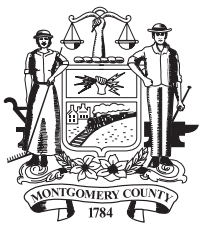
SWAMP CREEK WATERSHED

ACT 167 STORMWATER MANAGEMENT PLAN

VOLUME II

PLAN CONTENTS

Montgomery County, Pennsylvania



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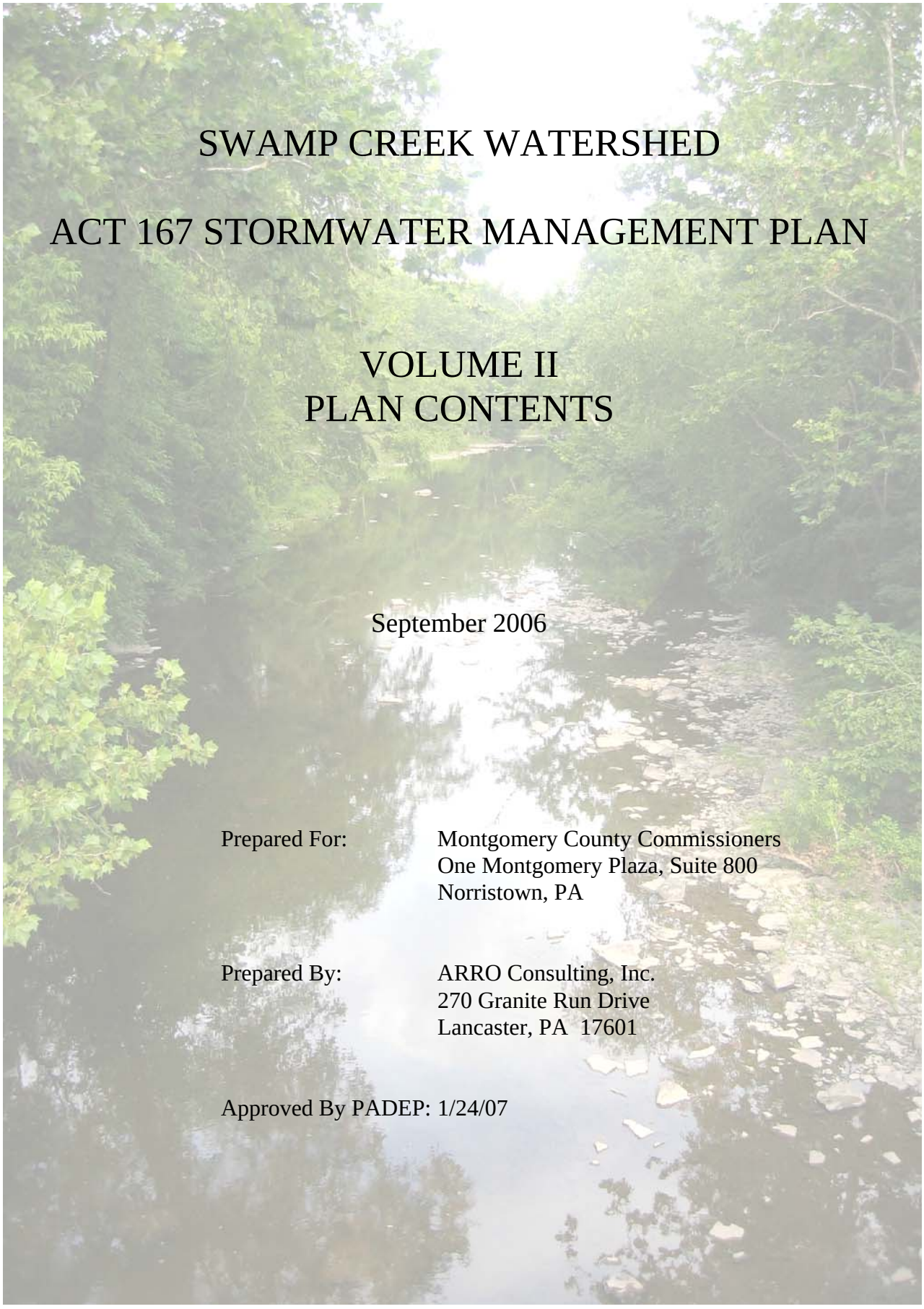

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ACT 167 STORMWATER MANAGEMENT PLAN

VOLUME II
PLAN CONTENTS

September 2006

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SECTION I – ACT 167 STORMWATER MANAGEMENT PLANNING AND IMPLEMENTATION

A. INTRODUCTION

The Swamp Creek Watershed Stormwater Management Plan has been prepared under an agreement with the Pennsylvania Department of Environmental Protection (DEP), and with assistance from ARRO Consulting, Inc. The intent of this plan is to coordinate stormwater management efforts among all the municipalities within the Swamp Creek watershed. Specifically, this is accomplished by identifying existing stormwater problem areas and projecting where future stormwater problems may occur within the 10-year timeframe of the plan. The model ordinance contains stormwater regulations that will prevent existing problems from becoming worse, and avoid the projected problems. Additional regulations pertaining to stormwater infiltration, water quality, and streambank protection are included. Public input was received from participating municipalities and agencies through the Watershed Plan Advisory Committee (WPAC) and the public hearing held on September 28, 2006.

B. ACT 167 STORMWATER MANAGEMENT PLANNING AND IMPLEMENTATION

The water that runs off the land into surface waters during and immediately following rainfall is referred to as stormwater. In a watershed where development is occurring, the volume of stormwater resulting from rainfall is greater than in an undeveloped watershed. The increase is due to the increased impervious areas (i.e., land covered by pavement, concrete, or buildings). The conversion of undeveloped land to residential, commercial, industrial uses disrupts the natural hydrology of the site. The hydrology of the site is even disrupted when land is converted from forest or meadow to cropland uses. This disruption involves decreased infiltration of rainfall and an increased rate and volume of runoff.

As development occurs, the increased quantity of stormwater runoff must be managed. Failure to do so can result in greater flooding, stream channel erosion, sedimentation, and reduced groundwater recharge. Stormwater management must be addressed in every land development proposal or any proposal that causes changes in land surface conditions. Past efforts to manage stormwater have usually focused on controlling the rate of discharge from individual sites after development. Ordinances typically have addressed stormwater control at the municipal level, but give no consideration to downstream impacts outside the municipality. This focus is changing to consider the overall hydrology of the development site, and the stormwater impacts of development on a watershed-wide basis.

Land development projects are often viewed as isolated occurrences and not necessarily related to a bigger picture. Even if a municipality takes a comprehensive look at the impacts of development in its portion of the watershed, its focus usually does not extend

beyond municipal borders. However, the cumulative impact of stormwater runoff from individual developments dramatically affects flooding conditions. This cumulative effect includes flooding, streambank erosion, property damage (sometimes running into the millions of dollars), and at times, loss of life. Because development is usually distributed across the watershed, and because runoff from various areas in the watershed may combine to cause large-scale problems downstream, the best approach towards creating an effective stormwater management strategy is the watershed based approach. At the same time, any stormwater management strategy must be practical and easily implemented by the municipalities, since under DEP's program, they are charged with implementing the plan.

1. The Pennsylvania Stormwater Management Act (Act 167)

The Pennsylvania General Assembly recognized the need to address serious flooding problems and in 1978 enacted Act 167, the Pennsylvania Stormwater Management Act. The statement of legislative findings at the beginning of Act 167 sums up the relationship between land development, accelerated runoff, and floodplain management. Specifically, this statement of legislative findings points out the following:

a. Inadequate management of stormwater runoff from development increases flood flows and velocity, contributes to erosion and sedimentation, overloads the carrying capacity of streams and storm sewers, greatly increases the cost of public stormwater facilities, undermines flood management and flood control efforts in downstream communities, reduces groundwater recharge, and threatens public health and safety.

b. A comprehensive stormwater management program, including reasonable regulation of development and activities causing accelerated runoff, is fundamental to the public health, safety and welfare and the protection of the people of the Commonwealth, their resources and their environment.

Until the enactment of Act 167, stormwater management addressed the *rate* of runoff, that is, how fast the runoff was leaving a site at various times during a storm. The peak rate of runoff, that period when the largest volume was leaving the site in the shortest time period, was of particular concern. The increase in the peak rate of runoff discharging from a development site was controlled to protect property immediately downstream. Minimal attention was given to the effects on locations further downstream (frequently because they were located in other municipalities), or to designing stormwater controls within the context of the entire watershed or the hydrologic cycle. Comprehensive stormwater management planning or intentional consistency among adjoining municipalities in the same watershed was rare, if not nonexistent.

Act 167 changed this approach by instituting a *watershed-based, comprehensive program* of stormwater management. The Act requires Pennsylvania counties to prepare and adopt stormwater management plans for each watershed located in

the county, as designated by the DEP. This plan for the Swamp Creek watershed was prepared to satisfy the requirements of Act 167, in consultation with municipalities located in the watershed, working through the WPAC. The plan contains stormwater controls to manage stormwater runoff from new development sites.

The controls prescribed in the plan are based on the expected development patterns and hydrologic characteristics of each individual watershed. The standards and criteria were developed from the technical evaluations performed in the planning process. The local watershed conditions and their effect on the timing and flow of stormwater from new development were considered through the modeling process. As required by Act 167, the plan is a comprehensive and practical implementation plan, developed with sensitivity to the overall needs (e.g., financial, legal, political, technical, etc.) of the municipalities in the watershed.

2. The Stormwater Management Planning Process

The watershed planning process for this study area considered the watershed characteristics as well as the resources (technical, political, and economic) of this area. This section presents the approach that has been developed to meet the specific requirements of Act 167.

3. Benefits of the Plan

The purpose of the plan is to provide all of the municipalities in the watershed with a consistent implementation strategy for comprehensive stormwater management. Currently, not all of the watershed municipalities enforce stormwater management regulations using the same criteria. A consistent management requirement throughout the watershed is imperative for sound stormwater control. The plan and ordinance developed will provide consistent regulations for the watershed.

The watershed planning approach recommended by DEP also provides the municipalities with a considerable amount of technical information, such as a detailed watershed runoff simulation model, that can be used for numerous other associated purposes. Municipalities and the county will have products that are usable for other planning and engineering purposes, such as land use updates. The technical component of the plan will provide a unique environmental database for county and municipal use. Technical support information provided as a part of the watershed modeling effort can be used by public works officials for bridge replacement and floodplain management analysis, design and regulatory permitting efforts. The stream encroachment permit process, which requires detailed stream flow data as a part of the application process, can be more efficiently and cost-effectively developed using the calibrated watershed model. The benefits of the watershed planning process are wide-ranging, even

beyond the important function of developing comprehensive stormwater management strategies and ordinance provisions.

4. The Swamp Creek Watershed Plan Development Process

In order to implement watershed-wide planning for stormwater runoff, it was necessary to consider all portions of the watershed. The process relies on municipalities to provide local data needed for stormwater management. The involvement of each municipality was critical to the process.

The WPAC was formed to initiate municipal level involvement in the overall development of the plan. The WPAC was formed of representatives from the following municipalities, the County Conservation District and interested groups:

WPAC Member	**Affiliation**
William Dingman	Bechtelsville Borough Engineer
John Ravert	Berks County Conservation District
Shannon Rossman	Berks County Planning Commission
Sandra Moser	Bechtelsville Borough Secretary
Charles Clark	Boyertown Borough Manager
Allen Stauffer	Colebrookdale Township
Eileen Pinder	District Township Secretary
Eileen Pinder	Douglass Township (Berks Co.) Secretary
Georgeann Rohrbach	Douglass Township (Mont. Co.) Secretary
William Bradford	Limerick Township Roadmaster
Lorraine Cuddy	Lower Frederick Township Manager
Rodney Hawthorne	Lower Pottsgrove Township Asst. Manager
Richard Kadwill	Montgomery County Conservation District
Drew Shaw	Montgomery County Planning Commission
Anne Klepfer	New Hanover Township Manager
George Rodenbough	Pike Township
Thomas Snyder	Schwenksville Borough Manager
Jennifer Bolognese	Upper Frederick Township Secretary
Sandra Fritz	Upper Pottsgrove Township Manager
Sandra Moser	Washington Township Secretary

5. Data Collection

The watershed model simulates the behavior of runoff and analyzes hydrologic data in the watershed for a range of storms. The data needed for the model

includes elevations, soils, geology, land use, floodplain/wetlands, and stream obstructions (bridges and culverts). The watershed covers a large area. The modeling effort requires that the watershed be divided into subwatersheds. The subwatersheds are created based on stream junctures, municipal boundaries, and identified problem areas where flooding or streambank erosion is occurring.

A municipal questionnaire was distributed to each WPAC member. The questionnaire solicited input from each municipality on specific problems in the watershed, as well as for the needs they may see for stormwater management in their particular area. The questionnaire was distributed at the first WPAC meeting, along with a summary of the purpose and goals of Act 167. The questionnaire was designed to develop interest by the responding municipalities in the need to implement stormwater management measures within their community. The results of the questionnaire are summarized in Table 1.

Table 1
Summary of Response Items from Phase I Municipal Questionnaire
(numbers refer to the various lists at the end of the questionnaire)

Municipality	Problems Concerns Identified (A)	Causes of Stormwater Problems (B)	Frequency of Occurrence (C)	Type of Damages Incurred
Bechtelsville Borough	1	3, 5	4	Private property damage, Road closure, Loss of vital services
Boyertown Borough	Survey not received			
Colebrookdale Township	1	3, 4, 5	4	Private property damage, Road closure
District Township	Survey not received			
Douglass Township (Berks)	Information not provided			
Douglass Township (Mont.)	1, 2	2, topography	3	Private property damage, Road closure
Limerick Township	1	2, 3, 4, 5	4	Public property damage
Lower Frederick Township	1, 2	4, backwater	4	Public property damage, Road closure
Lower Pottsgrove Township	Survey not received (very small portion of Township in watershed)			
New Hanover Township	1	1, 3	4	Private property damage (cars), Road closure
Pike Township	Survey indicated no problems within the watershed			
Schwenksville Borough	Survey not received (very small portion of Borough in watershed)			
Upper Frederick Township	1, 2	1, 4	3	Private property damage, Public property damage, Road closure
Upper Pottsgrove Township	Survey indicated no problems within the watershed			
Washington Township	2	3, 4	4	Private property damage, Road closure

(A) Problems/Concerns Identified
1. Stream flooding
2. Street flooding
3. Soil erosion
4. Stormwater pollution
5. Other

(B) Causes of Stormwater Problems
1. Too large an increase in uncontrolled runoff
2. Uncontrolled runoff from upstream
3. Inadequate drainage system
4. Obstructions that need to be removed
5. Lack of maintenance of drainage ways
6. Other

(C) Frequency of Occurrences
1. Every rain
2. More than 10 times per year
3. More than 1 time per year
4. Only on major flood events

6. Development of Standards and Criteria

The data gathered via the survey and through field investigations were then loaded into a model of the watershed. The modeling effort is described in more detail in Section VI, Stormwater Control Standards. The output from the model,

along with conclusions from the municipal questionnaire, were used to propose stormwater management release rate(s) that would serve to avoid future flooding problems and keep existing problems from becoming worse. Based on the model results, a 50% release rate was recommended for the entire watershed. This release rate was then incorporated in the model ordinance.

Other stormwater management criteria are required by DEP. Ordinance language to meet these requirements was developed, including detention standards to protect streambanks from excessive erosion and to improve water quality, and infiltration standards to encourage groundwater recharge. The ordinance was also reviewed and language added to bring it into compliance with DEP's MS4 stormwater program. A draft of the ordinance was distributed to the WPAC and DEP for review, and the final ordinance is included in the Plan.

SECTION II – WATERSHED CHARACTERISTICS AND THE IMPACT ON RUNOFF

A. Watershed Characteristics

The Swamp Creek watershed, as illustrated in Figure 1, is located in western Montgomery County and eastern Berks County. The municipalities found in the watershed are:

Bechtelsville Borough
Boyertown Borough
Colebrookdale Township
District Township
Douglass Township (Berks County)
Douglass Township (Montgomery County)
Limerick Township
Lower Frederick Township
Lower Pottsgrove Township
New Hanover Township
Pike Township
Schwenksville Borough
Upper Frederick Township
Upper Pottsgrove Township
Washington Township

The Swamp Creek drains an area of approximately 55.52 square miles and includes the following major tributaries: Goshenhoppen Creek, Middle Creek, Minister Creek, Scioto Creek, Schlegel Creek, and the West Branch to Swamp Creek. Swamp Creek flows into the Perkiomen Creek above Schwenksville.

1. Watershed Description

The Swamp Creek watershed extends from the headwaters in District and Pike Townships, Berks County, to the confluence of Swamp Creek with the Perkiomen Creek north of Schwenksville, Montgomery County. The 55.8 square mile watershed is divided between the two counties; 26% or 14.6 square miles in Berks County, and 73.8 % or 41.2 square miles in Montgomery County. The Berks county portion of the watershed includes all or part of 7 municipalities. Eight municipalities are included in the Montgomery County portion.

Figure 1 General Watershed Map

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SWAMP CREEK WATERSHED AREA DATA

Total Area: 55.52 square miles

Municipality	Watershed Area (sq.mi.)
Berks County	
District Township	0.8
Pike Township	2.0
Washington Township	6.0
Bechtelsville Borough	0.5
Colebrookdale Township	4.5
Boyertown Borough	0.5
Douglass Township (Berks Co.)	0.2
Total Watershed – Berks County	**14.5**
Montgomery County	
Douglass Twp. (Montgomery Co.)	12.5
New Hanover Township:	15.3
Upper Frederick Township	5.8
Lower Frederick Township	4.8
Schwenksville Borough	0.02
Limerick Township	2.0
Upper Pottsgrove Township	0.4
Lower Pottsgrove Township	0.2
Total Watershed – Montgomery County	**41.02**

According to the Pennsylvania Code, Chapter 93, Swamp Creek has the following protected water uses:

- Swamp Creek basin, source to Bechtelsville Dam: High Quality; Cold Water Fishes and Migratory Fishes.
- Swamp Creek basin, Bechtelsville Dam to bridge at Route 100: Cold Water Fishes and Migratory Fishes.
- Swamp Creek basin, bridge at Route 100 to mouth: Trout Stocking Fishes and Migratory Fishes.

2. Land Characteristics

The main stem of the Swamp Creek rises in the hills of Pike, District, and Washington Townships. The watershed boundary in this area is above the 1,000 foot contour, reaching 1,080 feet above sea level at its highest point. The area is hilly, and the stream corridor is narrow.

Below Bechtelsville, the Swamp Creek enters a wide, shallow bowl. Slopes along the main stem and its tributaries in this area are typically less than 5%, although towards the watershed boundary the slopes increase to about 15%. The stream meanders in this area, and three tributaries (Schlegel Run, Middle Creek, and Minister Creek) join the main stem.

In the lower third of the watershed, the width narrows and the two ridges that form the watershed converge on Schwenksville. The steeply sloped ridges are paralleled by the main stem, Goshenhoppen Creek, and Scioto Creek. The steeply sloped sides of the two ridges result in long straight channels for these three creeks. The Scioto and Goshenhoppen Creeks run in a relatively straight path for over 3 miles, and the main branch, including an unnamed tributary, flows without any significant meanders for about 6 miles. Please refer to Figure 2 for watershed slope information.

Figure 2 Slopes Map

This page back of slopes map

There are several important hydrologic features in the last few miles of the Swamp Creek before it empties into the Perkiomen Creek. The main stem is dammed at Sunrise Mill, a county historic site located about three miles upstream from the confluence of the Swamp and Perkiomen Creeks. A little over a mile downstream, a second dam crosses the main stem. The Scioto joins the main stem just 3,000 feet below the dam, and the Goshenhoppen Creek joins the main stem 5,000 feet below that. A third dam impounds the creek 500 feet downstream from the confluence of the main stem and the Goshenhoppen Creek. The confluence of the Swamp and Perkiomen Creeks is just 2,000 feet below this third dam.

Existing land use information was obtained from Berks and Montgomery Counties. Figure 3 shows the existing land cover information for the watershed. Woodland is the dominant land cover for portions of the watershed located in Pike Township, District Township, Limerick Township and Lower Frederick Township. There are also large woodland areas in Washington Township, Douglass Township, and New Hanover Township. These areas tend to be undeveloped. Additionally, there tends to be less development in the Berks County/upland portion of the watershed. Development in this portion of the watershed is concentrated near Route 100 and in Boyertown Borough and is a mix of commercial, industrial, and residential development. According to the existing land use information, most of the development within the watershed has generally occurred within Douglass and New Hanover Townships, in the central portion of the watershed. Most of the development in these municipalities is residential. There has also been some low density residential development in Upper Frederick Township, also in the central portion of the watershed. Despite development in these areas, Douglass, New Hanover, and Upper Frederick Townships still have significant areas that are agricultural, open space, or woodland.

3. Soils

The soils in the watershed include the following series.

- *Abbottstown Series (AbA, AbB2):* These are deep and moderately deep, somewhat poorly drained soils formed from weathered red and brown shale and sandstone. These soils have a slowly permeable subsoil that impedes the downward movement of water. These soils are wet late in fall, in winter, and early in spring.
- *Bouldery Alluvial Land (Bo):* This series consists of nearly level to gently sloping areas covered by boulders and stones. This soil is subject to flooding, usually several times each year. Permeability is moderate, and the water table is near or at the surface late in fall and during winter and spring.
- *Bowmansville Series (Bp, BrA, BrB):* Deep, poorly drained silt loams and silty clays make up the Bowmansville series. These soils formed from material washed from upland areas underlain by shale, sandstone, and diabase. They are nearly level or gently sloping and occur in floodplains

along streams. These soils have a moderate permeability, and experience a high water table late in fall, in winter, and in spring. Bedrock can be within 2 to 3 feet of the surface.

- *Brecknock Series (BsB2, BsC2, BtC, BtD, BvD):* The Brecknock series consists of deep to moderately deep, well-drained channery silt loams (*channery* refers to a soil that contains more than 15% fragments of thin, flat sandstone, limestone, or schist). The soil is formed from metamorphosed shale, called hornfels. These are gently sloping to steep, located on top of hills or low ridges. Depth to bedrock ranges from 2 to 5 feet, and permeability is moderate.
- *Croton Series (CrA, CrB2):* The Croton series is made up of soils that are deep, poorly drained, nearly level or gently sloping, formed from shale and sandstone. The thick subsoil impedes the downward movement of water. The water table is near the surface in late fall, in winter, and early in the spring.
- *Klinesville Series (KsE3):* The soils in the Klinesville series are well-drained, gently sloping to steep. These soils have a moderately rapid permeability. The bedrock is within 2 feet of the surface.
- *Lansdale Series (LdA2):* The Lansdale silt loam is a deep soil, with the bedrock at a depth of 5 to 10 feet. Slopes are gentle, usually 0 to 3 percent. It is moderately permeable, and surface runoff is slow to medium.
- *Legore Series (LgC3, LgD3):* The soils in this series are well-drained, moderately deep to deep soils that were formed from weathered diabase. They are found on moderately sloping to steep hills and ridges in the watershed. The Legore soils are moderately permeable. Surface runoff is rapid, and the hazard of erosion is severe.
- *Lehigh Series (LhB2, LhB3, LhC2, LhC3, LsD):* The Lehigh series consists of moderately deep to deep soils that are moderately well drained to somewhat poorly drained. These soils are formed from weathered hornfels, a metamorphosed shale. They have a slowly permeable layer in the subsoil that restricts the downward movement of water. The water table is within a foot of the surface in late fall, in winter and early in spring.
- *Made Land (MeB):* This category of soils, which refers to areas where earthmoving has altered the characteristics of soils, varies greatly from soil to soil. The characteristics of the soil also vary within each type. The MeB soil results from altering and mixing soils formed from shale and sandstone. It is mainly level to gently sloping, and may be comprised almost entirely of pieces of shale. The permeability is moderate to slow, and the water table is at the surface during winter and spring.

Figure 3 Existing Land Cover Map

Back of land cover map

- *Mount Lucas Series (MoA, MoB2, MoC2, MuB, MuD):* These are deep, moderately well-drained to somewhat poorly drained soils, formed from diabase. They are nearly level, and have moderately slow permeability in the subsoil. The MuB and MuD soil types are very stony silt loams that can contain stones up to 12 feet in diameter. The stones can be so numerous in places that there is little soil between them.
- *Neshaminy Series (NhB2, NhC2, NhD2, NsD):* The Neshaminy series is typified by deep, well-drained soils formed from weathered diabase. Permeability is moderate. The steeper soil types (NhC2, NhD2) are prone to rapid runoff. The NsD soil type is stonier than the other soil types in this series.
- *Penn Series (PeB2, PeB3, PeC3):* The Penn series soils are moderately deep to shallow soils, formed from weathered shale, sandstone and siltstone. They occur on undulating and hilly uplands, and are important agricultural soils. They have a rapid permeability. The Penn-Klinesville soil type (PkD3) consists of Penn and Klinesville soils that occur together too closely to separate. This soil type has moderate to rapid permeability, though surface runoff is rapid.
- *Raritan Series (RaA, RaB2):* This series consists of moderately well-drained to somewhat poorly drained soils formed from old stream sediments. The subsoil is firm, and restricts the downward movement of water. There is also a seasonal high water table.
- *Readington Series (ReA, ReB2):* Deep, moderately well-drained silt loam soils are in the Readington series. Surface drainage is slow, and the water table is within 18 inches of the surface in late fall, in winter, and early spring.
- *Reaville Series (RsA2, RsB2, RsB3, RsC3):* Moderately deep, moderately well-drained or somewhat poorly drained silt loams make up this series. These soils have a thin, slowly permeable subsoil that restricts the downward movement of water. There is a seasonal high water table, and bedrock is often near the surface.
- *Rowland Series (Rt, RwA, RwB):* The Rowland series consists of deep, moderately well-drained to somewhat poorly drained nearly level silt loam on floodplains. The soils have a high water table and are subject to flooding in late fall, in winter, and in early spring, as well as during high intensity storms.
- *Stony Land, Steep (Ste):* Slopes on this soil type are usually above 25%. The soil layer is thin, and runoff rapid.
- *Watchung Series (WaA, WaB, Wc):* These are deep, poorly drained soils. They have a slow permeability, and the subsoil inhibits percolation (the

downward movement of water). The water table is at the surface late in fall, in winter, and early in spring. Surface runoff is slow, and water frequently ponds.

The USDA Natural Resources Conservation Service (NRCS) has divided soils into four groups, referred to as hydrologic soil groups, based on the potential for having similar runoff potential under similar storm and cover conditions. Factors that would influence this potential include the following: depth to seasonally high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. The four groups are called A, B, C, and D, and they describe soils with increasing runoff potential from A to D. Group A soils have a high infiltration rate even when thoroughly wetted. Group B soils have a moderate infiltration rate when thoroughly wetted. They are typically deep, moderately well drained soils. Group C soils have a relatively low infiltration rate when thoroughly wetted. They typically consist of soils of fine texture or have a layer that impedes percolation. Group D soils have a very slow infiltration rate when thoroughly wetted. They typically consist of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay layer near the surface, or shallow soils over nearly impervious material.

Group A soils are not found in the Swamp Creek watershed. Much of the upstream, Berks County portion of the watershed consists of B soils. Some other scattered pockets of B soils can be found in the watershed, most notably on the south side of the downstream end of Swamp Creek. The majority of the watershed consists of C soils, especially within the Montgomery County portion of the watershed. Much of the watershed's floodplain areas consist of D soils.

The implication of this information, which is confirmed by observations during storm events, is that the majority of the watershed is not conducive to infiltration and does not drain very well, resulting in flooding, particularly in areas of development and roadways that are adjacent to Swamp Creek and any of its tributaries. Stormwater infiltration facilities therefore, will need to be carefully designed and sited in order to function well.

These soil series have been mapped and grouped according to hydrologic grouping during Phase II data preparation activities. Please refer to Figure 4 for the soils map.

4. Rainfall Information

The annual average total amount of precipitation (including rainfall and the water equivalent of snowmelt) is 43 inches (measured at Pottstown, PA). Within Montgomery County, a low of 32 inches and a high of 51 inches per year have been recorded. Early spring (March and April) and late summer (July, August, September) tend to be the wettest months. Most of the rainfall in the warm months comes in the form of showers and thunderstorms. At times these storms

produce considerable local flooding when the soils are unable to absorb the large volume of water coming off impervious surfaces and the natural or artificial drainage systems become overloaded.

B. Floodplains / Flood Hazard Areas

The Federal Emergency Management Agency (FEMA) manages the National Flood Insurance Program (NFIP). Thousands of communities across the United States and its territories participate in the NFIP by enforcing floodplain management ordinances in exchange for the opportunity for their property owners to purchase Federally-backed flood insurance. FEMA also identifies and maps the Nation's floodplains through the NFIP.

FEMA has identified 100-year floodplains for Swamp Creek and its tributaries through both detailed and approximate methods. When a floodplain has been studied by detailed methods, it means that hydrologic and hydraulic models, such as HEC-HMS and HEC-RAS, were used to develop the floodplain elevations at specific cross sections, and these floodplain elevations are used with topographic information to delineate the 100-year floodplains. Detailed studies result in 100-year base flood elevations, floodplain delineations, and floodway delineations. Floodways are defined as the stream channel and adjacent floodplain areas that are to be kept free of encroachments so the 100-year flood can be conveyed without increases in floodplain elevations greater than 1 foot. Streams that have been studied using detailed methods should have floodplains that have been delineated more accurately than those with floodplains determined using approximate methods. Floodplains for streams with higher flood and/or development potential are generally studied using detailed methods, and floodplains for streams considered to have lesser flood and/or development potential are determined using approximate methods. Floodplains determined using approximate methods are delineated considering criteria such as area topography and past flood observations.

The effective date for the floodplain delineation and mapping of the Montgomery County portions of the watershed is December 19, 1996, and the effective date of the Berks County portions of the watershed is December 5, 1997. Detailed floodplain analyses have been completed for the following stream reaches within the watershed, listed from the downstream limit of detailed study to the upstream limit of detailed study (all lengths are approximate):

<u>Swamp Creek</u>

- Confluence with Perkiomen Creek to a distance 16,500 feet upstream of the confluence or 6,000 feet upstream of the dam at Camp ArthurReeta.
- New Hanover Township boundary to a distance 8,700 feet upstream of the Township boundary, or 1,500 feet upstream of Colonial Road.
- Route 73 upstream to the Montgomery County – Berks County boundary.

- Montgomery County – Berks County boundary to a distance 4,300 feet upstream of the County boundary or 2,100 feet upstream of Mill Crest Road.
- Washington Township boundary to a distance 7,050 feet upstream of the Township boundary or 50 feet upstream of Race Street.

Goshenhoppen Creek

- Confluence with Swamp Creek to a distance 14,750 feet upstream of the confluence or 400 feet upstream of Faust Road.

Scioto Creek

- Confluence with Swamp Creek to a distance 19,700 feet upstream of the confluence or at Township Line Road.

West Branch Swamp Creek

- Confluence with Swamp Creek to a distance 14,500 feet upstream of the confluence or just upstream of Rhoads Road.

Minister Creek

- Reifsnyder Road (approximately 5000 feet upstream of confluence with Swamp Creek) to a distance 31,550 feet upstream of the confluence with Swamp Creek or the Montgomery County – Berks County boundary .

Minister Creek Tributary

- Confluence with Minister Creek to a distance 4,100 feet upstream of the confluence with Minister Creek.

Oley Creek

- Confluence with Minister Creek to a distance 4,100 feet upstream of the confluence with Minister Creek or the Montgomery County-Berks County boundary.

Schlegel Run

- Confluence with Swamp Creek to a distance 17,500 feet upstream of the confluence or at Hoffman Road.

Middle Creek

- Confluence with Swamp Creek to a distance 13,500 feet upstream of the confluence or 2,700 feet upstream of Congo Road.

Please refer to Figure 1 for the Swamp Creek floodplain delineation. The floodplains shown on this map include those determined by FEMA using both detailed and approximate methods.

Figure 4 Hydrologic Soil Group Map

Back of map

C. Survey of Existing Runoff Characteristics

The runoff characteristics of the Swamp Creek watershed are changing as increased development and new stormwater management regulations impact the hydrologic cycle. As existing forested areas, farmland and open spaces are developed, these natural areas are often converted to impervious areas or areas of grass or landscaping over relatively compacted soils. These changes result in the decreased ability of the ground to slow and/or infiltrate stormwater runoff, which then results in increased stormwater flow volumes and decreased groundwater recharge. This stormwater flow can often contain sediment or other pollutants from the land-altered areas, resulting in the decreased water quality of the receiving stream.

Portions of the watershed located near areas of land development are seeing streams reach their bankfull volumes more frequently and during smaller storm events due to the stormwater runoff volume increases. This results in streambank erosion and also undercut streambanks.

Several municipalities in the Swamp Creek watershed have indicated that they are concerned about decreasing groundwater recharge due to development. As impervious area increases, there is less available ground area where stormwater runoff can infiltrate before flowing toward a drainage structure or stream. As a result of this, the groundwater table is not being replenished as it was in the past.

Another factor influencing existing runoff characteristics is the lack of porous soils (hydrologic soil groups A and B) found within the Swamp Creek watershed. This watershed characteristic implies that there are limited areas where significant groundwater recharge is feasible, resulting in areas of significant runoff or pooling, depending on area slopes and the presence of stormwater management facilities.

D. Runoff Control Techniques and Their Efficiencies

As development occurs, the increased quantity of stormwater runoff must be addressed. Failure to do so can result in greater flooding, stream channel erosion, sedimentation, and reduced groundwater recharge. Stormwater management must be addressed in every land development proposal or any proposal that causes changes in land surface conditions. Past efforts to manage stormwater have usually focused on controlling the rate of discharge on a municipality-by-municipality basis. One goal of an Act 167 plan is to change this focus from runoff control by individual development or municipality to consider the stormwater impacts of development on a watershed-wide basis. The model Swamp Creek Stormwater Management Ordinance, discussed in Section VI, provides stormwater management requirements, design guidelines, and enforcement provisions to achieve this goal.

There exist several types of runoff control techniques that can be employed on development sites to meet the performance criteria outlined in the Swamp Creek Stormwater Management Ordinance. Various techniques to reduce and/or delay runoff corresponding to development type are listed in Table 2. A more exhaustive list of

techniques, along with specific design criteria, can be found in the *Pennsylvania Stormwater Best Management Practices Manual*, latest edition.

The design of an effective stormwater management plan involves careful planning. It may be necessary for the development site engineer / design professional to consider multiple runoff control techniques to meet the stormwater management requirements. Some items to consider when selecting the most appropriate runoff control measures for a particular development site include the following:

- Design constraints specific to watershed.
- Physical constraints such as soil characteristics, geology, depth to high groundwater table, development area slope and topography, existing drainage patterns, and stormwater facility siting.
- Ability of stormwater facility(ies) to meet design requirements / recommendations for development site.
- Advantages and disadvantages to each runoff control technique.
- Community acceptance of runoff control technique.
- Cost of runoff control technique.
- Maintenance required for runoff control technique to operate effectively.
- Permitting requirements for proposed improvements.

Table 2
Measures for Reducing and Delaying Urban Storm Runoff
Various On-Site Storm Water Control Methods

Area	Reducing Runoff	Delaying Runoff
A. Large Flat Roof	1. Cistern storage 2. Rooftop gardens 3. Pool storage or fountain storage	1. Ponding on roof by constructed downspouts 2. Increasing roof roughness: a. Rippled roof b. Graveled roof
B. Parking Lots	1. Porous pavement: a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measures for impervious areas: a. Rippled pavement b. Depressions c. Basins
C. Residential	1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Ground-water recharge: a. Perforated pipe b. Gravel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions	1. Reservoir of detention basin 2. Planting a high delaying grass (i.e. high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters, diversions, etc.
D. General	1. Gravel alleys 2. Porous sidewalks 3. Mulched planters	1. Gravel alleys

Source: Urban Hydrology for Small Watersheds. Technical Release No. 55

1. Best Management Practices

The impacts of the clearing, grading, addition of impervious area, and construction that are associated with land development include declining water quality, diminishing groundwater recharge and quality, degradation of stream channels, increased overbank flooding, and floodplain expansion. Best management practices (BMPs) have been developed to lessen these impacts of development on the environment. BMPs may be structural or non-structural and

are designed to detain or treat stormwater to improve water quality and recharge, protect stream channels from erosion, and decrease flooding. Some BMPs specifically control runoff, while others specifically control pollution. Several BMPs perform both of these functions.

The following is a summary of various BMPs. This is not an exhaustive list of BMPs. Additional information may be found in the *Pennsylvania Stormwater Best Management Practices Manual*, latest edition.

a. Nonstructural practices:

1) *Natural Area Conservation*: Natural areas are conserved at development sites, retaining pre-development hydrologic and water quality characteristics. Examples include forest retention areas, non-tidal wetlands and associated buffers, other areas in protective easements, and stream systems.

2) *Disconnection of Rooftop Runoff:* Rooftop runoff is disconnected and directed to a pervious area where it can infiltrate into the soil or filter over it.

3) *Disconnection of Non Rooftop Runoff:* Impervious surface runoff is disconnected by directing it to pervious areas where it can infiltrate into the soil or filter over it. This may be achieved by site grading that promotes overland vegetative filtering or by providing bioretention areas.

4) *Grass Channels:* Grass channels may be used to reduce the volume of runoff and pollutants during smaller storms. Grass channels may be designed to provide opportunities for groundwater recharge and water treatment.

5) *Sheetflow to Buffers:* Effective treatment in using this method is achieved when runoff from pervious and impervious areas is discharged to a grass or forested buffer through overland flow. A Riparian Buffer Zone (RBZ) is an example of this type of nonstructural BMP.

6) *Environmentally Sensitive Development:* Environmental site design techniques can be applied to low density or residential development. Design techniques include reducing impervious cover; increasing lot sizes or using clustering techniques; and using grass channels, rooftop runoff disconnections, and natural conservation areas.

7) *Riparian Buffer Zone (RBZ):* A RBZ is an area adjacent to a wetlands or watercourse that extends a minimum of fifty (50) feet to either side of the top-of-bank of the channel. The buffer area shall be maintained with and encouraged to use appropriate native vegetation.

8) *Street Sweeping:* This BMP involves the removal of trash and other pollutants from roadways and parking areas before they may enter a stream.

9) *Application and Storage of Fertilizers, Pesticides, and Highway Deicing Compounds*: Proper application and storage of these compounds can reduce the amounts entering a stream system.

b. Structural Practices:

1) *Bioretention Facility:* In a bioretention facility, sand and soil mixtures are mixed with native plants to remove pollutants such as suspended solids and nutrients in a low area or basin. These areas may also be designed to act to reduce peak runoff rates and recharge groundwater by infiltrating runoff.

2) *Constructed Treatment Wetland*: A constructed treatment wetlands is an artificial shallow water-filled basin that has been planted with emergent plant vegetation. These wetlands may be used to remove pollutants such as suspended solids, nutrients (nitrogen and phosphorus), heavy metals, toxic organic pollutants, and petroleum compounds. They may also be an effective means of reducing peak runoff rates and stabilizing flow adjacent to natural wetlands and streams.

3) *Filter Strip:* Filter strips are vegetated areas with mild, uniform slopes. These areas may be forested or vegetated with grasses. Filter strips located adjacent to waterbodies are called buffers. Filter strips are provided downgradient of development to trap sediment and sediment-born pollutants. They are used to "disconnect" impervious surfaces from storm sewers and lined channels and may be used to help to reduce peak discharge rates.

4) *Infiltration Trench:* An infiltration trench is an excavated, stone-filled trench in which stormwater runoff is collected and percolated to the surrounding soil. These trenches allow runoff from small drainage areas to percolate into the ground.

5) *Infiltration Basin:* An infiltration basin is an excavated, stone-filled area with a relatively-permeable soil bottom. The basin temporarily stores runoff and allows it to infiltrate into the ground.

6) *Permeable Paving:* Permeable paving is an alternative to conventional paving practices, which includes the use of porous bituminous concrete mixtures, permeable interlocking concrete paving blocks, concrete grid pavers, perforated brick pavers, or compacted gravel. Permeable paving reduces impervious area at a development site, reducing surface runoff and increasing infiltration.

7) *Dry Detention Basin:* A dry detention basin is a permanent stormwater management facility that stores stormwater runoff and is generally dry between storm events. The ability of the basin to store water allows a portion of the pollutants contained in the runoff to settle out. Additionally, these basins should be designed to reduce the potential for flooding and streambank scour and erosion in downstream areas. To qualify as a BMP, dry basins should provide extended detention during small storm events.

8) *Wet Detention Basin:* A wet detention basin is a permanent stormwater management facility that retains a permanent pool of water to enhance water quality and additional capacity above the permanent pool to detain stormwater runoff. These may be used in low density residential or commercial developments where there is a source of water to maintain the permanent pool in the pond.

9) *Sand Filter:* Sand filters treat runoff by allowing it to settle through sand. The runoff is then discharged to a storm drain, stream, or channel after it is filtered.

10) *Water Quality Inlet (Oil-Grit Separator):* These inlets are used to remove oil, grease, heavy particulates, absorbed hydrocarbons, and other floating substances from stormwater before the pollutants enter the storm sewer system. These inlets have multiple chambers and are best applied in small drainage areas with heavy vehicular traffic or large amounts of petroleum.

11) *Erosion and Sedimentation Control*: Erosion and sedimentation control measures reduce sediments released to areas downgradient from construction sites. Control measures include temporary construction entrances, silt fence, sedimentation basins, sediment traps, and inlet protection.

12) *Check Dam:* A check dam is a stone dam constructed in a swale or other watercourse to decrease the flow velocity, minimize scour, and promote sediment deposition.

13) *Level Spreader:* A level spreader is a perforated pipe, concrete curb, or other structure that is installed downgradient of a location of concentrated flow for the purpose of converting the flow into sheet flow. Level spreaders prevent erosive flows and promote infiltration.

14) *Trash Rack:* Trash racks are installed on basin risers or roof downspouts to keep trash or other relatively large pollutants from entering a treatment structure.

Please refer to the following design manuals for further information on the BMPs listed above and on additional BMPs:

c. *Pennsylvania Stormwater Best Management Practices Manual, April 2006 (draft)*

To download, go to the following website:
http://www.dep.state.pa.us/dep/subject/advcoun/stormwater/stormwatercomm.html

d. *Pennsylvania Handbook of Best Management Practices for Developing Areas, Spring 1998*

For summary and ordering information, go to the following website:
http://www.pacd.org/products/bmp/bmp_handbook.htm

e. *2000 Maryland Stormwater Design Manual, Volumes I and II*

To download, go to the following website:
http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp

f. *New Jersey Stormwater Best Management Practices Manual, April 2004*

To download, go to the following website:
http://www.njstormwater.org/tier_A/bmp_manual.htm

g. *Delaware Conservation Design for Stormwater Management Guidance Manual (1997)*

For ordering information, go to the following website:
http://www.dnrec.state.de.us/dnrec2000/divisions/soil/stormwater/apps/designmanualrequest.htm

h. *New York State Stormwater Management Design Manual, August 2003*

To download, go to the following website:
http://www.dec.state.ny.us/website/dow/toolbox/swmanual/

2. Advantages and Disadvantages of Various Runoff Control Facilities

The advantages and disadvantages for various runoff control facilities are tabulated below.

Runoff Control Facility	Advantages	Limitations
Bioretention Facility	• If designed properly, has shown ability to remove significant amounts of dissolved heavy metals, phosphorous, TSS, and fine sediments. • Requires relatively little engineering design in comparison to other stormwater management facilities (e.g. sand filters). • Provides groundwater recharge when the runoff is allowed to infiltrate into the subsurface. • Enhances the appearance of parking lots and provides shade and wind breaks, absorbs noise, and improves an area's landscape. • Maintenance on a bioretention facility is limited to the removal of leaves from the bioretention area each fall. • The vegetation recommended for use in bioretention facilities is generally hardier than the species typically used in parking lot landscapes. This is a particular advantage in urban areas where plants often fare poorly due to poor soils and air pollution.	• Low removal of nitrates. • Not applicable on steep, unstable slopes or landslide areas (slopes greater than 20 percent). • Requires relatively large areas. • Not appropriate at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable. • Clogging may be a problem, particularly if the BMP receives runoff with high sediment loads.
Catch Basin Inserts	• Provides moderate removal of larger particles and debris as pretreatment. • Low installation costs. • Units can be installed in existing traditional stormwater infrastructure. • Ease of installation. • Requires no additional land area.	• Vulnerable to accumulated sediments being resuspended at low flow rates. • Severe clogging potential if exposed soil surfaces exist upstream. • Maintenance and inspection of catch basin inserts may be required before and after each rainfall event, excessive cleaning, and maintenance. • Available head to meet design criteria. • Dissolved pollutants are not captured by filter media. • Limited pollutant removal capabilities.
Cisterns	• Requires little space for installation. • Reduces amount of stormwater runoff. • Conserves water usage.	• Limited amount of stormwater runoff can be captured. • Restricted to structure runoff.

Runoff Control Facility	Advantages	Limitations
Constructed Wetlands	• Artificial wetlands offer natural aesthetic qualities, wildlife habitat, erosion control, and pollutant removal. • Artificial wetlands can offer good treatment following treatment by other BMPs, such as wet ponds, that rely upon settling of larger sediment particles. They are useful for large basins when used in conjunction with other BMPs. • Wetlands that are permanently flooded are less sensitive to polluted water inflows because the ecosystem does not depend upon the polluted water inflow. • Can provide uptake of soluble pollutants such as phosphorous, through plant uptake. • Can be used as a regional facility.	• Although the use of natural wetlands may be more cost effective than the use of an artificial wetland; environmental, permitting and legal issues may make it difficult to use natural wetlands for this purpose. • Wetlands require a continuous base flow. • If not properly maintained, wetlands can accumulate salts and scum which can be flushed out by large storm flows. • Regular maintenance, including plant harvesting, is required to provide nutrient removal. • Frequent sediment removal is required to maintain the proper functioning of the wetland. • A greater amount of space is required for a wetland system than for an extended/dry detention basin treating the same amount of area. • Although artificial wetlands are designed to act as nutrient sinks, on occasion, the wetland may periodically become a nutrient source. • Wetlands that are not permanently flooded are more likely to be affected by drastic changes in inflow of polluted water. • Cannot be used on steep unstable slopes or densely populated areas. • Threat of mosquitoes. • Hydraulic capacity may be reduced with plant overgrowth.

Runoff Control Facility	Advantages	Limitations
Dry Wells	• Recommended in residential areas. • Requires minimal space to install. • Low installation costs. • Reduces amount of runoff. • Provides groundwater recharge. • Can serve small impervious areas like rooftops. • Helps to disconnect impervious surfaces.	• Offers little pretreatment, which may lead to clogging. • Dry wells should not be installed where hazardous or toxic materials are used, handled, stored or where a spill of such materials would drain into the dry well. • Risk of groundwater contamination in very coarse soils may require groundwater monitoring. • Not suitable on fill sites or steep slopes. • Must have a minimum of 2 to 3 feet between the bottom of the dry well and the seasonal high water table. • Dry wells service a limited drainage area, typically only rooftop runoff. • Dry wells must be located at least 10 feet away, on the down slope side of the structure, from building foundations to prevent seepage. • Stormwater runoff carrying bacteria, sediment, fertilizer, pesticides, and other chemicals may flow directly into the groundwater. • Loss of infiltrative capacity and high maintenance cost in fine soils. • Low removal of dissolved pollutants in very coarse soils. • Soils must be permeable. • Not recommended for use with commercial rooftops unless adequacy of pretreatment is assured.

Runoff Control Facility	Advantages	Limitations
Extended / Dry Detention Basins or Underground Tanks	• Modest removal efficiencies for the larger particulate fraction of pollutants. • Removal of sediment and buoyant materials. Nutrients, heavy metals, toxic materials, and oxygen-demanding particles are also removed with sediment substances associated with the particles. • Can be designed for combined flood control and stormwater quality control. • Potentially requires less capital cost and land area when compared to wet pond BMP. • Downstream channel protection when properly designed and maintained.	• Require sufficient area and hydraulic head to function properly. • Generally not effective in removing dissolved and finer particulate size pollutants from stormwater. • Some constraints other than the existing topography include, but are not limited to, the location of existing and proposed utilities, depth to bedrock, location and number of existing trees, and wetlands. • Extended/dry detention basins have moderate to high maintenance requirements. • Sediments can be resuspended if allowed to accumulate over time, and escape through the hydraulic control to downstream channels and streams. • Some environmental concerns with using extended/dry detention basins include potential impact on wetlands, wildlife habitat, aquatic biota, and downstream water quality. • May create mosquito breeding conditions and other nuisances.

Runoff Control Facility	Advantages	Limitations
Infiltration Basins	• High removal capability for particulate pollutants and moderate removal for soluble pollutants. • Groundwater recharge helps to maintain dry-weather flows in streams. • Can minimize increases in runoff volume. • When properly designed and maintained, it can replicate pre-development hydrology more closely than other BMP options. • Basins provide more habitat value than other infiltration systems.	• High failure rate due to clogging and high maintenance burden. • Low removal of dissolved pollutants in very coarse soils. • Not suitable on fill slopes or steep slopes. • Risk of groundwater contamination in very coarse soils may require groundwater monitoring. • Should not be used if significant upstream sediment load exists. • Slope of contributing watershed needs to be less than 20 percent. • Not recommended for discharge to a sole source aquifer. • Cannot be located within 100 feet of drinking water wells. • Metal and petroleum hydrocarbons could accumulate in soils to potentially toxic levels. • Relatively large land requirement. • Only feasible where soil is permeable and there is sufficient depth to bedrock and water table. • Need to be located a minimum of 10 feet down gradient and 100 feet upgradient from building foundations because of seepage problems.

Runoff Control Facility	Advantages	Limitations
Infiltration Trenches	• Provides groundwater recharge. • Trenches fit into small areas. • Good pollutant removal capabilities. • Can minimize increases in runoff volume. • Can fit into medians, perimeters, and other unused areas of a development site. • Helps replicate pre-development hydrology and increases dry weather baseflow.	• Slope of contributing watershed needs to be less than 20 percent. • Soil should have infiltration rate greater than 0.3 inches per hour and clay content less than 30 percent. • The bottom of infiltration trench should be at least 4 feet above the underlying bedrock and the seasonal high water table. • High failure rates of conventional trenches and high maintenance burden. • Low removal of dissolved pollutants in very coarse soils. • Not suitable on fill slopes or steep slopes. • Risk of groundwater contamination in very coarse soils may require groundwater monitoring. • Cannot be located within 100 feet of drinking water wells. • Need to be located a minimum of 10 feet down gradient and 100 feet up gradient from building foundations because of seepage problems. • Should not be used if upstream sediment load cannot be controlled prior to entry into the trench. • Metals and petroleum hydrocarbons could accumulate in soils to potentially toxic levels.
Media Filtration	• May require less space than other treatment control BMPs and can be located underground. • Does not require continuous base flow. • Suitable for individual developments and small tributary areas up to 100 acres. • Does not require vegetation. • Useful in watersheds where concerns over groundwater quality or site conditions prevent use of infiltration. • High pollutant removal capability. • Can be used in highly urbanized settings. • Can be designed for a variety of soils. • Ideal for aquifer regions.	• Given that the amount of available space can be a limitation that warrants the consideration of a sand filter BMP, designing one for a large drainage area where there is room for more conventional structures may not be practical. • Available head to meet design criteria. • Requires frequent maintenance to prevent clogging. • Not effective at removing liquid and dissolved pollutants. • Severe clogging potential if exposed soil surfaces exist upstream. • Sand filters may need to be placed offline to protect them during extreme storm events.

Runoff Control Facility	Advantages	Limitations
Porous Pavement	• Porous pavements operate in a similar fashion to infiltration trenches and thus provide similar water quality benefits, including reductions in fine-grained sediments, nutrients, organic matter, and trace metals. • In addition to water quality benefits, porous pavements also provide significant reductions in surface runoff. • An added benefit provided by the on-site infiltration is the extent to which the stormwater runoff is able to contribute to groundwater recharge. • Reduces pavement ponding.	• Only applicable for low-traffic volume areas. • To maintain effectiveness, porous pavements require frequent maintenance. • Porous pavements are not intended to remove sediments. • Easily clogged by sediments if not situated properly. • Limited to treating small areas (0.25 to 10 acres). • Contributing drainage area slopes should be 5 percent or less to limit amount of sediments that could potentially lead to clogging of porous pavement. • On average, porous pavements clog within 5 years if not maintained. Some studies have shown that porous pavement continues to function at a decreased level with limited clogging. • Underlying soil strata must have adequate infiltration capacity of at least 0.3 inches per hour but preferably 0.50 in/hr or more. Adequate soil permeability should extend for a depth of at least 4 feet. • The bottom of the reservoir layer should be at least 4 feet above the seasonal high water table. Porous pavements should be no closer than 100 feet from drinking wells and 100 feet upgradient and 10 feet down gradient from building foundations. Due to the risk of groundwater contamination, porous pavements should not be used for gas stations or other areas with a relatively high potential for chemical spills. Similarly, special consideration should be given to the use of porous pavements in wellhead protection areas serviced by sole source aquifers. • The porous pavement should not be located where run-on from adjacent areas can introduce sediments to the pavement surface. Similarly, areas subject to wind-blown sediment loads should be avoided. • Extended rain can reduce the pavement's load bearing capacity. • Slightly more expensive than traditional paving surfaces.

Runoff Control Facility	Advantages	Limitations
Storm Drain Inserts	• Low installation costs. • Prefabricated for different standard storm drain designs. • Require minimal space to install.	• Some devices may be vulnerable to accumulated sediments being resuspended during heavy storms. • Can only handle limited amounts of sediment and debris. • Maintenance and inspection of storm drain inserts are required before and after each rainfall event. • High maintenance costs. • Hydraulic losses.
Vegetated Filter Strips	• Lowers runoff velocity. • Slightly reduces runoff volume. • Slightly reduces watershed imperviousness. • Slightly contributes to groundwater recharge. • Aesthetic benefit of vegetated open spaces. • Preserves the character of riparian zones, prevents erosion along streambanks, and provides excellent urban wildlife habitat.	• Filter strips cannot treat high velocity flows, and do not provide enough storage or infiltration to effectively reduce peak discharges to predevelopment levels for design storms. This lack of quantity control dictates use in rural or low-density development. • Requires slope less than 5%. • Requires low to fair permeability of natural subsoil. • Large land requirement. • Often concentrates water, which significantly reduces effectiveness. • Pollutant removal is unreliable in urban settings.
Vegetated Swale	• Relatively easy to design, install and maintain. • Vegetated areas that would normally be included in the site layout, if designed for appropriate flow patterns, may be used as a vegetated swale. • Relatively inexpensive. • Vegetation is usually pleasing to residents.	• Irrigation may be necessary to maintain vegetative cover. • Potential for mosquito breeding areas. • Possibility of erosion and channelization over time. • Requires dry soils with good drainage and high infiltration rates for better pollutant removal.

Runoff Control Facility	Advantages	Limitations
Wet Ponds	• Wet ponds have recreational and aesthetic benefits due to the incorporation of permanent pools in the design. • Wet ponds offer flood control benefits in addition to water quality benefits. • Wet ponds can be used to handle large drainage areas. • High pollutant removal efficiencies for sediment, total phosphorus, and total nitrogen are achievable when the volume of the permanent pool is at least three times the water quality volume (the volume to be treated). • A wet pond removes pollutants from water by both physical and biological processes, thus they are more effective at removing pollutants than extended/dry detention basins. • Creation of aquatic and terrestrial habitat.	• Wet ponds may be feasible for stormwater runoff in residential or commercial areas with a combined drainage area of at least 5 acres. • An adequate source of water must be available to ensure a permanent pool throughout the entire year. • If the wet pond is not properly maintained or the pond becomes stagnant; floating debris, scum, algal blooms, unpleasant odors, and insects may appear. • Sediment removal is necessary every 5 to 10 years. • Heavy storms may cause mixing and subsequent resuspension of solids. • Evaporation and lowering of the water level can cause concentrated levels of salt and algae to increase. • Cannot be placed on steep unstable slopes. • Ponding volume and depth, pond designs may require approval from DEP Dam Safety.

Note: Advantages / Limitations adapted from Los Angeles County Development Planning for Storm Water Management Manual, September 2002.

3. Applicability of Runoff Control Measures in the Swamp Creek Watershed

a. Cisterns and Covered Ponds:

Cisterns and covered ponds are recommended for large commercial areas or industrial parks where stored runoff could be used for fire protection. These generally have low maintenance costs (for periodic sediment removal only). A disadvantage to these structures is that they generally can not store large runoff volumes. Because these structures do not drain by themselves, storage during various storms is dependent on the runoff volume removed between storm events.

b. Rooftop Gardens:

Rooftop gardens should be for commercial areas, industrial parks, or other areas with large building footprints.

c. Surface Pond Storage:

Surface pond storage is recommended for portions of the Swamp Creek watershed that have relatively porous soils (hydrologic soils group B),

where the stored runoff volume will infiltrate at the pond bottom. These structures are relatively inexpensive to install and maintain, and they help entrap sediment to improve the water quality of the receiving stream.

d. Ponding on Roof, Constricted Downspouts:

These practices can be used on large buildings, but are impractical for smaller buildings due to the limited storage volume. This may require expensive structural modifications. The community may view this as an undesirable runoff control alternative due to fears concerning using a roof as a storage area. These practices typically have low maintenance costs unless leaks occur.

e. Increased Roof Roughness:

Increased roof roughness is possible for industrial and commercial buildings, but is not generally recommended due to the minimal impact on runoff control on a watershed-wide basis. This method has moderate installation cost and little maintenance cost.

f. Porous Pavement:

Porous pavement is recommended in areas with large parking facilities and for portions of the Swamp Creek watershed that have relatively porous soils (hydrologic soil group B). This practice promotes groundwater recharge. It has a moderate cost when compared with conventional paving; however, it often eliminates the need for surface pond storage, which requires large land areas.

g. Grassed Channels and Vegetated Filter Strips:

These practices are recommended wherever site conditions allow throughout the watershed. Grassed channels and vegetated filter strips slow velocity, reduce erosion, promote infiltration, and promote filtering. These should be constructed in areas with minimal slopes. They have low installation and maintenance costs.

h. Ponding and Detention on Pavement:

These practices are recommended for paved areas that would not be adversely impacted by freezing. These are inexpensive, have low maintenance costs, and are capable of entrapping some pollutants. Runoff stored in this way may be warmed, which could impact the temperature of the receiving water.

i. Reservoir or Detention Basin:

Reservoirs/Detention Basins are recommended in all areas of the watershed. These are relatively easy to construct and maintain. They have moderate installation and maintenance costs. These can aid in entrapping sediment, which improves water quality.

j. Groundwater Recharge:

Groundwater recharge facilities are recommended throughout the watershed, where soil and geologic conditions permit. The installation and maintenance costs for these facilities depend on the type of recharge facility chosen.

k. High Delay Grass and Routing Flow Over Lawns:

These practices are recommended throughout the watershed. They delay runoff, entrap sediment, reduce velocities, reduce erosion, and improve water quality of receiving watercourse. They are relatively inexpensive to install and maintain.

SECTION III – PROBLEM AREAS AND EXISTING CONTROL STRATEGIES

A. Existing Obstructions

For the purpose of developing the Stremtul model, twenty-eight existing obstructions were identified along Swamp Creek and streams that drain into Swamp Creek. Several of these obstructions are located at problem areas identified by participating municipalities in the municipal surveys. The remaining obstructions were identified by research on FEMA Flood Insurance Rate Maps for these streams. The following criteria were also considered when selecting the additional significant flow obstructions: these obstructions are defined as having a drainage area of at least one square mile, having the ability to cause a significant increase in upstream flood elevations, or having sizing to cause significant peak flow reductions.

The following are the locations of the twenty-eight obstructions used in the model:

- Swamp Creek at Spring Mountain Road.
- Goshenhoppen Creek at Silver Brook Road.
- Swamp Creek at Gerloff Road.
- Scioto Creek at Faust Road.
- Scioto Creek at Perkiomenville Road.
- Tributary to Swamp Creek at Bragg Road.
- Swamp Creek at Swamp Creek Road (Camp Joy).
- Swamp Creek at Neiffer Road (above Keyser Road).
- West Branch Swamp Creek at Swamp Pike.
- West Branch Swamp Creek at New Hanover Square Road.
- West Branch Swamp Creek at Romig Road.
- West Branch Swamp Creek at Rhoads Road.
- Swamp Creek at Fagleysville Road.
- Minister Creek at New Hanover Square Road.
- Minister Creek at Reifsnyder Road.
- Minister Creek at Swamp Pike.
- Minister Creek at North Charlotte Street.
- Minister Creek at Kleman Road.
- Minister Creek at Route 100.
- Swamp Creek at New Hanover Square Road.
- Swamp Creek at New Road.

- Schlegel Creek at Kulps Road.
- Schlegel Creek at Hoffmansville Road.
- Middle Creek at Middle Creek Road.
- Swamp Creek at Congo Road.
- Swamp Creek at County Line Road.
- Swamp Creek at Mill Street.
- Swamp Creek at Old Route 100.

A chart of obstructions and their capabilities is included on the following page. Additionally, there are three dams along the Swamp Creek. All of these are low head and/or mill dams, with no storage behind these dams. These dams are full to the crest.

B. Existing Problem Drainage Areas

Municipalities located within the Swamp Creek watershed were asked to complete a municipal questionnaire that encouraged respondents to detail existing stormwater problems and locations within the municipality. The survey also asked for information such as the frequency and cause of stormwater problems, along with activities that have been initiated to address stormwater issues.

According to the survey responses, the sparsely populated, hilly regions of Douglass, Pike and Washington Townships in Berks County and Lower Pottsgrove and Upper Pottsgrove Townships in Montgomery Township, which are located at the headwaters of the Swamp Creek watershed, experience little or no stormwater problems. These areas are dependent on on-site water supply systems and have expressed an interest in management systems that will facilitate local groundwater recharge.

The small towns of Bechtelsville and Eshbach have experienced property damage, road closures and loss of service during major flooding events. In Colebrookdale Township, Berks County, moderate stormwater problems have been reported in the area north of Boyertown. Corrections need to be made in these communities to the existing drainage systems that are too small to handle the increased run-off caused by the significant increase in housing starts in the Route 100 corridor.

The central portion of Douglass Township in Montgomery Township has also seen a dramatic rise in new housing developments in the Gilbertsville area. The Swamp Creek tributaries increase in number and size in Douglass Township where the accumulated run-off from local and upstream sources force road closures and property damage 1 – 3 times per year. The increase in impervious cover has accentuated flooding in areas where the high water table historically forced streams to overflow their banks onto adjacent roads. This increase in stream velocity continues into New Hanover Township where road

Obstructions

closures occur several times a year. The lack of property damage associated with these flooding events may explain why this township only assigned a moderate severity to their stormwater problems. It was noted that streambank stabilization is not a problem in New Hanover Township; however, the road closures are the result of the streams overflowing their banks. Officials in Upper Frederick Township were one of two survey respondents to designate their stormwater problems as critical, yet property damage and road closures were reported at the same frequency as upstream municipalities. Obstructions in exiting systems there have created some of their flooding problems but in general, increased run-off is considered the major cause of flooding.

The conversion of farmland to residential development in these low-lying plains has increased both stormwater run-off during major precipitation events and the potential for property damage. The municipalities with the greatest flooding problems place the blame on an increase in upstream run-off. Upstream communities perceive little or no problem with stormwater. Officials in municipalities representing 95% of the watershed area are willing to participate in a planning process that will support a regional approach to stormwater management beneficial.

1. Proposed Solutions for Existing Drainage Problem Areas

The existing drainage problems within the Swamp Creek watershed can generally be included in the following categories: undersized stormwater conveyance systems, undersized bridges / culverts, roadways located in the floodplain / low areas in close proximity to streams, and poorly maintained drainageways. Commonly proposed solutions to these types of problems are listed below.

a. Undersized Stormwater Conveyance Systems

Conveyance systems should be designed according to the stormwater flows to be conveyed by the system. The stormwater flows could increase over time due to increased impervious areas or new conveyances within the drainage area that contribute stormwater flow to the conveyance system. To correct this type of drainage problem, the pipe sizes of the existing system should be analyzed to see if they carry the stormwater flows to the pipes. If the existing pipes are incapable of conveying the flows to the pipe, the existing pipe should be replaced with a new pipe of appropriate size. The number of inlets in the conveyance system should also be analyzed to determine if the system has an adequate number of inlets to capture the flow to the inlets. Additional inlets should be installed as necessary to capture the flows within the conveyance system drainage area. Typically, the owner of the conveyance system (i.e. municipality or private developer) would bear the cost of the analysis of the existing system, design of proposed system, and construction of proposed system.

b. Undersized Bridges/Culverts

Bridges and culverts should be designed to convey the stream and stormwater flows to these structures without causing a major obstruction to the flow. The flows could be conveyed through the structure or could alternatively be permitted to overtop the structure. To correct an undersized structure, a hydrologic and hydraulic analysis should be performed to determine the appropriate bridge / culvert size considering the stream and stormwater flows to the structure. Then the bridge / culvert could be replaced. Typically, the owner of the structure (i.e. municipality or private developer) would bear the cost of the hydrologic and hydraulic analysis, permitting, and construction of the proposed structure.

c. Roadways Located Within the Floodplain

The most obvious solutions to this type of problem are to move the roadway away from the stream or to increase the capacity of the adjacent stream to decrease the floodplain elevation. These solutions are often impractical due to costs associated with relocating roadways and stream impacts.

d. Poorly Maintained Drainageways

Sediment deposits and excessive vegetation are two common maintenance issues that decrease the conveyance capacity of storm sewers, bridges / culverts, swales, and streams. Maintenance, including the removal of the sediment and vegetation, could be performed to increase the capacity of a drainageway. Typically, the owner of the drainageway bears the maintenance cost.

2. Alternatives to Proposed Solutions

Alternatives to solutions listed above include regional detention facilities and non-structural alternatives such as stormwater, subdivision and land development, and zoning ordinances. Planned regional detention facilities can alleviate flooding impacts on downstream areas. Ordinances could be used to limit development and promote detention and infiltration. These practices can control flood elevation increases.

C. Existing and Proposed Stormwater Collection Systems and Their Impacts

Existing stormwater collection systems in most cases are located in the more urban portions of the watershed, such as Boyertown Borough, Bechtelsville Borough, and at the bottom of the watershed, near Schwenksville. They are also found more frequently in areas with more recent residential housing developments, such as Douglass Township and New Hanover Township, and along the watershed's more major roadways, including Route 100, Route 663, Route 73, Route 29, and Swamp Pike. Several of these conveyance systems were installed without specific stormwater management ordinance

requirements, and are therefore undersized, contributing to roadway flooding during storm events.

Stormwater collection systems are proposed for proposed land development projects. Due to the adoption of updated stormwater ordinances with conveyance system requirements in areas where development is occurring more frequently, proposed stormwater collection systems should have a more positive impact on stormwater conveyance and flooding than older existing systems. One issue that may be aggravated by proposed collection/conveyance systems with larger sizing is streambank erosion, as larger volumes of stormwater could be permitted to enter streams. However, these updated stormwater ordinances also include peak flow reduction requirements, which should act to slow the flow rate to streams.

D. Existing and Proposed Federal, State, and Local Flood Control Projects and Design Capacities

There are no known existing or proposed federal, state, or local flood control projects within the Swamp Creek watershed.

E. Existing Municipal Ordinance Provisions for Stormwater and Floodplain Management

The following municipal ordinances were obtained for the purpose of completing this report: Bechtelsville Borough, Colebrookdale Township, and Washington Township, all in Berks County; and Douglass Township, Lower Frederick Township, Lower Pottsgrove Township, New Hanover Township, and Upper Pottsgrove Township in Montgomery County. Each of these ordinances was adopted in 2004 or 2005. It appears that several of these ordinances are based on the DEP Municipal Separate Storm Sewer System (MS4) model ordinance. The MS4 program and permit falls under the National Pollution Discharge Elimination System program and permit that was established under the Clean Water Act. Municipalities that are considered to be "urbanized areas" according to census data are required to obtain a MS4 permit. The MS4 model ordinance was created for the use of MS4 municipalities to give them guidance in updating their stormwater ordinances, as required by their MS4 permit, to include the applicable MS4 requirements, including prohibited discharges from stormwater outfalls, erosion and sedimentation control requirements, post-construction stormwater management requirements, and sanctions to enforce these requirements.

Nearly all of the ordinances that were evaluated incorporate the MS4 requirements and include low impact development sections and an operations and maintenance agreement. Half of the ordinances have no peak flow reduction requirements, stormwater conveyance requirements, water quality requirements or infiltration requirements. Based on the requirements included in ordinances that were evaluated, and the dates of these ordinances, it appears that the majority of the land development that has occurred in the Swamp Creek watershed prior to the present time has occurred without peak flow reduction requirements, stormwater conveyance requirements, water quality

requirements, and infiltration requirements, resulting in various problems such as streambank erosion, undercut streambanks, poor water quality in streams, undersized conveyance systems, and lack of groundwater recharge.

Floodplain ordinances were not collected and evaluated for the purposes of this report.

SECTION IV – THE IMPACT OF FUTURE DEVELOPMENT

A. Projected Land Development Patterns and Potential Impacts on Runoff

1. Roadway Networks Leading To Potential Growth

The Swamp Creek watershed is crossed by several major roads, providing access to major employment/retail areas outside of the watershed. The headwaters area in Pike, Washington and District Townships is hilly, and most of the roads run along the Swamp Creek and its tributaries. Just below Bechtelsville, Route 100 crosses north/south through the watershed. Route 100 connects Pottstown and points south to the Allentown area. Route 663 parallels Route 100 to the east, and connects local employment and retail centers in Pottstown, East Greenville, Pennsburg, and Red Hill.

Three major roads travel East/West across the watershed. Hoffmansville Road, along the northern boundary, joins Route 73 in New Hanover Township. Route 73 connects with Route 29 in Zieglersville, providing access to Route 422 (the Pottstown Expressway) via Route 29. Route 422 connects eastward to King Of Prussia, providing access to the Pennsylvania Turnpike, Route 202, and the Schuylkill Expressway.

In the central portion of the watershed, Route 73 dips southwest, intersects Route 663, and then connects with Swamp Pike. This provides ample access to the central portion of the watershed, where the most rapid development in the watershed is occurring. Swamp Pike is a major East-West road, connecting the Boyertown area to Ridge Pike. Ridge Pike provides access to Routes 29 and 422.

The existing road network makes most of the watershed easily accessible. PADOT's 12-year program has several projects listed in this area. These road improvements should result in better, safer, more convenient access. Route 29 in the vicinity of Schwenksville is scheduled for resurfacing and shoulder work. The intersection of Route 73 and Swamp Pike is to be improved. The intersection of Route 663 and Swamp Pike will see a signal upgrade, new left turn lanes, and an extended culvert for drainage. Bridges over the Swamp Creek and its tributaries at Fagleysville Road, Colonial Road (Upper Frederick Township), and Wilson Avenue (Douglass Township) are scheduled for replacement. All of these projects are due to begin work within the next four years.

2. Types of Developments

Because the Swamp Creek watershed is accessible by major roads and because much of the area is rural, low density development, it has been attracting development for most of the 1990s. The majority of this development is residential, typically single family detached units. Scattered commercial and industrial development has occurred.

The residential development that has been proposed in the last decade is small-scale, most of the proposals are less than a dozen lots. There have been a handful of larger developments, 50 to 100 units each. Along with these, the watershed has seen a fair amount of frontage development, and subdivision of one or two small lots off of a large farm.

Future land use information, based on a 10-year build-out, was obtained from Berks County, Montgomery County, and from individual municipalities in the watershed. Figure 5 shows the future land use information for the watershed. According to this information, it appears that the development anticipated in the watershed over the next 10 years will occur primarily in the Berks County portion

Figure 5 Future Land Cover Map

Back of map

of the watershed, especially along Route 100. Significant residential development is anticipated to occur in Pike, Washington, and Colebrookdale Townships. Additionally, some commercial development is anticipated in Washington Township, and some commercial and industrial development is anticipated in Colebrookdale Township. Within the Montgomery County portion of the watershed, residential development is anticipated in New Hanover, Upper Frederick, and Lower Frederick Townships. Commercial development is anticipated along Route 100 in Douglass Township.

The potential impacts of these developments include increased stormwater runoff volumes due to an increase in impervious area and compacted grass / landscaped areas, and increased runoff velocities. Declining water quality could also result due to sediment from development and pollutants from impervious areas running into drainage systems and then into streams. It should be noted that the majority of the proposed development is located in the upper portions of the watershed; therefore, impacts to the stream will occur through all downstream portions of the watershed. Section VI discusses increases in stormwater runoff rates that are projected to result without the incorporation of peak flow reduction requirements into stormwater management ordinances. The Swamp Creek Model Stormwater Management Ordinance, also discussed in Section VI, includes stormwater requirements that should lessen these potential impacts of development.

B. Areas to Be Served By Stormwater Collection and Control Facilities

It is anticipated that new stormwater collection and control facilities will be installed in the watershed over the next 10 years, especially in areas where development is projected to occur, as discussed above. The design of these facilities will be governed by the applicable municipal stormwater management ordinance that is in place at the time when the proposed development is in its planning stages. The timing related to installation of these facilities will be dependent upon factors such as plan approval by the local municipality and the ability of the developer to fund the development. The costs of these facilities will be borne by private developers in most cases. The operation and maintenance of these facilities will most likely be the responsibility of the private property owner or potentially a homeowner's association. The Swamp Creek Model Stormwater Management Ordinance includes a sample Operations and Maintenance Agreement. The use of this agreement by municipalities is encouraged to ensure that stormwater facilities are properly maintained by the private property owners.

C. Present and Projected Development in Flood Hazard Areas

According to the existing land cover map, most of the flood hazard areas are located in areas designated as woodland, open space, and agricultural. One may conclude from this information that up until this point, there has not been much development in flood hazard areas. The future land cover map indicates that there is some anticipated development within floodplain areas. Most of this development is anticipated residential development

within Washington and Colebrookdale Townships. Some commercial development is anticipated within the floodplain in Douglass Township, Montgomery County.

Development in floodplain areas should be addressed by DEP and NFIP regulations.

SECTION V – CONTROL TECHNIQUES – CONSIDERING PRECIPITATION AS A RESOURCE

Stormwater quality has become a municipal issue. The new NPDES permitting program and other water-quality related programs (such as source water area protection program or the TMDL program) look at reducing pollutants in stormwater discharges. Stormwater quality is no longer just an environmental or ecological concern. Sediment in stormwater reduces the ability of the stream to convey stormwater, increasing flooding. Other pollutants in streams that supply drinking water to communities increase the cost of treatment, and the higher cost is passed along to residents and businesses. Basins and other stormwater facilities can be designed for more than just volume and rate control. With a little forethought and an understanding of the available alternatives, stormwater facilities can help meet municipal water quality goals. The discussion that follows is an introduction to the alternatives and considerations pertaining to various stormwater control techniques. The *Pennsylvania Stormwater Best Management Practices Manual*, latest edition, should be consulted for more detailed information.

A. An Assessment of Alternative Runoff Control Techniques and Their Efficiency in the Swamp Creek Watershed

Alternative runoff control techniques, most often referred to as stormwater Best Management Practices (BMPs), provide municipalities and developers with many tools for controlling and cleaning runoff, and restoring site hydrology. Selecting the most appropriate BMP can be difficult, for two main reasons. First, there are factors specific to each site that affect the performance of BMPs, most notably, soil type. Second, different BMPs achieve different goals. As goals or priorities pertaining to a particular site development change, the "right" BMP to achieve the goal may change too. The good news is that most often the use of BMPs are not an "either or" situation, but a "both and" opportunity. Several BMPs can be employed on a site, dispersed across the area or linked together. Combining the BMPs achieves multiple goals. For example, individual infiltration facilities, or rain gardens, can be installed on each lot to infiltrate roof runoff, while runoff from the roads, driveways, and other hard surfaces could be directed to a sediment forebay and naturalized storm basin.

The soils found on a particular site greatly influence the effectiveness of stormwater BMPs, in particular infiltration. Shallow bedrock and high water table may also affect the use of deep-rooted vegetation for naturalization. As mentioned earlier, the soils in the watershed can be grouped into 5 associations. The following generalized comments should be considered when considering BMPs for projects in certain soils groupings.

- *Abbottstown-Readington-Croton Association:* These are soils within the hydrologic soils group C or D. It may be possible to find specific sites within these soils that are suitable for infiltration. However, the seasonal high water table and the slow to moderately slow permeability of the subsoil may hinder efforts to infiltrate stormwater at rates greater than what is occurring on the site naturally.

- *Lehigh-Brecknock-Croton Association:* The Brecknock soils belong to Hydrologic group B, and are among the best soils in the watershed for infiltration. The Lehigh and Croton soils are from groups C and D, respectively. The soils in this association are found along the ridges and hills in the watershed. On the tops of the ridges, the slopes are not as steep. Siting BMPs on the slopes on the sides of the ridges may require additional planning and engineering.
- *Neshaminy-Mount Lucas-Watchung Association*: These are soils from hydrologic soils groupings C and D. Infiltration basins and other similar stormwater BMPs could be appropriate for these soils; site soil testing should be conducted to confirm this. Large stones and boulders, steep slopes, and shallow bedrock may make infiltration and the use of trees for naturalization difficult.
- *Reaville-Penn-Klinesville Association:* These are also soils from the C and D soils group, so soils testing will be necessary to determine the feasibility of BMPs. However, stormwater BMPs will be feasible for these soils in most areas. Again, site soil testing should be conducted to confirm this on individual sites.
- *Rowland-Birdsboro-Raritan Association:* The Rowland and Raritan soils belong to soils group C, while the Birdsboro soils are classified as B soils. Because of the potential for flooding, these soils are less likely to be feasible for infiltration BMPs. However, specific development sites may employ BMPs that preserve and enhance riparian vegetation, and there may be limited areas where BMPs can be used.

1. Applicability in the Swamp Creek Watershed

The upper reach of the Swamp Creek watershed has hills and some steeply sloping areas, while the lower end is shaped like a broad, shallow bowl. As shown on the soils map contained in Section 2, there are significant areas of soils from hydrologic soils grouping D. These conditions generally represent constraints to the use of BMPs. They may not completely preclude the use of BMPs, but rather, may require additional engineering and site work to employ the appropriate BMPs. For example, a development site may have areas of steep slope or shallow bedrock, making it difficult to find a location for a large stormwater basin. If individual infiltration facilities (rain gardens) are installed on each lot, the total amount of stormwater leaving the building lots will be reduced and a smaller basin will be needed. Also, several smaller basins could be used around the site, instead of one large basin. Flexibility and consideration of the broad range of stormwater alternatives will help find the best fit between site constraints and stormwater goals.

The soils in Hydrologic Group D are unlikely to infiltrate stormwater at a greater rate than is occurring naturally before development. However, various techniques, such as minimizing impervious surfaces and using numerous, small scale stormwater facilities, can be used to mimic predevelopment hydrology and reduce the impacts of development. Infiltration facilities should be employed in developments located on the B and C soils.

Once the soils, slopes, bedrock, and other considerations are taken into account, specific stormwater BMPs can be employed to achieve various goals. The following discussion of alternatives should assist in choosing the right BMPs to achieve the goals determined. It is important to remember that more than one BMP can be used on the site, and that several BMPs can be used together for greater effectiveness.

B. Introduction to BMPs Alternatives:

1. Naturalized Basins:

Naturalized basins are stormwater control facilities that are planted with native vegetation rather than maintained as mown lawn. Both dry basins, which drain completely between storms, and wet basins, which contain a permanent pool, can be designed as naturalized basins to address stormwater quality. The stems and leaves of the native plants and the organic layer that develops at the soil surface help filter stormwater. The plants may also take up certain pollutants, such as excess fertilizer, removing them before the stormwater is discharged to a creek. As additional benefits, the native plants encourage infiltration of stormwater, are attractive, and provide food for birds and other desirable animals.

Designing naturalized basins benefits the municipality, residents and the environment. If the basins are owned by the municipality, maintenance costs will be reduced once the vegetation is established and mowing is no longer necessary. Sediments and nutrients are removed by the vegetation before the stormwater reaches a stream, maintaining the stream function of conveying flood flows and supporting fish and wildlife. The vegetation selected can greatly increase the aesthetic appeal of a basin, providing color in all seasons and attracting birds and butterflies to the area.

2. Bioretention:

Bioretention islands are landscaping features adapted to treat stormwater runoff. They are most frequently located within parking lot islands but can also be incorporated into cul-de-sacs and small pocket gardens in residential land uses. Most municipalities require some type of planted island to break up parking lots. The bioretention island can be used instead of raised planters. The bioretention island is designed as a depression that collects and filters the first ½ inch of rainfall off paved surfaces. The paved areas are designed to direct surface runoff into the vegetated areas, which then absorb the stormwater and filter pollutants from the runoff. Often, the filtered runoff is collected in a perforated pipe under the island and discharged to the storm sewer system. In larger storm events, excess runoff is diverted past the island to a storm drain.

Bioretention islands are typically used for stormwater management in small drainage areas, such as a small parking lot, or an individual residential property. Numerous bioretention facilities could be used in larger paved areas if the grading divides the large area into smaller areas, each draining to a bioretention facility. Even existing parking lot landscape islands can be retrofitted to incorporate bioretention. They are quite versatile in that they can be employed in almost any soil condition, although the soil in which the vegetation is planted may need to be amended with sand to improve infiltration. Since the main function of these facilities is to improve stormwater quality, they should be used in conjunction with other stormwater facilities to address volume and rate of runoff.

To enhance pollutant removal, the bioretention island should be sized to be between 5% and 10% of the impervious area draining to it. The underlying planting bed should be designed as a sand/soil mix with a mulch layer above the soil. The surface of a bioretention area is usually planned so that it ponds a small depth of water (6-9 inches) above the filter bed. And some bioretention islands also are designed to help spread flows evenly and settle out large particles.

3. Porous Pavement:

Porous pavement is a permeable pavement surface with a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating it into the subsoil. Runoff is thereby infiltrated directly into the soil and receives some water quality treatment. Porous pavement is similar in appearance to traditional asphalt or concrete but is manufactured without "fine" materials, and instead incorporates void spaces that allow for infiltration.

The impervious surfaces in development increase runoff volumes and decrease infiltration that recharges groundwater. Often, the traditional stormwater facilities used to control this increased stormwater volume have no provision for groundwater recharge. As infiltration decreases, base flows in streams are decreased and previously flowing, small streams often dry up between rains. Some homeowners and public water suppliers rely on groundwater sources. With reduced infiltration and recharge, these drinking water supplies are reduced, sometimes significantly.

The ideal location for porous pavement is in low traffic or overflow parking areas. In extremely dense urban areas porous pavement has been used successfully in redevelopment projects, because it treats and stores stormwater without consuming extra land. Porous pavement can also be incorporated into developed sites where a parking lot is being resurfaced. Porous pavement should be avoided where activities generate highly contaminated runoff. Areas of low soil permeability, seasonal high groundwater tables, and areas close to drinking water supply wells should also be avoided. Wherever it is used, maintenance of porous pavement is critical to its performance. The overall maintenance goal for porous pavement is to prevent clogging of the void spaces within the surface material.

The surface of porous pavements must not be sealed or repaved with non-porous materials if it is to continue to function. Porous pavement is not suitable for areas where sand and salt are applied often or heavily. Periodic vacuuming of debris will be required to ensure the void spaces do not clog.

4. Wet Pond:

Also called extended detention ponds, these facilities are basins that have a permanent pool of water throughout the year. The wet pond is constructed with additional capacity to store runoff during and after storms. Wet ponds treat and filter stormwater runoff through settling and through nutrient uptake by plants and other aquatic organisms.

Stormwater basins are one of the most common methods chosen by engineers and developers to handle stormwater runoff generated from land development activities. Wet ponds control stormwater volume and rate of discharge, and also provide water quality benefits dry basins can not offer. The ability of a wet pond to store runoff for longer time periods decreases stormwater peak flows. The longer detention times can reduce stream channel erosion, a common result of traditional stormwater practices.

Wet ponds may be inappropriate in dense urban areas due to their space requirements. Most experts agree that in order to maintain a permanent water elevation within the pond, they should only be used for sites with drainage areas greater than 5 acres. Wet ponds have regulatory limitations to where they can be placed. For example, they should not be located within wetlands. Many wet ponds have been designed as an aesthetic site amenity, to create wildlife habitat or as a development focal point or recreational area. The results of one study suggest that "pond front" property can increase the selling price of a new property by 10% (EPA, 1995). Another study found that the perceived value (value estimated by residents of a community) of homes increased by about 15-25% when located near a wet pond (Emmerling-Dinovo, 1995).

5. Retrofitted Basin:

Most of the alternatives listed here are applicable to new development. The retrofitted basin, however, applies to existing stormwater facilities. A stormwater basin retrofit usually involves the modification of an existing basin's outlet structure. Stormwater basins typically contain large outlet pipes. These basins are designed to temporarily store and re-route runoff from large storms. Their primary purpose is to help control floods. Retrofitted basins still provide flood control protection, but through structural modifications that can also provide water quality and erosion control benefits.

Instead of just one outlet hole, retrofitted basins usually have two or more, of varying sizes. The additional holes can be added to an existing outlet structure or

through the construction of a low wall inside the basin. The use of weirs with v-notches, and special attachments to outlet structures can also be used to retrofit a stormwater basin. These modifications are meant to manage the smaller more frequent storms. Recent studies in stormwater management have shown that the smaller, more frequent storms typical to this region degrade water quality and increase streambank erosion. By slowing the velocity of the stormwater discharged, the retrofitted basin helps reduce erosion in the receiving stream. Reduced localized flooding can result from a retrofitted basin's ability to detain small storms for longer periods of time.

6. Riparian Buffers:

Also called a forested buffer, this is a buffer area preserved along the stream, including the streambank and all or part of the floodplain area. In nature these areas typically are forested, and as part of a development site they are usually planted as a meadow or woodland.

Riparian buffers provide numerous environmental and recreational benefits to streams, groundwater and downstream land areas. All landowners (individuals, businesses and municipalities) should make every effort to preserve riparian buffers and improve them by planting native vegetation. The existing stream corridor can be protected when development is proposed through ordinance requirements or through easement agreements.

7. Vegetated Swales:

Vegetated swales are constructed open-channel drainageways used to convey stormwater runoff. Vegetated swales are often used as an alternative to, or an enhancement of, traditional storm drains and pipes. They do not pond water for a long period of time or provide significant infiltration. Vegetated swales generally have a trapezoidal or parabolic shape with relatively flat side slopes. Individual vegetated swales generally treat small drainage areas (five acres or less).

Vegetation in swales allows for filtering of pollutants, and infiltration of runoff into groundwater. Densely vegetated swales can be designed to add visual interest to a site or to screen unsightly views. Broad swales on flat slopes with dense vegetation are the most effective at reducing the volume of runoff and pollutant removal. They should not be used in steep slope areas.

8. Sediment Forebay:

A sediment forebay is a small pool located near the inlet of a wet pond other stormwater management facility designed as an initial storage area to trap and settle out sediment and heavy pollutants before they reach the main basin. These facilities provide pretreatment of stormwater and can greatly reduce overall maintenance requirements. An earth berm, gabion wall, or other barrier near the inlet can be used to cause stormwater to pool temporarily. Forebays make basin

maintenance easier and less costly by trapping sediment in one small area where it is easily removed, and preventing sediment buildup in the rest of the facility.

These are the alternatives commonly used to control and treat stormwater. Variations of these alternatives and other stormwater BMPs can be used, depending on the conditions on-site and the goals of the stormwater management plan. More information on stormwater BMPs, including design criteria, can be found on the DEP website and in the *Pennsylvania Stormwater Best Management Practices Manual*, latest edition.

SECTION VI – STORMWATER CONTROL STANDARDS

A. Watershed Modeling Approach and Analysis

A decision that was evaluated early in the process of the development of the Stormwater Management Plan for Swamp Creek was which runoff simulation model should be utilized to accurately describe the Swamp Creek watershed. The need for the following model capabilities was considered in making this decision:

- Able to model design storms of various durations and frequencies to produce routed hydrographs that can be combined.
- Adaptable to the size of subwatersheds in this study.
- Capable of evaluating specific physical characteristics of the rainfall-runoff process.

After comparing available models, it was decided that the STREMTUL "front end" for the SCS TR20 hydrology program would be utilized to model the Swamp Creek watershed. Stremtul is a TR-20 based computer model developed by the Lancaster County Engineer's Office, with provisions for modeling infiltration volumes and multiple release rates. The STREMTUL model was chosen for the following reasons:

- The model was developed specifically to satisfy the requirements of the Pennsylvania Act 167 legislation, for which stream flows are the prime consideration.
- The program is designed to study large watersheds that have been broken up into smaller watersheds.
- Subarea parameters may be changed with relative ease using the STREMTUL program.
- STEMTUL provides the results of any combination of release rates.
- The program allows the user to easily move between existing and future parameters and results.

B. Model Development and Data Preparation

The Swamp Creek watershed was delineated using U.S.G.S. topography. The watershed was then further divided into 51 subwatersheds. The subwatershed information is presented on Figure 1. Problem areas identified by municpalities in the watershed, tributary confluences, and structures were factors in delineating the subwatersheds. The most downstream point of each of the subwatersheds was considered a "point of interest", where existing and future flows were determined and compared, and increased runoff was analyzed for its potential impact.

The purpose of choosing these subwatersheds and calculating existing and future flows for each subwatershed was to evaluate various future conditions release rates for the Swamp Creek watershed by controlling the stormwater runoff in each subarea. Recommended release rates were then incorporated into the Swamp Creek Watershed Model Stormwater Management Ordinance.

Other input to the STREMTUL model included time of concentration values and CN values. Time of concentration values were determined using SCS methodology. CN values were determined by using Berks and Montgomery County land use data and soils data, overlaying this information with the subwatershed area map. This information, along with information compiled during field visits to the watershed, was then used for STREMTUL input.

The resulting watershed model addressed the following:

- Peak discharges at the points of interest of each of the 51 subwatersheds.
- Time to peak for the above discharges.
- Runoff contributions of individual subareas at all downstream locations.
- Overall watershed timing.

Stremtul was used to model the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events for the purpose of comparing existing and future flows and then making recommendations regarding appropriate stormwater management practices to prevent future stormwater problems in the watershed.

C. Model Calibration

To assure that the model results are accurate and reliable, the model should be compared with field observations or recorded streamflows. Ideally, there would be records of streamflow and rainfall data for various locations within the watershed that would allow one to run the model using the rainfall and compare the model flows with the recorded streamflows for the same storm event. There are no known United States Geological Survey (USGS) stream gages within the Swamp Creek watershed. The Philadelphia Suburban Water Company and the Philadelphia Water Department were also contacted concerning availability of streamflow or flooding data. Neither agency has this information.

In the absence of recorded streamflow information, the existing conditions model results were compared with flows from FEMA Flood Insurance Studies, and flows calculated using PSU IV and estimated using stream gage data for a USGS gage along the Perkiomen Creek in Graterford and a USGS regional exponent. Flows from these various sources are shown in the table below.

Table 3
Comparison of Stremtul 100-Year Flow
With Other Calculated 100-Year Flows

Location	*100-Year Flow (cfs)*			
	Stremtul	***FEMA***	***PSU IV****	***Stream Gage Estimate*** **
Middle Creek *at confluence with Swamp Creek*	3,240	3,840	2,926	1,995
Minister Creek *at confluence with Swamp Creek*	5,374	5,940	4,353	3,057
West Branch Swamp Creek *at confluence with Swamp Creek*	1,964	2,440	2,002	1,396
Scioto Creek *at confluence with Swamp Creek*	3,933	2,200	3,014	1,982
Goshenhoppen Creek *at confluence with Swamp Creek*	3,296	1,700	2,055	1,335
Swamp Creek *at confluence with Perkiomen Creek*	15,451	13,150	11,789	11,635

* *The PSU IV calculations were completed without the urbanized area adjustment. Applying this adjustment results in flows that are closer to the Stremtul flows(for example, the adjusted Swamp Creek flow is 15,679 cfs, which is close to the Stremtul flow of 15,451 cfs)*

** *The following equation was utilized to obtain the stream gage estimate:* $Q=Q_{gage}*(DA_{location}/DA_{gage})^{(USGS\ regional\ exponent)}$, *where Q=flow and DA=drainage area. The gage flow is based on the maximum instantaneous peak flow for the Perkiomen Creek at Graterford, which is 35,800 cfs and occurred on June 22, 1972 according to Water Resource Data, Pennsylvania Water Year 1991. The USGS regional exponent for this area is 0.7.*

The flows generated using the Stremtul model are generally higher than the FEMA, PSU IV, and stream gage estimated flows. However, the flows are relatively close, suggesting that the model results have some level of accuracy. The higher Stremtul flows could reflect increased urbanization. Whereas the main purpose of the analysis is to not increase flows, the actual total flow carries less importance. If the flows are utilized for design, they will be conservatively high.

D. Model Results and Implications

Future flows were evaluated based on projected 10-year land use data, which was provided by Montgomery County, Berks County, and the municipalities. The County chose to evaluate flows based on a 10-year projection instead of an ultimate build-out scenario, anticipating that the required future watershed reevaluations can be utilized to provide stormwater management options for additional development. Future CN values were developed using soils information and the projected 10-year land use information, and input into the future conditions model. The resulting existing and future 100-year flows for the Swamp Creek watershed were determined to be 15, 451 cubic feet per second (cfs) and 15,860 cfs, respectively, a change in flow of less than 3% (although changes in flow in individual subareas were as great as 10%).

To address future increased runoff as a result of development, various release rate scenarios were applied to future conditions. The release rates restricted subarea peak flow rates to rates less than or equal to existing conditions. When a release rate is specified for a particular subarea in the Stremtul program, the entire existing flow of the subarea is reduced according to that release rate, regardless of how much of the actual land use is changing. It is therefore inappropriate to apply a release rate to an entire subarea when there is only a small area of development within a subarea. To accommodate this fact, release rates were only applied to subareas that had a change in CN of 2 or more between existing and future conditions. The subareas without a change of at least 2 were kept at existing conditions so that they did not cause undetained flow increases. Setting the threshold at 2 (change in CN value of at least 2 between existing and future conditions) resulted in 10 subareas that were considered to include future development (mostly along Route 100 or in areas just downstream of Route 100). Release rates were analyzed as follows: 0% reduction (post development flow equals predevelopment flow), 10% reduction (90% of predevelopment peak flow), 20% reduction, 30% reduction, 40% reduction, and 50% reduction. The results showed increases in flow of greater than 5% at multiple subareas, with the exception of the 50% reduction scenario, where only subarea 1-14's future flow was 6% greater than the existing flow. The 50% reduction scenario was the one that had the greatest reduction of flows along the main stem, which is where many of the problem areas and predicted increases in flow due to development are located.

ARRO is recommending a 50% release rate for the entire watershed, based on the modeling results described above. To verify the appropriateness of this recommendation, the future conditions model was run with one fully developed subarea added for each run, with a 50% reduction applied for the subarea. Subareas 1-3, 3-2, and 1-25 were chosen as representative of the various spacial locations throughout the watershed, also representing different runoff travel times. To represent a fully developed subarea, the future condition CN value was increased by 10, which was considered to be representative of a typical increase over existing conditions. Adding an additional "developed" subarea resulted in further flow reductions along the main stem of the stream.

The future conditions model was also run for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events assuming that the first 2.4" of rain would be infiltrated. This infiltrated value was determined based on a typical development scenario using current infiltration requirements for NPDES Phase II permits for construction activities, where the difference in the 2-year pre-development and 2-year post-development flows must be infiltrated. The infiltration was applied by the Stremtul model at any subarea that was determined to be "developed" based on the CN value and display threshold (in this case, a subarea was "developed" when the change in CN value was greater than or equal to 2). Using a release rate of 50% and 2.4" of infiltration resulted in watershed flows that were less than existing conditions flows.

The tables below list the existing peak flow, future peak flow, future peak flow with 50% reduction, and future peak flow with 50% reduction and infiltration for each subarea for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events.

Table 4
Swamp Creek Watershed Model Results: 2-Year Storm Event

subarea	*existing peak (cfs)*	*future peak (cfs)*	*future peak with 50% reduction (cfs)*	*future peak with 50% reduction and 2.4" infiltration (cfs)*
1-1	202.0	202.0	202.0	202.0
1-2	83.0	83.0	83.0	83.0
1-3	175.0	175.0	175.0	175.0
1-4	300.0	300.0	300.0	300.0
1-5	561.0	561.0	561.0	561.0
1-6	366.0	500.0	183.0	122.0
1-7	657.0	687.0	639.0	554.0
1-8	669.0	969.0	335.0	234.0
1-9	1,160.0	1,365.0	1,139.0	558.0
2-1	384.0	446.0	192.0	150.0
2-2	360.0	360.0	360.0	360.0
2-3	917.0	936.0	912.0	856.0
2-4	933.0	949.0	922.0	874.0
3-1	942.0	942.0	942.0	942.0
3-2	484.0	484.0	484.0	484.0
3-3	2,360.0	2,560.0	2,212.0	1,941.0
4-1	607.0	718.0	374.0	139.0
4-2	759.0	759.0	759.0	759.0
4-3	725.0	814.0	511.0	363.0
4-4	1,315.0	1,376.0	1,205.0	1,100.0
4-5	570.0	570.0	570.0	570.0
4-6	409.0	409.0	409.0	409.0
4-7	1,169.0	1,225.0	1,105.0	909.0
4-8	1,471.0	1,510.0	1,420.0	1,305.0
5-1	669.0	669.0	669.0	669.0
5-2	1,117.0	1,117.0	1,117.0	1,117.0
5-3	1,231.0	1,231.0	1,231.0	1,231.0
6-1	502.0	502.0	502.0	502.0
6-2	786.0	786.0	786.0	786.0
1-10	1,440.0	1,726.0	1,341.0	649.0
1-11	361.0	466.0	181.0	89.0
1-12	1,346.0	1,589.0	1,338.0	623.0
1-13	494.0	597.0	247.0	123.0
1-14	1,381.0	1,620.0	1,497.0	726.0
1-15	2,397.0	2,595.0	2,250.0	1,992.0
1-16	2,213.0	2,399.0	2,175.0	1,728.0
1-17	418.0	418.0	418.0	418.0
1-18	2,218.0	2,395.0	2,202.0	1,758.0
1-19	307.0	307.0	307.0	307.0
1-20	2,247.0	2,423.0	2,228.0	1,792.0

subarea	***existing peak (cfs)***	***future peak (cfs)***	***future peak with 50% reduction (cfs)***	***future peak with 50% reduction and 2.4" infiltration (cfs)***
1-21	3,202.0	3,377.0	3,191.0	2,885.0
1-22	353.0	353.0	353.0	353.0
1-23	445.0	445.0	445.0	445.0
1-24	3,501.0	3,550.0	3,463.0	3,353.0
1-25	3,225.0	3,398.0	3,213.0	2,960.0
1-26	433.0	433.0	433.0	433.0
1-27	3,652.0	3,694.0	3,622.0	3,535.0
1-28	287.0	287.0	287.0	287.0
1-29	3,730.0	3,773.0	3,699.0	3,603.0
1-30	4,321.0	4,338.0	4,320.0	4,282.0
1-31	4,601.0	4,619.0	4,652.0	4,571.0

greater than 5% increase in flow from existing condition

Table 5
Swamp Creek Watershed Model Results: 5-Year Storm Event

subarea	*existing peak (cfs)*	*future peak (cfs)*	*future peak with 50% reduction (cfs)*	*future peak with 50% reduction and 2.4" infiltration (cfs)*
1-1	535.0	535.0	535.0	535.0
1-2	219.0	219.0	219.0	219.0
1-3	421.0	421.0	421.0	421.0
1-4	643.0	643.0	643.0	643.0
1-5	1,313.0	1,313.0	1,313.0	1,313.0
1-6	742.0	931.0	371.0	371.0
1-7	1,534.0	1,599.0	1,472.0	1,456.0
1-8	1,246.0	1,613.0	623.0	623.0
1-9	1,978.0	2,218.0	2,048.0	1,710.0
2-1	717.0	799.0	359.0	359.0
2-2	614.0	614.0	614.0	614.0
2-3	1,461.0	1,495.0	1,415.0	1,287.0
2-4	1,390.0	1,422.0	1,337.0	1,239.0
3-1	1,578.0	1,578.0	1,578.0	1,578.0
3-2	958.0	958.0	958.0	958.0
3-3	4,161.0	4,264.0	3,754.0	3,335.0
4-1	924.0	1,056.0	608.0	580.0
4-2	1,277.0	1,277.0	1,277.0	1,277.0
4-3	1,081.0	1,172.0	838.0	629.0
4-4	2,039.0	2,097.0	1,908.0	1,726.0
4-5	963.0	963.0	963.0	963.0
4-6	671.0	671.0	671.0	671.0
4-7	2,062.0	2,154.0	1,926.0	1,594.0
4-8	2,397.0	2,462.0	2,298.0	2,090.0
5-1	1,109.0	1,109.0	1,109.0	1,109.0
5-2	1,719.0	1,719.0	1,719.0	1,719.0
5-3	1,876.0	1,876.0	1,876.0	1,876.0
6-1	841.0	841.0	841.0	841.0
6-2	1,398.0	1,398.0	1,398.0	1,398.0
1-10	2,382.0	2,622.0	2,344.0	2,085.0
1-11	625.0	746.0	313.0	313.0
1-12	2,297.0	2,539.0	2,406.0	1,964.0
1-13	795.0	919.0	398.0	398.0
1-14	2,426.0	2,575.0	2,556.0	1,979.0
1-15	4,222.0	4,324.0	3,807.0	3,412.0
1-16	3,936.0	4,056.0	3,726.0	3,215.0
1-17	673.0	673.0	673.0	673.0
1-18	3,895.0	3,996.0	3,765.0	3,264.0
1-19	512.0	512.0	512.0	512.0
1-20	3,937.0	4,035.0	3,802.0	3,305.0

subarea	***existing peak (cfs)***	***future peak (cfs)***	***future peak with 50% reduction (cfs)***	***future peak with 50% reduction and 2.4" infiltration (cfs)***
1-21	5,440.0	5,585.0	5,218.0	4,684.0
1-22	748.0	748.0	748.0	748.0
1-23	824.0	824.0	824.0	824.0
1-24	5,769.0	5,895.0	5,654.0	5,429.0
1-25	5,465.0	5,610.0	5,246.0	4,728.0
1-26	787.0	787.0	787.0	787.0
1-27	5,935.0	6,012.0	5,853.0	5,668.0
1-28	567.0	567.0	567.0	567.0
1-29	6,063.0	6,151.0	5,951.0	5,753.0
1-30	6,897.0	6,807.0	6,881.0	6,807.0
1-31	7,282.0	7,132.0	7,294.0	7,211.0

greater than 5% increase in flow from existing condition

Table 6
Swamp Creek Watershed Model Results: 10-Year Storm Event

subarea	*existing peak (cfs)*	*future peak (cfs)*	*future peak with 50% reduction (cfs)*	*future peak with 50% reduction and 2.4" infiltration (cfs)*
1-1	880.0	880.0	880.0	880.0
1-2	357.0	357.0	357.0	357.0
1-3	668.0	668.0	668.0	668.0
1-4	1,018.0	1,018.0	1,018.0	1,018.0
1-5	2,123.0	2,123.0	2,123.0	2,123.0
1-6	1,094.0	1,319.0	547.0	547.0
1-7	2,417.0	2,486.0	2,350.0	2,351.0
1-8	1,764.0	2,162.0	882.0	882.0
1-9	2,853.0	3,150.0	2,946.0	2,531.0
2-1	1,015.0	1,110.0	508.0	508.0
2-2	835.0	835.0	835.0	835.0
2-3	1,854.0	1,887.0	1,935.0	1,677.0
2-4	1,776.0	1,816.0	1,752.0	1,556.0
3-1	2,144.0	2,144.0	2,144.0	2,144.0
3-2	1,343.0	1,343.0	1,343.0	1,343.0
3-3	5,512.0	5,799.0	5,093.0	4,796.0
4-1	1,194.0	1,354.0	804.0	784.0
4-2	1,722.0	1,722.0	1,722.0	1,722.0
4-3	1,360.0	1,478.0	1,087.0	842.0
4-4	2,670.0	2,745.0	2,487.0	2,245.0
4-5	1,297.0	1,297.0	1,297.0	1,297.0
4-6	893.0	893.0	893.0	893.0
4-7	2,831.0	2,934.0	2,652.0	2,333.0
4-8	3,165.0	3,244.0	3,028.0	2,788.0
5-1	1,492.0	1,492.0	1,492.0	1,492.0
5-2	2,257.0	2,257.0	2,257.0	2,257.0
5-3	2,459.0	2,459.0	2,459.0	2,459.0
6-1	1,127.0	1,127.0	1,127.0	1,127.0
6-2	1,921.0	1,921.0	1,921.0	1,921.0
1-10	3,263.0	3,647.0	3,280.0	3,062.0
1-11	851.0	992.0	426.0	426.0
1-12	3,124.0	3,505.0	3,342.0	2,978.0
1-13	1,055.0	1,179.0	528.0	528.0
1-14	3,094.0	3,469.0	3,339.0	2,897.0
1-15	5,606.0	5,890.0	5,199.0	4,901.0
1-16	5,205.0	5,556.0	4,857.0	4,615.0
1-17	894.0	894.0	894.0	894.0
1-18	5,039.0	5,356.0	4,848.0	4,574.0
1-19	677.0	677.0	677.0	677.0
1-20	5,088.0	5,405.0	4,893.0	4,622.0

subarea	*existing peak (cfs)*	*future peak (cfs)*	*future peak with 50% reduction (cfs)*	*future peak with 50% reduction and 2.4" infiltration (cfs)*
1-21	7,157.0	7,366.0	7,071.0	6,680.0
1-22	1,077.0	1,077.0	1,077.0	1,077.0
1-23	1,123.0	1,123.0	1,123.0	1,123.0
1-24	7,802.0	7,999.0	7,791.0	7,425.0
1-25	7,188.0	7,409.0	7,103.0	6,703.0
1-26	1,114.0	1,114.0	1,114.0	1,114.0
1-27	7,952.0	8,129.0	7,943.0	7,618.0
1-28	824.0	824.0	824.0	824.0
1-29	8,086.0	8,258.0	8,066.0	7,746.0
1-30	9,052.0	9,106.0	9,063.0	8,943.0
1-31	9,492.0	9,543.0	9,518.0	9,406.0

greater than 5% increase in flow from existing condition

Table 7
Swamp Creek Watershed Model Results: 25-Year Storm Event

subarea	*existing peak (cfs)*	*future peak (cfs)*	*future peak with 50% reduction (cfs)*	*future peak with 50% reduction and 2.4" infiltration (cfs)*
1-1	1,217.0	1,217.0	1,217.0	1,217.0
1-2	494.0	494.0	494.0	494.0
1-3	907.0	907.0	907.0	907.0
1-4	1,399.0	1,399.0	1,399.0	1,399.0
1-5	2,834.0	2,834.0	2,834.0	2,834.0
1-6	1,434.0	1,655.0	717.0	717.0
1-7	3,095.0	3,137.0	3,123.0	3,123.0
1-8	2,214.0	2,697.0	1,107.0	1,107.0
1-9	3,659.0	3,985.0	3,682.0	3,347.0
2-1	1,292.0	1,397.0	646.0	646.0
2-2	1,032.0	1,032.0	1,032.0	1,032.0
2-3	2,340.0	2,382.0	2,453.0	2,148.0
2-4	2,236.0	2,290.0	2,207.0	1,955.0
3-1	2,640.0	2,640.0	2,640.0	2,640.0
3-2	1,727.0	1,727.0	1,727.0	1,727.0
3-3	7,067.0	7,149.0	6,465.0	6,133.0
4-1	1,451.0	1,603.0	983.0	967.0
4-2	2,130.0	2,130.0	2,130.0	2,130.0
4-3	1,621.0	1,716.0	1,296.0	1,033.0
4-4	3,279.0	3,336.0	3,063.0	2,755.0
4-5	1,595.0	1,595.0	1,595.0	1,595.0
4-6	1,093.0	1,093.0	1,093.0	1,093.0
4-7	3,534.0	3,624.0	3,309.0	2,975.0
4-8	3,881.0	3,954.0	3,713.0	3,449.0
5-1	1,838.0	1,838.0	1,838.0	1,838.0
5-2	2,685.0	2,685.0	2,685.0	2,685.0
5-3	2,907.0	2,907.0	2,907.0	2,907.0
6-1	1,386.0	1,386.0	1,386.0	1,386.0
6-2	2,386.0	2,386.0	2,386.0	2,386.0
1-10	4,233.0	4,548.0	4,181.0	4,046.0
1-11	1,057.0	1,205.0	529.0	529.0
1-12	4,077.0	4,369.0	4,278.0	3,922.0
1-13	1,276.0	1,422.0	638.0	638.0
1-14	4,028.0	4,250.0	4,212.0	3,681.0
1-15	7,188.0	7,270.0	6,592.0	6,261.0
1-16	6,687.0	6,795.0	5,961.0	5,640.0
1-17	1,081.0	1,081.0	1,081.0	1,081.0
1-18	6,419.0	6,551.0	5,960.0	5,579.0
1-19	840.0	840.0	840.0	840.0
1-20	6,479.0	6,610.0	6,013.0	5,634.0

subarea	***existing peak (cfs)***	***future peak (cfs)***	***future peak with 50% reduction (cfs)***	***future peak with 50% reduction and 2.4" infiltration (cfs)***
1-21	8,873.0	9,036.0	8,489.0	8,032.0
1-22	1,340.0	1,340.0	1,340.0	1,340.0
1-23	1,408.0	1,408.0	1,408.0	1,408.0
1-24	9,666.0	9,786.0	9,411.0	9,077.0
1-25	8,916.0	9,078.0	8,537.0	8,084.0
1-26	1,374.0	1,374.0	1,374.0	1,374.0
1-27	9,874.0	9,986.0	9,633.0	9,308.0
1-28	1,070.0	1,070.0	1,070.0	1,070.0
1-29	10,019.0	10,133.0	9,776.0	9,451.0
1-30	11,203.0	11,269.0	11,108.0	10,914.0
1-31	11,672.0	11,734.0	11,613.0	11,449.0

greater than 5% increase in flow from existing condition

Table 8
Swamp Creek Watershed Model Results: 50-Year Storm Event

subarea	*existing peak (cfs)*	*future peak (cfs)*	*future peak with 50% reduction (cfs)*	*future peak with 50% reduction and 2.4" infiltration (cfs)*
1-1	1,589.0	1,589.0	1,589.0	1,589.0
1-2	647.0	647.0	647.0	647.0
1-3	1,157.0	1,157.0	1,157.0	1,157.0
1-4	1,807.0	1,807.0	1,807.0	1,807.0
1-5	3,803.0	3,803.0	3,803.0	3,803.0
1-6	1,770.0	2,010.0	885.0	885.0
1-7	4,281.0	4,347.0	4,143.0	4,143.0
1-8	2,689.0	3,219.0	1,345.0	1,345.0
1-9	4,860.0	5,275.0	4,782.0	4,441.0
2-1	1,580.0	1,696.0	790.0	790.0
2-2	1,238.0	1,238.0	1,238.0	1,238.0
2-3	2,860.0	2,895.0	2,969.0	2,634.0
2-4	2,731.0	2,787.0	2,698.0	2,436.0
3-1	3,134.0	3,134.0	3,134.0	3,134.0
3-2	2,133.0	2,133.0	2,133.0	2,133.0
3-3	8,599.0	8,853.0	8,108.0	7,651.0
4-1	1,703.0	1,855.0	1,172.0	1,166.0
4-2	2,550.0	2,550.0	2,550.0	2,550.0
4-3	1,870.0	1,960.0	1,518.0	1,234.0
4-4	3,908.0	3,973.0	3,670.0	3,314.0
4-5	1,898.0	1,898.0	1,898.0	1,898.0
4-6	1,296.0	1,296.0	1,296.0	1,296.0
4-7	4,250.0	4,349.0	3,998.0	3,650.0
4-8	4,621.0	4,702.0	4,430.0	4,150.0
5-1	2,194.0	2,194.0	2,194.0	2,194.0
5-2	3,156.0	3,156.0	3,156.0	3,156.0
5-3	3,413.0	3,413.0	3,413.0	3,413.0
6-1	1,659.0	1,659.0	1,659.0	1,659.0
6-2	2,840.0	2,840.0	2,840.0	2,840.0
1-10	5,607.0	6,164.0	5,311.0	5,111.0
1-11	1,273.0	1,414.0	637.0	637.0
1-12	5,243.0	5,730.0	5,358.0	5,006.0
1-13	1,505.0	1,663.0	753.0	753.0
1-14	5,063.0	5,480.0	5,262.0	4,759.0
1-15	8,739.0	8,986.0	8,264.0	7,807.0
1-16	8,199.0	8,544.0	7,531.0	7,055.0
1-17	1,275.0	1,275.0	1,275.0	1,275.0
1-18	7,852.0	8,180.0	7,475.0	6,994.0
1-19	993.0	993.0	993.0	993.0
1-20	7,923.0	8,249.0	7,539.0	7,058.0

subarea	*existing peak (cfs)*	*future peak (cfs)*	*future peak with 50% reduction (cfs)*	*future peak with 50% reduction and 2.4" infiltration (cfs)*
1-21	10,772.0	11,048.0	10,440.0	9,848.0
1-22	1,584.0	1,584.0	1,584.0	1,584.0
1-23	1,675.0	1,675.0	1,675.0	1,675.0
1-24	11,721.0	11,896.0	11,463.0	10,980.0
1-25	10,818.0	11,094.0	10,490.0	9,900.0
1-26	1,636.0	1,636.0	1,636.0	1,636.0
1-27	11,862.0	12,036.0	11,619.0	11,177.0
1-28	1,336.0	1,336.0	1,336.0	1,336.0
1-29	12,036.0	12,219.0	11,778.0	11,322.0
1-30	13,267.0	13,366.0	12,936.0	12,670.0
1-31	13,812.0	13,898.0	13,454.0	13,232.0

greater than 5% increase in flow from existing condition

Table 9
Swamp Creek Watershed Model Results: 100-Year Storm Event

subarea	*existing peak (cfs)*	*future peak (cfs)*	*future peak with 50% reduction (cfs)*	*future peak with 50% reduction and 2.4" infiltration (cfs)*
1-1	1,967.0	1,967.0	1,967.0	1,967.0
1-2	804.0	804.0	804.0	804.0
1-3	1,424.0	1,424.0	1,424.0	1,424.0
1-4	2,256.0	2,256.0	2,256.0	2,256.0
1-5	4,751.0	4,751.0	4,751.0	4,751.0
1-6	2,110.0	2,395.0	1,055.0	1,055.0
1-7	5,285.0	5,373.0	5,104.0	5,104.0
1-8	3,204.0	3,696.0	1,602.0	1,602.0
1-9	6,094.0	6,444.0	6,084.0	5,861.0
2-1	1,880.0	2,002.0	940.0	940.0
2-2	1,442.0	1,442.0	1,442.0	1,442.0
2-3	3,375.0	3,422.0	3,490.0	3,146.0
2-4	3,240.0	3,303.0	3,200.0	2,926.0
3-1	3,658.0	3,658.0	3,658.0	3,658.0
3-2	2,548.0	2,548.0	2,548.0	2,548.0
3-3	10,122.0	10,460.0	9,493.0	9,193.0
4-1	1,949.0	2,117.0	1,345.0	1,343.0
4-2	2,978.0	2,978.0	2,978.0	2,978.0
4-3	2,108.0	2,225.0	1,649.0	1,412.0
4-4	4,564.0	4,650.0	4,207.0	3,892.0
4-5	2,217.0	2,217.0	2,217.0	2,217.0
4-6	1,488.0	1,488.0	1,488.0	1,488.0

subarea	*existing peak (cfs)*	*future peak (cfs)*	*future peak with 50% reduction (cfs)*	*future peak with 50% reduction and 2.4" infiltration (cfs)*
4-7	4,977.0	5,090.0	4,625.0	4,280.0
4-8	5,374.0	5,466.0	5,110.0	4,834.0
5-1	2,559.0	2,559.0	2,559.0	2,559.0
5-2	3,642.0	3,642.0	3,642.0	3,642.0
5-3	3,933.0	3,933.0	3,933.0	3,933.0
6-1	1,926.0	1,926.0	1,926.0	1,926.0
6-2	3,296.0	3,296.0	3,296.0	3,296.0
1-10	6,771.0	7,459.0	6,644.0	6,440.0
1-11	1,480.0	1,640.0	740.0	740.0
1-12	6,266.0	6,891.0	6,570.0	6,243.0
1-13	1,747.0	1,894.0	874.0	874.0
1-14	6,006.0	6,504.0	6,322.0	5,964.0
1-15	10,287.0	10,613.0	9,678.0	9,374.0
1-16	9,669.0	10,138.0	8,792.0	8,624.0
1-17	1,480.0	1,480.0	1,480.0	1,480.0
1-18	9,241.0	9,675.0	8,744.0	8,539.0
1-19	1,161.0	1,161.0	1,161.0	1,161.0
1-20	9,323.0	9,755.0	8,815.0	8,612.0
1-21	12,547.0	12,884.0	12,084.0	11,605.0
1-22	1,840.0	1,840.0	1,840.0	1,840.0
1-23	1,964.0	1,964.0	1,964.0	1,964.0
1-24	13,642.0	13,867.0	13,276.0	12,766.0
1-25	12,597.0	12,934.0	12,139.0	11,663.0
1-26	1,903.0	1,903.0	1,903.0	1,903.0
1-27	13,807.0	14,015.0	13,467.0	12,988.0
1-28	1,602.0	1,602.0	1,602.0	1,602.0
1-29	13,965.0	14,199.0	13,633.0	13,168.0
1-30	14,955.0	15,314.0	15,008.0	14,738.0
1-31	15,451.0	15,860.0	15,676.0	15,444.0

greater than 5% increase in flow from existing condition

E. Criteria and Standards for Stormwater Management

1. Comprehensive Stormwater Management

Land development within the Swamp Creek watershed impacts the hydrologic cycle of the watershed. As previously undeveloped areas are converted to impervious areas or compacted grass or landscaped areas, groundwater recharge decreases and stormwater runoff increases, leading to increased erosion in receiving streams. Typically, stormwater management has been addressed on a

site-by-site basis or a municipality-by-municipality basis, where it is mainly the stormwater impacts to the development site or to the municipality that are considered when designing facilities to mitigate stormwater impacts. One of the purposes of the Act 167 program is to encourage a comprehensive watershed approach to stormwater management, where it is acknowledged that land development affects not only the individual site or municipality, but the entire watershed.

2. National Pollutant Discharge Elimination System (NPDES), Phase II Requirements

In addition to the Pennsylvania Act 167 program, the Federal NPDES program also serves to encourage a comprehensive widespread approach to stormwater management. The NPDES Program Phase II regulations were published in the Federal Register in December 1999. The Phase II program impacted operators of small municipal separate storm sewer systems (MS4s) by requiring them to obtain NPDES permits for their storm sewer discharges. These permit holders are municipalities located in "urbanized areas" of the state, as identified using census data. All municipalities within the Swamp Creek watershed are MS4 municipalities, with the exception of District and Pike Townships in Berks County.

As a part of the NPDES permit, the impacted municipalities are required to implement six minimum control measures, including the following: public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site stormwater runoff control, post-construction stormwater management, and pollution prevention/good housekeeping for municipal operations. In Pennsylvania, the NPDES program is regulated by the DEP, which also regulates the Act 167 program. The Act 167 program serves to fulfill several NPDES permit requirements, including the following:

- A municipality's participation in the Act 167 program fulfills the public involvements and participation minimum control measure.
- The Swamp Creek Model Stormwater Management Ordinance incorporates stormwater ordinance updates that are required for MS4 municipalities, including ordinance requirements related to prohibited stormwater discharges, construction site stormwater runoff control, and post-construction stormwater management.
- The Act 167 program strongly encourages the use of stormwater management BMPs, including BMPs for groundwater recharge and water quality volume. The NPDES program requires groundwater recharge and water quality volume for newly developed areas and also requires that municipalities have some method for ensuring that stormwater management BMPs are properly maintained.

3. Goals of the Act 167 Plan

Recognizing the need to deal with the serious problem of flooding, the Pennsylvania General Assembly enacted Act 167, the Pennsylvania Stormwater Management Act. The statement of legislative findings at the beginning of Act 167 sums up the critical relationship between land development, accelerated runoff, and floodplain management. Specifically, this statement of legislative findings points out the following:

a. Inadequate management of stormwater runoff from development increases flood flows and velocity, contributes to erosion and sedimentation, overloads the carrying capacity of streams and storm sewers, greatly increases the cost of public stormwater facilities, undermines floodplain management and floodplain control efforts in downstream communities, reduces groundwater recharge, and threatens public health and safety.

b. A comprehensive stormwater management program including reasonable regulation of development and activities causing accelerated runoff, is fundamental to the public health, safety and welfare and the protection of the people of the Commonwealth, their resources and their environment.

To prevent the inadequate management or stormwater runoff from development and promote sound water and land use practices, a comprehensive stormwater management plan should address the following objectives:

- Maintain groundwater recharge.
- Implement non-point source pollution removal technologies.
- Reduce channel erosion.
- Manage overbank flood events.
- Manage extreme flood events.

The performance standards listed below were incorporated in the model ordinance for Swamp Creek, and should serve to help to meet these objectives.

4. Performance Standards

a. Groundwater Recharge Standard – to maintain groundwater recharge

Groundwater recharge involves infiltrating stormwater into the ground, replenishing the groundwater supply, which then provides baseflow to streams. Design of the infiltration facilities shall consider groundwater recharge to compensate for the reduction in the recharge that occurs when the ground surface is disturbed or impervious surface is created. Infiltration may not be feasible on every site due to site-specific limitations such as soil type.

Infiltration BMPs shall meet the following minimum requirements:

1) Infiltration BMPs intended to receive runoff from developed areas shall be selected based on suitability of soils and site conditions and shall be constructed on soils that have the following characteristics:

    a) A minimum depth of twenty-four (24) inches, and preferably 36 inches, between the bottom of the BMP and the top of the limiting zone (e.g., seasonally high water table, groundwater, bedrock, etc.).

    b) An infiltration rate sufficient to accept the additional stormwater load and dewater completely as determined by field tests.

    c) The infiltration facility shall be capable of completely infiltrating the recharge (infiltration) volume within three (3) days (72 hours) or less.

    d) Pretreatment shall be provided prior to infiltration.

2) The size of the infiltration facility shall be based upon the Net Two Year Volume Approach, where the recharge volume to be captured and infiltrated shall be the volume difference between the pre-development 2-year, 24-hour storm event and post-development 2-year, 24-hour storm event.

3) Soils - A detailed soils evaluation of the project site shall be required to determine the suitability of infiltration facilities. The evaluation shall be performed by a qualified design professional and at a minimum address soil permeability, depth to bedrock, and subgrade stability. The general process for designing the infiltration BMP shall be the following:

    a) Analyze hydrologic soil groups as well as natural and man-made features within the site to determine general areas of suitability for infiltration practices. In areas where development on fill material is under consideration, conduct geotechnical investigations of sub-grade stability; infiltration may not be ruled out without conducting these tests.

    b) Provide field tests such as double ring infiltrometer or hydraulic conductivity tests (at the level of the proposed infiltration surface) to determine the appropriate hydraulic conductivity rate. Percolation tests are not recommended for design purposes.

c) Design the infiltration structure for the required recharge volume based on field determined capacity at the level of the proposed infiltration surface.

d) If on-lot infiltration structures are proposed, it must be demonstrated that the soils are conducive to infiltrate on the lots identified.

4) Stormwater Hotspots – Below is a list of examples of designated hotspots. If a site is designated as a hotspot, it has important implications for how stormwater is managed. First and foremost, untreated stormwater runoff from hotspots shall not be allowed to recharge into groundwater where it may contaminate water supplies. Second, a greater level of stormwater treatment shall be considered at hotspot sites to prevent pollutant washoff after construction. The Environmental Protection Agency's (EPA) NPDES stormwater program requires some industrial sites to prepare and implement a stormwater pollution prevention plan.

Examples of hotspots include the following:

- Vehicle salvage yards and recycling facilities.
- Vehicle fueling stations.
- Vehicle service and maintenance facilities.
- Vehicle and equipment cleaning facilities.
- Fleet storage areas (bus, truck, etc.).
- Industrial sites based on Standard Industrial Codes.
- Marinas (service and maintenance).
- Outdoor liquid container storage.
- Outdoor loading/unloading facilities.
- Public works storage areas.
- Facilities that generate or store hazardous materials.
- Commercial container nursery.
- Other land uses and activities as designated by an appropriate review authority.

The following land uses and activities are not normally considered hotspots:

- Residential streets and rural highways.
- Residential development.

- Institutional development.
- Office developments.
- Nonindustrial rooftops.
- Pervious areas, except golf courses and nurseries (which may need an integrated pest management (IPM) plan).

While large highways (average daily traffic volume greater than thirty thousand) are not designated as stormwater hotspots, it is important to ensure that highway stormwater management plans adequately protect groundwater.

Extreme caution shall be exercised where infiltration is proposed in Source Water Protection Areas as defined by a local Municipality or water authority. Infiltration facilities shall be used in conjunction with other innovative or traditional BMPs, stormwater control facilities, and nonstructural stormwater management alternatives.

Extreme caution shall be exercised where salt or chloride (municipal salt storage) would be a pollutant since soils do little to filter this pollutant, and it may contaminate the groundwater. Specific consideration should be given to the particular type of salt or deicing material to be used within this watershed in regards to its potential long-term effects on the soils, especially in areas that contain clay soil.

The infiltration requirement in High Quality or Exceptional Value waters shall be subject to DEP's Chapter 93 Anti-degradation Regulations.

An impermeable liner will be required in detention basins where the possibility of groundwater contamination exists. Safeguards should be provided against groundwater contamination for land uses that may cause groundwater contamination should there be a mishap or spill.

b. Water Quality Standard – to implement non-point source pollution removal technologies

Pollutants such as sediments and oils tend to accumulate on the impervious surfaces that result from land development. During storm events, these pollutants are washed off of the impervious surfaces and into stormwater management facilities or directly into streams, resulting in declining water quality in the receiving streams. A goal of the Act 167 program is to reduce non-point source pollution to receiving streams. The water quality standard has been established to achieve this goal.

To control post-construction stormwater impacts from regulated earth disturbance activities, state water quality requirements can be met by BMPs, including site design, which provide for replication of pre-construction stormwater infiltration and runoff conditions so that post-construction stormwater discharges do not degrade the physical, chemical, or biological characteristics of the receiving waters. As described in the DEP Comprehensive Stormwater Management Policy (#392-0300-002, September 28, 2002), this may be achieved by the following:

1) Infiltration: replication of pre-construction stormwater infiltration conditions,

2) Treatment: use of water quality treatment BMPs to ensure filtering out of the chemical and physical pollutants from the stormwater runoff, and

3) Streambank and Streambed Protection: management of volume and rate of post-construction stormwater discharges to prevent physical degradation of receiving waters (e.g., from scouring).

Developed areas shall provide adequate storage and treatment facilities necessary to capture and treat stormwater runoff. If site conditions allow for infiltration, the water quality volume and the recharge volume are the same volume and may be managed in a single facility. If infiltration can not be physically accomplished, the water quality volume should be calculated using the Net Two Year Volume Approach, where the recharge volume to be captured and infiltrated shall be the volume difference between the pre-development 2-year, 24-hour storm event and post-development 2-year, 24-hour storm event. In this case, the water quality volume may be captured and treated by methods other than infiltration BMPs.

This volume requirement can be accomplished by the permanent volume of a wet basin or the detained volume from other BMPs. Where appropriate, wet basins shall be utilized for water quality control.

The water quality volume shall take a minimum of 24 hours to be discharged from a BMP facility. Release of the water quality volume can begin at the start of the storm (i.e., the invert of the water quality orifice is at the invert of the facility). The design of the facility shall provide for protection from clogging and unwanted sedimentation.

For areas within defined special protection subwatersheds that include High Quality and Exceptional Value waters, the temperature and quality of water and streams shall be maintained through the use of temperature sensitive BMPs and stormwater conveyance systems.

A combination of different BMPs may be utilized to achieve the design objectives described above.

If a perennial or intermittent stream passes through the development site, a stream buffer should be created that extends a minimum of fifty (50) feet to either side of the top-of-bank of the channel. The buffer area shall be maintained with and encouraged to use appropriate native vegetation.

c. Streambank Erosion Standard - to reduce channel erosion

Another land development impact to receiving streams is streambank erosion. The addition of new impervious areas results in increased stormwater flow rates and volumes. Streambank erosion occurs due to the increased stream velocities resulting from increased stormwater flow rates. It also occurs due to increased stormwater flow volumes. Streams are generally expected to flow full to the tops of their banks during a 2-year storm event. The streambank erosion standard involves detaining stream flows to the 1-year storm event to minimize streambank erosion.

BMP design to minimize streambank erosion involves designing the BMP to detain the proposed conditions 2-year, 24-hour design storm to the existing conditions 1-year flow using the SCS Type II distribution. Additionally, provisions shall be so that the proposed conditions 1-year storm takes a minimum of twenty-four (24) hours to drain from the facility from a point where the maximum volume of water from the 1-year storm is captured. Release of water can begin at the start of the storm.

d. Stormwater Peak Rate Control Standard – to manage overbank and extreme flood events

Stream flooding is impacted by land development within the stream's watershed. Flooding may be aggravated by the placement of buildings or other obstructions in floodplain areas, and it may also be aggravated by increased in stormwater runoff from new land development. Streams are generally expected to flow full to the tops of their banks during a 2-year storm event. Therefore, overbank flood events are considered to be flood events resulting from 2-year, 5-year, and 10-year storms. Extreme flood events are considered to be flood events resulting from more severe storms, such as the 25-year, 50-year, and 100-year storm events. The peak rate control standard is proposed as a method to protect against increased flooding as land development increases. The watershed model completed for the Swamp Creek Act 167 Plan included an analysis related to the level of peak rate control necessary to protect against the impacts of proposed development within the watershed. This analysis is described in

the model results and implications section above and resulted in the components of the peak rate control standard described below:

Within the Swamp Creek watershed, the criteria for peak runoff control are designed to reduce the post-development peak flow to 50% of the pre-development peak flow. Development sites must control proposed conditions runoff rates to 50% of the existing conditions runoff rates for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events.

For any proposed development site, a less restrictive runoff control may be used (including no detention) if the developer can prove that "no harm" would be caused by discharging at a higher runoff rate. The "no harm" option may be used when an developer can prove that the proposed conditions hydrograph is less than the existing conditions hydrograph at all points in time for a 24-hour hydrograph, or if it can be proven that the proposed conditions will not cause increases in 2-, 5-, 10-, 25-, 50-, and 100-year peak flows at all points downstream within the Act 167 study area.

e. Recommended Procedure to Achieve Performance Standards

The following sequence should be used by a developer to minimize the increases in stormwater runoff and impacts to water quality resulting from the proposed regulated activity:

1) Prepare an Existing Resource and Site Analysis Map (ERSAM) showing environmentally sensitive areas including, but not limited to, steep slopes, ponds, lakes, streams, wetlands, hydric soils, vernal pools, stream buffers, hydrologic soil groups, wooded areas, and potential infiltration areas. Land development, any existing recharge areas, and other requirements outlined in the municipal SALDO shall also be included.

2) Establish a stream buffer.

3) Prepare a draft project layout avoiding environmentally sensitive areas.

4) Identify site-specific existing conditions drainage areas, discharge points, recharge areas, and hydrologic soil group B (areas conducive to infiltration). Infiltration should still be considered in well draining soils listed as hydrologic soil group C, but additional soils testing should be performed to verify onsite conditions and placement of these BMPs.

5) Evaluate nonstructural stormwater management alternatives:

    a) Minimize earth disturbance.

    b) Minimize impervious surfaces.

c) Break up large impervious surfaces.

6) Satisfy the groundwater recharge (infiltration) objective and provide for stormwater pretreatment prior to infiltration.

7) Provide for water quality protection.

8) Provide streambank erosion protection.

9) Conduct an existing conditions runoff analysis.

10) Prepare final project design to maintain existing conditions drainage areas and discharge points, to minimize earth disturbance and impervious surfaces, and, to the maximum extent possible, to ensure that the remaining site development has no surface or point discharge.

11) Conduct a proposed conditions runoff analysis based on the final design that meets the release rate requirements.

12) Manage any remaining runoff prior to discharge through detention, bioretention, direct discharge, or other structural control.

Table 10
Required Criteria and Standards in the Swamp Creek Watershed

Required Standard	***Benefit***
Stormwater Management Provide peak rate runoff control.	• No increase in runoff on a watershed wide basis. • Stormwater attenuation.
Recharge/Infiltration Recharge/infiltration BMPs are required where soil and geologic conditions permit. All proposed development shall investigate the implementation of infiltration or retention structures as opposed to surface detention and shall adhere to the infiltration requirements presented in the model ordinance.	• Groundwater recharge. • Stream baseflow recharge. • Flow attenuation.
Water Quality Provide adequate storage and treatment facilities necessary to capture and treat the water quality volume.	• Capture and treats polluted stormwater, providing improved water quality.
Calculation Methodology Required calculation methodology is presented in the model ordinance.	• Consistent stormwater management calculations.
Discharge of Accelerated Runoff Accelerated stormwater runoff shall be safely discharged into existing discharge points and storm sewers without adversely affecting properties or causing channel scouring and erosion.	• Safe conveyance. • Continued surface and groundwater quality. • Flow attenuation.

Required Standard	***Benefit***
Inappropriate Outlets If it is not possible to direct stormwater flow from a development site to a stream, tributary, stabilized channel, or storm sewer, then runoff shall be collected in a BMP and discharged at a nonerosive rate. Outlets discharging onto adjacent property owner(s)' properties must have adjacent property owner(s)' written permission, unless the post-development condition is an improvement to the pre-development condition.	• Safe conveyance. • Continued surface and groundwater quality. • Flow attenuation.
Streambank Protection Reduce 2-year post-development flow to 1-year post-development flow.	• Reduces number of erosive storms, thereby reducing streambank erosion.
Wetlands Network with regulatory agencies to determine appropriate management techniques within wetland areas.	• Infiltration. • Surface and groundwater recharge. • Stream baseflow. • Water quality. • Flow attenuation and detention.
Erosion and Sediment Pollution Control Network with administrative and regulatory agencies to sequence and control earth disturbance sites to maintain and protect areas designated for infiltration or leave areas of native vegetation intact.	• Infiltration. • Structure integrity. • Surface water quality. • Safe conveyance. • Stream, culvert, and channel capacity.

Table 11
Recommended Criteria and Standards in the Swamp Creek Watershed

Recommended Standard	*Benefit*
Floodplains Floodplains should be kept free of fill or obstructions to retain stream channel conveyance and storage capacity.	• Natural stormwater detention / flood control downstream. • Protection of existing conveyance capacity.
Roof Drains, Residential/Commercial Prevent all roof drains from discharging into storm sewers, roadside ditches, or channels. Discharge to lawn, infiltration, or storage facilities is recommended so that stormwater is reused.	• Infiltration. • Flow attenuation. • Increases time of concentration.
Pervious Surfaces The use of pervious surfaces is encouraged for parking surfaces and sidewalks.	• Infiltration. • Groundwater recharge.
Structures Concentrate on locating facilities within areas conducive to recharge and accommodate infiltration to meet release rate requirements.	• Infiltration. • Groundwater recharge. • Stream baseflow.
Steep Slopes Regulate activities in critical slope areas where management of stormwater by structure is inappropriate. Slopes should be vegetated with native vegetation.	• Stream baseflow. • Flow attenuation. • Conveyance integrity. • Surface water quality.
Green Roof Construct rooftop gardens.	• Flow attenuation. • Small storm retention.
Stream Buffer Provide stream buffer of 50 feet measured from the top of bank on both sides of a stream.	• Water quality. • Flood drainage reduction. • Habitat enhancement. • Erosion reduction.
Existing Storm Sewers or Culverts Discharge into existing sewer networks or culverts will be based on system capacity or design storm(s), whichever is more restrictive.	• Preserve sewer/culvert capacity, thereby reducing operation and maintenance and replacement costs.

*Note: The Swamp Creek Model Stormwater Management Ordinance should be referenced for more detailed standards and criteria.

F. Model Stormwater Management Ordinance

Pennsylvania municipalities are empowered to regulate land use activities that affect runoff and surface and groundwater quality and quantity by the authority of the Stormwater Management Act, Act of October 4, 1978, 32 P.S., P.L. 864 (Act 167) Section 680.1 et seq., as amended. Among the requirements of Act 167 is the

requirement that municipalities implement the stormwater management plan through a stormwater ordinance that was developed as part of the plan. This ordinance could be adopted essentially "as is" by a municipality, or the municipality could make some modifications to the model ordinance to fulfill the specific needs of the municipality. Additionally, a municipality may need to make some revisions to their Subdivision and Land Development Ordinance and/or their Zoning Ordinance to ensure that these ordinances are consistent with the Stormwater Management Ordinance and include appropriate cross-references.

The Swamp Creek Model Stormwater Management Ordinance will not completely replace the existing storm drainage ordinance provisions currently in effect in the watershed's municipalities for the following reasons:

- Not all of the municipalities in the Swamp Creek watershed are completely within the watershed. For those portions of the municipality outside the Swamp Creek watershed, the existing ordinance provisions would still apply.
- Permanent and temporary stormwater control facilities are regulated by the model ordinance. Stormwater management and erosion and sedimentation control during construction would continue to be regulated under the existing stormwater ordinance and Chapter 102 Erosion and Sediment Pollution Controls, Title 25 of DEP regulations.
- The model ordinance contains only those minimum stormwater runoff control criterion and standards that are necessary or desirable from a total watershed perspective. Additional stormwater management design criteria (i.e. inlet spacing, inlet type, collection system details, etc.), which should be based on sound engineering practice, should be regulated under the current ordinance provisions or as part of the general responsibilities of the municipal engineer.

The model ordinance includes nine articles, each with specific requirements, as well as a set of appendices. Each of these is described below.

Article I – General Provisions: This article includes an introduction to the ordinance as well as a description of the legal authority of the ordinance and applicability of the ordinance to specific development scenarios.

Article II – Definitions: This article includes the definitions for words and terms used in the ordinance.

Article III – Drainage Plan Requirements: This article describes the various components required for a drainage plan submission. The procedure for drainage plan submissions and reviews is also outlined in this article.

Article IV – Stormwater Management: This article includes the technical provisions and requirements specific to stormwater management that resulted from the Swamp Creek model analysis and are recommended to implement the Swamp Creek Stormwater

Management Plan. Requirements for groundwater recharge, water quality, and peak rate control, as well as stormwater facility design criteria, and a description of acceptable calculation methodology, are listed in this article.

Article V – Inspections: This article describes inspection procedures for permanent BMPs and stormwater management facilities.

Article VI – Fees and Expenses: This article contains provisions for a municipal review fee.

Article VII – Maintenance Responsibilities: This article lists the owner's operations and maintenance responsibilities for BMPs and stormwater management facilities.

Article VIII – Prohibitions: This article lists prohibited discharges and connections to a municipality's storm sewer system, and includes requirements related to roof drains and BMP alterations.

Article IX – Enforcement and Penalties: This article describes procedures and penalties to give municipalities the authority to enforce their stormwater management ordinance.

Appendices – The appendices consist of various sets of guidelines that supplement the design requirements and guidelines included in the body of the ordinance.

According to the Stormwater Management Act, Swamp Creek municipalities shall adopt or amend and implement such ordinances and regulations as are necessary to regulate development within the municipality in a manner consistent with the Swamp Creek Stormwater Management Plan and other applicable provisions of the Act. This shall occur within six months of the adoption and approval of the Swamp Creek Stormwater Management Plan.

The following amendment is required for municipalities that issue an occupancy permit:

- An Occupancy Permit shall not be secured or issued unless the provisions of the Swamp Creek Stormwater Management Ordinance have been followed. The Occupancy Permit shall be required for each lot owner and/or developer of all subdivisions and land development in the municipality, unless exempted by the exemption criteria.

F. Model Stormwater Management Ordinance

The following ordinance provisions must be retained when a municipality either elects to create a single-purpose stormwater management ordinance or amends existing subdivision and land development or zoning ordinances to implement the stormwater management plan.

Article I – General Provisions

Article II – Definitions

Article IV – Design Criteria for Stormwater Management Facilities: Sections 401, 402, 403, 404, 405, 406, 407, 408 (except section E), 409, and 410 (Sections A through I only)

Article V – Inspections (language may be modified by the municipality)

Article VII – Maintenance (language may be modified by the municipality)

Article VIII – Prohibitions

Article IX – Enforcement and Penalties (only when enacting a single-purpose ordinance)

The following ordinance provisions are recommended to be retained:

Article III – Drainage Plan Requirements

Article IV – Design Criteria: Section 410.J through 410.CC

Article VI – Fees and Expenses

Article VII – Maintenance: Section 709

Appendices

Municipalities may enact a single-purpose stormwater management ordinance different from the model ordinance or may revise language in an existing ordinance as long as the Act 167 Plan requirements for groundwater recharge, water quality, streambank erosion, and peak runoff control are maintained in the ordinance. It is recommended that the revised stormwater management ordinance be reviewed by the municipal engineer, municipal solicitor, and DEP prior to ordinance adoption.

SECTION VII – SWAMP CREEK STORMWATER MANAGEMENT ORDINANCE

[*MUNICIPALITY*]
STORMWATER MANAGEMENT ORDINANCE

ORDINANCE NO._____ OF _____

_[*Municipality*], __[*County*] _ COUNTY,
PENNSYLVANIA

Adopted at a Public Meeting held on
_____, 20__

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ARTICLE I – GENERAL PROVISIONS

Section 101. Short Title

This Ordinance shall be known as the "[*Municipality*] Stormwater Management Ordinance."

Section 102. Statement of Findings

The governing body of the Municipality finds that:

A. Inadequate management of accelerated stormwater runoff resulting from development throughout a watershed increases flood flows and velocities, contributes to erosion and sedimentation, overtaxes the carrying capacity of existing streams and storm sewers, greatly increases the cost of public facilities to convey and manage stormwater, undermines floodplain management and flood reduction efforts in upstream and downstream communities, reduces groundwater recharge, and threatens public health and safety.

B. Inadequate planning and management of stormwater runoff resulting from land development throughout a watershed can also harm surface water resources by changing the natural hydrologic patterns, accelerating stream flows (which increase scour and erosion of stream beds and stream banks, thereby elevating sedimentation), destroying aquatic habitat, and elevating aquatic pollutant concentrations and loadings such as sediments, nutrients, heavy metals, and pathogens. Groundwater resources are also impacted through loss of recharge.

C. A comprehensive program of stormwater management, including minimization of impacts of development, redevelopment, and activities causing accelerated erosion and loss of natural infiltration, is fundamental to the public health, safety, welfare, and the protection of the people of the Municipality and all of the people of the Commonwealth, their resources, and the environment.

D. Stormwater can be an important water resource by providing groundwater recharge for water supplies and baseflow of streams, which also protects and maintains surface water quality.

E. Impacts from stormwater runoff can be minimized by using project designs that maintain the natural hydrologic regime and sustain high water quality, groundwater recharge, stream baseflow, and aquatic ecosystems. The most cost effective and environmentally advantageous way to manage stormwater runoff is through nonstructural project design that minimizes impervious surfaces and sprawl, avoids sensitive areas (i.e., stream buffers, floodplains, steep slopes), and considers topography and soils to maintain the natural hydrologic regime.

F. Public education on the control of pollution from stormwater is an essential component in successfully addressing stormwater.

G. Federal and state regulations require certain municipalities to implement a program of stormwater controls. These municipalities are required to obtain a permit for stormwater discharges from their separate storm sewer systems under the National Pollutant Discharge Elimination System (NPDES). [*This should only be included by the municipality if applicable.*]

H. Nonstormwater discharges to municipal separate storm sewer systems can contribute to pollution of waters of the Commonwealth by the Municipality.

Section 103. Purpose

The purpose of this Ordinance is to promote the public health, safety, and welfare within the Municipality by maintaining the natural hydrologic regime and minimizing the impacts described in Section 102 of this Ordinance through provisions designed to:

A. Promote alternative project designs and layouts that minimize the impacts on surface and groundwater.

B. Promote nonstructural best management practices (BMPs).

C. Minimize increases in runoff stormwater volume.

D. Minimize impervious surfaces.

E. Manage accelerated stormwater runoff and erosion and sedimentation problems and stormwater runoff impacts at their source by regulating activities that cause these problems.

F. Provide review procedures and performance standards for stormwater planning and management.

G. Utilize and preserve existing natural drainage systems as much as possible.

H. Manage stormwater impacts close to the runoff source, requiring a minimum of structures and relying on natural processes.

I. Focus on infiltration of stormwater to maintain groundwater recharge, to prevent degradation of surface and groundwater quality, and to otherwise protect water resources.

J. Maintain existing baseflows and quality of streams and watercourses, where possible.

K. Meet legal water quality requirements under state law, including regulations at 25 Pennsylvania Code Chapter 93.4.a requiring protection and maintenance of “existing uses” and maintenance of the level of water quality to support those uses in all streams, and the protection and maintenance of water quality in “special protection” streams.

L. Address the quality and quantity of stormwater discharges from the development site.

M. Provide a mechanism to identify stormwater controls necessary to meet NPDES permit requirements.

N. Implement an illegal discharge detection and elimination program that addresses non-stormwater discharges into the Municipality’s separate storm sewer system.

O. Preserve the flood-carrying capacity of streams.

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

Q. Provide performance standards and design criteria for watershed-wide stormwater management and planning.

R. Provide proper operation and maintenance of all permanent stormwater management facilities and BMPs that are implemented in the Municipality.

Section 104. Statutory Authority

The Municipality is empowered to regulate land use activities that affect runoff and surface and groundwater quality and quantity by the authority of:

A. Act of October 4, 1978, 32 P.S., P.L. 864 (Act 167) Section 680.1 et seq., as amended, the "Stormwater Management Act" (hereinafter referred to as "the Act");

B. Water Resources Management Act of 2002, as amended;

C. First Class Township Code, 53 P.S. Section 55101, et seq., Second Class Township Code, 53 P.S. Sections 66501 et seq., 66601 et seq., and the Borough Code, 53 P.S. Section 46201 et seq.;

D. Pennsylvania Municipalities Planning Code, Act 247, as amended.

Section 105. Applicability/Regulated Activities

This Ordinance shall apply to all areas of the Municipality within the Swamp Creek watershed.

This Ordinance contains only the stormwater management performance standards and design criteria that are necessary or desirable from a watershed-wide perspective. Local stormwater management design criteria (e.g., inlet spacing, inlet type, collection system design and details, outlet structure design, etc.) shall continue to be regulated by the applicable municipal ordinances and applicable state regulations.

The following activities are defined as "regulated activities" and shall be regulated by this Ordinance unless exempted by Section 106:

A. Land development,

B. Subdivisions,

C. Alteration of the natural hydrologic regime,

D. Construction or reconstruction of or addition of new impervious or semipervious surfaces (i.e., driveways, parking lots, roads, etc.),

E. Construction of new buildings or additions to existing buildings,

F. Redevelopment,

G. Diversion piping or encroachments in any natural or man-made channel,

H. Nonstructural and structural stormwater management BMPs or appurtenances thereto,

I. Earth disturbance activities of greater than five thousand (5,000) square feet.[1]

J. Any of the above regulated activities that were approved more than five (5) years prior to the effective date of this Ordinance and resubmitted for municipal approval.

K. Prohibited or polluted discharges,

L. Any other activities that may affect stormwater runoff.

Table 105.1 summarizes the applicability requirements of the ordinance. "Proposed Impervious Surface" in Table 105.1 includes new, additional, or replacement impervious surface/cover. Repaving existing surfaces without reconstruction does not constitute "replacement."

[1] This Ordinance applies to any earth disturbance activity greater than or equal to five thousand (5,000) square feet that is associated with a development or redevelopment project. Earth disturbance activities of less than one (1) acre that are associated with redevelopment projects are exempt from the Section 407 stream bank erosion requirements. Earth disturbance activities and associated stormwater management controls are also regulated under existing state law and implementing regulations. This Ordinance shall operate in coordination with those parallel requirements; the requirements of this Ordinance shall be no less restrictive in meeting the purposes of this Ordinance than state law.

TABLE 105.1

ORDINANCE APPLICABILITY

Ordinance Article or Section	Type of Project	Proposed Impervious Surface				Earth Disturbance	
		0-1,000 sq.ft.	1,000-5,000 sq.ft.	5,000 sq.ft. – 1 acres	> 1 acre	5,000 sq.ft. – 1 acre	>1 acre
Article III Drainage Plan Requirements	Development	N/A	Modified	Yes	Yes	Modified	Yes
	Redevelopment	N/A	Modified	Yes	Yes	Modified	Yes
Section 404 Nonstructural Project Design	Development	N/A	Yes	Yes	Yes	Yes	Yes
	Redevelopment	N/A	Yes	Yes	Yes	Yes	Yes
Section 405 Groundwater Recharge	Development	N/A	Yes	Yes	Yes	N/A	Yes
	Redevelopment	N/A	Yes	Yes	Yes	N/A	Yes
Section 406 Water Quality Requirements	Development	Yes	Yes	Yes	Yes	Yes	Yes
	Redevelopment	Yes	Yes	Yes	Yes	Yes	Yes
Section 407 Stream Bank Erosion Requirements	Development	N/A	Exempt	Yes	Yes	N/A	Yes
	Redevelopment	N/A	Exempt	Exempt	Yes	N/A	Yes
Section 408 Stormwater Peak Rate Control and Management Districts	Development	N/A	Exempt	Yes	Yes	Yes	Yes
	Redevelopment	N/A	Exempt	Yes	Yes	Yes	Yes
Erosion & Sediment Pollution Control Plan Submission to the Conservation District	Earth Disturbance	**See Earth Disturbance Requirements**	See Earth Disturbance Requirements	See Earth Disturbance Requirements	See Earth Disturbance Requirements	Yes	Yes
		Refer to municipal earth disturbance requirements, as applicable)					

Legend:
Yes - Drainage plan required with associated section provision.
N/A - Not applicable – exempt from drainage plan submission.
Exempt - Exempt from required section provision – Drainage plan submission may still be required if other section provisions are applicable (yes in box).
Modified - Modified drainage plan required

– Sites with less than one thousand (1,000) square feet of impervious surface, but between five thousand (5,000) square feet and one (1) acre of earth disturbance must submit a drainage plan to the Municipality which need only consist of the items in Sections 302.A.2 and 4; 302.B.7, 8, 11, and 22; and 302.D.1 and 3 and related supportive material needed to determine compliance with Sections 404 and 408.
– Sites with more than one thousand (1,000) square feet, but less than five thousand (5,000) square feet of impervious surface must submit a drainage plan; however, it need not consist of the items in Sections 407 and 408.

Section 106. Exemptions

A. Exemptions for Land Use Activities

The following land use activities are exempt from the drainage plan submission requirements of this Ordinance.

1. Use of land for gardening for home consumption.

2. Agriculture when operated in accordance with a conservation plan, nutrient management plan, or erosion and sedimentation control plan approved by the County Conservation District, including activities such as growing crops, rotating

crops, tilling of soil, and grazing animals. Installation of new or expansion of existing farmsteads, animal housing, waste storage, and production areas having impervious surfaces that result in a net increase in earth disturbance of greater than five thousand (5,000) square feet shall be subject to the provisions of this Ordinance.

3. Forest management operations that are following the Department of Environmental Protection's (DEP) management practices contained in its publication "Soil Erosion and Sedimentation Control Guidelines for Forestry" and are operating under an approved erosion and sedimentation plan and must comply with the stream buffer requirements in Section 406.G.

4. Road replacement, development, or redevelopment that has less than one thousand (1,000) square feet of new, additional, or replaced impervious surface/cover, or in the case of earth disturbance only, less than five thousand (5,000) square feet of disturbance, is exempt from this Ordinance.

B. Exemptions for Land Development Activities

The following land development and earthmoving activities are exempt from the drainage plan submission requirements of this Ordinance.

1. A maximum of one thousand (1,000) square feet of new, additional, or replacement proposed impervious surface. Or in the case of earth disturbance resulting in less than one thousand (1,000) square feet of impervious cover (as noted above)

2. Up to a maximum of five thousand (5,000) square feet of disturbed earth. These criteria shall apply to the total development even if the development is to take place in phases. The date of the municipal Ordinance adoption shall be the starting point from which to consider tracts as "parent tracts" upon which future subdivisions and respective earth disturbance computations shall be cumulatively considered.

The activities exempted above are still encouraged to implement the voluntary stormwater management practices as indicated in Ordinance Appendix B.

C. Additional Exemption Criteria:

1. Exemption Responsibilities - An exemption shall not relieve the Applicant from implementing such measures as are necessary to protect public health, safety, and property.

2. HQ and EV Streams - An exemption shall not relieve the Applicant from meeting the special requirements for watersheds draining to identified high quality (HQ) or exceptional value (EV) waters and Source Water Protection Areas (SWPA) and requirements for nonstructural project design sequencing (Section 404).

3. Drainage Problems - If a drainage problem is documented or known to exist downstream of or is expected from the proposed activity, then the Municipality may require the Applicant to comply with this Ordinance.

4. Emergency Exemption - Emergency maintenance work performed for the protection of public health, safety, and welfare. A written description of the scope and extent of any emergency work performed shall be submitted to the [*Municipality*] within two (2) calendar days of the commencement of the activity. If the [*Municipality*] finds that the work is not an emergency, then the work shall cease immediately, and the requirements of this Ordinance shall be addressed as applicable.
5. Maintenance Exemption - Any maintenance to an existing stormwater management system made in accordance with plans and specifications approved by the municipal Engineer or [*Municipality*].
6. Even though the developer is exempt, he is not relieved from complying with other regulations.

Section 107. Repealer

Any ordinance or ordinance provision of the Municipality inconsistent with any of the provisions of this Ordinance is hereby repealed to the extent of the inconsistency only.

Section 108. Severability

Should any section or provision of this Ordinance be declared invalid by a court of competent jurisdiction, such decision shall not affect the validity of any of the remaining provisions of this Ordinance.

Section 109. Compatibility with Other Ordinances or Legal Requirements

Approvals issued pursuant to this Ordinance do not relieve the Applicant of the responsibility to secure required permits or approvals for activities regulated by any other applicable code, rule, act, or ordinance.

To the extent that this Ordinance imposes more rigorous or stringent requirements for stormwater management, the specific requirements contained in this Ordinance shall be followed.

Nothing in this Ordinance shall be construed to affect any of the Municipality's requirements regarding stormwater matters that do not conflict with the provisions of this Ordinance, such as local stormwater management design criteria (e.g., inlet spacing, inlet type, collection system design and details, outlet structure design, etc.). Conflicting provisions in other municipal ordinances or regulations shall be construed to retain the requirements of this Ordinance addressing state water quality requirements.

ARTICLE II – DEFINITIONS

Section 201. Interpretation

For the purposes of this Ordinance, certain terms and words used herein shall be interpreted as follows:

A. Words used in the present tense include the future tense; the singular number includes the plural, and the plural number includes the singular; words of masculine gender include feminine gender; and words of feminine gender include masculine gender.

B. The word "includes" or "including" shall not limit the term to the specific example, but is intended to extend its meaning to all other instances of like kind and character.

C. The word "person" includes an individual, firm, association, organization, partnership, trust, company, corporation, unit of government, or any other similar entity.

D. The words "shall" and "must" are mandatory; the words "may" and "should" are permissive.

E. The words "used" or "occupied" include the words "intended, designed, maintained, or arranged to be used, occupied, or maintained."

Section 202. Definitions

Accelerated Erosion – The removal of the surface of the land through the combined action of man's activity and the natural processes of a rate greater than would occur because of the natural process alone.

Agricultural Activities – The work of producing crops and raising livestock including tillage, plowing, disking, harrowing, pasturing, mushroom growing, nursery, and sod operations and installation of conservation measures. Construction of new buildings or impervious area is not considered an agricultural activity.

Alteration – As applied to land, a change in topography as a result of the moving of soil and rock from one location or position to another; also the changing of surface conditions by causing the surface to be more or less impervious; land disturbance.

Applicant – A person who has filed an application for approval to engage in any regulated activity defined in Section 105 of this Ordinance.

As-built Drawings – Engineering or site drawings maintained by the contractor as he constructs the project and upon which he documents the actual locations of the building components and changes to the original contract documents. These documents, or a copy of same, are turned over to the municipal Engineer at the completion of the project.

Bankfull – The channel at the top-of-bank or point from where water begins to overflow onto a floodplain.

Baseflow – Portion of stream discharge derived from groundwater; the sustained discharge that does not result from direct runoff or from water diversions, reservoir releases, piped discharges, or other human activities.

Bioretention – A stormwater retention area that utilizes woody and herbaceous plants and soils to remove pollutants before infiltration occurs.

BMP (Best Management Practice) – Methods, measures, or practices used to prevent or reduce surface runoff and/or water pollution including, but not limited to, structural and nonstructural stormwater management practices and operation and maintenance procedures. See also Non-structural Best Management Practice (BMP).

Buffer – The area of land immediately adjacent to any stream, measured perpendicular to and horizontally from the top-of-bank on both sides of a stream (see Top-of-bank).

Channel – An open drainage feature through which stormwater flows. Channels include, but shall not be limited to, natural and man-made drainageways, swales, streams, ditches, canals, and pipes flowing partly full.

Channel Erosion – The widening, deepening, or headward cutting of channels and waterways caused by stormwater runoff or bankfull flows.

Cistern – An underground reservoir or tank for storing rainwater.

Conservation District – The [*Berks or Montgomery*] County Conservation District.

Conveyance – A facility or structure used for the transportation or transmission of something from one place to another.

Culvert – A structure with its appurtenant works that carries water under or through an embankment or fill.

Dam – A man-made barrier, together with its appurtenant works, constructed for the purpose of impounding or storing water or another fluid or semifluid. A dam may include a refuse bank, fill, or structure for highway, railroad, or other purposes which impounds or may impound water or another fluid or semifluid.

Department – The Pennsylvania Department of Environmental Protection.

Designee – The agent of the [*Berks or Montgomery*] County Planning Commission, [*Berks or Montgomery*] County Conservation District, and/or agent of the Governing Body involved with the administration, review, or enforcement of any provisions of this Ordinance by contract or memorandum of understanding.

Design Professional (Qualified) – A Pennsylvania Registered Professional Engineer, Registered Landscape Architect, or Registered Professional Land Surveyor trained to develop stormwater management plans.

Design Storm – The magnitude and temporal distribution of precipitation from a storm event measured in probability of occurrence (e.g., a 5-year storm) and duration (e.g., twenty-four (24) hours), used in the design and evaluation of stormwater management systems.

Detention Basin – An impoundment designed to collect and retard stormwater runoff by temporarily storing the runoff and releasing it at a predetermined rate. Detention basins are

designed to drain completely soon after a rainfall event and become dry until the next rainfall event.

Developer – A person who seeks to undertake any regulated earth disturbance activities at a project site in the Municipality.

Development – Any human-induced change to improved or unimproved real estate, whether public or private, including, but not limited to, land development, construction, installation, or expansion of a building or other structure, land division, street construction, drilling, and site alteration such as embankments, dredging, grubbing, grading, paving, parking or storage facilities, excavation, filling, stockpiling, or clearing. As used in this Ordinance, development encompasses both new development and redevelopment.

Development Site – The specific tract or parcel of land where any regulated activity set forth in Section 105 is planned, conducted, or maintained.

Diameter at Breast Height (DBH) – The outside bark diameter at breast height which is defined as four and one half (4.5) feet (1.37m) above the forest floor on the uphill side of the tree.

Diffused Drainage Discharge – Drainage discharge that is not confined to a single point location or channel, including sheet flow or shallow concentrated flow.

Discharge – 1. (verb) To release water from a project, site, aquifer, drainage basin, or other point of interest; 2. (noun) The rate and volume of flow of water such as in a stream, generally expressed in cubic feet per second (see Peak Discharge).

Discharge Point – The point of discharge for a stormwater facility.

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

Ditch – A man-made waterway constructed for irrigation or stormwater conveyance purposes.

Downslope Property Line – That portion of the property line of the lot, tract, or parcels of land being developed, located such that overland or pipe flow from the project site would be directed towards it by gravity.

Drainage Conveyance Facility – A stormwater management facility designed to transport stormwater runoff that includes channels, swales, pipes, conduits, culverts, and storm sewers.

Drainage Easement – A right granted by a landowner to a grantee allowing the use of private land for stormwater management purposes.

Drainage Permit – A permit issued by the Municipality after the drainage plan has been approved.

Drainage Plan – The documentation of the stormwater management system, if any, to be used for a given development site, the contents of which are established in Section 302.

Earth Disturbance Activity – A construction or other human activity which disturbs the surface of land including, but not limited to, clearing and grubbing, grading, excavations, embankments, land development, agricultural plowing or tilling, timber harvesting activities, road maintenance

activities, mineral extraction, and the moving, depositing, stockpiling, or storing of soil, rock, or earth materials.

Emergency Spillway – A conveyance area that is used to pass peak discharge greater than the maximum design storm controlled by the stormwater facility.

Encroachment – A structure or activity that changes, expands, or diminishes the course, current, or cross-section of a watercourse, floodway, or body of water.

Erosion – The process by which the surface of the land, including water/stream channels, is worn away by water, wind, or chemical action.

Erosion and Sediment Control Plan – A plan that is designed to minimize accelerated erosion and sedimentation. Said plan must be submitted to and approved by the appropriate Conservation District before construction can begin.

Exceptional Value Waters – Surface waters of high quality that satisfy Pennsylvania Code Title 25 Environmental Protection, Chapter 93, Water Quality Standards, §93.4b(b) (relating to anti-degradation).

Existing Conditions – The initial condition of a project site prior to the proposed alteration. If the initial condition of the site is undeveloped land, the land use shall be considered as "meadow" unless the natural land cover is proven to generate a lower curve number or Rational "c" value, such as forested lands.

Flood – A temporary condition of partial or complete inundation of land areas from the overflow of streams, rivers, and other waters of this Commonwealth.

Floodplain – Any land area susceptible to inundation by water from any natural source or as delineated by the applicable Department of Housing and Urban Development, Federal Insurance Administration Flood Hazard Boundary Map as being a special flood hazard area.

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

Fluvial Geomorphology – The study of landforms associated with river channels and the processes that form them.

Forest Management/Timber Operations – Planning and associated activities necessary for the management of forest lands. These include timber inventory and preparation of forest management plans, silvicultural treatment, cutting budgets, logging road design and construction, timber harvesting, and reforestation.

Freeboard – A vertical distance between the elevation of the design high-water and the top of a dam, levee, tank, basin, swale, or diversion berm. The space is required as a safety margin in a pond or basin.

Grade – 1. (noun) A slope, usually of a road, channel, or natural ground specified in percent and shown on plans as specified herein. 2. (verb) To finish the surface of a roadbed, the top of an embankment, or the bottom of an excavation.

Grassed Waterway – A natural or man-made waterway, usually broad and shallow, covered with erosion-resistant grasses used to convey surface water.

Groundwater – Water beneath the earth's surface that supplies wells and springs and is often between saturated soil and rock.

Groundwater Recharge – The replenishment of existing natural underground water supplies from rain or overland flow.

High Quality Waters – Surface waters having quality which exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water by satisfying Pennsylvania Code Title 25 Environmental Protection, Chapter 93, Water Quality Standards, § 93.4b(a).

Hotspots – Areas where land use or activities generate highly contaminated runoff, with concentrations of pollutants in excess of those typically found in stormwater.

Hydrograph – A graph representing the discharge of water versus time for a selected point in the drainage system.

Hydrologic Regime – The hydrologic cycle or balance that sustains quality and quantity of stormwater, baseflow, storage, and groundwater supplies under natural conditions.

Hydrologic Soil Group – A classification of soils by the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), into four runoff potential groups. The groups range from A soils, which are very permeable and produce little runoff, to D soils, which are not very permeable and produce much more runoff.

Impervious Surface – A surface that prevents the infiltration of water into the ground. Impervious surfaces include, but are not limited to, streets, sidewalks, pavements, driveway areas, or roofs. Any surface areas designed to be gravel or crushed stone shall be regarded as impervious surfaces.

Impoundment – A retention or detention basin designed to retain stormwater runoff and release it at a controlled rate.

Infill – Development that occurs on smaller parcels that remain undeveloped but are within or in very close proximity to urban or densely developed areas. Infill development usually relies on existing infrastructure and does not require an extension of water, sewer, or other public utilities.

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.

Infiltration Structures – A structure designed to direct runoff into the underground water (e.g., French drains, seepage pits, or seepage trenches).

Inflow – The flow entering the stormwater management facility and/or BMP.

Inlet – The upstream end of any structure through which water may flow.

Intermittent Stream – A stream that flows only part of the time. Flow generally occurs for several weeks or months in response to seasonal precipitation or groundwater discharge.

Invert – The lowest surface, the floor or bottom of a culvert, drain, sewer, channel, basin, BMP, or orifice.

Land Development – Any of the following activities:

(i) The improvement of one (1) lot or two (2) or more contiguous lots, tracts, or parcels of land for any purpose involving:

a. A group of two (2) or more residential or nonresidential buildings, whether proposed initially or cumulatively, or a single nonresidential building on a lot or lots regardless of the number of occupants or tenure,

or

b. The division or allocation of land or space, whether initially or cumulatively, between or among two (2) or more existing or prospective occupants by means of, or for the purpose of, streets, common areas, leaseholds, condominiums, building groups, or other features;

(ii) A subdivision of land;

(iii) Development in accordance with Section 503(1.1) of the PA Municipalities Planning Code.

Limiting Zone – A soil horizon or condition in the soil profile or underlying strata that includes one of the following:

(i) A seasonal high water table, whether perched or regional, determined by direct observation of the water table or indicated by soil mottling.

(ii) A rock with open joints, fracture or solution channels, or masses of loose rock fragments, including gravel, with insufficient fine soil to fill the voids between the fragments.

(iii) A rock formation, other stratum, or soil condition that is so slowly permeable that it effectively limits downward passage of water.

Lot – A designated parcel, tract, or area of land established by a plat or otherwise as permitted by law and to be used, developed, or built upon as a unit.

Main Stem (Main Channel) – Any stream segment or other runoff conveyance used as a reach in watershed-specific hydrologic models.

Manning Equation (Manning Formula) – A method for calculation of velocity of flow (e.g., feet per second) and flow rate (e.g., cubic feet per second) in open channels based upon channel shape, roughness, depth of flow, and slope. “Open channels” may include closed conduits so long as the flow is not under pressure.

Maximum Design Storm – The maximum (largest) design storm that is controlled by the stormwater facility.

Municipal Engineer – A professional engineer licensed as such in the Commonwealth of Pennsylvania, duly appointed as the Engineer for a Municipality, planning agency, or joint planning commission.

Municipality – [*Municipal Name*], [*Berks or Montgomery*] County, Pennsylvania.

Natural Condition – Pre-development condition.

Natural Hydrologic Regime – See Hydrologic Regime.

Natural Recharge Area – Undisturbed surface area or depression where stormwater collects and a portion of which infiltrates and replenishes the underground and groundwater.

Nonpoint Source Pollution – Pollution that enters a waterbody from diffuse origins in the watershed and does not result from discernible, confined, or discrete conveyances.

Nonstormwater Discharges – Water flowing in stormwater collection facilities, such as pipes or swales, which is not the result of a rainfall event or snowmelt.

Nonstructural Best Management Practice (BMPs) – Methods of controlling stormwater runoff quantity and quality, such as innovative site planning, impervious area and grading reduction, protection of natural depression areas, temporary ponding on site, and other techniques.

NPDES – National Pollutant Discharge Elimination System, the federal government's system for issuance of permits under the Clean Water Act, which is delegated to DEP in Pennsylvania.

NRCS – Natural Resource Conservation Service (previously SCS).

Open Channel – A conveyance channel that is not enclosed.

Outfall – "Point source" as described in 40 CFR § 122.2 at the point where the Municipality's storm sewer system discharges to surface waters of the Commonwealth.

Outflow – The flow exiting the stormwater management facility and/or BMP.

Outlet – Points of water disposal to a stream, river, lake, tidewater, or artificial drain.

Parent Tract – The parcel of land from which a land development or subdivision originates, determined from the date of municipal adoption of this Ordinance.

Parking Lot Storage – Involves the use of parking areas as temporary impoundments with controlled release rates during rainstorms.

Peak Discharge – The maximum rate of stormwater runoff from a specific storm event.

Penn State Runoff Model – The computer-based hydrologic model developed at Pennsylvania State University.

Pipe – A culvert, closed conduit, or similar structure (including appurtenances) that conveys stormwater.

Planning Commission – The Planning Commission of [*Municipal Name*].

Point Source – Any discernible, confined, and discrete conveyance including, but not limited to, any pipe, ditch, channel, tunnel, or conduit from which stormwater is or may be discharged, as defined in state regulations at 25 Pennsylvania Code § 92.1.

Post-construction – Period after construction during which disturbed areas are stabilized, stormwater controls are in place and functioning, and all proposed improvements in the approved land development plan are completed.

Pre-construction – Prior to commencing construction activities.

Pre-development Condition – Undeveloped/natural condition.

Pretreatment – Techniques employed in stormwater BMPs to provide storage or filtering to trap coarse materials and other pollutants before they enter the system, but not necessarily designed to meet the water quality volume requirements of Section 406.

Project Site – The specific area of land where any regulated activities in the Municipality are planned, conducted, or maintained.

Rational Formula – A rainfall-runoff relation used to estimate peak flow.

Reach – Any stream segment or other runoff conveyance used in the watershed-specific hydrologic models.

Recharge – The replenishment of groundwater through the infiltration of rainfall, other surface waters, or land application of water or treated wastewater.

Reconstruction – Demolition and subsequent rebuilding of impervious surface.

Record Drawings – Original documents revised to suit the as-built conditions and subsequently provided by the Engineer to the client. The Engineer reviews the contractor's as-builts against his/her own records for completeness, then either turns these over to the client or transfers the information to a set of reproducibles, in both cases for the client's permanent records.

Redevelopment – Any development that requires demolition or removal of existing structures or impervious surfaces at a site and replacement with new impervious surfaces. Maintenance activities such as top-layer grinding and re-paving are not considered to be redevelopment. Interior remodeling projects and tenant improvements are also not considered to be redevelopment.

Regulated Activities – Actions or proposed actions that have an impact on stormwater runoff quality or quantity and that are specified in Section 105 of this Ordinance.

Regulated Earth Disturbance Activity – Defined under NPDES Phase II regulations as earth disturbance activity of one (1) acre or more with a point source discharge to surface waters or the Municipality's storm sewer system or five (5) acres or more regardless of the planned runoff. This includes earth disturbance on any portion of, part, or during any stage of a larger common plan of development.

Release Rate – The percentage of existing conditions peak rate of runoff from a site or subarea to which the proposed conditions peak rate of runoff must be reduced to protect downstream areas.

Repaving – Replacement of the impervious surface that does not involve reconstruction of an existing paved (impervious) surface.

Replacement Paving – Reconstruction of and full replacement of an existing paved (impervious) surface.

Retention Basin – A structure in which stormwater is stored and not released during the storm event. Retention basins are designed for infiltration purposes and do not have an outlet. The retention basin must infiltrate stored water in four (4) days or less.

Return Period – The average interval, in years, within which a storm event of a given magnitude can be expected to recur. For example, the 25-year return period rainfall would be expected to recur on the average of once every twenty-five (25) years.

Riser – A vertical pipe extending from the bottom of a pond that is used to control the discharge rate from the pond for a specified design storm.

Road Maintenance – Earth disturbance activities within the existing road cross-section, such as grading and repairing existing unpaved road surfaces, cutting road banks, cleaning or clearing drainage ditches, and other similar activities.

Roof Drains – A drainage conduit or pipe that collects water runoff from a roof and leads it away from the structure.

Rooftop Detention – The temporary ponding and gradual release of stormwater falling directly onto flat roof surfaces using controlled-flow roof drains in building designs.

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

SALDO – Subdivision and land development ordinance.

Sediment Basin – A barrier, dam, or retention or detention basin located and designed in such a way as to retain rock, sand, gravel, silt, or other material transported by water during construction.

Sediment Pollution – The placement, discharge, or any other introduction of sediment into the waters of the Commonwealth.

Sedimentation – The process by which mineral or organic matter is accumulated or deposited by the movement of water or air.

Seepage Pit/Seepage Trench – An area of excavated earth filled with loose stone or similar coarse material into which surface water is directed for infiltration into the underground water.

Separate Storm Sewer System – A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) primarily used for collecting and conveying stormwater runoff.

Shallow Concentrated Flow – Stormwater runoff flowing in shallow, defined ruts prior to entering a defined channel or waterway.

Sheet Flow – A flow process associated with broad, shallow water movement on sloping ground surfaces that is not channelized or concentrated.

Soil Cover Complex Method – A method of runoff computation developed by NRCS that is based on relating soil type and land use/cover to a runoff parameter called curve number (CN).

Source Water Protection Areas (SWPA) – The zone through which contaminants, if present, are likely to migrate and reach a drinking water well or surface water intake.

Special Protection Subwatersheds – Watersheds that have been designated by DEP as EV or HQ waters.

Spillway – A conveyance that is used to pass the peak discharge of the maximum design storm that is controlled by the stormwater facility.

State Water Quality Requirements – The regulatory requirements to protect, maintain, reclaim, and restore water quality under Pennsylvania Code Title 25 and the Clean Streams law.

Storage Indication Method – A reservoir routing procedure based on solution of the continuity equation (inflow minus outflow equals the change in storage) with outflow defined as a function of storage volume and depth.

Storm Frequency – The number of times that a given storm "event" occurs or is exceeded on the average in a stated period of years (see Return Period).

Storm Sewer – A system of pipes and/or open channels that conveys intercepted runoff and stormwater from other sources but excludes domestic sewage and industrial wastes.

Stormwater – The surface runoff generated by precipitation reaching the ground surface.

Stormwater Management District – Those subareas of a watershed in which some type of detention is required to meet the plan requirements and the goals of Act 167.

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

Stormwater Management Plan – The watershed plan, known as the "Swamp Creek Watershed Act 167 Stormwater Management Plan," for managing those land use activities that will influence stormwater runoff quality and quantity and that would impact the Swamp Creek watershed adopted by Berks County and Montgomery County as required by the Act of October 4, 1978, P.L. 864 (Act 167).

Stormwater Management Site Plan – The plan prepared by the Applicant or his representative indicating how stormwater runoff will be managed at the particular site of interest according to this Ordinance.

Stream – A natural watercourse.

Stream Buffer – The land area adjacent to each side of a stream essential to maintaining water quality (see Buffer).

Stream Enclosure – A bridge, culvert, or other structure in excess of one hundred (100) feet in length upstream to downstream which encloses a regulated water of the Commonwealth.

Subarea (Subwatershed) – The smallest drainage unit of a watershed for which stormwater management criteria have been established in the stormwater management plan.

Subdivision – The division or redivision of a lot, tract, or parcel of land by any means into two (2) or more lots, tracts, parcels, or other divisions of land including changes in existing lot lines for the purpose, whether immediate or future, of lease, partition by the court for distribution to heirs or devisees, transfer of ownership, or building or lot development; provided, however, that the subdivision by lease of land for agricultural purposes into parcels of more than ten (10) acres not involving any new street or easement of access or any residential dwelling shall be exempted.

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

Swale – A low-lying stretch of land that gathers or carries surface water runoff.

Timber Operations – See Forest Management.

Time-of-concentration (Tc) – The time required for surface runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. This time is the combined total of overland flow time and flow time in pipes or channels, if any.

Top-of-bank – Highest point of elevation in a stream channel cross-section at which a rising water level just begins to flow out of the channel and over the floodplain.

Undeveloped Condition – Natural condition (see also Pre-development Condition).

Vernal Pond – Seasonal depressional wetlands that are covered by shallow water for variable periods from winter to spring but may be completely dry for most of the summer and fall.

Watercourse – A channel or conveyance of surface water having a defined bed and banks, whether natural or artificial, with perennial or intermittent flow.

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

Watershed – Region or area drained by a river, watercourse, or other body of water, whether natural or artificial.

Wellhead – 1. A structure built over a well, 2. The source of water for a well.

Wellhead Protection Area – The surface and subsurface area surrounding a water supply well, well field, or spring supplying a public water system through which contaminants are reasonably likely to move toward and reach the water source.

Wet Basin – Pond for urban runoff management that is designed to detain urban runoff and always contains water.

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

Woods – A natural groundcover with more than one (1) viable tree of a DBH of six (6) inches or greater per fifteen hundred (1,500) square feet which existed within three (3) years of application; a cover condition for which SCS curve numbers have been assigned or to which equivalent Rational Method runoff coefficients have been assigned.

ARTICLE III – DRAINAGE PLAN REQUIREMENTS

Section 301. General Requirements

For any of the activities regulated by this Ordinance, the preliminary or final approval of subdivision and/or land development plans, the issuance of any building or occupancy permit, or the commencement of any earth disturbance activity may not proceed until the Property Owner or Applicant or his/her agent has received written approval of a drainage plan from the Municipality, obtained an NPDES Permit for Stormwater Discharges Associated with Construction Activities, if greater than 1 Acre of Land Disturbance, from the local Conservation District and/ or DEP, and an adequate Erosion and Sediment Control Plan review by the Conservation District.

Section 302. Drainage Plan Contents

The drainage plan shall consist of a general description of the project including sequencing items described in Section 404, calculations, maps, and plans. A note on the maps shall refer to the associated computations and erosion and sediment control plan by title and date. The cover sheet of the computations, erosion and sediment control plan, and Post-Construction Stormwater Management (PCSWM) Plan shall refer to the associated maps by
title and date. All drainage plan materials shall be submitted to the Municipality in a format that is clear, concise, legible, neat, and well organized; otherwise, the drainage plan shall not be accepted for review and shall be returned to the Applicant.
The following items shall be included in the drainage plan:

A. General

1. General description of the project including those areas described in Section 404.B.
2. General description of proposed permanent stormwater management techniques, including construction specifications of the materials to be used for stormwater management facilities.
3. Complete hydrologic, hydraulic, and structural computations for all stormwater management facilities.
4. An erosion and sediment control plan, including all reviews and letters of adequacy from the Conservation District.
5. A general description of proposed nonpoint source pollution controls.
6. The Drainage Plan Application and completed fee schedule form and associated fee (Ordinance Appendix C-1).
7. The Drainage Plan Checklist (Appendix C-2).

B. Maps

Map(s) of the project area shall be submitted on 24-inch x 36-inch sheets and/or shall be prepared in a form that meets the requirements for recording at the offices of the Recorder of Deeds of [*Berks or Montgomery*] County. If the SALDO has more stringent criteria than this Ordinance, then the more stringent criteria shall apply. The contents of the map(s) shall include, but not be limited to:

1. The location of the project relative to highways, municipal boundaries, or other identifiable landmarks.
2. Existing contours at intervals of two (2) feet. In areas of slopes greater than [__] percent, 5-foot contour intervals may be used.
3. Existing streams, lakes, ponds, or other waters of the Commonwealth within the project area.
4. Other physical features including flood hazard boundaries, stream buffers, existing drainage courses, areas of natural vegetation to be preserved, and the total extent of the upstream area draining through the site.
5. The locations of all existing and proposed utilities, sanitary sewers, and water lines within fifty (50) feet of property lines.
6. An overlay showing soil names, boundaries and limitations (in Tabular Format).
7. Limits of earth disturbance, including the type and amount of impervious area that would be added.
8. Proposed structures, roads, paved areas, and buildings.
9. Final contours at intervals of two (2) feet. In areas of steep slopes (greater than [__] percent), 5-foot contour intervals may be used.
10. The name of the development, the name and address of the owner of the property, and the name of the individual or firm preparing the plan.
11. The date of submission.
12. A graphic and written scale of one (1) inch equals no more than fifty (50) feet; for tracts of twenty (20) acres or more, the scale shall be one (1) inch equals no more than one hundred (100) feet.
13. A north arrow.
14. The total tract boundary and size with distances marked to the nearest foot and bearings to the nearest degree.
15. Existing and proposed land use(s).
16. A key map showing all existing man-made features beyond the property boundary that would be affected by the project.
17. Location of all open channels, as well as indicating where they are draining after they leave the site (storm sewer, defined drainage swale, stream channel, Waters of the Commonwealth, etc.).

18. Overland drainage patterns and swales.

19. A 15-foot wide access easement around all stormwater management facilities that would provide ingress to and egress from a public right-of-way.

20. The location of all erosion and sediment control facilities and all post-construction stormwater management facilities, BMPs, systems, etc.

21. A note on the plan indicating the location and responsibility for maintenance of stormwater management facilities that would be located off site. All offsite facilities shall meet the performance standards and design criteria specified in this Ordinance.

22. A statement, signed by the Applicant, acknowledging that any revision to the approved Post-Construction Stormwater Management Plan must be approved by the Municipality and the Conservation District and/ or DEP (if greater than 1 acre of land disturbance), and that a revised erosion and sediment control plan must be submitted to the Conservation District for a determination of adequacy.

23. The following signature block for the Design Engineer:

> "I, (Design Engineer), on this date (date of signature), hereby certify that the drainage plan meets all design standards and criteria of the [Municipality] Stormwater Management Ordinance."

C. Supplemental Information to be Submitted to the Municipality

1. A written description of the following information shall be submitted by the Applicant and shall include:

   a. The overall stormwater management concept for the project designed in accordance with Section 404.

   b. Stormwater runoff computations as specified in this Ordinance.

   c. Stormwater management techniques to be applied both during and after development.

   d. Expected project time schedule.

   e. Development stages or project phases, if so proposed.

   f. An operations and maintenance plan in accordance with Section 702 of this Ordinance.

2. An erosion and sediment control plan.

3. A description of the effect of the project (in terms of runoff volumes and peak flows) on adjacent properties and on any existing municipal stormwater collection system that may receive runoff from the project site.

4. A Declaration of Adequacy and Highway Occupancy Permit from the Pennsylvania Department of Transportation (PennDOT) District office when utilization of a PennDOT storm drainage system is proposed.

D. Stormwater Management Facilities

1. All PCSWM BMP facilities must be located on a plan and described in detail. The PCSWM Plan Package should include at a minimum Pre- and Post-Drainage Area Plans, an Overall PCSWM Plan, PCSWM Details Sheets, Landscaping or Conservation Plans, etc.

2. When infiltration measures such as seepage pits, beds, or trenches are used, the locations of existing and proposed septic tank, infiltration areas and wells must be shown. Minimum setback distances should be identified from water supply wells, septic areas, and any adjacent or downgradient buildings and/ or structures with below grade floors or inhabitable space.

3. All calculations, assumptions, and criteria used in the design of the stormwater management facilities must be shown.

Section 303. Plan Submission

The Municipality shall require receipt of a complete drainage plan, as specified in this Ordinance.

A. Proof of application or documentation of required permit(s) or approvals for the programs listed below shall be part of the plan:

   1. NPDES Permit for Stormwater Discharges from Construction Activities

   2. DEP Joint Permit Application

   3. PennDOT Highway Occupancy Permit

   4. Chapter 105 (Dam Safety and Waterway Management)

   5. Chapter 106 (Floodplain Management)

   6. Any other permit under applicable state or federal regulations

B. The plan shall be coordinated with the state and federal permit process and the municipal SALDO review process.

C. For projects that require SALDO approval, the drainage plan shall be submitted by the Applicant as part of the preliminary plan submission where applicable for the regulated activity.

D. For regulated activities that do not require SALDO approval, see Section 301, General Requirements.

E. Six (6) copies of the drainage plan shall be submitted and distributed as follows:

   1. Two (2) copies to the Municipality accompanied by the requisite municipal review fee, as specified in this Ordinance.

   2. Two (2) copies to the County Conservation District.

   3. One (1) copy to the municipal Engineer.

   4. One (1) copy to the County Planning Commission/Department.

F. Any submissions to the agencies listed above that are found to be incomplete shall not be accepted for review and shall be returned to the Applicant with a notification in writing of the specific manner in which the submission is incomplete.

Section 304. Drainage Plan Review

A. The municipal Engineer shall review the drainage plan for consistency with this Ordinance and the respective Act 167 Stormwater Management Plan. Any found incomplete shall not be accepted for review and shall be returned to the Applicant.

B. The municipal Engineer shall review the drainage plan for any subdivision or land development against the municipal SALDO provisions not otherwise superseded by this Ordinance.

C. The Conservation District, in accordance with established criteria and procedures, shall review the drainage plan for consistency with stormwater management and erosion and sediment pollution control requirements and provide comments to the Municipality. Such comments shall be considered by the Municipality prior to final approval of the drainage plan.

D. For activities regulated by this Ordinance, the municipal Engineer shall notify the Applicant and the Municipality in writing, within [__] calendar days, whether the drainage plan is consistent with the Act 167 Stormwater Management Plan.

1. If the municipal Engineer determines that the drainage plan is consistent with the Act 167 Stormwater Management Plan, the municipal Engineer shall forward a letter of consistency to the municipal Secretary who will then forward a copy to the Applicant.

2. If the municipal Engineer determines that the drainage plan is inconsistent or noncompliant with the Act 167 Stormwater Management Plan, the municipal Engineer shall forward a letter to the municipal Secretary with a copy to the Applicant citing the reason(s) and specific Ordinance sections for the inconsistency or noncompliance. Inconsistency or noncompliance may be due to inadequate information to make a reasonable judgment as to compliance with the Act 167 Stormwater Management Plan. Any drainage plans that are inconsistent or noncompliant may be revised by the Applicant and resubmitted when consistent with this Ordinance. The municipal Secretary shall then notify the Applicant of the municipal Engineer’s findings. Any inconsistent or noncompliant drainage plans may be revised by the Applicant and resubmitted consistent with this Ordinance.

E. For regulated activities specified in Section 105 of this Ordinance that require a building permit, the municipal Engineer shall notify the municipal Building Permit Officer in writing, within a time frame consistent with the municipal Building Code and/or municipal SALDO, whether the drainage plan is consistent with the Act 167 Stormwater Management Plan. The municipal Building Permit Officer shall forward a copy of the consistency/inconsistency letter to the Applicant. Any drainage plan deemed inconsistent may be revised by the Applicant and resubmitted consistent with this Ordinance.

F. For regulated activities under this Ordinance that require an NPDES Permit Application, the Applicant shall forward a copy of the municipal Engineer's letter stating that the drainage plan is consistent with the Act 167 Stormwater Management Plan to the Conservation District and/or DEP. In addition, a short summary of the proposed Post-Construction Stormwater Management design and proposed BMPs should also be forwarded to the Conservation District and/ or DEP. DEP and the Conservation District may consider the municipal Engineer's review comments in determining whether to issue a permit.

G. The Municipality shall not grant preliminary or final approval to any subdivision or land development for regulated activities specified in Section 105 of this Ordinance if the drainage plan has been found by the municipal Engineer to be inconsistent with the Act 167 Stormwater Management Plan. All required permits from DEP must be obtained prior to approval of any subdivision or land development.

H. No building permits for any regulated activity specified in Section 105 of this Ordinance shall be approved by the Municipality if the drainage plan has been found to be inconsistent with the Act 167 Stormwater Management Plan, as determined by the municipal Engineer and Conservation District, or without considering the comments of the municipal Engineer and Conservation District. All required permits from DEP must be obtained prior to issuance of a building permit.

I. The Applicant shall be responsible for completing record drawings of all stormwater management facilities included in the approved drainage plan. The record drawings and an explanation of any discrepancies with the design plans shall be submitted to the municipal Engineer for final approval. In no case shall the Municipality approve the record drawings until the Municipality receives a copy of an approved Declaration of Adequacy and/or Highway Occupancy Permit from the PennDOT District office, NPDES Permit, and any other applicable permits or approvals from DEP or the Conservation District. The above permits and approvals must be based on the record drawings.

J. The Municipality's approval of a drainage plan shall be valid for a period not to exceed [*recommend 5*] years commencing on the date that the Municipality signs the approved drainage plan. If stormwater management facilities included in the approved drainage plan have not been constructed, or if constructed, record drawings of these facilities have not been approved within this [__] year time period, then the Municipality may consider the drainage plan inconsistent or noncompliant and may revoke any and all permits. Drainage plans that are determined to be inconsistent or noncompliant by the Municipality shall be resubmitted in accordance with Section 306 of this Ordinance.

Section 305. Modification of Plans

A. A modification to a submitted drainage plan under review by the Municipality for a development site that involves the following shall require a resubmission to the Municipality of a modified drainage plan consistent with Section 303 of this Ordinance and be subject to review as specified in Section 304 of this Ordinance:

1. Change in stormwater management facilities or techniques,

2. Relocation or redesign of stormwater management facilities, or

3. Is necessary because soil or other conditions are not as stated on the drainage plan as determined by the municipal Engineer.

B. A modification to an already approved or inconsistent or noncompliant drainage plan shall be submitted to the Municipality, accompanied by the applicable municipal review and inspection fee. A modification to a drainage plan for which a formal action has not been taken by the Municipality shall be submitted to the Municipality accompanied by the applicable municipal review and inspection fee.

Section 306. Resubmission of Inconsistent or Noncompliant Drainage Plans

An inconsistent or noncompliant drainage plan may be resubmitted with the revisions addressing the municipal Engineer's concerns documented in writing. It must be addressed to the municipal Secretary in accordance with Section 303 of this Ordinance, distributed accordingly, and be subject to review as specified in Section 304 of this Ordinance. The applicable municipal review and inspection fee must accompany a resubmission of an inconsistent or noncompliant drainage plan.

ARTICLE IV – STORMWATER MANAGEMENT

Section 401. General Requirements

A. Applicants proposing regulated activities in the Municipality that do not fall under the exemption criteria shown in Section 106 shall submit a drainage plan consistent with this Ordinance and the respective Act 167 Stormwater Management Plan to the Municipality for review. The stormwater management criteria of this Ordinance shall apply to the total proposed development even if development is to take place in stages.

B. The Applicant is required to find practicable alternatives to the surface discharge of stormwater, the creation of impervious surfaces, and the degradation of waters of the Commonwealth and must maintain as much as possible the natural hydrologic regime.

C. The drainage plan must be designed consistent with the sequencing provisions of Section 404 to ensure maintenance of the natural hydrologic regime, to promote groundwater recharge, and to protect groundwater and surface water quality and quantity. The drainage plan designer must proceed sequentially in accordance with Article IV of this Ordinance.

D. Stormwater drainage systems shall be designed in order to permit unimpeded flow along natural watercourses, except as modified by stormwater management facilities or open channels consistent with this Ordinance.

E. Existing points of concentrated drainage that discharge onto adjacent property shall not be altered in any manner which could cause property damage without permission of the affected property owner(s) and shall be subject to any applicable discharge criteria specified in this Ordinance.

F. Areas of existing diffused drainage discharge, whether proposed to be concentrated or maintained as diffused drainage areas, shall be subject to any applicable discharge criteria in the general direction of existing discharge, except as otherwise provided by this Ordinance. If diffused drainage discharge is proposed to be concentrated and discharged onto adjacent property, the Applicant must document that adequate downstream conveyance facilities exist to safely transport the concentrated discharge or otherwise prove that no erosion, sedimentation, flooding, or other impacts will result from the concentrated discharge.

G. Where a development site is traversed by existing streams, drainage easements shall be provided conforming to the line of such streams. The terms of the easement shall conform to the stream buffer requirements contained in Section 406.G of this Ordinance.

H. Any stormwater management facilities regulated by this Ordinance that would be located in or adjacent to waters of the Commonwealth or delineated wetlands shall be subject to approval by DEP through the Joint Permit Application or the Environmental Assessment Approval process, or where deemed appropriate, by the DEP General Permit process. When there is a question as to whether wetlands may be involved, it is the responsibility of the Applicant or his agent to show that the land in question cannot be classified as wetlands; otherwise, approval to work in the area must be obtained from DEP.

I. Any proposed stormwater management facilities regulated by this Ordinance that would be located on state highway rights-of-way shall be subject to approval by PennDOT.

J. Minimization of impervious surfaces and infiltration of runoff through seepage beds, infiltration trenches, etc., is encouraged where soil conditions permit in order to reduce the size or eliminate the need for detention facilities or other structural BMPs.

K. All stormwater runoff shall be pretreated for water quality prior to discharge to surface or groundwater.

L. All regulated activities within the Municipality shall be designed, implemented, operated, and maintained to meet the purposes of this Ordinance, through these two elements:

1. Erosion and sediment control during earth disturbance activities (e.g., during construction), and

2. Water quality protection measures after completion of earth disturbance activities (i.e., after construction), including operations and maintenance.

M. No regulated earth disturbance activities within the Municipality shall commence until the requirements of this Ordinance are met.

N. Post-construction water quality protection shall be addressed as required by Section 406.

O. Operations and maintenance of permanent stormwater BMPs shall be addressed as required by Article VII.

P. All BMPs used to meet the requirements of this Ordinance shall conform to the state water quality requirements and any more stringent requirements as set forth by the Municipality.

Q. Techniques described in Appendix D (Low Impact Development) of this Ordinance shall be considered because they reduce the costs of complying with the requirements of this Ordinance and the state water quality requirements.

R. In selecting the appropriate BMPs or combinations thereof, the Applicant shall consider the following:

1. Total contributing area.

2. Permeability and infiltration rate of the site’s soils.

3. Slope and depth to bedrock.

4. Seasonal high water table.

5. Proximity to building foundations and wellheads.

6. Erodibility of soils.

7. Land availability and configuration of the topography.

8. Peak discharge and required volume control.

9. Stream bank erosion.

10. Effectiveness of the BMPs to mitigate potential water quality problems.

11. The volume of runoff that will be effectively treated.

12. The nature of the pollutant being removed.

13. Maintenance requirements.

14. Creation/protection of aquatic and wildlife habitat.

15. Recreational value.

R. The applicant may meet the stormwater management criteria through off-site stormwater management measures as long as the proposed measures are in the same subwatershed as shown in Ordinance Appendix A.

Section 402. Permit Requirements by Other Governmental Entities

The following permit requirements may apply to certain regulated earth disturbance activities and must be met prior to commencement of regulated earth disturbance activities, as applicable:

A. All regulated earth disturbance activities subject to permit requirements by DEP under regulations at 25 Pennsylvania Code Chapter 102.

B. Work within natural drainageways subject to permit by DEP under 25 Pennsylvania Code Chapter 105.

C. Any stormwater management facility that would be located in or adjacent to surface waters of the Commonwealth, including wetlands, subject to permit by DEP under 25 Pennsylvania Code Chapter 105.

D. Any stormwater management facility that would be located on a state highway right-of-way or require access from a state highway shall be subject to approval by PennDOT.

E. Culverts, bridges, storm sewers, or any other facilities which must pass or convey flows from the tributary area and any facility which may constitute a dam subject to permit by DEP under 25 Pennsylvania Code Chapter 105.

Section 403. Erosion and Sediment Control During Regulated Earth Disturbance Activities

A. No regulated earth disturbance activities within the Municipality shall commence until the Municipality receives an approval from the Conservation District of an erosion and sediment control plan for construction activities.

B. DEP has regulations that require an erosion and sediment control plan for any earth disturbance activity of five thousand (5,000) square feet or more, under 25 Pennsylvania Code § 102.4(b).

C. In addition, under 25 Pennsylvania Code Chapter 92, a DEP Permit for Stormwater Discharges Associated with Construction Activities is required for land disturbances greater than 1 acre.

D. Evidence of any necessary permit(s) for regulated earth disturbance activities from the appropriate DEP regional office or County Conservation District must be provided to the Municipality.

E. A copy of the erosion and sediment control plan and any required permit, as required by DEP regulations, shall be available on the project site at all times.

F. Additional erosion and sediment control design standards and criteria are recommended to be applied where infiltration BMPs are proposed. They shall include the following:

1. Areas proposed for infiltration BMPs shall be protected from sedimentation and compaction during the construction phase to maintain maximum infiltration capacity. Additional measures, such as placement of orange construction fencing around proposed Infiltration BMPs during construction to minimize or eliminate traffic overtop of these areas, and temporary sealing off of pipes and inlet connections to Infiltration BMPs to prevent sediment clogging should be given consideration.

2. Infiltration BMPs shall not be constructed nor receive runoff until the entire drainage area contributory to the infiltration BMP has achieved final stabilization.

Section 404. Nonstructural Project Design (Sequencing to Minimize Stormwater Impacts)

A. The design of all regulated activities shall include the following to minimize stormwater impacts.

1. The Applicant shall find practicable alternatives to the surface discharge of stormwater, such as those listed in Appendix E, Table E-4, the creation of impervious surfaces, and the degradation of waters of the Commonwealth and must maintain as much as possible the natural hydrologic regime of the site.

2. An alternative is practicable if it is available and capable of implementation after taking into consideration existing technology and logistics in light of overall project purposes and other municipal requirements.

3. All practicable alternatives to the discharge of stormwater are presumed to have less adverse impact on quantity and quality of waters of the Commonwealth unless otherwise demonstrated.

B. The Applicant shall demonstrate that the regulated activities were designed in the following sequence. The goal of the sequence is to minimize the increases in stormwater runoff and impacts to water quality resulting from the proposed regulated activity:

1. Prepare an Existing Resource and Site Analysis Map (ERSAM) showing environmentally sensitive areas including, but not limited to, steep slopes, ponds, lakes, streams, wetlands, hydric soils, vernal pools, stream buffers, hydrologic soil groups, wooded areas, and potential infiltration areas. Land development, any existing recharge areas, and other requirements outlined in the municipal SALDO shall also be included.

2. Establish a stream buffer according to Section 406.G.

3. Prepare a draft project layout avoiding sensitive areas identified in Section 404.B.1.

4. Identify site-specific existing conditions drainage areas, discharge points, recharge areas, and hydrologic soil groups A and B (areas conducive to infiltration). Infiltration should still be considered in well draining soils listed as hydrologic soil group C, but additional soils testing should be performed to verify onsite conditions and placement of these BMPs.

5. Evaluate nonstructural stormwater management alternatives:

    a. Minimize earth disturbance.

    b. Minimize impervious surfaces.

    c. Break up large impervious surfaces.

6. Satisfy the groundwater recharge (infiltration) objective (Section 405) and provide for stormwater pretreatment prior to infiltration.

7. Provide for water quality protection in accordance with Section 406 water quality requirements.

8. Provide stream bank erosion protection in accordance with Section 407 stream bank erosion requirements.

9. Determine into what management district the site falls (Ordinance Appendix A) and conduct an existing conditions runoff analysis.

10. Prepare final project design to maintain existing conditions drainage areas and discharge points, to minimize earth disturbance and impervious surfaces, and, to the maximum extent possible, to ensure that the remaining site development has no surface or point discharge.

11. Conduct a proposed conditions runoff analysis based on the final design that meets the management district requirements (Section 408).

12. Manage any remaining runoff prior to discharge through detention, bioretention, direct discharge, or other structural control.

Section 405. Groundwater Recharge

Maximizing the groundwater recharge capacity of the area being developed is required. Design of the infiltration facilities shall consider groundwater recharge to compensate for the reduction in the recharge that occurs when the ground surface is disturbed or impervious surface is created. It is recommended that roof runoff be directed to infiltration BMPs that may be designed to compensate for the runoff from parking areas. These measures are required to be consistent with Section 103 and to take advantage of utilizing any existing recharge areas. Infiltration may not be feasible on every site due to site-specific limitations such as soil type. If it cannot be physically accomplished, then the design professional shall be responsible to show that this cannot be physically accomplished. Appropriate soils testing and/or geotechnical evaluation should be included as part of any documentation for infiltration BMPs. If it can be physically

accomplished, then the volume of runoff to be infiltrated shall be determined from Section 405.A.2.

A. Infiltration BMPs shall meet the following minimum requirements:

1. Infiltration BMPs intended to receive runoff from developed areas shall be selected based on suitability of soils and site conditions and shall be constructed on soils that have the following characteristics:

a. A minimum depth of twenty-four (24) inches, preferably 36 inches, between the bottom of the BMP and the top of the limiting zone (e.g., SHWT, groundwater, bedrock, etc.).

b. An infiltration rate sufficient to accept the additional stormwater load and dewater completely as determined by field tests conducted by the Applicant's design professional.

c. The infiltration facility shall be capable of completely infiltrating the recharge (infiltration) volume (Rev) within three (3) days (72 hours) or less.

d. Pretreatment shall be provided prior to infiltration.

2. The size of the infiltration facility shall be based upon the Net Two Year Volume Approach, where the recharge (infiltration) volume (Re_v) to be captured and infiltrated shall be the volume difference between the pre-development 2-year, 24-hour storm event and post-development 2-year, 24-hour storm event.

The recharge volume calculated using this section is the minimum volume the Applicant must control through an infiltration BMP facility. However, if a site has areas of soils where additional volume of recharge can be achieved, the Applicant is encouraged to infiltrate as much of the stormwater runoff from the site as possible.

B. Soils - A detailed soils evaluation of the project site shall be required to determine the suitability of infiltration facilities. The evaluation shall be performed by a qualified design professional and at a minimum address soil permeability, depth to bedrock, and subgrade stability. The general process for designing the infiltration BMP shall be:

1. Analyze hydrologic soil groups as well as natural and man-made features within the site to determine general areas of suitability for infiltration practices. In areas where development on fill material is under consideration, conduct geotechnical investigations of sub-grade stability; infiltration may not be ruled out without conducting these tests.

2. Provide field tests such as double ring infiltrometer or hydraulic conductivity tests (at the level of the proposed infiltration surface) to determine the appropriate hydraulic conductivity rate. Percolation tests are not recommended for design purposes.

3. Design the infiltration structure for the required recharge (Re_v) volume based on field determined capacity at the level of the proposed infiltration surface.

4. If on-lot infiltration structures are proposed by the Applicant's design professional, it must be demonstrated to the Municipality that the soils are conducive to infiltrate on the lots identified.

C. Stormwater Hotspots – Below is a list of examples of designated hotspots. If a site is designated as a hotspot, it has important implications for how stormwater is managed. First and foremost, untreated stormwater runoff from hotspots shall not be allowed to recharge into groundwater where it may contaminate water supplies. Therefore, the Re_v requirement shall NOT be applied to development sites that fit into the hotspot category (the entire WQ_v must still be treated). Second, a greater level of stormwater treatment shall be considered at hotspot sites to prevent pollutant washoff after construction. The Environmental Protection Agency's (EPA) NPDES stormwater program requires some industrial sites to prepare and implement a stormwater pollution prevention plan.

Examples of hotspots:

- Vehicle salvage yards and recycling facilities
- Vehicle fueling stations
- Vehicle service and maintenance facilities
- Vehicle and equipment cleaning facilities
- Fleet storage areas (bus, truck, etc.)
- Industrial sites based on Standard Industrial Codes
- Marinas (service and maintenance)
- Outdoor liquid container storage
- Outdoor loading/unloading facilities
- Public works storage areas
- Facilities that generate or store hazardous materials
- Commercial container nursery
- Other land uses and activities as designated by an appropriate review authority

The following land uses and activities are not normally considered hotspots:

- Residential streets and rural highways
- Residential development
- Institutional development
- Office developments
- Nonindustrial rooftops
- Pervious areas, except golf courses and nurseries (which may need an integrated pest management (IPM) plan).

While large highways (average daily traffic volume (ADT) greater than thirty thousand (30,000) are not designated as stormwater hotspots, it is important to ensure that highway stormwater management plans adequately protect groundwater.

D. Extreme caution shall be exercised where infiltration is proposed in SWPAs as defined by the local Municipality or water authority.

E. Infiltration facilities shall be used in conjunction with other innovative or traditional BMPs, stormwater control facilities, and nonstructural stormwater management alternatives.

F. Extreme caution shall be exercised where salt or chloride (municipal salt storage) would be a pollutant since soils do little to filter this pollutant, and it may contaminate the groundwater. The qualified design professional shall evaluate the possibility of groundwater contamination from the proposed infiltration facility and perform a hydrogeologic justification study if necessary. Specific consideration should be given to the particular type of salt or deicing material to be used within this watershed in regards to its potential long-term effects on the soils, especially in areas that contain clay soil.

G. The infiltration requirement in HQ or EV waters shall be subject to the Department's Chapter 93 Anti-degradation Regulations.

H. An impermeable liner will be required in detention basins where the possibility of groundwater contamination exists. A detailed hydrogeologic investigation may be required by the Municipality.

I. The Municipality shall require the Applicant to provide safeguards against groundwater contamination for land uses that may cause groundwater contamination should there be a mishap or spill.

Section 406. Water Quality Requirements

The Applicant shall comply with the following water quality requirements of this Article.

A. No regulated earth disturbance activities within the Municipality shall commence until approval by the Municipality of a plan that demonstrates compliance with post-construction state water quality requirements.

B. The BMPs shall be designed, implemented, and maintained to meet state water quality requirements and any other more stringent requirements as determined by the Municipality.

C. To control post-construction stormwater impacts from regulated earth disturbance activities, state water quality requirements can be met by BMPs, including site design, which provide for replication of pre-construction stormwater infiltration and runoff conditions so that post-construction stormwater discharges do not degrade the physical, chemical, or biological characteristics of the receiving waters. As described in the DEP Comprehensive Stormwater Management Policy (#392-0300-002, September 28, 2002), this may be achieved by the following:

1. Infiltration: replication of pre-construction stormwater infiltration conditions,

2. Treatment: use of water quality treatment BMPs to ensure filtering out of the chemical and physical pollutants from the stormwater runoff, and

3. Stream bank and Stream bed Protection: management of volume and rate of post-construction stormwater discharges to prevent physical degradation of receiving waters (e.g., from scouring).

D. Developed areas shall provide adequate storage and treatment facilities necessary to capture and treat stormwater runoff. If site conditions allow for infiltration, the water quality volume and the recharge volume are the same volume and may be managed in a single facility. If infiltration can not be physically accomplished, the water quality volume should be calculated using the Net Two Year Volume Approach described in Section 405.A.2. In this case, the water quality volume may be captured and treated by methods other than infiltration BMPs.

This volume requirement can be accomplished by the permanent volume of a wet basin or the detained volume from other BMPs. Where appropriate, wet basins shall be utilized for water quality control and shall follow the guidelines of the BMP manuals referenced in Ordinance Appendix F.

The water quality volume shall take a minimum of 24 hours to be discharged from a BMP facility. Release of the water quality volume can begin at the start of the storm (i.e., the invert of the water quality orifice is at the invert of the facility). The design of the facility shall provide for protection from clogging and unwanted sedimentation.

E. For areas within defined special protection subwatersheds that include EV and HQ waters, the temperature and quality of water and streams shall be maintained through the use of temperature sensitive BMPs and stormwater conveyance systems.

F. To accomplish the above, the Applicant shall submit original and innovative designs to the municipal Engineer for review and approval. Such designs may achieve the water quality objectives through a combination of different BMPs.

G. If a perennial or intermittent stream passes through the site, the Applicant shall create a stream buffer extending a minimum of fifty (50) feet to either side of the top-of-bank of the channel. The buffer area shall be maintained with and encouraged to use appropriate native vegetation (refer to Appendix B of the Pennsylvania Stormwater Best Management Practices Manual, latest version, for plant lists). If the applicable rear or side yard setback is less than fifty (50) feet or a stream traverses the site, the buffer width may be reduced to twenty-five (25) percent of the setback and/or to a minimum of ten (10) feet. If an existing buffer is legally prescribed (i.e., deed, covenant, easement, etc.) and it exceeds the requirements of this Ordinance, the existing buffer shall be maintained. *[Note: The Municipality may select a smaller buffer width (above) if desired, but the selected buffer may not be less than ten (10) feet]*. This does not include lakes or wetlands.

H. Evidence of any necessary permit(s) for regulated earth disturbance activities from the appropriate DEP regional office must be provided to the Municipality. The issuance of an NPDES Construction Permit (or permit coverage under the statewide General Permit (PAG-2)) satisfies the requirements of § 406.A. [*]

*[***** This sentence above is optional -- if the Municipality has additional or more stringent requirements than those in state regulations, then this sentence should not be used.]*

Section 407. Stream Bank Erosion Requirements

A. In addition to the control of water quality volume (in order to minimize the impact of stormwater runoff on downstream stream bank erosion), the primary requirement is to design a BMP to detain the proposed conditions 2-year, 24-hour design storm to the existing conditions 1-year flow using the SCS Type II distribution. Additionally, provisions shall be made (such as adding a small orifice at the bottom of the outlet structure) so that the proposed conditions 1-year storm takes a minimum of twenty-four (24) hours to drain from the facility from a point where the maximum volume of water from the 1-year storm is captured (i.e., the maximum water surface elevation is achieved in the facility). Release of water can begin at the start of the storm (i.e., the invert of the water quality orifice is at the invert of the facility).

B. The minimum orifice size in the outlet structure to the BMP shall be three (3) inches in diameter where possible, and a trash rack shall be installed to prevent clogging. On sites with small drainage areas contributing to this BMP that do not provide enough runoff volume to allow a 24-hour attenuation with the 3-inch orifice, the calculations shall be submitted showing this condition. Orifice sizes less than three (3) inches can be utilized, provided that the design will prevent clogging of the intake.

Section 408. Stormwater Peak Rate Control

A. Within the Swamp Creek watershed, the criteria for peak runoff control are designed to reduce the post-development peak flow to 50% of the pre-development peak flow. Development sites must control proposed conditions runoff rates to 50% of the existing conditions runoff rates for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events.

B. The calculated peak discharges shall apply regardless of whether the grading plan changes the drainage area by subarea. An exception to the above may be granted if discharges from multiple subareas recombine in proximity to the site. In this case, peak discharge in any direction may be a 100% release rate provided that the overall site discharge meets the weighted average release rate.

C. Off-Site Areas - Off-site areas that drain through a proposed development site are not subject to release rate criteria when determining allowable peak runoff rates. However, on-site drainage facilities shall be designed to safely convey off-site flows through the development site.

D. Site Areas - Where the site area to be impacted by a proposed development activity differs significantly from the total site area, only the proposed impact area utilizing stormwater management measures shall be subject to the peak rate control standards noted above. In other words, unimpacted areas bypassing the stormwater management facilities would not be subject to the peak rate control standards.

E. Alternate Criteria for Redevelopment Sites - For redevelopment sites, one of the following minimum design parameters shall be accomplished, whichever is most appropriate for the given site conditions as determined by [*Municipality*];

1. Meet the full requirements specified by Sections 408.A through 408.F or

2. Reduce the total impervious surface on the site by at least twenty percent (20%); based upon a comparison of existing impervious surface to proposed impervious surface.

Section 409. Calculation Methodology

A. Stormwater runoff from all development sites with a drainage area of greater than two hundred (200) acres shall be calculated using a generally accepted calculation technique that is based on the NRCS Soil Cover Complex Method. Table 409.1 summarizes acceptable computation methods, and the method selected by the design professional shall be based on the individual limitations and suitability of each method for a particular site. Note that successors to the methods listed in Table 409.1 are also acceptable, such as WinTR55 for TR-55 and WinTR20 for TR-20. The Municipality may allow the use of the Rational Method to estimate peak discharges from drainage areas that contain less than two hundred (200) acres. The Soil Cover Complex Method shall be used for drainage areas greater than two hundred (200) acres.

TABLE 409.1

ACCEPTABLE COMPUTATION METHODOLOGIES FOR

STORMWATER MANAGEMENT PLANS

Method	Developed By	Applicability
TR-20 (or commercial computer package based on TR-20)	USDA NRCS	Applicable where use of full hydrology computer model is desirable or necessary.
TR-55 (or commercial computer package based on TR-55)	USDA NRCS	Applicable for land development plans where limitations described in TR-55.
HEC-1/ HEC-HMS	US Army Corps of Engineers	Applicable where use of a full hydrologic computer is desirable or necessary.
PSRM	Penn State University	Applicable where use of a hydrologic model is desirable or necessary; simpler than TR-20 or HEC-1.
Rational Method (or commercial computer package based on Rational Method)	Emil Kuichling (1889)	For sites less than two hundred (200) acres, or as approved by the Municipality and/or municipal Engineer.
Other Methods	Varies	Other computation methodologies approved by the Municipality and/or municipal Engineer.

B. All calculations consistent with this Ordinance using the Soil Cover Complex Method shall use the appropriate design rainfall depths for the various return period storms according to the region in which they are located as presented in Table E-1 in Appendix E of this Ordinance. If a hydrologic computer model such as PSRM or HEC-1 / HEC-HMS is used for stormwater runoff calculations, then the duration of rainfall shall be twenty-four (24) hours.

C. The following criteria shall be used for runoff calculations:

1. For development sites not considered redevelopment, the ground cover used in determining the existing conditions flow rates shall be as follows:

a. Wooded sites shall use a ground cover of “woods in good condition.” A site shall be considered to be a wooded site where a biological community dominated by trees and other woody plants exists that covers an area of 10,000 square feet or more, and contains at least 100 trees with at least 50% of those trees having a dbh of 2” or greater. (Duerksen, Christopher J., with

Suzanne Richman, Tree Conservation Ordinances, Planning Advisory Service Report Number 446, American Planning Association, Chicago, Illinois, and Scenic America, Washington, D.C., August, 1993.)

b. The undeveloped portion of the site including agriculture, bare earth, and fallow ground shall be considered as "meadow in good condition," unless the natural ground cover generates a lower curve (CN) number or Rational "c" value (i.e., woods) as listed in Tables E-2 or E-3 in Appendix E of this Ordinance.

c. Offsite land use conditions used to determine storm flows for designing storm facilities shall be based on existing land uses assuming winter or poor land cover conditions.

2. For development considered redevelopment sites, the ground cover used in determining the existing conditions flow rates for the developed portion of the site shall be based upon actual land cover conditions.

D. All calculations using the Rational Method shall use rainfall intensities consistent with appropriate times-of-concentration for overland flow and return periods presented in the appropriate curves from the PennDOT Storm-Duration-Frequency Chart (Region 4 is included in Figure E-3. The user should refer to the Atlas 14, Volume 2, Storm-Duration-Frequency Chart). Times-of-concentration for overland flow shall be calculated using the methodology presented in Chapter 3 of *Urban Hydrology for Small Watersheds*, NRCS, TR-55 (as amended or replaced from time to time by NRCS). Times-of-concentration for channel and pipe flow shall be computed using Manning's equation.

E. Runoff curve numbers (CN) for both existing and proposed conditions to be used in the Soil Cover Complex Method shall be obtained from Table E-2 in Appendix E of this Ordinance.

F. Runoff coefficients (c) for both existing and proposed conditions for use in the Rational Method shall be obtained from Table E-3 in Appendix E of this Ordinance.

G. Where uniform flow is anticipated, the Manning equation shall be used for hydraulic computations and to determine the capacity of open channels, pipes, and storm sewers. Values for Manning's roughness coefficient (n) shall be consistent with accepted published values.

H. Outlet structures for stormwater management facilities shall be designed to meet the performance standards of this Ordinance using any generally accepted hydraulic analysis technique or method.

I. The design of any stormwater detention facilities intended to meet the performance standards of this Ordinance shall be verified by routing the design storm hydrograph through these facilities using the Storage-Indication Method. The design storm hydrograph shall be computed using a calculation method that produces a full hydrograph. The Municipality may approve the use of any generally accepted full hydrograph approximation technique that shall use a total runoff volume that is consistent with the volume from a method that produces a full hydrograph.

Section 410. Other Requirements

A. All wet basin designs shall incorporate biologic controls consistent with the West Nile Guidance found in Appendix G.

B. Any stormwater management facility (i.e., detention basin) required or regulated by this Ordinance designed to store runoff and requiring a berm or earthen embankment shall be designed to provide an emergency spillway to handle flow up to and including the 100-year proposed conditions. The height of embankment must provide a minimum [*recommended 1.0 foot*] of freeboard above the maximum pool elevation computed when the facility functions for the 100-year proposed conditions inflow. Should any stormwater management facility require a dam safety permit under DEP Chapter 105, the facility shall be designed in accordance with Chapter 105 and meet the regulations of Chapter 105 concerning dam safety. Chapter 105 may be required to pass storms larger than the 100-year event.

C. Any facilities that constitute water obstructions (e.g., culverts, bridges, outfalls, or stream enclosures) and any work involving wetlands governed by DEP Chapter 105 regulations (as amended or replaced from time to time by DEP) shall be designed in accordance with Chapter 105 and will require a permit from DEP.

D. Any other drainage conveyance facility that does not fall under Chapter 105 regulations must be able to convey, without damage to the drainage structure or roadway, runoff from the 25-year design storm with a minimum one (1.0) foot of freeboard measured below the lowest point along the top of the roadway. Any facility that constitutes a dam as defined in DEP Chapter 105 regulations may require a permit under dam safety regulations. Any facility located within a PennDOT right-of-way must meet PennDOT minimum design standards and permit submission requirements.

E. Any drainage conveyance facility and/or channel not governed by Chapter 105 regulations must be able to convey, without damage to the drainage structure or roadway, runoff from the 25-year design storm. Conveyance facilities to or exiting from stormwater management facilities (i.e., detention basins) shall be designed to convey the design flow to or from that structure. Roadway crossings located within designated floodplain areas must be able to convey runoff from a 100-year design storm. Any facility located within a PennDOT right-of-way must meet PennDOT minimum design standards and permit submission requirements.

F. Storm sewers must be able to convey proposed conditions runoff from a [*5-, 10-, or 25-*] year design storm without surcharging inlets, where appropriate.

G. Adequate erosion protection shall be provided along all open channels and at all points of discharge.

H. The design of all stormwater management facilities shall incorporate sound engineering principles and practices. The Municipality reserves the right to disapprove any design that would result in construction in or continuation of a stormwater problem area.

The following article provisions are optional.

Design Criteria for Stormwater Management Facilities

I. Any stormwater management facility (i.e., detention basin) required or regulated by this Ordinance designed to store runoff and requiring a berm or earthen embankment shall be designed to provide the following (at a minimum):

1. The maximum water depth shall not exceed six (6) feet.
2. The minimum top width of all dams/embankments/berms shall be five (5) feet.
3. The interior side slopes shall not be greater than five (5) horizontal to one (1) vertical.
4. All basins shall be structurally sound and shall be constructed of sound and durable materials. The completed structure and the foundation of all basins shall be stable under all probable conditions of operation. An emergency spillway shall be provided for the basin and shall be capable of discharging the 100-year peak rate of runoff that enters the basin after development, in a manner that will not damage the integrity of the facility and will not create a downstream hazard. Where practical, the emergency spillway shall be constructed in undisturbed ground. An easement for inspection and repair shall be provided when the conveyance structure crosses property boundaries.
5. All basins not including Groundwater Recharge and/or Water Quality storage shall include an outlet structure to permit draining the basin to a completely dry position within twenty-four (24) hours following the end of the design rainfall. All basins that do include Groundwater Recharge and/or Water Quality storage shall include an outlet structure to permit draining the basin to the level of the Groundwater Recharge and/or Water Quality storage within twenty-four (24) hours following the end of the design rainfall.
6. A cutoff trench of relatively impervious material shall be provided within all basin embankments.
7. All structures passing through Detention Basin embankments shall have properly spaced concrete cutoff collars and all piping must be watertight. All structures passing through Dam embankments shall have seepage diaphragms and drains.
8. All discharge control devices with appurtenances shall be made of reinforced concrete and stainless or hot dip galvanized steel. Bolts/fasteners are to be stainless or galvanized steel.
9. Low flow channels shall be provided from each water carrying facility to the outlet structure for all basins that do not include Groundwater Recharge and/or Water Quality storage. Low flow channels shall be one (1) percent minimum slope and shall be designed to enable ease of maintenance. All basins that do include Groundwater Recharge and/or Water Quality storage shall not be required to have a low flow channel.

10. Minimum slope within a basin that does not include Groundwater Recharge and/or Water Quality storage shall be two (2) percent positive grade to the low flow channel.

11. Design storms for the computation of retention basins (where approved) volumes shall be based upon a 24-hour storm with 100-year return period (a storm with a 1% chance of occurrence each year).

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

13. All structures (detention basins, cisterns, etc.), other than those used for Groundwater Recharge Volume and Water Quality Volume, must completely drain within 24 hours after the end of the design storm.

14. Soils used for the construction of basins shall have low erodibility factors ("K"factors).

J. Minimum floor elevations for all structures that would be affected by a basin, other temporary impoundments, or open conveyance systems where ponding may occur shall be two (2) feet above the 100-year water surface. If basement or underground facilities are proposed, detailed calculations addressing the effects of stormwater ponding on the structure and waterproofing and/or flood-proofing design information shall be submitted for approval.

K. All storm sewer pipes, culverts and bridges (excluding detention and retention basin outfall structures), gutters and swales conveying water originating only from within the boundaries of the Development Site shall be designed for a twenty-five (25) year storm event. All storm sewer pipes, culverts and bridges (excluding detention and retention basin outfall structures) conveying water originating from offsite shall be designed for a fifty (50) year storm event. Drainage easements shall be provided to contain and convey the 100-year frequency flood throughout the Development Site. Easements shall begin at the furthest upstream property line of the proposed Development Site in a watershed.

L. A concentrated discharge of stormwater to an adjacent property shall be within an existing natural drainageway or watercourse or otherwise an easement shall be required.

M. Storm sewer pipes other than those used as roof drains, detention basin underdrains, and street subbase underdrains, shall have a minimum diameter of fifteen (15) inches and be made of reinforced concrete pipe, corrugated galvanized metal pipe, smooth lined corrugated polyethylene pipe, or approved equivalent. Where installation conditions merit, structural calculations that address the actual design requirements will be required.

N. Storm sewer pipes and culverts shall be installed on sufficient slopes to provide a minimum velocity of three (3) feet per second when flowing full.

O. All storm sewer pipe and culverts shall be laid to a minimum depth of one (1) foot from finished subgrade to the crown of pipe in paved areas and one (1) foot from finished grade to the crown of pipe in grassed areas.

P. Curves in pipes or box culverts without an inlet or manhole are prohibited. Tee joints, elbows and wyes are also prohibited.

Q. Manholes, inlets, headwalls and endwalls proposed for dedication or located along streets or subject to vehicular traffic, shall conform to the requirements of the PennDOT, Bureau of Design, Standards for Roadway Construction in effect at the time the design is submitted, or as otherwise modified by the Municipality.

R. Headwalls and endwalls shall be used where stormwater runoff enters or leaves the storm sewer horizontally from a natural or manmade channel. PennDOT Type "DW" headwalls and endwalls shall be utilized.

S. Stormwater roof drains, sump pumps, and pipes, shall not directly discharge water into a street right-of-way or discharge into a sanitary sewer or storm sewer.

T. All existing and natural watercourses, channels, drainage systems, wetlands and areas of surface water concentration shall be maintained in their existing condition unless an alteration is approved by the Municipality and any other necessary approving body.

U. Flow velocities from any storm sewer may not result in erosion of the receiving channel.

V. Energy dissipators shall be placed at the outlets of all storm sewer pipes, culverts, and bridges where flow velocities exceed maximum permitted channel velocities as specified below:

1. Three (3) feet per second where only sparse vegetation can be established and maintained because of shade or soil condition.

2. Four (4) feet per second where normal growing conditions exist and vegetation is to be established by seeding.

3. Five (5) feet per second where a dense, vigorous sod can be quickly established or where water can be temporarily diverted during establishment of vegetation. Netting and mulch or the equivalent methods for establishing vegetation shall be used.

4. Six (6) feet per second where there exists a well established sod of good quality.

W. The following conditions shall be met for all swales:

1. Capacities and velocities shall be computed using the Manning equation. The design parameters shall be as follows:

(a) Vegetated swales shall meet the following two design considerations:

(i) the first shall consider swale stability based upon a low degree of retardance ("n"=.03);

(ii) the second shall consider swale capacity based upon a high degree of retardance ("n"=.05).

(b) All vegetated swales shall have a minimum slope of one (1) percent unless approved by the municipal engineer.

(c) The “n” factors to be used for paved or rip-rap swales or gutters shall be based upon accepted engineering design practices as approved by the Municipality.

2. All swales shall be designed to concentrate low flows to minimize siltation and meandering.

X. Manning “n” values used for design of pipes and culverts shall be in accordance with accepted published values.

Y. All storm sewer crossings of streets shall be perpendicular to the street centerline.

Z. Storm facilities not located within a public right-of-way shall be contained in and centered within an easement. Easements shall follow property boundaries where possible.

AA. Adequate erosion protection shall be provided along all open channels, and at all points of discharge.

BB. All groundwater recharge facilities shall be designed to empty within three (3) days (72 hours) or less subsequent to any storm event. All water quality facilities shall be designed so that water is released slowly for a minimum of 24 hours subsequent to any storm event. All infiltration, detention or retention facilities the volume of which will be used for stormwater management (pre-development vs. post-development) shall be designed to empty within 24 hours subsequent to any storm event. Volumes that will not be available within 24 hours subsequent to any storm event shall not be used for stormwater management (pre-development vs. post-development).

ARTICLE V – INSPECTIONS

Section 501. Inspections

A. The municipal Engineer or his municipal designee shall inspect all phases of the installation of the permanent BMPs and/or stormwater management facilities as deemed appropriate by the municipal Engineer.

B. During any stage of the work, if the municipal Engineer or his municipal designee determines that the permanent BMPs and/or stormwater management facilities are not being installed in accordance with the approved stormwater management plan, the Municipality shall revoke any existing permits or other approvals and issue a cease and desist order until a revised drainage plan is submitted and approved, as specified in this Ordinance, and until the deficiencies are corrected.

C. A final inspection of all BMPs and/or stormwater management facilities shall be conducted by the municipal Engineer or his municipal designee to confirm compliance with the approved drainage plan prior to the issuance of any occupancy permit.

ARTICLE VI – FEES AND EXPENSES

Section 601. Municipality Drainage Plan Review and Inspection Fee

Fees shall be established by the Municipality to defray plan review and construction inspection costs incurred by the Municipality. All fees shall be paid by the Applicant at the time of drainage plan submission. A review and inspection fee schedule shall be established by resolution of the municipal Governing Body based on the size of the regulated activity and based on the Municipality's costs for reviewing drainage plans and conducting inspections pursuant to Section 501. The Municipality shall periodically update the review and inspection fee schedule to ensure that review costs are adequately reimbursed.

Section 602. Expenses Covered by Fees

The fees required by this Ordinance shall at a minimum cover:

A. Administrative costs.

B. The review of the drainage plan by the Municipality and the municipal Engineer.

C. The site inspections.

D. The inspection of stormwater management facilities and drainage improvements during construction.

E. The final inspection upon completion of the stormwater management facilities and drainage improvements presented in the drainage plan.

F. Any additional work required to enforce any permit provisions regulated by this Ordinance, correct violations, and assure proper completion of stipulated remedial actions.

ARTICLE VII – MAINTENANCE RESPONSIBILITIES

Section 701. Performance Guarantee

A. For subdivisions and land developments, the Applicant shall provide a financial guarantee to the Municipality for the timely installation and proper construction of all stormwater management controls as:

1. Required by the approved drainage plan equal to or greater than the full construction cost of the required controls, or

2. The amount and method of payment provided for in the SALDO.

B. For other regulated activities, the Municipality may require a financial guarantee from the Applicant.

Section 702. Responsibilities for Operations and Maintenance of Stormwater Controls and BMPs

A. No regulated earth disturbance activities within the Municipality shall commence until approval by the Municipality of a stormwater control and BMP operations and maintenance plan that describes how the permanent (e.g., post-construction) stormwater controls and BMPs will be properly operated and maintained.

B. The following items shall be included in the stormwater control and BMP operations and maintenance plan:

1. Map(s) of the project area, in a form that meets the requirements for recording at the offices of the Recorder of Deeds of [*Berks or Montgomery*] County, shall be submitted on _____-inch x -_____-inch sheets. The contents of the maps(s) shall include, but not be limited to:

   a. Clear identification of the location and nature of permanent stormwater controls and BMPs,

   b. The location of the project site relative to highways, municipal boundaries, or other identifiable landmarks,

   c. Existing and final contours at intervals of two (2) feet, or others as appropriate,

   d. Existing streams, lakes, ponds, or other bodies of water within the project site area,

   e. Other physical features including flood hazard boundaries, sinkholes, streams, existing drainage courses, and areas of natural vegetation to be preserved,

   f. The locations of all existing and proposed utilities, sanitary sewers, and water lines within fifty (50) feet of property lines of the project site,

   g. Proposed final changes to the land surface and vegetative cover, including the type and amount of impervious area that would be added,

h. Proposed final structures, roads, paved areas, and buildings, and

i. A 15-foot wide access easement around all stormwater controls and BMPs that would provide ingress to and egress from a public right-of way.

2. A description of how each permanent stormwater control and BMP will be operated and maintained, and the identity and contact information associated with the person(s) responsible for operations and maintenance,

3. The name of the project site, the name and address of the owner of the property, and the name of the individual or firm preparing the plan, and

4. A statement, signed by the landowner, acknowledging that the stormwater controls and BMPs are fixtures that can be altered or removed only after approval by the Municipality.

C. The stormwater control and BMP operations and maintenance plan for the project site shall establish responsibilities for the continuing operation and maintenance of all permanent stormwater controls and BMPs, as follows:

1. If a plan includes structures or lots that are to be separately owned and in which streets, sewers, and other public improvements are to be dedicated to the Municipality, stormwater controls and BMPs may also be dedicated to and maintained by the Municipality;

2. If a plan includes operations and maintenance by a single ownership or if sewers and other public improvements are to be privately owned and maintained, then the operation and maintenance of stormwater controls and BMPs shall be the responsibility of the owner or private management entity.

D. The Municipality shall make the final determination on the continuing operations and maintenance responsibilities. The Municipality reserves the right to accept or reject the operations and maintenance responsibility for any or all of the stormwater controls and BMPs.

Section 703. Municipal Review of a Stormwater Control and BMP Operations and Maintenance Plan

A. The Municipality shall review the stormwater control and BMP operations and maintenance plan for consistency with the purposes and requirements of this Ordinance and any permits issued by DEP.

B. The Municipality shall notify the Applicant in writing whether or not the stormwater control and BMP operations and maintenance plan is approved.

C. The Municipality may require a “record drawing” of all stormwater controls and BMPs and an explanation of any discrepancies with the operations and maintenance plan.

Section 704. Adherence to an Approved Stormwater Control and BMP Operations and Maintenance Plan

It shall be unlawful to alter or remove any permanent stormwater control and BMP required by an approved stormwater control and BMP operations and maintenance plan or to allow the property to remain in a condition which does not conform to an approved stormwater control and BMP operations and maintenance plan.

Section 705. Operations and Maintenance Agreement for Privately Owned Stormwater Controls and BMPs

A. The Applicant shall sign an operations and maintenance agreement with the Municipality covering all stormwater controls and BMPs that are to be privately owned. The maintenance agreement shall be transferred with transfer of ownership. The agreement shall be substantially the same as the agreement in Appendix H of this Ordinance.

B. Other items may be included in the agreement where determined necessary to guarantee the satisfactory operation and maintenance of all permanent stormwater controls and BMPs. The agreement shall be subject to the review and approval of the Municipality.

Section 706. Stormwater Management Easements

A. Stormwater management easements are required for all areas used for off-site stormwater control.

B. Stormwater management easements shall be provided by the Applicant or property owner if necessary for access for inspections and maintenance or the preservation of stormwater runoff conveyance, infiltration, and detention areas and other stormwater controls and BMPs by persons other than the property owner. The purpose of the easement shall be specified in any agreement under Section 705.

Section 707. Maintenance Agreement for Privately Owned Stormwater Facilities

A. Prior to final approval of the site's drainage plan, the Applicant shall sign and record the maintenance agreement contained in Appendix H which is attached and made part hereof covering all stormwater control facilities that are to be privately owned.

B. Other items may be included in the agreement where determined necessary to guarantee the satisfactory maintenance of all facilities. The maintenance agreement shall be subject to the review and approval of the municipal Solicitor and Governing Body.

Section 708. Recording of an Approved Stormwater Control and BMP Operations and Maintenance Plan and Related Agreements

A. The owner of any land upon which permanent stormwater controls and BMPs will be placed, constructed, or implemented, as described in the stormwater control and BMP operations and maintenance plan, shall record the following documents in the Office of

the Recorder of Deeds for [*Berks or Montgomery*] County, within fifteen (15) days of approval of the stormwater control and BMP operations and maintenance plan by the Municipality:

1. The operations and maintenance plan, or a summary thereof,
2. Operations and maintenance agreements under Section 705, and
3. Easements under Section 706.

B. The Municipality may suspend or revoke any approvals granted for the project site upon discovery of failure on the part of the owner to comply with this section.

The following article provisions are optional.

Section 709. Municipal Stormwater Control and BMP Operation and Maintenance Fund

A. Persons installing stormwater controls or BMPs shall be required to pay a specified amount to the Municipal Stormwater Control and BMP Operation and Maintenance Fund to help defray costs of periodic inspections and maintenance expenses. The amount of the deposit shall be determined as follows:

1. If the stormwater control or BMP is to be privately owned and maintained, the deposit shall cover the cost of periodic inspections performed by the Municipality for a period of ten (10) years, as estimated by the municipal Engineer. After that period of time, inspections will be performed at the expense of the Municipality.
2. If the stormwater control or BMP is to be owned and maintained by the Municipality, the deposit shall cover the estimated costs for maintenance and inspections for ten (10) years. The municipal Engineer will establish the estimated costs utilizing information submitted by the Applicant.
3. The amount of the deposit to the fund shall be converted to present worth of the annual series values. The municipal Engineer shall determine the present worth equivalents, which shall be subject to the approval of the Governing Body.

B. If a stormwater control or BMP is proposed that also serves as a recreational facility (e.g., ball field or lake), the Municipality may reduce or waive the amount of the maintenance fund deposit based upon the value of the land for public recreational purpose.

C. If at some future time, a stormwater control or BMP (whether publicly or privately owned) is eliminated due to the installation of storm sewers or other storage facility, the unused portion of the maintenance fund deposit will be applied to the cost of abandoning the facility and connecting to the storm sewer system or other facility. Any amount of the deposit remaining after the costs of abandonment are paid will be returned to the depositor.

D. If stormwater controls or BMPs are accepted by the Municipality for dedication, the Municipality may require persons installing stormwater controls or BMPs to pay a specified amount to the Municipal Stormwater Control and BMP Operation and

Maintenance Fund to help defray costs of operations and maintenance activities. The amount may be determined as follows:

1. The amount shall cover the estimated costs for operations and maintenance for ten (10) years, as determined by the Municipality.

2. The amount shall then be converted to present worth of the annual series values.

E. If a stormwater control or BMP is proposed that also serves as a recreational facility (e.g., ball field or lake), the Municipality may adjust the amount due accordingly.

F. The Municipality may shall require Applicants to pay a fee to the Municipal Stormwater Control and BMP Operation and Maintenance Fund to cover longterm maintenance of stormwater controls and BMPs.

G. The Municipality may require Applicants to pay a fee to the Municipal Stormwater Control and BMP Operation and Maintenance Fund to cover stormwater related problems that may arise from the land development and earth disturbance.

ARTICLE VIII – PROHIBITIONS

Section 801. Prohibited Discharges

Note: The following language taken from DEP's NPDES program and model NPDES ordinance is required to be incorporated into this Ordinance.

A. No person in the Municipality shall allow, or cause to allow, stormwater discharges into the Municipality's separate storm sewer system which are not composed entirely of stormwater, except (1) as provided in subsection B below, and (2) discharges allowed under a state or federal permit.

B. Discharges that may be allowed based on a finding by the Municipality that the discharge(s) do not significantly contribute to pollution to surface waters of the Commonwealth, are:

1. Discharges from fire fighting activities
2. Potable water sources including dechlorinated water line and fire hydrant flushings
3. Irrigation drainage
4. Routine external building washdown (which does not use detergents or other compounds)
5. Air conditioning condensate
6. Water from individual residential car washing
7. Spring water from crawl space pumps
8. Uncontaminated water from foundation or from footing drains
9. Flows from riparian habitats and wetlands
10. Lawn watering
11. Pavement washwaters where spills or leaks of toxic or hazardous materials have not occurred (unless all spill material has been removed) and where detergents are not used
12. Dechlorinated swimming pool discharges
13. Uncontaminated groundwater

C. In the event that the Municipality determines that any of the discharges identified in Section 801.B significantly contribute to pollution of waters of the Commonwealth, or is so notified by DEP, the Municipality will notify the responsible person to cease the discharge.

D. Upon notice provided by the Municipality under Section 801.C, the discharger will have a reasonable time, as determined by the Municipality, to cease the discharge consistent with the degree of pollution caused by the discharge.

E. Nothing in this section shall affect a discharger's responsibilities under state law.

Section 802. Prohibited Connections

A. The following connections are prohibited, except as provided in Section 801.B above:

1. Any drain or conveyance, whether on the surface or subsurface, which allows any non-stormwater discharge including sewage, process wastewater, and wash water to enter the separate storm sewer system and any connections to the storm drain system from indoor drains and sinks; and

2. Any drain or conveyance connected from a commercial or industrial land use to the separate storm sewer system that has not been documented in plans, maps, or equivalent records and approved by the Municipality.

Section 803. Roof Drains

A. Roof drains shall not be connected to streets, sanitary or storm sewers, or roadside ditches in order to promote overland flow and infiltration/percolation of stormwater where advantageous to do so.

B. When it is more advantageous to connect directly to streets or storm sewers, connections of roof drains to streets or roadside ditches may be permitted on a case by case basis as determined by the Municipality.

C. Roof drains shall discharge to infiltration areas or vegetative BMPs to the maximum extent practicable.

Section 804. Alteration of BMPs

A. No person shall modify, remove, fill, landscape, or alter any existing stormwater control or BMP unless it is part of an approved maintenance program without the written approval of the Municipality.

B. No person shall place any structure, fill, landscaping, or vegetation into a stormwater control or BMP or within a drainage easement that would limit or alter the functioning of the stormwater control or BMP without the written approval of the Municipality.

ARTICLE IX – ENFORCEMENT AND PENALTIES

Section 901. Right-of-Entry

A. Upon presentation of proper credentials, duly authorized representatives of the Municipality may enter at reasonable times upon any property within the Municipality to inspect the implementation, condition, or operation and maintenance of the stormwater controls or BMPs in regard to any aspect governed by this Ordinance.

B. Stormwater control and BMP owners and operators shall allow persons working on behalf of the Municipality ready access to all parts of the premises for the purposes of determining compliance with this Ordinance.

C. Persons working on behalf of the Municipality shall have the right to temporarily locate on any stormwater control or BMP in the Municipality such devices as are necessary to conduct monitoring and/or sampling of the discharges from such stormwater control or BMP.

D. Unreasonable delays in allowing the Municipality access to a stormwater control or BMP is a violation of this Article.

Section 902. Public Nuisance

A. The violation of any provision of this Ordinance is hereby deemed a public nuisance.

B. Each day that a violation continues shall constitute a separate violation.

Section 903. Enforcement Generally

A. Whenever the Municipality finds that a person has violated a prohibition or failed to meet a requirement of this Ordinance, the Municipality may order compliance by written notice to the responsible person. Such notice may, without limitation, require the following remedies:

1. Performance of monitoring, analyses, and reporting;
2. Elimination of prohibited connections or discharges;
3. Cessation of any violating discharges, practices, or operations;
4. Abatement or remediation of stormwater pollution or contamination hazards and the restoration of any affected property;
5. Payment of a fine to cover administrative and remediation costs;
6. Implementation of stormwater controls and BMPs; and
7. Operation and maintenance of stormwater controls and BMPs.

B. Such notification shall set forth the nature of the violation(s) and establish a time limit for correction of these violations(s). Said notice may further advise that, if applicable, should the violator fail to take the required action within the established deadline, the work will

be done by the Municipality or designee, and the expense thereof shall be charged to the violator.

C. Failure to comply within the time specified shall also subject such person to the penalty provisions of this Ordinance. All such penalties shall be deemed cumulative and shall not prevent the Municipality from pursuing any and all other remedies available in law or equity.

Section 904. Suspension and Revocation of Permits and Approvals

A. Any building, land development, or other permit or approval issued by the Municipality may be suspended or revoked by the Municipality for:

1. Noncompliance with or failure to implement any provision of the permit;
2. A violation of any provision of this Ordinance; or
3. The creation of any condition or the commission of any act during construction or development which constitutes or creates a hazard or nuisance, pollution, or which endangers the life, health, or property of others.

B. A suspended permit or approval shall be reinstated by the Municipality when:

1. The municipal Engineer or designee has inspected and approved the corrections to the stormwater controls and BMPs or the elimination of the hazard or nuisance, and/or
2. The Municipality is satisfied that the violation of the Ordinance, law, or rule and regulation has been corrected.

C. A permit or approval that has been revoked by the Municipality cannot be reinstated. The Applicant may apply for a new permit under the procedures outlined in this Ordinance.

Section 905. Penalties

A. Any person violating the provisions of this ordinance shall be subject to a fine of not less than $ _____ nor more than $ _____ for each violation, recoverable with costs. Each day that the violation continues shall constitute a separate offense and the applicable fines are cumulative.

B. In addition, the Municipality, through its Solicitor, may institute injunctive, mandamus, or any other appropriate action or proceeding at law or in equity for the enforcement of this Ordinance. Any court of competent jurisdiction shall have the right to issue restraining orders, temporary or permanent injunctions, mandamus, or other appropriate forms of remedy or relief.

Section 906. Notification

In the event that a person fails to comply with the requirements of this Ordinance or fails to conform to the requirements of any permit issued hereunder, the Municipality shall provide

written notification of the violation. Such notification shall state the nature of the violation(s) and establish a time limit for correction of these violation(s). Failure to comply within the time specified shall subject such person to the penalty provisions of this Ordinance. All such penalties shall be deemed cumulative and shall not prevent the Municipality from pursuing any and all remedies. It shall be the responsibility of the owner of the real property on which any regulated activity is proposed to occur, is occurring, or has occurred to comply with the terms and conditions of this Ordinance.

Section 907. Enforcement

The municipal Governing Body is hereby authorized and directed to enforce all of the provisions of this Ordinance. All inspections regarding compliance with the drainage plan shall be the responsibility of the municipal Engineer or other qualified persons designated by the Municipality.

A. A set of design plans approved by the Municipality shall be on file at the site throughout the duration of the construction activity. Periodic inspections may be made by the Municipality or designee during construction.

B. It shall be unlawful for any person, firm, or corporation to undertake any regulated activity under Section 104 on any property except as provided for in the approved drainage plan and pursuant to the requirements of this Ordinance. It shall be unlawful to alter or remove any control structure required by the drainage plan pursuant to this Ordinance or to allow the property to remain in a condition that does not conform to the approved drainage plan.

C. At the completion of the project and as a prerequisite for the release of the performance guarantee, the owner or his representatives shall:

    1. Provide a certification of completion from an engineer, architect, surveyor, or other qualified person verifying that all permanent facilities have been constructed according to the plans and specifications and approved revisions thereto.

    2. Provide a set of as-built (record) drawings.

D. After receipt of the certification by the Municipality, a final inspection shall be conducted by the municipal Engineer or designated representative to certify compliance with this Ordinance.

E. Prior to revocation or suspension of a permit and at the request of the Applicant, the Governing Body will schedule a hearing to discuss the noncompliance if there is no immediate danger to life, public health, or property. The expense of a hearing shall be the Applicant’s responsibility.

F. Occupancy Permit: An occupancy permit shall not be issued unless the certification of completion pursuant to Section 907.C.1 has been secured. The occupancy permit shall be required for each lot owner and/or Applicant for all subdivisions and land developments in the Municipality.

Section 908. Appeals

A. Any person aggrieved by any action of the [*Municipal Name*] or its designee may appeal to [*the Municipality's Governing Body*] within thirty (30) days of that action.

B. Any person aggrieved by any decision of [*the Municipality's Governing Body*] may appeal to the County Court of Common Pleas in the County where the activity has taken place within thirty (30) days of the municipal decision.

ENACTED and ORDAINED at a regular meeting of the _____ on the _____ of _____, 20 _____ **.**

This Ordinance shall take effect immediately.

_____
[Name]

_____
[Title]

_____
[Name]

_____
[Title]

_____
[Name]

_____
[Title]

_____
[Name]

_____
[Title]

_____
[Name]

_____
[Title]

ATTEST:

_____

Secretary

I hereby certify that the foregoing Ordinance was advertised in the _____ _____ , 20 _____ **,** a newspaper of general circulation in the Municipality and was duly enacted and approved as set forth at a regular meeting of the Municipality's Governing Body held on _____ ,20 _____ .

_____

Secretary

ORDINANCE APPENDIX A

SWAMP CREEK STORMWATER MANAGEMENT DISTRICT WATERSHED MAP

Insert Swamp Creek Stormwater Management District Watershed Map Here

The following article provisions are optional.

ORDINANCE APPENDIX B

Voluntary stormwater management procedures for projects with less than one thousand (1,000) square feet of proposed impervious area or less than five thousand (5,000) square feet of earth disturbance

VOLUNTARY STORMWATER MANAGEMENT PROCEDURES FOR PROJECTS MEETING THE LAND COVER EXEMPTION CRITERIA

What are the Act 167 stormwater management requirements?

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.

Who is affected by these requirements?

The Act 167 stormwater management requirements affect all NEW development in the Municipality. Individual home construction projects on single-family lots that result in less than one thousand (1,000) square feet of impervious area (including the building footprint driveway, sidewalks, and parking areas) or less than five thousand (5,000) square feet of earth disturbance are not required to submit formal drainage plans to the Municipality or County; however, they are still encouraged to address water quality and groundwater recharge criteria specified in this Ordinance (Sections 405 and 406).

Do I require professional services to meet these requirements?

This brochure has been developed to assist the individual homeowner in meeting the voluntary water quality and groundwater recharge goals of this Ordinance. If the guidelines presented in this brochure are followed, the individual homeowner will not require professional services to comply with these water quality and groundwater recharge goals.

What do I need to send to the Municipality?

Even though a formal drainage plan is not required for individual lot owners, a brief description of the proposed infiltration facilities, including types of material to be used, total impervious areas and volume calculations as shown above, and a simple sketch plan showing the following information shall be submitted to the contractor prior to construction:

- Location of proposed structures, driveways, or other paved areas with approximate size in square feet.
- Location of any existing or proposed on-site septic system and/or potable water wells showing rough proximity to infiltration facilities.

Determination of Recharge Volume

The amount of recharge volume that should be provided can be determined using Ordinance Section 405.

Example Recharge Volume:

STEP 1 – Determine Total Impervious Surfaces.

STEP 2 – Determine Required Recharge (Infiltration) Volume (Re_v) Using Ordinance Section 405.

STEP 3 – Sizing of Select Infiltration Method

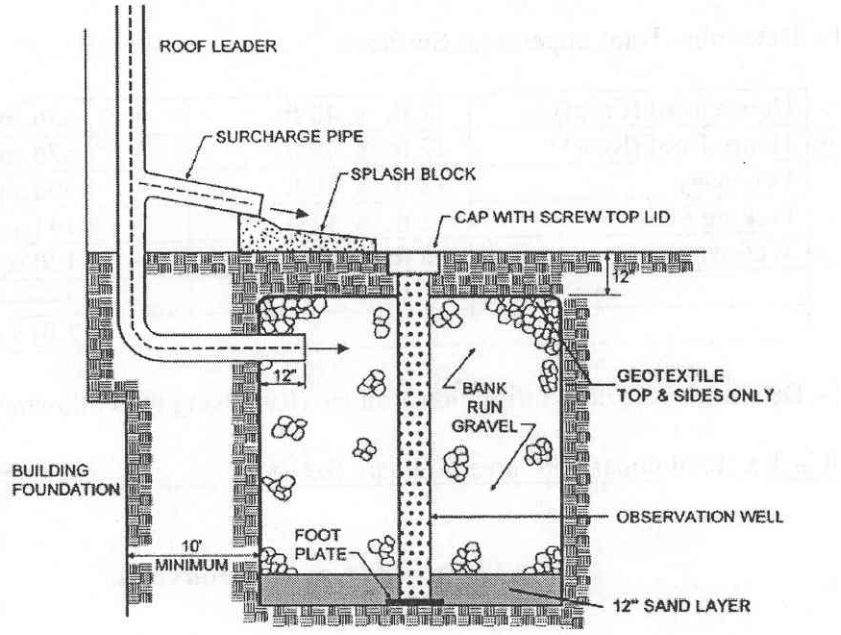
The following pages show several methods of infiltrating stormwater runoff from residential areas. Their appropriateness depends on the amount of infiltration volume required and the amount of land available. More than one method can be implemented on a site, depending on site constraints. Dry wells should be used only for receiving runoff from roof drains. Infiltration trenches are appropriate for receiving runoff from driveways, sidewalk, or parking areas. Other methods may be appropriate, but these should be discussed with the Municipal Engineer prior to installation.

Dry Wells

Dry wells are effective methods of infiltrating runoff from roof leaders. These facilities should be located a minimum of ten (10) feet from the building foundation to avoid seepage problems. A dry well can be either a structural prefabricated chamber or an excavated pit filled with aggregate. Construction of a dry well should be performed after all other areas of the site are stabilized to avoid clogging. During construction, compaction of the subgrade soil should be avoided, and construction should be performed with only light machinery. Depth of dry wells in excess of three and one half (3½) feet should be avoided. Gravel fill should be an average one and one half to three (1.5 – 3.0) inches in diameter. Dry wells should be inspected at least four (4) times annually as well as after large storm events.

FIGURE B-1

TYPICAL DRY WELL CONFIGURATION



Source: Maryland Stormwater Design Manual

Example Sizing:

STEP 1 – Determine Total Impervious Surfaces

STEP 2 – Determine Required Recharge (Infiltration) Volume (Rev) Using Ordinance Section 405.

STEP 3 – Sizing of Select Infiltration Method

Volume of facility = Depth x Width x Length
Volume of facility must account for assumed 40% void ratio in gravel bed.

EXAMPLE
STEP 1: Suppose proposed impervious surface = 500 square feet; provide stormwater management under voluntary stormwater management procedures.

STEP 2: Required Recharge (Infiltration) Volume (Rev) is determined using Ordinance Section 405. Suppose Rev = 90 cubic feet.

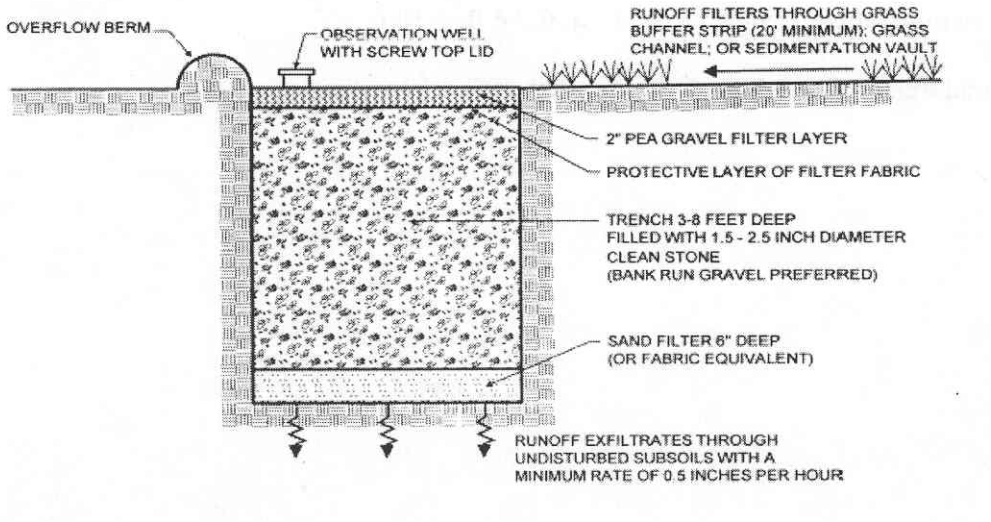
STEP 3: Facility volume = Rev / 0.40 (accounting for void ratio in bed). Therefore, the proposed facility volume = 90 / 0.40 = 225 cubic feet.

Infiltration Trenches

An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives stormwater runoff. Runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. Infiltration trenches perform well for removal of fine sediment and associated pollutants. Pretreatment using buffer strips, swales, or detention basins is important for limiting amounts of coarse sediment entering the trench which can clog and render the trench ineffective.

FIGURE B-2

TYPICAL INFILTRATION TRENCH CONFIGUATION



Source: Maryland Stormwater Design Manual

Example Sizing:

STEP 1 – Suppose proposed impervious surface = 500 square feet; provide stormwater management under voluntary stormwater management procedures.

STEP 2 – Required Recharge (Infiltration) Volume (Rev) is determined using Ordinance Section 405. Suppose Rev = 90 cubic feet.

STEP 3 – Sizing of Select Infiltration Method

Volume of facility = Depth x Width x Length

Required facility volume = Rev / 0.40 (accounting for void ratio in bed). Therefore, the proposed facility volume = 90 / 0.40 = 225 cubic feet.

Set D = 3 ft; determined required surface area of trench

225 cu. ft. / 3 = 75 sq. ft.

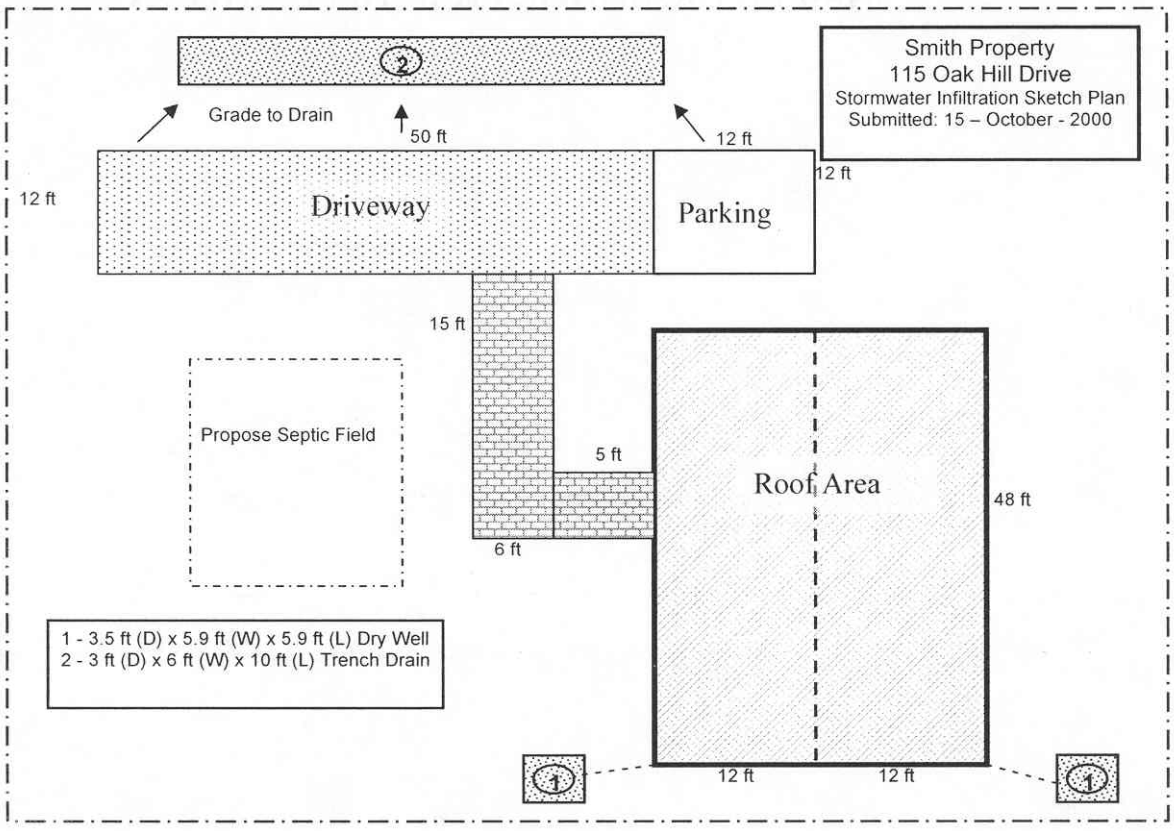
The width of the trench should be greater than 2 times its depth (2 x D); therefore, in this example a trench width of 7 feet is selected;

Determine trench length: L = 75 sq. ft. / 7 ft. = 10.8 ft.

Final trench dimensions: 3 ft. (D) x 7 ft. (W) x 10.8 ft. (L)

FIGURE B-3

SAMPLE SITE SKETCH PLAN



Source: Maryland Stormwater Design Manual

ORDINANCE APPENDIX C – 1

SAMPLE DRAINAGE PLAN APPLICATION

SAMPLE DRAINAGE PLAN APPLICATION

(To be attached to the "land subdivision plan or development plan review application" or "minor land subdivision plan review application")

Application is hereby made for review of the Stormwater Management Plan and related data as submitted herewith in accordance with the _____Stormwater Management Ordinance.

_____ Final Plan _____ Preliminary Plan _____ Sketch Plan

Date of Submission _____ Submission No. _____

1. Name of subdivision or development _____

2. Name of Applicant _____ Telephone No. _____

   (if corporation, list the corporation's name and the names of two officers of the corporation

   _____ Officer 1

   _____ Officer 2

   Address _____ Zip _____

   Applicant's interest in subdivision or development
   (if other than property owner, give owner's name and address)

3. Name of Property Owner _____ Telephone No. _____

   Address _____ Zip _____

4. Name of engineer or surveyor _____ Telephone No. _____

   Address _____ Zip _____

5. Type of subdivision or development proposed:

_____ Single-family lots	_____ Townhouses	_____ Commercial (Multi-lot)
_____ Two-family lots	_____ Garden Apartments	_____ Commercial (One lot)
_____ Multi-family Lots	_____ Mobile Home Park	_____ Industrial (Multi-lot)
_____ Cluster Type Lots	_____ Campground	_____ Industrial (One lot)
_____ Planned Residential Development	_____ Other (_____)	

6. Linear feet of new road proposed _____ L.F.

7. Area of proposed and existing impervious area on the entire tract:

   a. Existing (to remain) _____ S.F. _____ % of property

   b. Proposed _____ S.F. _____ % of property

8. Stormwater

   a. Does the peak rate of runoff from proposed conditions exceed that flow which occurred for existing conditions for the designated design storm? _____

   b. Design storm utilized (on-site conveyance systems) (24 hr.) _____
   No. of Subarea _____
   Watershed Name _____
   Explain: _____

   c. Does the submission and/or district meet the criteria for the applicable management district? _____

   d. Number of subarea(s) from Ordinance Appendix A of the _____ _____Stormwater Management Plan or other subareas identified in other watershed stormwater management plans _____

   e. Type of proposed runoff control _____

   f. Does the proposed stormwater control criteria meet the requirements/guidelines of the Stormwater Ordinance? _____
   If not, what variances/waivers are requested? _____
   Reasons _____

   g. Does the plan meet the requirements of Article III of the Stormwater Ordinance? _____
   If not, what variances/waivers are requested? _____
   Reasons why _____

   h. Was TR-55, June 1986, utilized in determining the time of concentration? _____

   i. What hydrologic method was used in the stormwater computations? _____

   j. Is a hydraulic routing through the stormwater control structure submitted? _____

   k. Is a construction schedule or staging attached? _____

   l. Is a recommended maintenance program attached? _____

9. Erosion and Sediment Pollution Control (E&S):

   a. Has the stormwater management and E&S plan, supporting documentation, and narrative been submitted to the _____ County Conservation District? _____

   b. Total area of earth disturbance _____ S.F.

10. Wetlands

   a. Have the wetlands been delineated by someone trained in wetland delineation? _____

b. Have the wetland lines been verified by a state or federal permitting authority? _____

c. Have the wetlands been surveyed? _____

d. Total acreage of wetland within the property _____

e. Total acreage of wetland disturbed _____

f. Supporting documentation _____

11. Filing

a. Has the required fee been submitted? _____
Amount

b. Has the proposed schedule of construction inspection to be performed by the Applicant's Engineer been submitted? _____

c. Name of individual who will be making the inspections _____

d. General comments about stormwater management at the development

_____

_____

CERTIFICATE OF OWNERSHIP AND ACKNOWLEDGMENT OF APPLICATION:

COMMONWEALTH OF PENNSYLVANIA
COUNTY OF [*County Name*].

On this the _____ day of _____ , 20 _____ , before me, the undersigned officer, personally appeared _____ who, being duly sworn according to law, deposes and says that _____ are owners of the property described in this application and that the application was made with _____ knowledge and/or direction and does hereby agree with the said application and to the submission of the same.

_____ Property Owner

My Commission Expires _____ 20 _____

Notary Public _____

THE UNDERSIGNED HEREBY CERTIFIES THAT TO THE BEST OF HIS KNOWLEDGE AND BELIEF THE INFORMATION AND STATEMENTS GIVEN ABOVE ARE TRUE AND CORRECT.

SIGNATURE OF APPLICANT _____

//

(Information Below This Line To Be Completed By The Municipality)

(Name of) Municipality official submission receipt:

Date complete application received _____ plan number _____

Fees _____ date fees paid _____ received by _____

Official submission receipt date _____

Received by _____

_____

Municipality

PROPOSED SCHEDULE OF FEES

[Note: It is recommended that Municipalities adopt a fee schedule independent of the Ordinance so that fee schedules can be adjusted as need arises without having to go through the Ordinance revision public hearing process. This schedule of fees is to be submitted by the applicant with the land development plan]

Subdivision name _____ Submittal No. _____

Owner _____ Date _____

Engineer _____

1.	Filing fee	$ _____
2.	Proposed land use	$ _____
	2a. Subdivision, campgrounds, mobile home parks, and multi-family dwelling where the units are located in the same local watershed	$ _____
	2b. Multi-family dwelling where the designated open space is located in a different local watershed from the proposed units	$ _____
	2c. Commercial/industrial	$ _____
	2d. Other	$ _____
3.	Relative amount of earth disturbance	
	3a. Residential	
	road <500 l.f.	$ _____
	road 500 – 2,640 l.f.	$ _____
	road >2,640 l.f.	$ _____
	3b. Commercial/industrial and other	
	impervious area <3,500 s.f.	$ _____
	impervious area 3,500 – 43,560 s.f.	$ _____
	impervious area >43,560 s.f.	$ _____
4.	Relative size of project	
	4a. Total tract area: <1 ac.	$ _____
	1 - 5 ac.	$ _____
	5 - 25 ac.	$ _____
	25 – 100 ac.	$ _____
	100 – 200 ac.	$ _____
	>200 ac.	$ _____

5.	Stormwater control measures	
	5a. Detention basins and other controls which require a review of hydraulic routings ($ per control)	$
	5b. Other control facilities which require storage volume calculations but no hydraulic routings ($ per control)	$
6.	Site inspection ($ per inspection)	$
	TOTAL	**$**

All subsequent reviews shall be 25% of the amount of the initial review fee unless a new application is required as per Section 306 of the Stormwater Ordinance. A new fee shall be submitted with each revision in accordance with this schedule.

ORDINANCE APPENDIX C – 2

DRAINAGE PLAN CHECKLIST

DRAINAGE PLAN CHECKLIST

Project: _____

Municipality: _____

Engineer: _____

Submittal No.: _____

Date: _____

ARTICLE I: GENERAL PROVISIONS

Reference: Section 105 Applicability/Regulated Activities

1. Is the Proposed Project within the Swamp Creek watershed? ☐ Yes ☐ No
2. Does the Proposed Project meet the definition of a "Regulated Activity"? ☐ Yes ☐ No

STOP – If you have checked NO for either of the above questions, you are not required to submit a Storm Water Management Plan under the Swamp Creek Stormwater Management Ordinance.

ARTICLE I: GENERAL PROVISIONS

Reference: Section 106 Exemptions

Note: Parent Tract refers to the total parcel configuration on the date of the Municipal Stormwater Management Ordinance and includes any subdivision of lands which may have occurred after than date.

Parent Tract Area: _____ acres

Total Existing Impervious Area (as of the date of the Municipal Stormwater Management Ordinance): _____ acres

Total New Impervious Area (all Phases): _____ acres

Parcel IS Exempt ☐ Parcel IS NOT Exempt ☐

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 404 Nonstructural Project Design

1. Has an Existing Resource and Site Analysis Map (ERSAM) been prepared?

   ☐ Yes ☐ No, Explain _____

ARTICLE IV: STORMWATER MANAGEMENT (Continued)

2. Are any of the following Environmentally Sensitive areas identified on site?

Steep Slopes	☐ Yes	☐ No	☐ Unknown
Ponds / Lakes / Vernal Pools	☐ Yes	☐ No	☐ Unknown
Streams	☐ Yes	☐ No	☐ Unknown
Wetlands	☐ Yes	☐ No	☐ Unknown
Hydric soils	☐ Yes	☐ No	☐ Unknown
Flood plains	☐ Yes	☐ No	☐ Unknown
Stream Buffer Zones	☐ Yes	☐ No	☐ Unknown
Hydrologic Soil Groups A or B	☐ Yes	☐ No	☐ Unknown
Recharge Areas	☐ Yes	☐ No	☐ Unknown
Others: _____	☐ Yes	☐ No	☐ Unknown

3. Does the site layout plan avoid Environmentally Sensitive Areas identified on site?

☐ Yes ☐ No, Explain _____

_____

_____

4. Has a stream buffer been established per Section 406.G.?

☐ Yes ☐ No, Explain _____

_____

_____

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 405 Groundwater Recharge

1. Is the proposed activity considered a "Stormwater Hotspot"? ☐ Yes ☐ No

2. Have provisions been installed to promote groundwater recharge on site?

☐ Yes ☐ No, Explain _____

_____

_____

3. Total Recharge Volume Required: _____ cubic feet

4. How is the Required Recharge Volume being addressed?

☐ Infiltration Trench ☐ Dry Swales

☐ Infiltration Basin ☐ Other: _____

☐ Bioretention

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 406 Water Quality Requirements

1. Have provisions been installed to address stormwater runoff water quality on site?

   ☐ Yes ☐ No, Explain _____

2. Total Water Quality Volume Required: _____ acre feet

3. Is the site in a Special Protection watershed which includes Exceptional Value (EV) of High Quality (HQ) waters?

   ☐ Yes ☐ No

4. How is the Required Recharge Volume being addressed?

   ☐ Wet Detention Basin ☐ Sand Filter

   ☐ Extended Dry Detention Basin ☐ Constructed Wetlands

   ☐ Bioretention ☐ Other: _____

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 407 Streambank Erosion Requirements

1. Has the 2- year proposed conditions flow been reduced to the 1- year existing conditions flow?

   ☐ Yes ☐ No, Explain

2. Does the proposed conditions 1- year storm drain over a minimum 24- hour period?

   ☐ Yes ☐ No, Explain _____

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 408 Stormwater Peak Rate Control and Management Districts

1. Does the Proposed Conditions Runoff meet the Criteria established in Section 408.A?

   ☐ Yes ☐ No, if you answered Yes proceed to Section V.

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 409 Calculation Methodology

1. Which method(s) are utilized in the site stormwater management plan for computing stormwater runoff rates and volumes?

   ☐ TR-20 ☐ PSRM

   ☐ TR-55 ☐ Rational Method

   ☐ HEC-1 / HEC-HMS ☐ Other: _____

2. Were Table E-1 or Figure E-3 in Appendix E utilized in rainfall determination?

   ☐ Yes ☐ No, Explain _____

3. Were Table E-2 (Runoff Curve Numbers) or Table E-3 in the Appendix E (Rational Runoff Coefficients) utilized in calculations for runoff?

   ☐ Yes ☐ No, Explain _____

4. For any proposed storm water detention facility, were the appropriate design storms routed through the facility using the Storage-Indication Method?

   ☐ Yes ☐ No, Explain _____

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 410 Other Requirements

1. Is this project subject to PENNDOT approval?

   ☐ Yes ☐ No

   a. If "YES" have these plans been forwarded to PENNDOT for review?

      ☐ Yes ☐ No, Explain _____

2. Have proposed wet detention basins incorporated biologic control consistent with the West Nile Guidelines presented in Appendix G?

   ☐ Yes ☐ No ☐ Not Applicable

ARTICLE IV: STORMWATER MANAGEMENT (continued)

3. Are any proposed stormwater facilities subject to PADEP Chapter 105 permitting?

   ☐ Yes ☐ No

   a. If "YES" have these plans been forwarded to PADEP for review?

☐ Yes ☐ No, Explain _____

ARTICLE VII: MAINTENANCE RESPONSIBLITIES

Reference: Section 702 Responsibilities for Operations and Maintenance of Stormwater Controls/BMPs

1. Has a Stormwater Control and BMP Operations and Maintenance Plan been approved by the Municipality?

   ☐ Yes ☐ No, Explain _____

2. Who shall assume responsibility for implementing the Stormwater Control and BMP Operations and Maintenance Plan?

   ☐ Municipality ☐ Homeowner Association

   ☐ Private Owner ☐ Other: _____

ORDINANCE APPENDIX D

LOW IMPACT DEVELOPMENT (LID) PRACTICES

LOW IMPACT DEVELOPMENT (LID) PRACTICES

ALTERNATIVE APPROACH FOR MANAGING STORMWATER RUNOFF

Natural hydrologic conditions can be altered radically by poorly planned development practices such as introducing unnecessary impervious surfaces, destroying existing drainage swales, constructing unnecessary storm sewers, and changing local topography. A traditional drainage approach of development has been to remove runoff from a site as quickly as possible and capture it in a detention basin. This approach leads ultimately to the degradation of water quality as well as expenditure of additional resources for detaining and managing concentrated runoff at some downstream location.

The recommended alternative approach is to promote practices that will minimize proposed conditions runoff rates and volumes, which will minimize needs for artificial conveyance and storage facilities. To simulate pre-development hydrologic conditions, infiltration is often necessary to offset the loss of infiltration by creation of impervious surfaces. The ability of the ground to infiltrate depends upon the soil types and its conditions.

Preserving natural hydrologic conditions requires careful alternative site design considerations. Site design practices include preserving natural drainage features, minimizing impervious surface area, reducing the hydraulic connectivity of impervious surfaces, and protecting natural depression storage. A well-designed site will contain a mix of all of those features. The following describes various techniques to achieve the alternative approach:

- **Preserving Natural Drainage Features**. Protecting natural drainage features, particularly vegetated drainage swales and channels, is desirable because of their ability to infiltrate and attenuate flows and to filter pollutants. However, this objective is often not accomplished in land development. In fact, commonly held drainage philosophy encourages just the opposite pattern -- streets and adjacent storm sewers are typically located in the natural headwater valleys and swales, thereby replacing natural drainage functions with a completely impervious system. As a result, runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Developments designed to fit site topography also minimize the amount of grading on site.
- **Protecting Natural Depression Storage Areas.** Depressional storage areas either have no surface outlet or drain very slowly following a storm event. They can be commonly seen as ponded areas in farm fields during the wet season or after large runoff events. Traditional development practices eliminate these depressions by filling or draining, thereby obliterating their ability to reduce surface runoff volumes and trap pollutants. The volume and release rate characteristics of depressions should be protected in the design of the development site. The depressions can be protected by simply avoiding the depression or by incorporating its storage as additional capacity in required detention facilities.
- **Avoiding Introduction of Impervious Areas**. Careful site planning should consider reducing impervious coverage to the maximum extent possible. Building footprints,

sidewalks, driveways, and other features producing impervious surfaces should be evaluated to minimize impacts on runoff.

- **Reducing the Hydraulic Connectivity of Impervious Surfaces**. Impervious surfaces are significantly less of a problem if they are not directly connected to an impervious conveyance system (such as a storm sewer). Two basic ways to reduce hydraulic connectivity are routing of roof runoff over lawns and reducing the use of storm sewers. Site grading should promote increasing travel time of stormwater runoff and should help reduce concentration of runoff to a single point in the development.
- **Routing Roof Runoff Over Lawns.** Roof runoff can be easily routed over lawns in most site designs. The practice discourages direct connection of downspouts to storm sewers or parking lots. The practice also discourages sloping driveways and parking lots to the street. By routing roof drains and crowning the driveway to run off to the lawn, the lawn is essentially used as a filter strip.
- **Reducing the Use of Storm Sewers**. By reducing use of storm sewers for draining streets, parking lots, and back yards, the potential for accelerating runoff from the development can be greatly reduced. The practice requires greater use of swales and may not be practical for some development sites, especially if there are concerns for areas that do not drain in a “reasonable” time. The practice requires educating local citizens and public works officials who expect runoff to disappear shortly after a rainfall event.
- **Reducing Street Widths.** Street widths can be reduced by either eliminating on-street parking or by reducing roadway widths. Municipal planners and traffic designers should encourage narrower neighborhood streets that ultimately could lower maintenance.
- **Limiting Sidewalks to One Side of the Street.** A sidewalk on one side of the street may suffice in low-traffic neighborhoods. The lost sidewalk could be replaced with bicycle/recreational trails that follow back-of-lot lines. Where appropriate, backyard trails should be constructed using pervious materials.
- **Using Permeable Paving Materials**. These materials include permeable interlocking concrete paving blocks or porous bituminous concrete. Such materials should be considered as alternatives to conventional pavement surfaces, especially for low use surfaces such as driveways, overflow parking lots, and emergency access roads.
- **Reducing Building Setbacks.** Reducing building setbacks reduces impervious cover associated with driveway and entry walks and is most readily accomplished along low traffic streets where traffic noise is not a problem.
- **Constructing Cluster Developments.** Cluster developments can also reduce the amount of impervious area for a given number of lots. The biggest savings occurs with street length, which also will reduce costs of the development. Cluster development groups the construction activity in less-sensitive areas without substantially affecting the gross density of development.

In summary, a careful consideration of the existing topography and implementation of a combination of the above mentioned techniques may avoid construction of costly stormwater control measures. Benefits include reduced potential for downstream flooding and water quality degradation of receiving streams/water bodies, enhancement of aesthetics, and reduction of development costs. Other benefits include more stable baseflows in receiving streams, improved groundwater recharge, reduced flood flows, reduced pollutant loads, and reduced costs for conveyance and storage.

ORDINANCE APPENDIX E

STORMWATER MANAGEMENT DESIGN CRITERIA

TABLE E-1
Precipitation-Frequency Atlas of the United States

TABLE E-2
RUNOFF CURVE NUMBERS

TABLE E-3
RATIONAL RUNOFF COEFFICIENTS

TABLE E-4
NONSTRUCTURAL STORMWATER MANAGEMENT MEASURES

TABLE E-1

Precipitation-Frequency Atlas of the United States

Precipitation Frequency Estimates (inches)																		
ARI* (years)	**5 min**	**10 min**	**15 min**	**30 min**	**60 min**	**120 min**	**3 hr**	**6 hr**	**12 hr**	**24 hr**	**48 hr**	**4 day**	**7 day**	**10 day**	**20 day**	**30 day**	**45 day**	**60 day**
1	0.34	0.54	0.67	0.92	1.15	1.37	1.50	1.88	2.29	2.71	3.13	3.48	4.06	4.61	6.22	7.75	9.84	11.80
2	0.40	0.64	0.81	1.11	1.40	1.67	1.82	2.27	2.77	3.26	3.78	4.19	4.87	5.50	7.38	9.13	11.56	13.81
5	0.47	0.76	0.96	1.36	1.74	2.09	2.29	2.84	3.48	4.10	4.76	5.23	6.01	6.70	8.80	10.64	13.29	15.77
10	0.52	0.84	1.06	1.53	2.00	2.41	2.65	3.31	4.08	4.80	5.55	6.08	6.95	7.67	9.91	11.81	14.58	17.21
25	0.58	0.93	1.18	1.75	2.33	2.85	3.14	3.96	4.96	5.81	6.69	7.28	8.29	9.01	11.41	13.34	16.22	19.01
50	0.63	1.00	1.27	1.91	2.58	3.20	3.52	4.49	5.70	6.67	7.63	8.27	9.39	10.09	12.59	14.49	17.43	20.32
100	0.67	1.06	1.35	2.06	2.84	3.55	3.92	5.06	6.51	7.59	8.63	9.30	10.56	11.20	13.76	15.63	18.56	21.53
200	0.71	1.12	1.42	2.20	3.09	3.90	4.32	5.65	7.38	8.59	9.70	10.41	11.80	12.36	14.95	16.75	19.64	22.66
500	0.75	1.19	1.50	2.38	3.42	4.39	4.87	6.50	8.66	10.06	11.23	11.97	13.56	13.96	16.54	18.19	20.96	24.04
1000	0.79	1.24	1.55	2.52	3.67	4.76	5.30	7.17	9.74	11.27	12.48	13.24	14.99	15.23	17.75	19.26	21.90	25.00

Source: Atlas 14, Volume 2, US Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Hydrometeorological Design Studies Center, Silver Springs, Maryland 20910. NOAA's Atlas 14 can be found on the internet at http://hdsc.nws.noaa.gov/hdsc/pfds/.

TABLE E-2

RUNOFF CURVE NUMBERS

LAND USE DESCRIPTION	Hydrologic Condition	HYDROLOGIC SOIL GROUP A	B	C	D
Open Space					
Grass cover < 50%	Poor	68	79	86	89
Grass cover 50% to 75%	Fair	49	69	79	84
Grass cover > 75%	Good	39	61	74	80
Meadow		30	58	71	78
Agricultural					
Pasture, grassland, or range – Continuous forage for grazing	Poor	68	79	86	89
Pasture, grassland, or range – Continuous forage for grazing	Fair	49	69	79	84
Pasture, grassland, or range – Continuous forage for grazing	Good	39	61	74	80
Brush—brush-weed-grass mixture with brush the major element	Poor	48	67	77	83
Brush—brush-weed-grass mixture with brush the major element	Fair	35	56	70	77
Brush—brush-weed-grass mixture with brush the major element	Good	30	48	65	73
Fallow Bare soil	----	77	86	91	94
Crop residue cover (CR)	Poor	76	85	90	93
Woods – grass combination (orchard or tree farm)	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77
Commercial	(85% impervious)	89	92	94	95
Industrial	(72% impervious)	81	88	91	93
Industrial	(50% impervious)	71	82	88	90
Residential districts by average lot size:	% Impervious:				
1/8 acre or less * (townhouses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Farmstead		59	74	82	86
Smooth surfaces (concrete, asphalt, gravel, or bare compacted soil)		98	98	98	98
Water		98	98	98	98
Mining/newly graded areas (pervious areas only)		77	86	91	94

* Includes multi-family housing unless justified lower density can be provided.

Note: Existing site conditions of bare earth or fallow ground shall be considered as meadow when choosing a CN value.

Source: NRCS (SCS) TR-55

TABLE E-3

RATIONAL RUNOFF COEFFICIENTS

HYDROLOGIC SOIL GROUP	A			B			C			D		
SLOPE	**0-2%**	**2-6%**	**6%+**	**0-2%**	**2-6%**	**6%+**	**0-2%**	**2-6%**	**6%+**	**0-2%**	**2-6%**	**6%+**
LAND USE DESCRIPTION												
Cultivated Land												
Winter Conditions	.14	.23	.34	.21	.32	.41	.27	.37	.48	.34	.45	.56
Summer Conditions	.10	.16	.22	.14	.20	.28	.19	.26	.33	.23	.29	.38
Fallow Fields												
Poor Conditions	.12	.19	.29	.17	.25	.34	.23	.33	.40	.27	.35	.45
Good Conditions	.08	.13	.16	.11	.15	.21	.14	.19	.26	.18	.23	.31
Forest/Woodland	.08	.11	.14	.10	.14	.18	.12	.16	.20	.15	.20	.25
Grass Areas												
Good Conditions	.10	.16	.20	.14	.19	.26	.18	.22	.30	.21	.25	.35
Average Conditions	.12	.18	.22	.16	.21	.28	.20	.25	.34	.24	.29	.41
Poor Conditions	.14	.21	.30	.18	.28	.37	.25	.35	.44	.30	.40.	.50
Impervious Areas	.90	.91	.92	.91	.92	.93	.92	.93	.94	.93	.94	.95
Weighted Residential												
Lot Size 1/8 Acre	.29	.33	.36	.31	.35	.40	.34	.38	.44	.36	.41	.48
Lot Size 1/4 Acre	.26	.30	.34	.29	.33	.38	.32	.36	.42	.34	.38	.46
Lot Size 1/3 Acre	.24	.28	.31	.26	.32	.35	.29	.35	.40	.32	.36	.45
Lot Size 1/2 Acre	.21	.25	.28	.24	.27	.32	.27	.32	.37	.30	.34	.43
Lot Size 1 Acre	.18	.23	.26	.21	.24	.30	.24	.29	.36	.28	.32	.41

TABLE E-4

NONSTRUCTURAL STORMWATER MANAGEMENT MEASURES

Nonstructural Stormwater Measure	Description
Natural Area Conservation	Conservation of natural areas such as forest, wetlands, or other sensitive areas in a protected easement, thereby retaining their existing hydrologic and water quality characteristics.
Disconnection of Rooftop Runoff	Rooftop runoff is disconnected and then directed over a pervious area where it may either infiltrate into the soil or filter over it. This is typically obtained by grading the site to promote overland flow or by providing bioretention on single-family residential lots.
Disconnection of Nonrooftop Runoff	Disconnect surface impervious cover by directing it to pervious areas where it is either infiltrated or filtered through the soil.
Buffers	Buffers effectively treat stormwater runoff. Effective treatment constitutes capturing runoff from pervious and impervious areas adjacent to the buffer and treating the runoff through overland flow across a grassy or forested area.
Grass Channel (Open Section Roads)	Open grass channels are used to reduce the volume of runoff and pollutants during smaller storms.
Environmentally Sensitive Rural Development	Environmental site design techniques are applied to low-density or rural residential development.

Source: Maryland Department of the Environment, "Maryland Stormwater Design Manual," Baltimore, MD, 2000

ORDINANCE APPENDIX F

REFERENCES

REFERENCES

BMP Manuals

California
California Stormwater BMP Handbook: New Development and Redevelopment (January 2003) – separate file available at **http://www.cabmphandbooks.org/Development.asp**

Georgia
Georgia Stormwater Management Manual Volume 2: Technical Handbook (August 2001)- separate file **(http://www.georgiastormwater.com/)**

Maryland
2000 Maryland Stormwater Design Manual –
http://www.mde.state.md.us/Programs/Waterprograms/SedimentandStormwater/stormwater design/index.asp

Massachusetts
Stormwater Management, Volume Two: Stormwater Technical Handbook (Massachusetts, 1997) – separate file available at
http://www.state.ma.us/dep/brp/stormwtr/stormpub.htm

Minnesota
Minnesota Urban Small Sites BMP Manual: Stormwater Best Management Practices for Cold Climates (July 2001) –
http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm

New Jersey
Revised Manual for New Jersey: Best Management Practices for Control of Nonpoint Source Pollution from Stormwater (Fifth Draft May 2000) –
http://www.state.nj.us/dep/watershedmgt/bmpmanual.htm

New York
New York State Stormwater Management Design Manual (2001) –
http://www.dec.state.ny.us/website/dow/swmanual/swmanual.html

Pennsylvania
Pennsylvania Stormwater Best Management Practices Manual, January 2005 (draft).
Pennsylvania Association of Conservation Districts, Pennsylvania Handbook of Best Management Practices for Developing Areas, November 14, 1997.

Washington
Stormwater Management Manual for Western Washington (August 2001) –
http://www.ecy.wa.gov/programs/wq/stormwater/manual.html

Federal
Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring (FHWA) – **http://www.fhwa.dot.gov/environment/ultraurb/3fs1.htm**

USEPA Infiltration Trench Fact Sheet (September 1999) – **http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm**

Riparian Buffer References

Alliance for the Chesapeake Bay, Pennsylvania Department of Environmental Protection, September 2000. *Forest Buffer Toolkit*, Stream ReLeaf Program.

Penn State College of Agricultural Sciences, 1996. *Establishing Vegetative Buffer Strips Along Streams to Improve Water Quality.* Publication # AGRS-67.

Fike, Jean, June 1999. *Terrestrial & Palustrine Plant Communities of Pennsylvania,* Pennsylvania Natural Diversity Inventory, The Nature Conservancy, Western Pennsylvania Conservancy, and Pennsylvania Department of Conservation and Natural Resources.

Pennsylvania Association of Conservation Districts, Inc., Keystone Chapter, Soil and Water Conservation Society, Pennsylvania Department of Environmental Protection, Natural Resources Conservation Service, 1998. Pennsylvania Handbook of Best *Management Practices for Developing Areas.* Prepared by CH2MHill.

Palone, R. S. and A. H. Todd (eds), 1997. *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers.* Chesapeake Bay Program and Northeastern Area State and Private Forestry. Natural Resources Conservation Service Cooperative State Research Education and Extension Services.

The Federal Interagency Stream Restoration Working Group (FISRWG, 10/1998). *Stream Corridor Restoration Principles, Processes, and Practices*. GPO Item No. 0120-A; SuDocs No. A57.6/2:EN3/PT.653. ISBN-0-934213-59-3. Published October 1998. Revised August 2000.

ORDINANCE APPENDIX G

STORMWATER CONTROLS AND BEST MANAGEMENT PRACTICES
OPERATIONS AND MAINTENANCE AGREEMENT

STORMWATER CONTROLS AND BEST MANAGEMENT PRACTICES

OPERATIONS AND MAINTENANCE AGREEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, 200__, by and between _____, (hereinafter the "Landowner"), and _____, _____ County, Pennsylvania, (hereinafter "Municipality");

WITNESSETH

WHEREAS, the Landowner is the owner of certain real property as recorded by deed in the land records of _____ County, Pennsylvania, Deed Book _____ at Page _____, (hereinafter "Property").

WHEREAS, the Landowner is proceeding to build and develop the Property; and

WHEREAS, the Stormwater Controls and BMP Operations and Maintenance Plan approved by the Municipality (hereinafter referred to as the "Plan") for the property identified herein, which is attached hereto as Appendix A and made part hereof, provides for management of stormwater within the confines of the Property through the use of Best Management Practices (BMPs); and

WHEREAS, the Municipality and the Landowner, his successors, and assigns agree that the health, safety, and welfare of the residents of the Municipality and the protection and maintenance of water quality require that on-site stormwater BMPs 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 groundwater recharge, and to otherwise meet the purposes of the municipal Stormwater Management Ordinance, including but not limited to infiltration trenches, seepage pits, filter strips, bioretention, wet ponds, permeable paving, rain gardens, grassed swales, forested buffers, sand filters, and detention basins.

- Infiltration Trench – A BMP surface structure designed, constructed, and maintained for the purpose of providing infiltration or recharge of stormwater into the soil and/or groundwater aquifer,
- Seepage Pit – An underground BMP structure designed, constructed, and maintained for the purpose of providing infiltration or recharge of stormwater into the soil and/or groundwater aquifer,

- Rain Garden – A BMP overlain with appropriate mulch and suitable vegetation designed, constructed, and maintained for the purpose of providing infiltration or recharge of stormwater into the soil and/or underground aquifer, and

WHEREAS, the Municipality requires, through the implementation of the Plan, that stormwater management BMPs as required by said Plan and the municipal Stormwater Management Ordinance be constructed and adequately operated and maintained by the Landowner, his successors, and assigns.

NOW, THEREFORE, in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The BMPs shall be constructed by the Landowner in accordance with the plans and specifications identified in the Plan.
2. The Landowner shall operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Municipality and in accordance with the specific maintenance requirements noted on the Plan.
3. The Landowner hereby grants permission to the Municipality, its authorized agents, and employees to enter upon the property, at reasonable times and upon presentation of proper identification, to inspect the BMP(s) whenever it deems necessary. Whenever possible, the Municipality shall notify the Landowner prior to entering the property.
4. In the event that the Landowner fails to operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Municipality, the Municipality or its representatives may enter upon the Property and take whatever action is deemed necessary to maintain said BMP(s). This provision shall not be construed to allow the Municipality to erect any permanent structure on the land of the Landowner. It is expressly understood and agreed that the Municipality 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 Municipality.
5. In the event that the Municipality, pursuant to this Agreement, performs work of any nature or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner shall reimburse the Municipality for all expenses (direct and indirect) incurred within ten (10) days of receipt of an invoice from the Municipality.
6. The intent and purpose of this Agreement is to ensure the proper maintenance of the on-site BMP(s) by the Landowner; provided, however, that this Agreement shall not be deemed to create or effect any additional liability on any party for damage alleged to result from or be caused by stormwater runoff.
7. The Landowner, its executors, administrators, assigns, and other successors in interest shall release the Municipality's employees and designated representatives from all damages, accidents, casualties, occurrences, or claims which might arise or be asserted against said employees and representatives from the construction, presence, existence, or maintenance of the BMP(s) by the Landowner or Municipality. In the event that a claim is asserted against the Municipality, its designated representatives, or employees, the Municipality shall promptly notify the Landowner, and the Landowner shall defend, at his own expense, any

suit based on the claim. If any judgment or claims against the Municipality's employees or designated representatives shall be allowed, the Landowner shall pay all costs and expenses regarding said judgment or claim.

8. The Municipality shall inspect the BMP(s) at a minimum of once every three (3) years to ensure their continued functioning.

This Agreement shall be recorded at the Office of the Recorder of Deeds of _____ County, Pennsylvania, and shall constitute a covenant running with the Property and/or equitable servitude and shall be binding on the Landowner, his administrators, executors, assigns, heirs, and any other successors in interest, in perpetuity.

ATTEST:

WITNESS the following signatures and seals:

(SEAL) For the Municipality:

_____

(SEAL) For the Landowner:

_____

ATTEST:
_____ (City, Borough, Township)
County of _____, Pennsylvania
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 _____, 200_.

_____ _____

NOTARY PUBLIC **(SEAL)**

SECTION VIII – IMPLEMENTATION

A. Priorities for Implementation

The Swamp Creek Watershed Stormwater Management Plan has been prepared by Montgomery County, with assistance from ARRO Consultants, Inc., Berks County, the municipalities within the watershed, and DEP. The final steps involve adoption of the plan by Berks and Montgomery Counties, and approval of the plan by DEP. Once the plan is approved by DEP, it is implemented by the municipalities, which revise their existing stormwater ordinance or adopt the stand-alone ordinance contained in the plan. As required by Act 167, the Swamp Creek watershed municipalities have six months from DEP approval to adopt the necessary ordinance provisions. This process is described in the following section.

1. DEP Approval

The watershed plan was adopted by Montgomery and Berks Counties, and submitted to DEP for approval. A draft of the stormwater management plan and draft model ordinance had been sent to the Watershed Plan Advisory Committee (WPAC) and DEP prior to adoption of the plan. DEP reviewed the plan to determine that all of the sections specified in the Scope of Study have been included. The DEP also reviewed the plan for consistency with municipal floodplain management plans, State programs that regulate dams, encroachments and other water obstructions, and State and Federal flood control programs. The review process also ensures that the plan is compatible with other watershed stormwater plans in the basin, and that the plan is consistent with the policies of Act 167.

2. Plan Distribution

Once the Plan was approved by DEP, the Montgomery County Planning Commission distributed one hard copy of the plan to each municipality. The plan includes this report, appendices, figures, and the model ordinance.

3. Plan Implementation

The watershed municipalities are required, under Act 167, to adopt the ordinance provisions contained in the Swamp Creek Watershed Plan. The Plan contains the Act 167 Stormwater Management Plan Model Ordinance. This is a single purpose stormwater ordinance that could be adopted by each municipality with little modification to implement the plan. The municipality could adopt the ordinance itself and reference the existing subdivision and land development ordinance and possibly the zoning ordinance, and comply with the requirements of Act 167.

The municipality may choose to incorporate the standards and criteria of the stormwater ordinance into its existing ordinance rather than adopt the stand alone

ordinance. In this case, it is recommended that the subwatershed map delineating the watershed subareas and the stormwater management criteria assigned to each subarea be enacted as part of each municipality's zoning or subdivision ordinance. This way the requirements for management of stormwater will be applicable to all changes in land use and not limited to activities that are subject to subdivision and land development regulations.

4. Level of Government Involvement in Stormwater Management

In order to implement this plan, the following actions must occur:

- Municipal adoption of the standards and criteria of the plan through the municipal stormwater ordinance provisions. Act 167 requires that this be accomplished within six months of the plan's adoption and approval. Model ordinance provisions will be distributed to all of the watershed municipalities. The Montgomery and Berks Counties Planning agencies will be available upon request to assist municipalities in the adoption of the model ordinance provisions to fit particular municipal ordinance structures.
- Maintenance and operation of the computer model (as necessary), and compilation of data required for periodically updating the plan.

All future stormwater facilities, including facilities owned or financed by state funds will have to be consistent with the plan, even though they might not otherwise be subject to municipal regulation.

5. PENNVEST Funding

The PENNVEST Act of 1988, as amended, provides low interest loans to governmental entities for constructing, improving or rehabilitating stormwater projects. Eligible projects can include conveyance, storage and infiltration of stormwater and best management practices to address non-point source pollution associated with stormwater.

In order to qualify for a loan under PENNVEST, the municipality or county:

- Must be located in a watershed for which there is an existing county adopted and DEP approved stormwater plan with enacted stormwater ordinances consistent with the plan, or
- Must have enacted a stormwater control ordinance consistent with the Stormwater Management Act.

By adopting the standards and criteria for stormwater control and implementing the plan, the municipality is able to apply for PENNVEST loans for stormwater projects.

6. Landowner's/Developer's Responsibilities

Any landowner and any person engaged in the alteration or development of land that may affect stormwater runoff characteristics shall implement such measures consistent with the provisions of the applicable watershed stormwater plan as are reasonably necessary to prevent injury to health, safety or other property. Such measures shall include such actions as are required:

- To assure the maximum rate of stormwater runoff is no greater after development than prior to development activities; or
- To manage the quantity, velocity and direction of resulting stormwater runoff in a manner that otherwise adequately protects health and property from possible injury.

Many developers throughout the state, after realizing the natural resource, public safety and potential economic advantages of proper stormwater management, are constructing development consistent with natural resources protection. An example of such development procedure is the low impact development ordinance contained in the DEP model ordinance for MS4 municipalities.

B. Plan Review, Adoption, and Updating Procedures

1. County Adoption

Prior to plan completion, Montgomery County transmitted a sample of the proposed Swamp Creek Stormwater Ordinance for review to PADEP and the municipalities represented by the Watershed Plan Advisory Committee. Montgomery County then transmitted a draft plan that included the draft ordinance for review to the municipal planning commission and the governing body of each involved municipality, the County Planning Department or Commission and the Watershed Plan Advisory Committee by official correspondence. This review included an evaluation of the plan's consistency with other plans and programs affecting the watershed. The reviews and comments were submitted to the county by official correspondence. The county received, tabulated, and responded to the comments. The plan was revised as necessary.

Montgomery and Berks Counties held a joint public hearing at a location in the watershed. A notice for the hearing was published two weeks prior to the hearing date. The meeting notice contained a summary of the principal provisions of the plan and stated where copies of the plan could be examined or obtained within each municipality. The comments received at the public hearing were reviewed by the county and appropriate modifications to the plan were considered.

The plan was passed as a resolution by the respective County governing bodies for the purpose of adoption. The resolution included references to the volumes,

figures, appendices and model ordinance. The County resolutions were recorded in the minutes of regular meetings of the Montgomery and Berks counties commissioners.

Montgomery County then submitted the following to DEP: a letter of transmittal and one hard and one digital copy of the adopted plan, the review by each affected municipal planning agency and local governing body and the County Planning Department, public hearing notice and minutes, and the resolution of adoption of the plan by each County. The letter of transmittal stated that Montgomery County has complied with all procedures outlined in Act 167 and requested that DEP approve the adopted plan.

2. Provisions for Plan Revision

Section 5 of the Stormwater Management Act requires that the stormwater management plan be updated at least every five years. This requirement considers the changes in land use, obstructions, flood control projects, floodplain identification, and management objectives or policy that may take place within the watershed.

It will be necessary to collect and manage the required data in a consistent manner and preferably store it in a central location. This is not only to prepare an updated plan, but also, if required, to make interim runs on the runoff simulation model to analyze the impact of a proposed major development or a proposed major stormwater management facility. When the update is initiated, the WPAC will be reconvened to review changes in the watershed and determine the extent if the update required. Montgomery County will review the recommendations of the Watershed Plan Advisory Committee and determine if revisions are to be made. A revised plan would be subject to the same rules of adoption as the original plan. Should the County determine that no revisions to the plan are required for a period of five consecutive years, the County will adopt a resolution stating that the plan has been reviewed and been found satisfactory to meet the requirements of Act 167. The resolution will then be forwarded to DEP.

Stormwater Districts Map