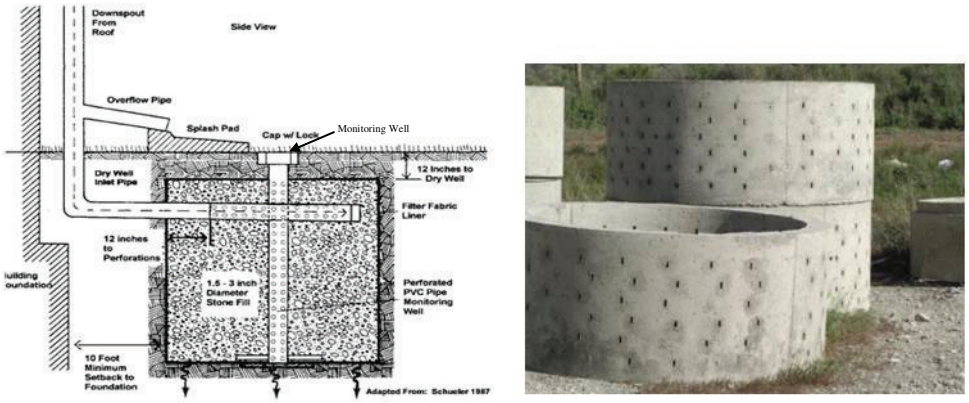
Source: Pennsylvania Stormwater BMP Manual (2006)

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 C-6 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 ten (10) feet from the building foundation to avoid foundation seepage problems and are not recommended if their installation would create a risk for basement flooding.
- Construction of a dry well should be performed after surface soils in all other areas of the site are 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.
- Depth of a dry well should be between **1.5 feet and 4 feet**. Gravel fill should consist of stone of an average of one and one half to three (1.5 – 3.0) inches in diameter with the gravel fill wrapped in a nonwoven geotextile that separates the stone fill from the surrounding soil.
- At least 1 foot of soil needs to 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 connect to other on-site substantial infiltration areas or pervious areas.
- Every dry well needs to have at least one monitoring well.
- Infiltration testing is recommended to ensure that the underlying soil is capable of infiltrating the needed volume of stormwater.

Figure C-6: Typical Dry Well Configuration filled with Stone Fill (DRY WELL #2) (Left) and Structural Prefabricated Chamber (DRY WELL #1) (Right)



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

Routine Maintenance for BMPs

- Vegetation along the surface of an infiltration trench should be maintained in good condition, and any bare spots should be revegetated as soon as possible.
- Vehicles shouldn't be parked or driven on an infiltration trench, and care should be taken to avoid excessive compaction by mowers.
- Any debris such as leaves blocking flow from reaching an infiltration trench or bioretention/rain garden should be routinely removed.
- While vegetation is being established, pruning and weeding may be required for a bioretention/rain garden.
- Mulch in a bioretention/rain garden needs to be re-spread when erosion is evident. Once every two to three years or after major storms the entire area may require mulch replacement.
- At least twice a year the landowner needs to inspect the bioretention/rain garden for sediment buildup and vegetative conditions.
- During periods of extended drought, the bioretention/rain garden requires watering.
- Trees and shrubs in a bioretention/rain garden need to be inspected at least twice per year by the landowner to evaluate their health. If they are in poor health, they need to be replaced.
- Dry wells need to be inspected by the landowner at least four 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/recycling sites and in compliance with local, state, and federal waste regulations.
- For dry wells, gutters need to be regularly cleaned out, and proper connections must be maintained to facilitate the effectiveness of the dry well.
- The filter screen for the dry well that intercepts roof runoff must be replaced as necessary.
- Dry wells that are damaged need to be fixed or replaced within two weeks of being damaged.

- If an intermediate sump box exists in conjunction with a dry well, it must be cleaned out at least once per year.
- Rain barrels and cisterns need to be cleared of debris routinely at least every three months and after significant storms to allow stormwater from gutters to enter them.
- Gutters that directly convey rain water to dry wells, rain barrels, and cisterns need to be routinely cleared of trash and debris at least every three months and after significant storms.
- Rain barrels and cisterns must be kept covered.
- Rain barrels and cisterns should be routinely emptied so that they are only ¼ of the way full to allow for storage of additional rainwater.
- Overflow outlets from rain barrels and cisterns must be kept free and clear of debris.
- Rain barrels and cisterns that are damaged need to be fixed or replaced within two weeks of being damaged.

C.4 Example

Simplified Approach Volume Determination:

Joe Homeowner wants to build a 400 square foot two car garage, and a 540 square foot (30' L x 18' W) impervious driveway that is graded so that the stormwater runoff drains to the grassy area along one edge of the driveway. (A duplicate of Table C-1 is provided below in Table C-6, a duplicate of Table C-3 is provided below in Table C-7 and outlines the steps of this example) a duplicate of Figure C-1 (Figure C-7) and a duplicate of Table C-4 are provided in Table C-8.

STEP 1 - 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 (Front)	30 ft. x 18 ft.	=	540 sq. ft.

Total Proposed Impervious Surface			**940 sq. ft.**

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 driveway.

Select a BMP or combination of BMPs from Section C.3 to be used to satisfy the volume requirement. Determine the length, width, depth and other requirements for the BMPs in Section C.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 C-7 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.

STEP 2 and 3 for BMP #1 (Rain Barrel/Cistern)

STEP 2 - 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 C-6:

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

STEP 3 - Determine the volume that BMP #1 must be to satisfy the volume requirements using Columns 2 and 3 in Table C-6:

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 row in Column 3 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. A combination of rain barrels could be used in succession as shown in Figure C-2, or a cistern could be used.

Table C-6: Example – Calculating Storage Volume for Rain Barrel/Cistern[1]

Column 1	Column 2	Column 3
Proposed Impervious Area (square feet)	**Volume of Rain Barrel/Cistern[2] (cubic feet)**	**Volume of Rain Barrel/Cistern (gallons)**
I	V_{RBcf}	V_{RBgal}
Sum of all Proposed Impervious Areas	$(1*(1/12)*I)/0.75=V_{RBcf}$	$V_{RBcf} * 7.48=V_{RBgal}$
50	6	42
100	11	83
200	22	166
300	33	249
400	44	332
500	56	416
600	67	499
700	78	582
800	89	665
900	100	748
1000	111	831
1100	122	914
1200	133	997
1300	144	1,081
1400	156	1,164
1500	167	1,247
1600	178	1,330
1700	189	1,413
1800	200	1,496
1900	211	1579
2000	222	1662
2100	233	1745
2200	244	1829
2300	256	1912
2400	267	1995
2500	278	2,078
2600	289	2161
2700	300	2244
2800	311	2327
2900	322	2410
3000	333	2494
3100	344	2577
3200	356	2,660
3300	367	2743
3400	378	2826
3500	389	2909
3600	400	2992
3700	411	3075
3800	422	3158
3900	433	3,242
4000	444	3325
4100	456	3408
4200	467	3491
4300	478	3574
4400	489	3657
4500	500	3740
4600	511	3,823
4700	522	3906
4800	533	3990
4900	544	4073
4999	555	4,155

[1]The typical volume of a rain barrel is between 50-200 gallons, so more than 1 rain barrel may be needed. Larger volumes may require a cistern.
[2]Assume that the rain barrel/cistern is 25% full

STEPS 2 and 3 for BMP #2 (Infiltration Trench)

STEP 2 - Select the proposed impervious area value for BMP #2, the infiltration trench, using Column 1 in Table C-7:

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 800.

STEP 3 - Utilizing the value from Column 1 determined above, and the surface area that the proposed BMP will occupy, identify the proposed depth and corresponding surface area needed using Column 2 in Table C-7:

Joe Homeowner would like to place the infiltration trench along the edge of the driveway that the runoff drains to, 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 C.3, is 3 feet. Therefore, the area of the infiltration trench is:

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

To find the minimum depth of the trench, move toward the right side of the table from 800 square feet in Column 1 to Column 2, and find the column with a value of as close to but not more than 60 square feet, which is 56 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 3.0 feet.

Selected BMPs: Rain barrel(s) ≥ 166 gallons and a 20' L x 3' W x 3.0' D infiltration trench

STEP 4 – Make a sketch of the site plan as shown in Figure C-7, and fill in the small projects worksheet found as shown in Table C-8.

Table C-7: Example – Calculating Storage Volume Surface Area and Depth for Infiltration Trench

Column 1	Column 2							
Total Proposed Impervious Area (square 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′*
	Infiltration Trench (2.0'-5.0')							
	Dry Well #2 (1.5'-4.0')							
I	*A(sf)*							
Sum of all Proposed Impervious Areas	A = Volume/D, where Volume[1] = ((1/12)**I*)/0.4							
100	14	10	8	7	6	5	5	4
200	28	21	17	14	12	10	9	8
300	42	31	25	21	18	16	14	13
400	56	42	33	28	24	21	19	17
500	69	52	42	35	30	26	23	21
600	83	63	50	42	36	31	28	25
700	97	73	58	49	42	36	32	29
2 800	111	83	67	**3** 56	48	42	37	33
900	125	94	75	63	54	47	42	38
1000	139	104	83	69	60	52	46	42
1100	153	115	92	76	65	57	51	46
1200	167	125	100	83	71	63	56	50
1300	181	135	108	90	77	68	60	54
1400	194	146	117	97	83	73	65	58
1500	208	156	125	104	89	78	69	63
1600	222	167	133	111	95	83	74	67
1700	236	177	142	118	101	89	79	71
1800	250	188	150	125	107	94	83	75
1900	264	198	158	132	113	99	88	79
2000	278	208	167	139	119	104	93	83
2100	292	219	175	146	125	109	97	88
2200	306	229	183	153	131	115	102	92
2300	319	240	192	160	137	120	106	96
2400	333	250	200	167	143	125	111	100
2500	347	260	208	174	149	130	116	104
2600	361	271	217	181	155	135	120	108
2700	375	281	225	188	161	141	125	113
2800	389	292	233	194	167	146	130	117
2900	403	302	242	201	173	151	134	121
3000	417	313	250	208	179	156	139	125
3100	431	323	258	215	185	161	144	129
3200	444	333	267	222	190	167	148	133
3300	458	344	275	229	196	172	153	138
3400	472	354	283	236	202	177	157	142
3500	486	365	292	243	208	182	162	146
3600	500	375	300	250	214	188	167	150
3700	514	385	308	257	220	193	171	154
3800	528	396	317	264	226	198	176	158
3900	542	406	325	271	232	203	181	163
4000	556	417	333	278	238	208	185	167
4100	569	427	342	285	244	214	190	171
4200	583	438	350	292	250	219	194	175
4300	597	448	358	299	256	224	199	179
4400	611	458	367	306	262	229	204	183
4500	625	469	375	313	268	234	208	188
4600	639	479	383	319	274	240	213	192
4700	653	490	392	326	280	245	218	196
4800	667	500	400	333	286	250	222	200
4900	681	510	408	340	292	255	227	204
4999	694	521	417	347	298	260	231	208

[1]Assume a void ratio of 40%

Figure C-7: Typical Dry Well Configuration filled with Stone Fill (Left) and Structural Prefabricated Chamber (Right)

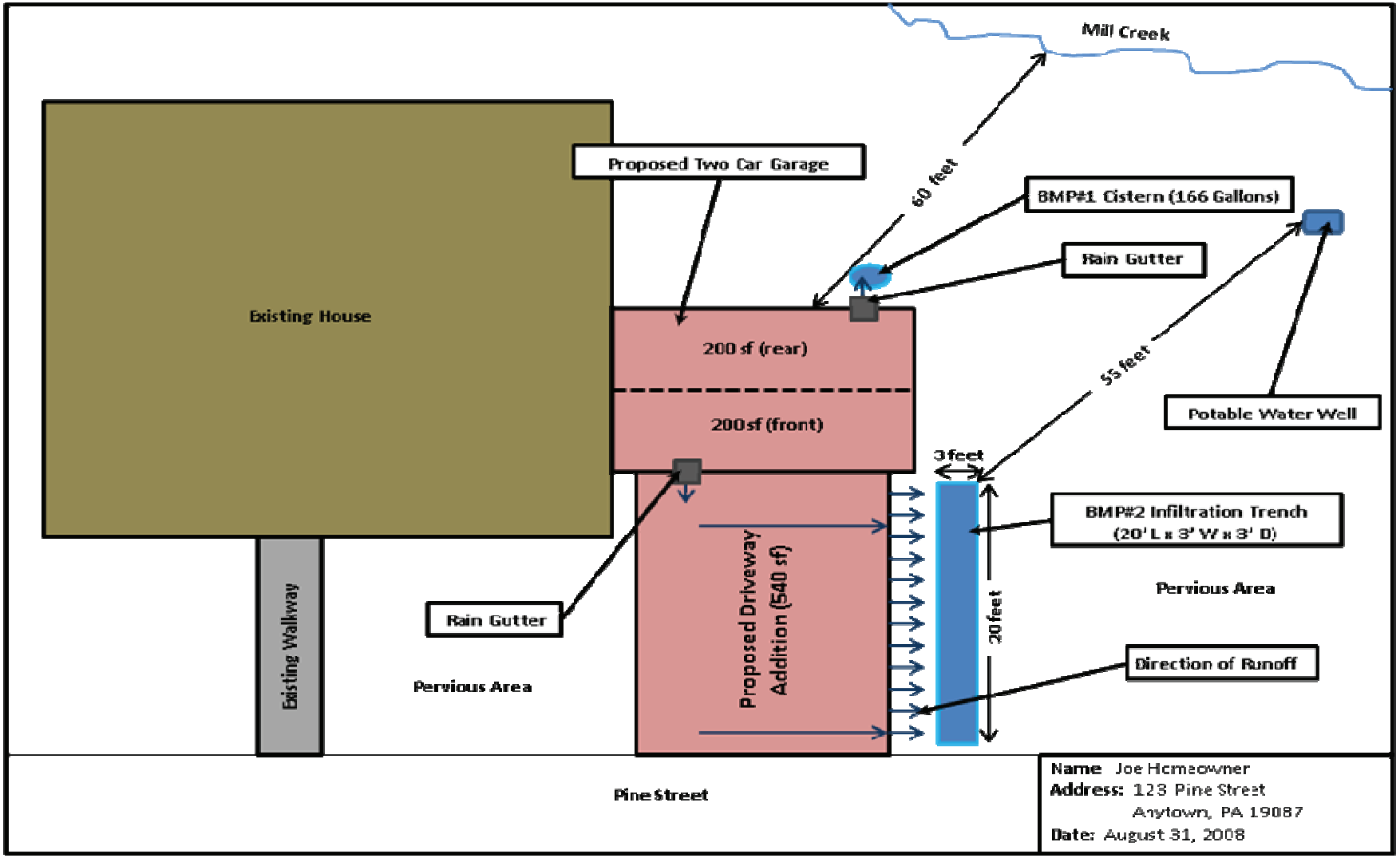


Table C-8: Example – Small Projects Worksheet with Results

Small Projects Worksheet			
STEP 1			
Proposed Impervious Surface for BMP #1	**Proposed Impervious Surface for BMP #2**	**Proposed Impervious Surface for BMP #3**	
200	740		
STEPS 2&3			
Rain Barrel or Cistern			
Proposed Impervious Surface from Column 1 in Table C-5	**Volume from Column 2 or 3 in Table C-5**		
200	166		
Rain Garden/Bioretention or Dry Well #1			
Proposed Impervious Surface from Column 1 in Table C-2	**Area of BMP from Column 2 in Table C-2**	**Depth of BMP from Column 2 in Table C-2**	**Types of Material to Be Used**
Infiltration Trench or Dry Well #2			
Proposed Impervious Surface from Column 1 in Table C-6	**Area of BMP from Column 2 in Table C-6**	**Depth of BMP from Column 2 in Table C-6**	**Types of Material to Be Used**
800	56	3	Infiltration Trench, Uniformly Graded Aggregate, HDPE 8" pipe, Geotextile material, Grass planted on top
Note: For additional BMPs, use additional sheets			