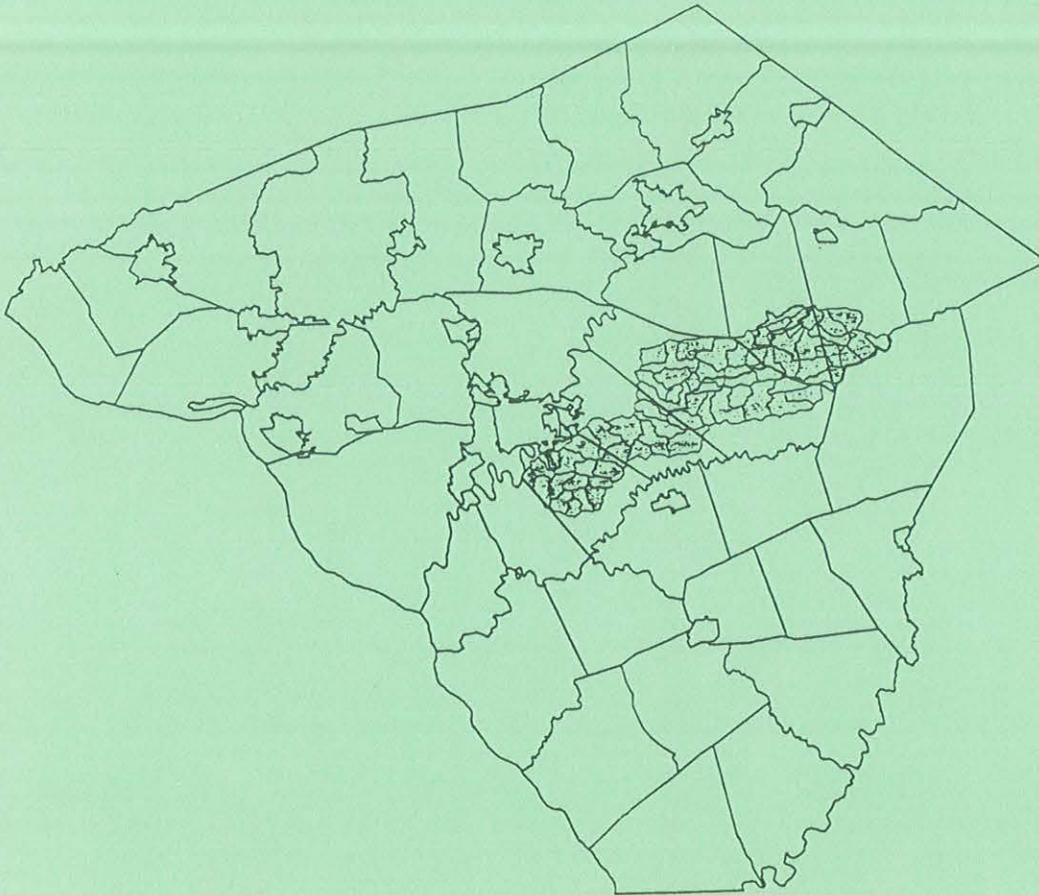


**ACT 167
WATERSHED STORM WATER
MANAGEMENT PLAN**

VOLUME II - PLAN CONTENTS

MILL CREEK WATERSHED



LANCASTER COUNTY, PENNSYLVANIA
FILE NO. SWMP (193:36)
PROJECT NO. 92428

DECEMBER 1996

PREPARED FOR:

LANCASTER COUNTY COMMISSIONERS
50 NORTH DUKE STREET
LANCASTER, PA 17602

VOLUME II - PLAN CONTENTS

Page

SECTION I. INTRODUCTION

A. INTRODUCTION	1
B. STORM WATER MANAGEMENT	1

SECTION II. ACT 167

A. STORM WATER MANAGEMENT ACT	2
B. PURPOSE OF THE STUDY	2
C. PLAN FORMAT	3

SECTION III. MILL CREEK WATERSHED CHARACTERISTICS

A. DRAINAGE AREA	4
B. LAND USE	4
C. TOPOGRAPHY AND STREAMBED PROFILE	4
D. SOILS	5
E. CLIMATE	5
F. DESCRIPTION OF DATA COLLECTION	6
1. Topography	
2. Geology	
3. Soils	
4. Land Cover/Land Use	
G. SIGNIFICANT OBSTRUCTIONS	7
H. PROJECTED AND ALTERNATIVE LAND DEVELOPMENT PATTERNS IN THE WATERSHED	7
1. Projected Land Development Patterns	
2. Impact of Runoff From Future Development	
I. PRESENT AND PROJECTED DEVELOPMENT IN THE FLOOD HAZARD AREAS	11
1. Present Conditions	
2. Future Conditions	
J. SURVEY EXISTING DRAINAGE PROBLEMS AND PROPOSED SOLUTIONS	13
K. EXISTING AND PROPOSED STORM WATER COLLECTION SYSTEMS	14
L. EXISTING AND PROPOSED STATE, FEDERAL AND LOCAL FLOOD CONTROL PROJECTS	14
M. STORM WATER COLLECTION AND CONTROL FACILITIES	14

SECTION IV.	WATERSHED TECHNICAL ANALYSIS MODELING	
	A. WATERSHED MODELING	14
	B. CALIBRATION PROCESS	15
	C. MODELING PROCESS	15
SECTION V.	STANDARDS AND CRITERIA FOR CONTROL OF STORM WATER RUNOFF	
	A. PERFORMANCE STANDARDS	16
	B. WATERSHED LEVEL RUNOFF CONTROL PHILOSOPHY	23
SECTION VI.	ALTERNATIVE RUNOFF CONTROL TECHNIQUES AND THEIR EFFICIENCY IN THE WATERSHEDS	
	A. STORM WATER CONTROLS	23
	B. BEST MANAGEMENT PRACTICES	30
SECTION VII.	THE DEVELOPMENT OF THE MODEL ORDINANCE	33
SECTION VIII.	MODEL ORDINANCE	37
SECTION IX.	THE DEVELOPMENT OF PRIORITIES FOR IMPLEMENTATION OF ACTION WITHIN THE PLAN	
	A. PADEP APPROVAL OF THE PLAN	75
	B. PUBLISHING THE FINAL PLAN	75
	C. MUNICIPAL ADOPTION OF ORDINANCE PROVISIONS TO IMPLEMENT THE PLAN	76
	D. LEVEL OF GOVERNMENT INVOLVEMENT IN STORM WATER MANAGEMENT	76
	E. COUNTY WIDE COORDINATION	79
	F. DEVELOPMENT OF A SYSTEMATIC APPROACH FOR CORRECTION OF EXISTING STORM DRAINAGE PROBLEM AREAS	82
SECTION X.	PLAN REVIEW ADOPTION AND UPDATING PROCEDURES	
	A. COUNTY ADOPTION	83
	B. PROVISIONS FOR PLAN REVISION	83

APPENDICES

1. TABLE OF CONTENTS FOR THE TECHNICAL APPENDIX

FIGURES

- III-1 SITE LOCATION
- III-2 WATERSHED BOUNDARY (See print on back cover.)
- IV-1 CALCULATION METHODOLOGIES COMPARISON

TABLES

- III-1 LAND USE STATUS BY CATEGORY
- III-2 DEVELOPMENT POTENTIAL BY MUNICIPALITY BASED UPON EXISTING PATTERNS IN THE MILL CREEK WATERSHED

- III-3 PRESENT VERSUS FUTURE PEAK FLOWS
- III-4 AVAILABLE FLOOD INSURANCE STUDIES
- III-5 PRESENT RESIDENTIAL AND COMMERCIAL AREAS WITHIN THE 100-YEAR FLOOD PLAN
- III-6 MILL CREEK WATERSHED STORM WATER PROBLEM AREAS (see print on back cover.)
- V-1 STANDARDS AND CRITERIA
- VI-1 MEASURES FOR REDUCING AND DELAYING URBAN STORM RUNOFF
- VI-2 ADVANTAGES AND DISADVANTAGES OF MEASURES FOR REDUCING AND DELAYING RUNOFF
- VI-3 SUITABILITY OF RUNOFF CONTROL MEASURES IN THE MILL CREEK WATERSHED
- VII-1 TYPICAL STORM WATER MANAGEMENT ORDINANCE PROVISIONS
- VII-2 SPECIAL STORM WATER MANAGEMENT PROVISIONS
- IX-1 PUBLIC INVOLVEMENT IN STORM WATER MANAGEMENT

PLATES

- I. EXISTING LAND USE
- II. FUTURE LAND USE CONDITIONS
- III. HYDROLOGIC SOIL GROUPS
- IV. OBSTRUCTIONS, PROBLEM AREAS, FLOODING & STORM WATER CONTROL FACILITIES

VOLUME II

SECTION I

INTRODUCTION

A. Introduction

The Mill Creek Watershed is located in the eastern portion of Lancaster County, adjacent to the Conestoga River.

Large portions of this watershed are undeveloped with a potential for extensive growth. The effects of this potential growth and development on drainage, flooding, and erosion problems is a major concern for municipal officials and affected property owners. Extensive commercial growth along U.S. Routes 30, 340, and 23 can result in accelerated storm water runoff which has the potential of causing flooding and erosion problems for property owners along Mill Creek. Stream water quality can also become degraded as impervious areas grow throughout the watershed.

B. Storm Water Management

Storm water management entails bringing surface runoff caused by precipitation events under control. In past years, storm water control was viewed only on a site-specific basis. Recently, local perspectives and policies have changed, with the realization that proper storm water management can only be accomplished by evaluating the comprehensive picture (i.e. by analyzing what adverse impacts a development located in a watershed's headwaters may have on flooding downstream). Proper storm water management reduces flooding, soil and stream bank erosion and sedimentation and improves the overall quality of the receiving streams.

Storm water management requires cooperation between the state, county and local officials and involves proper planning, engineering, construction, operation and maintenance. This includes educating the public and local officials and requires program development, financing, revising policy, developing workable criteria and adopting ordinances. The Mill Creek Watershed Storm Water Management Plan, prepared under the Pennsylvania Storm Water Management Act, will enable continued development to occur within the Watershed, utilizing both structural and nonstructural measures to properly manage storm water runoff in the watershed.

SECTION II

ACT 167

A. Storm Water Management Act

The Pennsylvania General Assembly, recognizing the adverse effects of inadequate management of excessive rates and volumes of storm water runoff resulting from development, approved the Storm Water Management Act, P.L. 864, No. 167, October 4, 1978. Act 167 provides for the regulation of land and water use for flood control and storm water management purposes. It imposes duties and confers powers to the Department of Environmental Protection (DEP), municipalities and counties and provides for enforcement and appropriations. The Act requires the DEP to designate watersheds and develop guidelines for storm water management and model storm water ordinances (the designated watersheds were approved by the Environmental Quality Board July 15, 1980, and the guidelines and model ordinances were approved by the Legislature May 14, 1985). The Act provides for grants to be appropriated by the General Assembly and administered by the Department for 75% of the allowable costs for preparation of official storm water management plans and administrative, enforcement and implementation costs incurred by any municipality or county in accordance with Chapter III - Storm Water Management Grants and Reimbursement Regulations (adopted by the Environmental Quality Board August 27, 1985).

Each county must prepare and adopt a watershed Storm Water Management Plan for each of its designated watersheds in consultation with the municipalities, and will periodically review and revise such plans at least every five years when funding is available. Within six months following adoption and approval of a watershed storm water plan, each municipality is required to adopt or amend, and implement ordinances and regulations as are necessary to regulate development within the municipality in a manner consistent with the applicable watershed storm water plan and the provisions of the Act.

Developers are required to manage the quantity, velocity, and direction of resulting storm water runoff in a manner which adequately protects health and property from possible injury, and must implement control measures that are consistent with provisions of the watershed plan and the Act. The Act also provides for civil remedies for those aggrieved by inadequate management of accelerated storm water runoff.

B. Purpose of the Study

There is increased sentiment statewide, as well as local recognition, that a sound and effective storm water management plan should be a diversified multiple-purpose plan. This plan should address the full range of hydrologic consequences resulting from development instead of simply focusing on controlling site-specific peak flow, without

consideration of tributary timing, flow volume reduction, base flow augmentation, water quality control and ecological protection.

Managing storm water runoff on a site-specific basis does not meet the requirements of watershed-wide storm water management objectives. The timing of flood peaks for each subbasin within a watershed contributes greatly to the flooding potential of a particular storm. Each storm water control site within a subbasin should be managed by evaluating the comprehensive picture. The overall objective of the Plan is to maintain peak flows throughout the watershed to existing conditions as the watershed becomes developed.

By developing the Mill Creek Watershed Storm Water Management Plan, reasonable regulation of development activities can be administered to control accelerated runoff and thus protect the health, safety and welfare of the public. The Plan shall include recognition of the various rules, regulations and laws at the federal, state, county and municipal level. Once implemented, the Plan will aid in reducing costly flood damages by reducing the source and cause of local uncontrolled runoff. The Plan will make municipalities and developers more aware of comprehensive planning in storm water control and will also help maintain the quality of both the Mill Creek and its tributaries.

C. Plan Format

The plan format of the Mill Creek Storm Water Management Plan consists of Volume I, Executive Summary, Volume II, Plan Content, and the Technical Appendices. Volume I provides an overview of Act 167 and Watershed Level Storm Water Management.

Volume II provides the purpose of the study, data collection, identification of existing problems, present conditions, projected and alternative land development patterns and the model ordinance. Volume II also assesses the impact of managing storm water by utilizing the criteria and standards set forth in this Plan.

The Technical Appendices provide all of the supporting data, procedures, parameters and watershed modeling.

In order to provide for planning consistency in computational methods utilized for storm water calculations in the Mill Creek Watershed, standards and criteria had to be established. Thus, standards were established for runoff curve numbers, rational 'C' values, rainfall depths and intensities, and time of concentration.

SECTION III

MILL CREEK WATERSHED CHARACTERISTICS

The Mill Creek is located in the eastern portion of Lancaster County as illustrated in Figure III-1 and contains nine municipalities in the County as listed below.

MILL CREEK WATERSHED - MUNICIPALITIES

LANCASTER COUNTY

1. Pequea Township
2. West Lampeter Township
3. East Lampeter Township
4. Leacock Township
5. Upper Leacock Township
6. Earl Township
7. East Earl Township
8. New Holland Borough
9. City of Lancaster

A. Drainage Area

Mill Creek drains a total surface area of approximately 57 square miles.

The major tributaries to the Mill Creek are Groff Run, Muddy Run and Big Spring Run.

B. Land Use

Land use in the watershed consists of approximately 68% crop land, 8% woodland, 2% pasture land, and 3% open space. Approximately 7% of the area is used for commercial and industrial use, 10% residential area and 2% farmsteads. Extensive tracts of woodland exist in the Welsh Mountains at the eastern edge of the watershed.

Although the land use in the Mill Creek Watershed is diversified, large portions of the land is undeveloped with the potential for extensive future development.

Routes 30, 340 and 23 are the major transportation arteries within the Watershed. Most areas of commercial and industrial development potential exist along these routes. Residential development exists throughout the Watershed.

Table III-1 shows the overall land use by category within the Mill Creek Watershed.

C. Topography and Streambed Profile

The topography of the watershed is characterized nearly level to steep well-drained soils in undulating broad valleys formed in residuum from limestone. The highest point in the Watershed is an unnamed hill in the Welsh Mountains with an elevation of 1100 feet above sea level U.S.G.S. datum. The lowest point occurs at the Conestoga River confluence with an approximate elevation of 230 feet. There is one major impoundment in the watershed and there are many small farm ponds ranging in size from 1/3 to 1 acre. The streams generally have shallow beds which causes bottom land flooding during prolonged rains, typically in the spring of the year. Currently, most of the bottom land is farmed. The average stream bed slope of the Mill Creek is approximately 0.50 percent.

The New Holland reservoir is the only major impoundment in the Mill Creek Watershed. The reservoir is located in the Welsh Mountains near the most upgradient area in watershed. The area which drains to the reservoir is mostly wooded and owned by the New Holland Borough Water Authority. The location of this reservoir has little effect on the analysis of the watershed.

Table III-1 Land Use Status By Category 1993		
Land Use	Area (acres)	Percent
Commercial/Industrial/Institutional	2,390	7.2
Farmstead	706	2.0
Forest	2,857	7.9
Meadow/Grass	947	2.6
Open Space	1,142	3.2
Residential	3,470	9.6
Row Crops	24,340	67.5

D. Soils

Soil properties influence the process of runoff generation and are therefore classified into four hydrologic soil groups, A through D. The A soils have the lowest runoff potential and are typically sands and gravels whereas the D soils have a high runoff potential and are typically clay soils. The majority of the soils in the watershed are of the B and C hydrologic soil group.

The Letort-Pequea-Conestoga and the Duffield-Hagartown soils account for 95% of the soils in the watershed. These soils are nearly level to steep well-drained soils formed in residuum of limestone. The Clymer-Chester soils account for the remaining 5%. These soils are nearly level to very steep well-drained soils formed in residuum from sandstone, micascist and quartzite. This soil makes up the area of the Welsh Mountains.

E. Climate

Lancaster County is generally cool and humid. The average annual precipitation is about 45 inches.

Major rain producing storms, other than hurricanes, tend to have the same general characteristics. They are slow moving storms from the south or southwest with an abundance of moisture that has been transported from the Gulf of Mexico and resupplied with Atlantic Ocean moisture by a strong, nearly stationary, Bermuda High. At the same time, there is frequently a blocking high pressure area to the northeast of Pennsylvania.

Intense local flash floods are most likely to occur in squall lines just to the east of a slow moving north-south oriented cold front. These are usually warm weather phenomena where afternoon heating adds to the instability of the already unstable, moist air mass.

Large magnitude floods occurred in June 1972 and September 1975. Lesser floods occurred in November and December 1993 and January 1996.

F. Description of Data Collection

1. **Topography:** The base map was developed using Lancaster County GIS data. The data was gathered for the County at one inch equals two hundred feet. The vertical interval is five feet. The coverages used for this project included land use, roads, contours, soils, streams, municipal boundaries, zoning, urban growth boundaries, and parks and open space. Subwatersheds were determined for the modeling process. The subwatersheds were made into a GIS coverage and is shown on the Subwatershed Boundary Map in the Executive Summary.
2. **Geology:** Geology plays a major role in this study. Ninety-five percent of the basin has underlying carbonate geology. This was taken into consideration when the modeling process was completed.
3. **Soils:** Soils derived from the underlying bedrock (residual soils) have various drainage properties depending upon the type of bedrock from which they evolved. Soils derived from limestone shales and siltstones may be fairly well-drained. S.C.S has nationally classified soils into four hydrologic soil groups, A through D. Hydrologic soil group A is the most pervious with the least amount of natural runoff while soils in hydrologic group D are tight, low permeable soils with high runoff rates. Plate III shows the locations of the four hydrologic soil groups for the Mill Creek Watershed. Soils were identified from the Lancaster County Soil Surveys of the U.S. Department of Agriculture's Soil Conservation Service.
4. **Land Cover/Land Use:** Existing land use was determined from 1993 Lancaster County GIS data. The land use coverage was delivered using the modified Anderson Level II procedure. The existing conditions land use maps for the Mill Creek Watershed may be found in Plate I.

G. Significant Obstructions

Approximately 120 structures were field verified and analyzed with HY-8.

The obstruction capacities were then compared to the peak flow at that point derived through the modeling process for each design storm duration and frequency. Flood frequency relationships were then developed from each obstruction and are recorded in tabular form in the Technical Appendix. From these flood-frequency relationships, those obstructions found to be significant were determined. A significant obstruction is defined as "any structure or assembly of materials which would impede, retard, cause ponding or diversion of storm water runoff or erosion of surrounding land or stream banks." The obstructions were classified into seven (7) categories as follows:

- Those obstructions which are able to pass the 100-year, 24-hour storm and greater without obstructing the flow.
- Those obstructions which are not able to pass the 100-year, 24-hour storm and greater without obstructing the flow.
- Those obstructions which are not able to pass the 50-year, 24-hour storm and greater without obstructing the flow.
- Those obstructions which are not able to pass the 25-year, 24-hour storm and greater without obstructing the flow.
- Those obstructions which are not able to pass the 10-year, 24-hour storm and greater without obstructing the flow.
- Those obstructions which are not able to pass the 5-year, 24-hour storm and greater without obstructing the flow.
- Those obstructions which are not able to pass the 2-year, 24-hour storm and greater without obstructing the flow.

The locations of all 120 obstructions can be found on the Pipe/Structure Capacity Map.

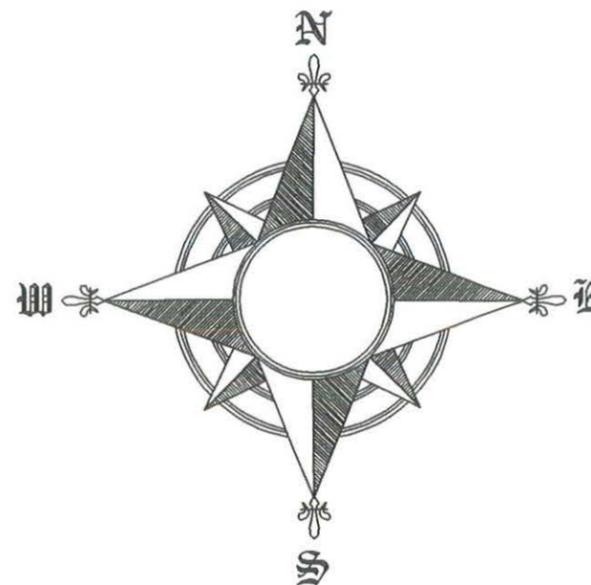
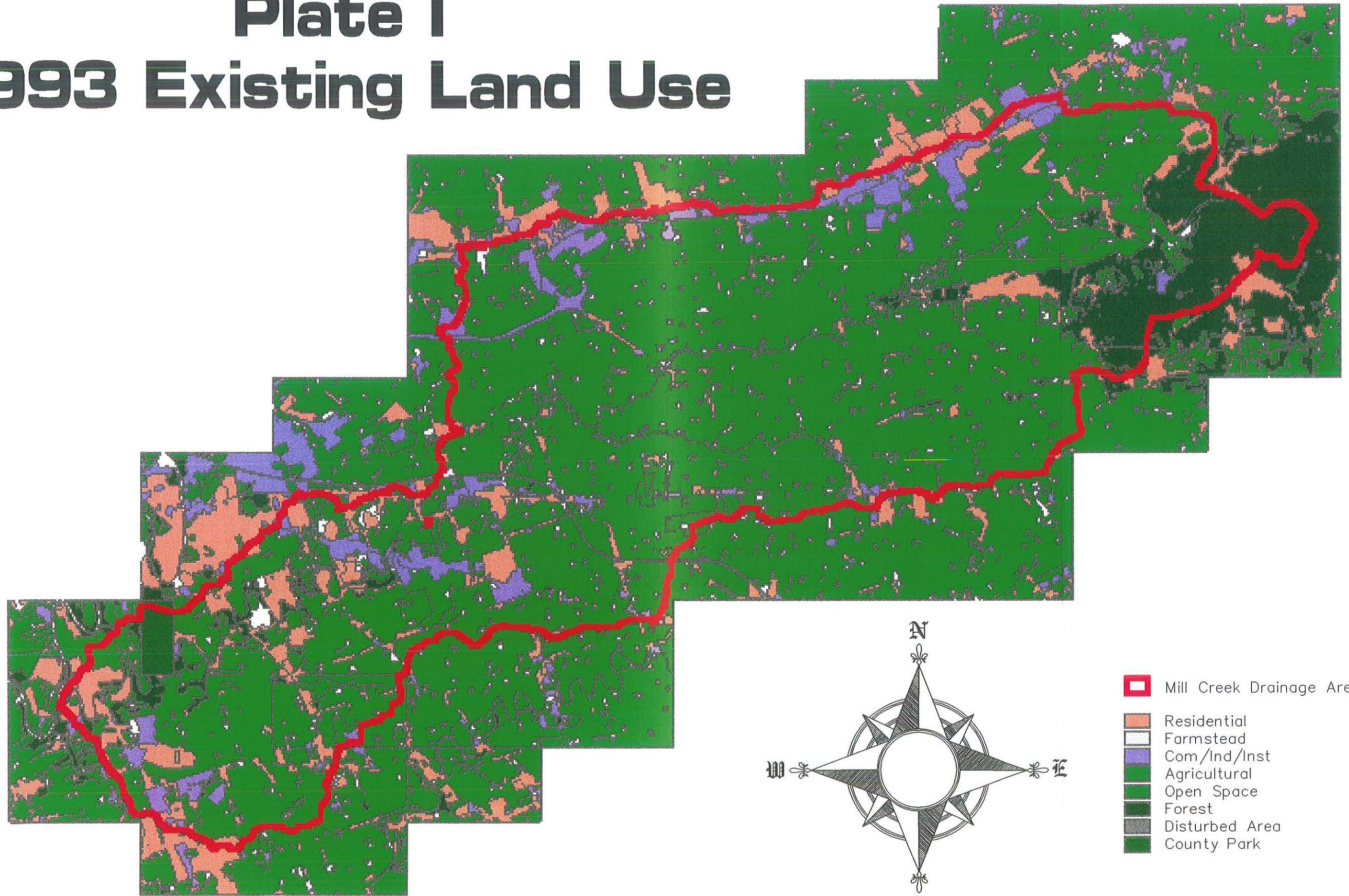
H. Projected and Alternative Land Development Patterns in the Watershed

1. Projected Land Development Patterns

Most of the townships within the watershed are predominantly rural in nature and largely undeveloped. Conversely, a majority of suitable land in the Borough of New Holland has been developed. Overall, potential development pressures will be significant based on existing zoning.

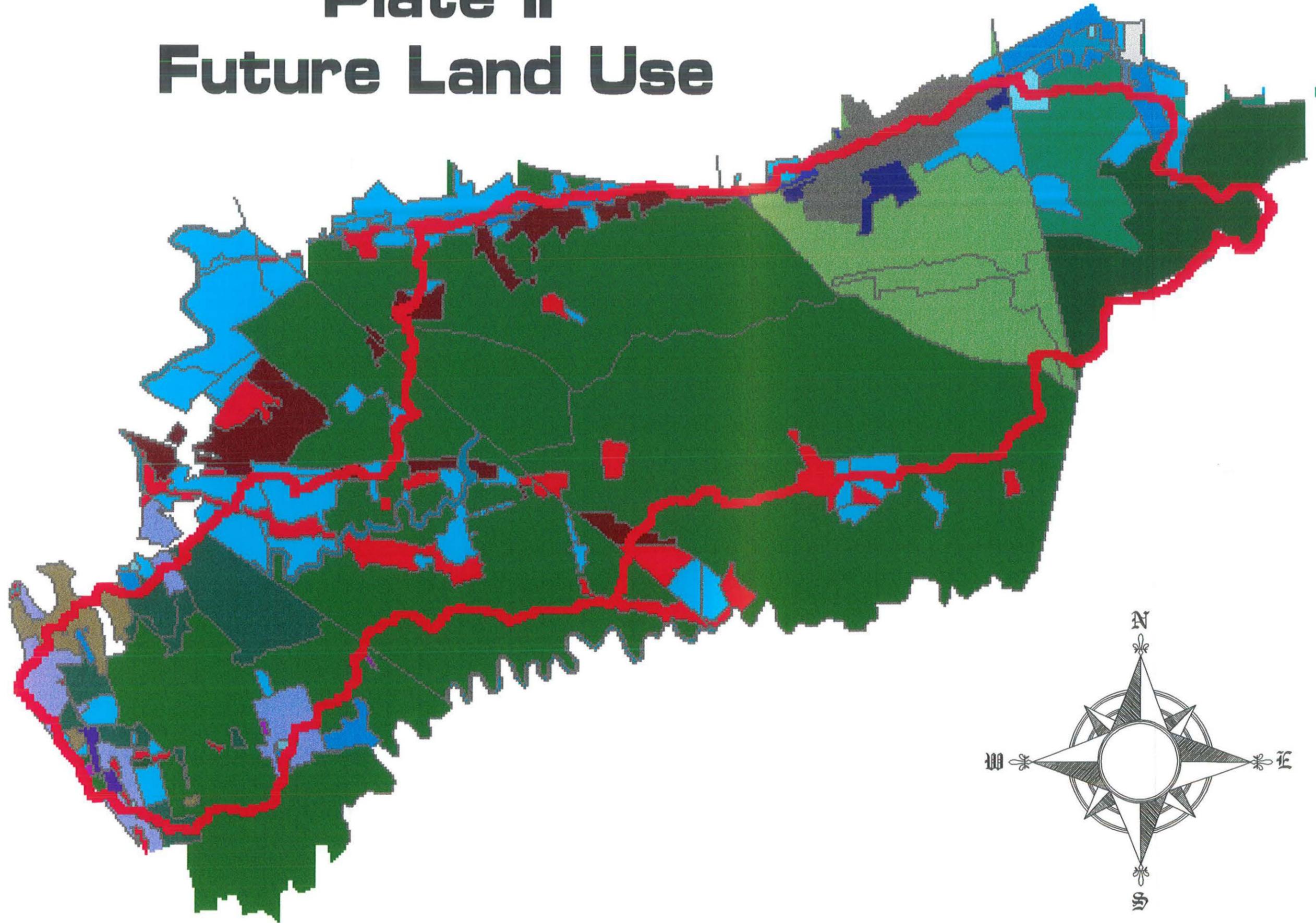
Plate I

1993 Existing Land Use



- Mill Creek Drainage Area
- Residential
- Farmstead
- Com/Ind/Inst
- Agricultural
- Open Space
- Forest
- Disturbed Area
- County Park

Plate II Future Land Use



- █ Mill Creek Watershed
- West Lampeter**
 - █ A
 - █ CO
 - █ HC
 - █ I
 - █ NC
 - █ OS
 - █ R
 - █ R1
 - █ R2
 - █ R3
 - █ RURAL
 - █ VC
- Earl**
 - █ C
 - █ I
 - █ NEW HOL BORO
 - █ R
 - █ RA
 - █ RU
- East Earl**
 - █ A
 - █ C/O
 - █ CG
 - █ LI
 - █ MR
 - █ NC
 - █ RL
 - █ RM
 - █ Terre Hill Boro
 - █ VI
- East Lampeter**
 - █ C1
 - █ C2
 - █ I
 - █ R
 - █ R1
 - █ R2
 - █ R2M
 - █ R3
 - █ S
- Leacock**
 - █ A
 - █ C
 - █ I
 - █ LAC
 - █ R
 - █ RR
- Upper Leacock**
 - █ A
 - █ AS
 - █ GC
 - █ I
 - █ IAS
 - █ MU
 - █ Q
 - █ R1
 - █ R2
 - █ VC

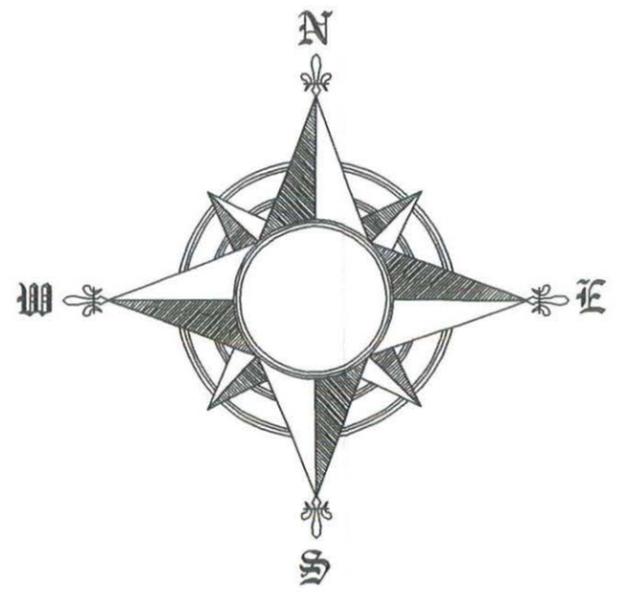
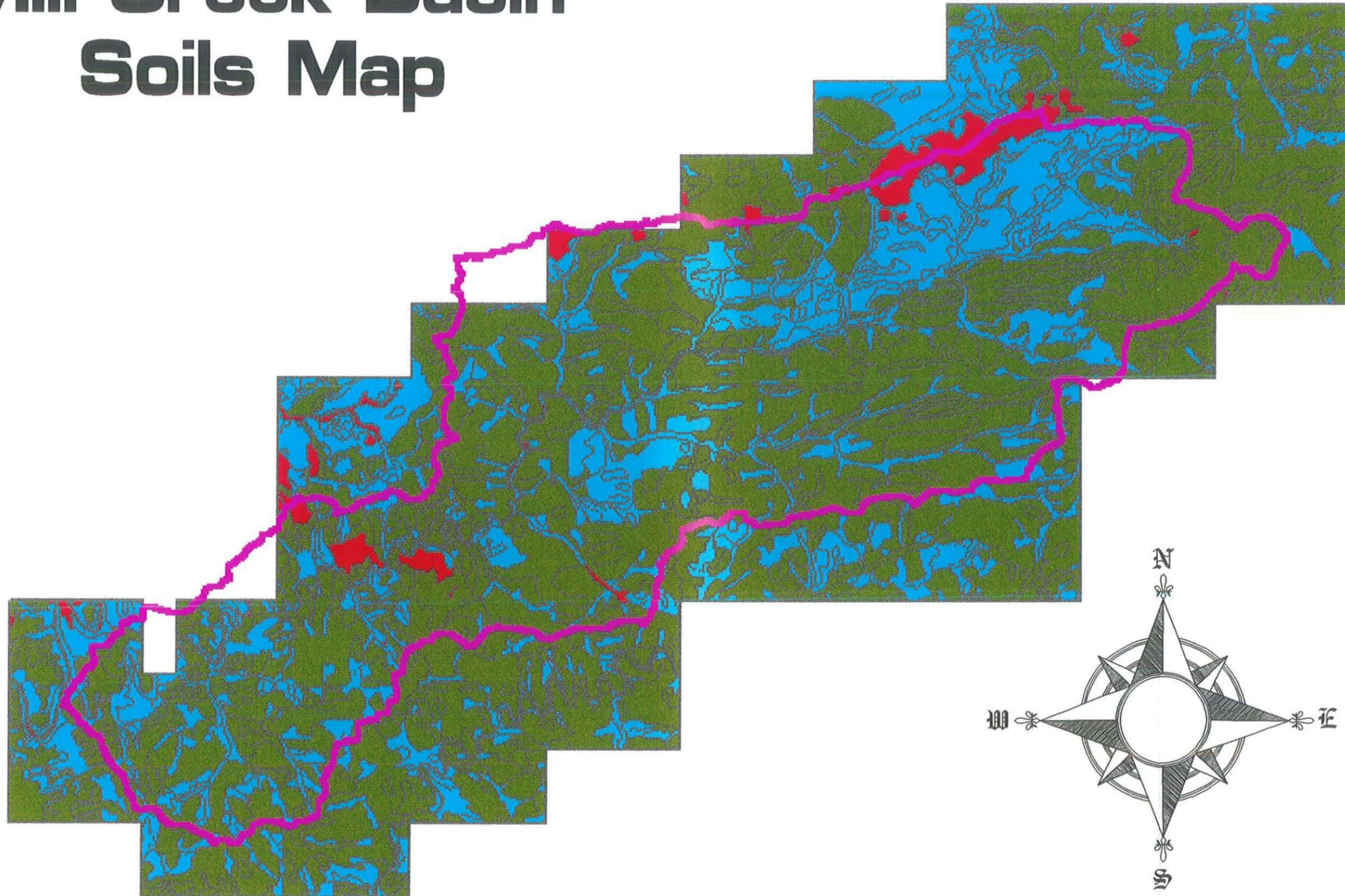


Plate III Mill Creek Basin Soils Map



Soil Types	
	Mill Creek Drainage Area
	BA - B
	BDA - B
	BDB - B
	BDC - B
	BED - B
	CBA - B
	CBA - B
	CBCX - B
	CKA - C
	CLB - B
	CLD - B
	CLF - B
	CNA - B
	CNB - B
	CNC - B
	DBA - B
	DBD - B
	ECA - B
	ECB - B
	GBB - B
	GBC - B
	GBD - B
	GDB - C
	HAA - C
	HAB - C
	HBC - C
	HBD - C
	HC - D
	HFA - B
	HFB - B
	HFC - B
	HGD - B
	HG - D
	LDS - B
	LDB - B
	LDC - B
	LG - B
	LN - C
	MAB - B
	MAC - B
	MAD - B
	MBF - B
	NC - C
	ND - B
	NE - B
	PA - C
	PEC - C
	PED - C
	PEE - C
	QU - D
	UC - D
	W - D

Future development within the Mill Creek Watershed will most likely occur where public facilities are available. Commercial and industrial development will most likely be confined to industrial parks or areas where public water and sewer are or will soon be available.

Table III-2 provides an overview of the types of development that will occur when existing patterns are considered for each municipality within the watershed.

2. Impact of Runoff From Future Development

A Future Land Use Map was developed using existing zoning and UGB's in conjunction with physical limitations (wetlands, floodplain, topography) as can be seen in Plate II. The potential impact of additional runoff was then evaluated by placing the future land use conditions into the computer model and re-running the model. A comparison of the predicted future conditions flows with and without control of post-development flows versus the existing conditions flows for the 100-year, 24-hour storm can be found in Table III-3. Other storm frequencies can be found in the Technical Appendix. Increased development in a watershed increases runoff peaks, volumes, and velocities. This decreases the time to peak, increasing the frequency of flooding.

TABLE III-2 Development Potential by Municipality Based Upon Existing Patterns in the Mill Creek Watershed						
Municipality	R-1	R-2	R-3	R-4	I	C
New Holland Borough	—	—	0	0	0	0
East Earl Township	0	X	X	0	—	—
Earl Township	0	X	X	0	X	X
Upper Leacock Township	0	X	X	X	X	X
Leacock Township	0	X	0	0	X	0
East Lampeter Township	0	X	X	X	X	X
West Lampeter Township	0	X	X	X	X	X
Pequea Township	0	0	0	—	0	—
City of Lancaster	—	—	—	—	—	—

R-1 Residential lots 2 acres to 4 acres
 R-2 Residential lots ½ acre to 1 acre
 R-3 Residential lots ¼ acre to ½ acre
 R-4 Residential lots ¼ acre or less
 I Industrial
 C Commercial

X Major Development Impact
 O Minor Development Impact
 — No Development Impact

TABLE III-3
100 Year Storm of 24-hour Duration

Subarea Number	Present Conditions (CFS)	Future with No Control (CFS)	Future With SWM Control (CFS) Per This Plan
1	10051.0	10852.6	10325.4
2	10152.9	10955.0	10401.8
3	10231.3	11031.3	10454.2
4	10181.7	10973.5	10398.9
5	10263.9	11056.8	10456.5
6	10455.7	11248.1	10588.0
7	2309.2	2477.0	1868.0
8	644.3	690.2	633.7
9	478.9	478.9	478.9
10	2003.1	2173.6	1541.1
11	1024.1	1162.6	511.0
12	427.5	485.5	213.0
13	10078.4	10848.5	10068.9
14	10413.0	11210.2	10287.7
15	868.3	943.5	978.5
16	572.0	572.0	572.0
17	10417.1	11212.5	10257.9
18	10354.1	11148.2	10196.9
19	10399.1	11182.5	10187.7
20	1733.2	2154.4	1047.0
21	822.6	1139.3	617.0
22	10160.2	10893.7	9778.4
23	10045.6	10776.6	9730.3
24	9292.6	9895.0	8641.2
25	2806.1	3366.6	2641.6
26	10300.7	11059.5	9998.4
27	9446.7	10065.4	8722.7
28	10181.7	10937.4	9873.6
29	10447.5	11224.7	10170.1
30	10431.8	11203.3	10130.6
31	9555.5	10190.2	8736.6

Subarea Number	Present Conditions (CFS)	Future with No Control (CFS)	Future With SWM Control (CFS)
32	2356.7	2538.5	2106.9
33	2212.9	2399.7	1960.7
34	7124.4	7597.4	6537.2
35	7123.2	7602.7	6500.2
36	6207.9	6693.6	5619.6
37	7234.1	7725.8	6507.6
38	774.3	774.3	774.3
39	953.7	1203.3	476.9
40	4397.3	4810.3	3722.5
41	1109.9	1212.9	555.0
42	6463.8	6974.9	5650.8
43	6618.1	7209.1	5478.6
44	5548.0	5960.4	4736.5
45	2104.1	2287.4	1865.3
46	1557.5	1557.5	1557.5
47	627.8	627.8	627.8
48	This Subarea	Number was not used	
49	553.0	553.0	553.0
50	442.0	442.0	442.0
51	5199.7	5616.3	4411.7
52	2826.3	3064.2	2524.8
53	3330.4	3672.6	2720.3
54	2182.3	2525.9	1567.8
55	519.6	607.1	259.9
56	1189.4	1208.8	1185.2
57	735.1	735.1	735.1
58	544.3	544.3	544.3
59	202.8	202.8	202.8
60	10486.1	11263.8	10208.2
61	10245.8	11002.6	9945.1
62	3499.6	3768.1	3248.8
63	2423.5	2641.2	1806.4

I. Present and Projected Development in the Flood Hazard Areas

1. Present Conditions

The U.S. Department of Housing and Urban Development, Federal Insurance Administration has prepared a flood insurance study for several municipalities in the Mill Creek Watershed. The areas studied by detailed methods were known flood hazard areas and areas of projected development. Those areas studied by approximate methods were those areas having low development potential or minimal flood hazards.

Table III-4 summarizes the status of available flood data for the various township and streams.

TABLE III-4 Available Flood Insurance Studies			
Municipality	Stream	Agency	Type of Study
East Earl Township	Mill Creek	FEMA	Detailed
Earl Township	Mill Creek	FEMA	Approximate
New Holland Borough	None		
East Lampeter Township	Mill Creek	FEMA	Detailed/Approximate
West Lampeter Township	Mill Creek	FEMA	Detailed/Approximate
Upper Leacock Township	Mill Creek	FEMA	Approximate
Leacock Township	Mill Creek	FEMA	Approximate
	Muddy Run	FEMA	Approximate
Pequea Township	Mill Creek		
City of Lancaster *	Mill Creek	FEMA	Detailed

FEMA - Federal Emergency Management Agency

* Detailed Study included in West Lampeter Township Study

Detailed methods included hydrologic computations and detailed HEC-2 backwater computations. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction. Approximate analyses were used to study those areas having low development potential or minimal flood hazards.

At present, the 100-year floodplain within the Mill Creek Watershed is primarily cultivated fields and meadow lands. However, several residential and commercial areas along the Mill Creek and its tributaries lie within the floodplain.

Table III-5 outlines the type of development and land use which infringe upon the floodplain by township, general location and creek or tributary.

<p style="text-align: center;">TABLE III-5 Mill Creek Present Residential and Commercial Areas Within 100-Year Floodplain</p>			
Township/Borough	Stream	Land Use Which Infringes on Flood Boundary	General Location
City of Lancaster	Mill Creek	None	Not applicable
New Holland	None	None	Not applicable
Pequea	None	None	Not applicable
East Earl	None	None	Not applicable
Earl	Mill Creek	Residential	Airport and Trailer Roads
Upper Leacock	Mill Creek	None	Not applicable
Leacock	Mill Creek	None	Not applicable
East Lampeter	Mill Creek	None	Not applicable
West Lampeter	Mill Creek	Residential	Linden Avenue and Mill Creek Road

2. Future Conditions

As can be seen from the projected Future Land Use Map, Plate II, the potential for development in the floodplains is great. However, the 100-year flood elevation was determined on the land use characteristics at the time of the study and does not account for increased runoff due to developmental pressures. Therefore, the potential for future flooding would increase as development continues if this Watershed Storm Water Management Plan were not adopted. The trend would be that flood elevations would not rise significantly on broad, level floodplains but the floodplains would expand considerably in width, whereas in streams with steep embankments, the flood elevation would most likely increase significantly with little increase in the floodplain width. Increased flows from developing watershed conditions would also widen the current floodway widths in many instances, thus resulting in the potential for existing development to infringe on the floodway. With the implementation of the Plan, the 100-year flood elevation at a particular site should be no higher in the future than it is now, if development is not allowed to encroach into the delineated floodplain.

J. Survey Existing Drainage Problems and Proposed Solutions

There were no significant flooding problems reported on the WPAC survey or mentioned at any WPAC meeting. Minor inconveniences such as roadways becoming flooded in rural areas and minor street flooding in New Holland Borough do exist. This is not uncommon considering most of the Mill Creek and its tributaries flow through agricultural, forest, and rural development.

Erosion and Sedimentation (E&S)

The LCCD is responsible for administering Title 25, Chapter 102 (Erosion Regulations Control). These regulations address accelerated erosion and the resulting sedimentation from earthmoving activities. Permanent stabilization of exposed areas and proper stabilization of channels of conveyance will reduce these problems.

Although the initial survey did not indicate the occurrence of erosion and sediment problems, it should be noted that stream bank erosion problems are evident throughout this watershed. Most complaints about erosion are the result of poor farming practices.

Culverts and Outlets

The minor problems identified above are the result of inadequately sized culverts which traverse State roads, Township roads, or private access roads. The typical solution involves performing a hydrologic study to determine pipe size and replacing the pipe with a properly sized unit. Costs are borne by the owner of the road.

Bridges

Many bridges reach capacity on an annual basis. The proposed solutions involve performing hydrologic studies and increasing the hydraulic capacity underneath the roadway.

Channels of Conveyance

Problem areas on channels of conveyance were identified in the watershed. These sites consist of road ditches and drainage ditches that extend to and from these roads. These problems are often associated with undersized culverts. Typically, these channels of conveyance are undersized and have excessive flow velocities which cause scouring of the channel. The resulting down stream sedimentation further reduces capacity and causes increased road maintenance costs. Inadequate channel capacities result in flooding of adjacent properties. Solutions consist of increasing channel capacity, stabilizing drainageways with appropriate material and, in some cases, providing positive drainage to extend the channels to existing drainage systems.

Streams

The minor problems listed above include eroding stream banks. Proposed solutions consist of stabilizing the banks using rock rip-rap, cribbing, or geotextiles.

Flooding

The minor problems listed above are flooding in nature. Most of these are caused by inadequate conveyance systems in developed areas or undersized culverts and bridges.

K. Existing and Proposed Storm Water Collection Systems

The only storm sewer system is located in the Borough of New Holland. Generally, small diameter trunk lines feed into the natural channels avoiding any large collector main. The design storm that the system is capable of handling is indeterminate since many of the pipes were installed prior to standards being adopted. The projected life span is good with general maintenance required for removal of debris at inlets and pipe and manhole cleaning. Expansion capabilities are limited due to existing capacities, the general built-out nature of the Borough, and topography.

L. Existing and Proposed State, Federal and Local Flood Control Projects

No Federal or local flood control projects exist or are known to be proposed at this time.

M. Storm Water Collection and Control Facilities

Due to the nature of the watershed and the fact that the largest projects are constructed by the private sector, there are no municipal storm water collection and control facilities proposed for the next ten years. The cost, design capacity, construction and operation of these private facilities cannot be projected at this time since they occur on a case-by-case basis as a developer buys land, submits plans, and develops the tract. Typically, the cost of such facilities are paid through the developer's financing with costs transferred to the buyer.

SECTION IV

WATERSHED TECHNICAL ANALYSIS - MODELING

A. Watershed Modeling

An initial step in the preparation of this Storm Water Management Plan was the identification of the storm water runoff simulation model to be utilized. A number of widely accepted computer models are available each of which has its own forte; however, for this study, it was necessary to select a model which:

- Could model design storms of various durations and frequencies to produce routable hydrographs which could be combined.
- Was adaptable to the size of subwatersheds in this study.
- Could evaluate specific physical characteristics of the rainfall-runoff process.
- Was capable of utilizing GIS coverages to provide model input.

The model comparison yielded the decision that the Geostorm GIS "front end" for TR-20 would be utilized for the following reasons:

- TR-20 had been developed by the hydrology branch of the Soil Conservation Service (SCS) specifically for the analysis of the timing of surface flow contributions to peak rates at various locations in a watershed.
- The data requirements make it easily adaptable for input from GIS.
- Input parameters provide a flexible calibration process.
- It has the ability to analyze reservoir or detention basin routing effects and location on the watershed.
- It is accepted by the Pennsylvania Department of Environmental Protection.

B. Calibration Process

In order to model a watershed with confidence and reliability, the chosen computer model should be calibrated against actual field data or actual storm events. There are, however, no recording stream gauges located on the Mill Creek, therefore, stream flow records for particular storm events are nonexistent. The model runs were checked using the detailed studies completed for FEMA. Some correlation was found, but the limited hydrology analysis completed for the FEMA study could not be used as the only calibration check for the model. The unique shape of the basin resulted in peak flow rates being generated at the confluence of the Mill Creek and Groff's Run and being routed downstream to the confluence of the Mill Creek with the Conestoga River. No other verification of the model was available.

C. Modeling Process

The Mill Creek Watershed was subdivided into 62 subwatersheds for modeling purposes. Considerations in the subdivision process were: location of obstructions, known flooding, drainage or erosion problems, zoning, and tributary confluences. The most downstream point of each of these areas was considered a "point of interest" in which increased runoff was analyzed for its potential impact.

The ultimate goal for selecting the key points of interest was to provide overall watershed storm water runoff control through effective control of individual subarea storm runoff. Thus, comprehensive control of storm water runoff for the entire watershed can be achieved through storm water management in each subbasin.

The watershed was modeled to determine the hydrologic response for the 2, 5, 10, 25, 50 and 100-year storm events for the 24-hour storm, the results of which can be found in the Technical Appendix.

The modeling process addressed:

- peak discharge values at various locations along the stream and its tributaries;
- time to peak for the above discharges;
- runoff contributions of individual subareas at selected downstream locations;
- flow values contained in the channel and overflow values; and
- overall watershed timing.

Additional model runs were made for the purpose of assessing alternative storm water management approaches. This involves an evaluation of constant vs. variable release rate options.

SECTION V

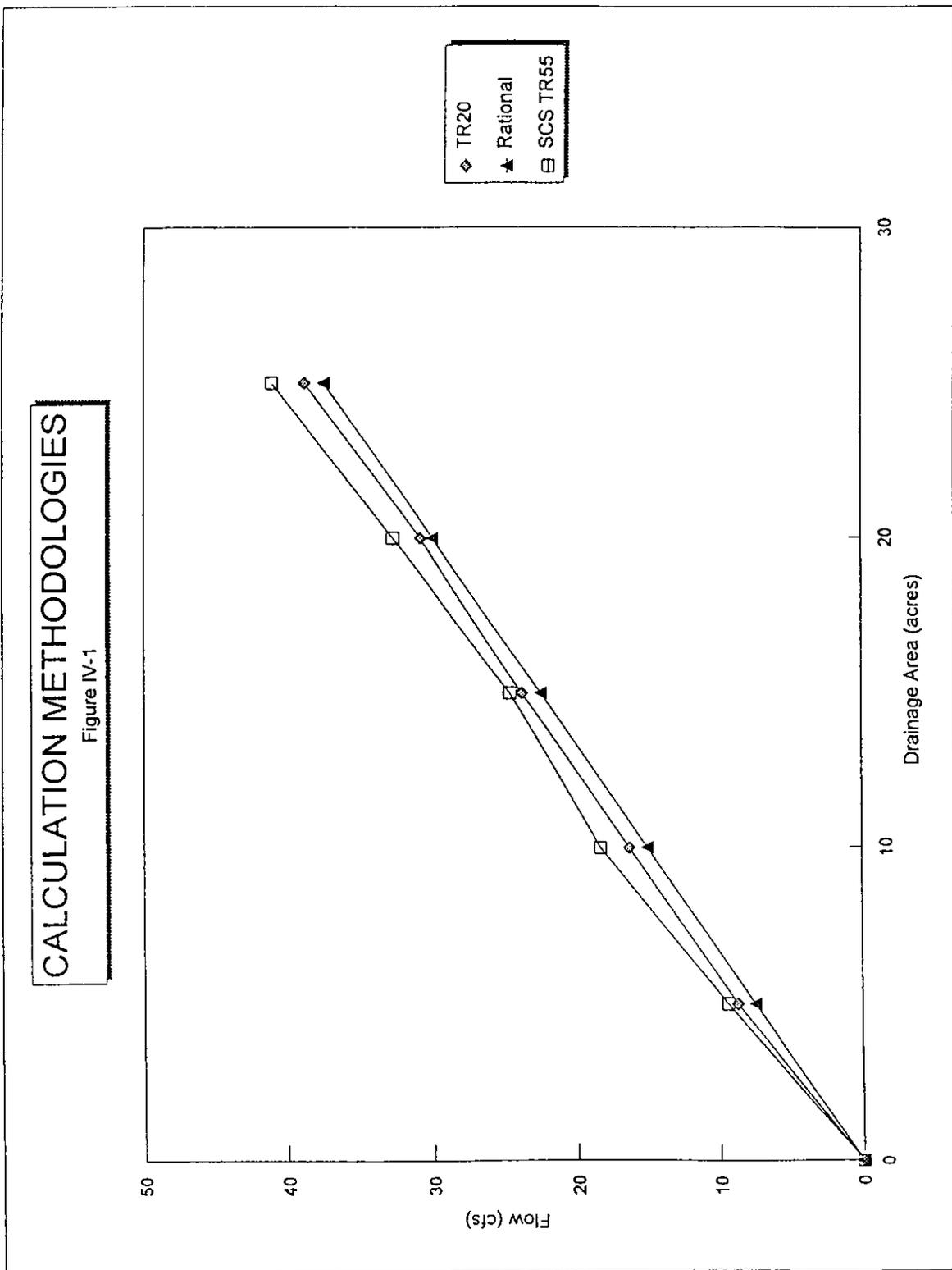
STANDARDS AND CRITERIA FOR THE CONTROL OF STORM WATER

A. Performance Standards

An engineering evaluation of the applicability of various calculation methodologies was conducted as part of the Plan preparation and was supported by previous research. Typical subwatersheds varying in size were selected to evaluate desktop methods for determining onsite runoff. The results were compared with the calibrated TR-20 results. Figure IV-1 shows a comparison of three calculation methodologies for one-acre lots. The conclusions drawn from the analysis are that, utilizing the Soil Conservation Service curve numbers and rational 'C' values specified in Ordinance Appendix B, either the curve number method or rational method can be used to determine pre- and post-development runoff peak rates.

The rational method only determines peak rates, however. The design of any detention facility would have to include a routing of the calculated runoff through the basin. Routing refers to the calculation process of taking the post-development runoff and determining if the detention facility's stage/storage/discharge characteristics are

adequate. The hydrograph can be generated through the use of the PSUHM program and the PennDOT IDF curves, where the peak intensity occurs at 3 times the T_c and the storm length is 10 times the T_c . This hydrograph is similar to the SCS Type II 24-hour hydrograph.



The performance standards and criteria that have been developed through the watershed modeling analysis are summarized in Table V-1.

TABLE V-1 CRITERIA & STANDARDS	
STANDARD	BENEFIT
<u>Storm Water Management</u> Release rates vary by Districts.	No increase in runoff on a watershed wide basis, storm water detention and attenuation
<u>Design Storm</u> Consideration to be given to the 2, 10, 25, 50, and 100 year design storms.	No increase in runoff in entire range of design storms, continued surface and groundwater quality.
<u>Floodplains</u> All floodplains shall not be filled so as to reduce the storage capacity.	Natural storm water detention/flood control downstream. Protection of existing conveyance capacity.
<u>Hydrologic Soils Groups A & B</u> All development proposed in hydrologic soil groups A & B should investigate the implementation of infiltration or retention structures for the Storm Water Control measures as opposed to surface detention. This also pertains to the portions of the watershed that have storm sewers. Recharge structures installed prior to tapping into the storm sewers are recommended where soils and physical conditions permit.	Groundwater/stream base flow recharge, flow attenuation.
<u>Existing Storm Sewers or Culverts</u> 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 O & M and replacement costs.
<u>Roof Drains, Residential/Commercial</u> Prevent all roof drains from discharging into storm sewers, roadside ditches or channels. Discharge to lawns, recharge basin or storage facilities.	Promotes infiltration, flow attenuation and increases runoff time of concentration, flow attenuation.
<u>Discharge of Accelerated Runoff</u> Accelerated storm water runoff shall not be discharged into drainage patterns and storm sewers as it may adversely affect properties or cause channel scouring and erosion.	Safe conveyance, continued surface and groundwater quality, flow attenuation.

<p><u>Inappropriate Outlets</u> If outlet from storm water conveyance systems from a development site to a stream, tributary, stabilized channel, or storm sewer is not possible, runoff shall be collected in a detention/retention facility and discharge at a nonerosive rate. Outlets discharging onto adjacent property owner's properties must have adjacent property owner's written permission.</p>	<p>Safe conveyance, continued surface and ground water quality, storm water detention, flow attenuation.</p>
<p><u>Pervious Surfaces</u> The use of pervious materials will be encouraged for parking surfaces and sidewalks.</p>	<p>Infiltration, groundwater recharge.</p>
<p><u>Structures</u> Concentrate on locating facilities within areas conducive to recharge and design, accommodate recharge to meet release rate requirements.</p>	<p>Infiltration, groundwater recharge, stream base flow.</p>
<p><u>Wetlands</u> Network regulatory agencies involvement within wetland areas.</p>	<p>Infiltration, structure integrity, surface water quality, safe conveyance, stream, culvert, and channel capacity.</p>
<p><u>Steep Slopes</u> Regulate activities in critical slope areas where management of storm water by structure is inappropriate.</p>	<p>Stream base flow, flow attenuation conveyance integrity, surface water quality.</p>

Note: See Volume I and the Model Ordinance for more detailed standards and criteria.

1. Description of Performance Standard Districts

In performing the tasks for the Mill Creek Watershed Plan under Act 167, the goal was to provide a runoff control strategy which should be implemented so as not to increase stormwater runoff anywhere in the Mill Creek basin. It was also important to determine to what extent storm water detention would be required in individual subareas. Individual subareas would fall into one of three districts:

- a. One Hundred Percent Predevelopment Release Rate: In these subareas it was determined to be advantageous not to over detain the runoff volume. Development areas which can be discharged directly to the main channel may do so if discharge will not cause an erosion problem. Other areas in these basins may discharge 100% of the predevelopment runoff rate. This is an effort to direct the storm flows to the Mill Creek before the peak flow rate arrives.
- b. Seventy-five Percent Predevelopment Rate: In these subareas it was determined to be advantageous not to over detain the runoff volume; however,

100% release rates could not be permitted without damage to tributary streams before reaching the Mill Creek.

- c. Fifty Percent Predevelopment: In these subareas it was determined to be advantageous to over detain the storm water flows at development sites so as not to increase peak flows on Mill Creek. Most of these subareas directly contribute to the peak flows.

Development in the 100% release rate subareas designated on the Subwatershed Boundary Map as 100% predevelopment flow rate areas must convey the generated storm water runoff to a stream or watercourse in a safe manner. The design must manage the quantity, velocity and direction of resulting storm water runoff in a manner which adequately protects health and property from possible injury pursuant to Act 167, does not overtax existing drainage facilities, and does not cause erosion or sedimentation. Anyone who proposes no detention for greater than the 2-year storm must show that the downstream natural or man-made channel or watercourse has the capacity within its banks to convey the 2-year design storm at velocities which are not erosive. Acceptable velocities shall be based upon criteria contained in the PADEP "Erosion and Sediment Pollution Control Program Manual." The flows from the site must also be safely conveyed by the stream and its overbanks without causing additional erosion or sedimentation, or creating any damage, safety or property hazard. The post-development flow greater than pre-development flow can only be released if it does not aggravate a significant obstruction or existing problem area as identified on Pipe/Structure Capacity Map, Volume II. If it would, proper storm water management, obstruction replacement or standard detention would be required. Any increase in flow from the 50-year storm not carried by downstream drainage facilities must be addressed and, where necessary, additional controls installed to assure upstream collection of this water by control facilities where required by the storm water design in accordance with Chapter 105, as well as any local ordinances.

Proper analysis of channel capacity downstream of a development site for the purpose of discharging greater than pre-development peak flow rates is essential for insuring that the goal of not creating any new problem areas or aggravating existing drainage problem areas is achieved. The analysis must include the assumption of complete build-out of the tributary areas to the channel being evaluated based upon the Future Land Use Map (Plate II, Volume II) or the latest zoning revision after Plan adoption. Also, storm water control measures consistent with the Plan must be assumed in analyzing projected development tributary to the point of evaluation.

Culverts, bridges, stream enclosures, or any other facilities proposed within an area where no detention is required, must pass flows for the 50-year design storm without causing a backwater that would act as a "detention basin" in conformance with Chapter 105 criteria or other local ordinances. Such facilities shall allow an unimpeded flow to be conveyed.

Stream channels, water courses or other conveyance facilities may be improved to meet the above requirements and alleviate existing capacity deficiencies as long as local, state, and federal requirements are met and permits obtained.

Any proposed facilities that constitute stream enclosures, channel modifications, or dams, as regulated in PADEP Chapter 105 regulations (as amended or replaced from time to time by PADEP), shall be designed in accordance with Chapter 105 and will require a permit from PADEP. The definition of a dam is defined in Chapter 105 regulations. Any roadway crossing, including pipes, bridges, storm sewers or any other drainage conveyance facilities, or any work involving wetlands as described in PADEP Chapter 105 regulations, shall be designed in accordance with Chapter 105 regulations and may require a permit from the Department. Any roadway crossing any facility located within a PADOT right-of-way must meet PADOT minimum design standards and permit submission requirements.

2. Sub-Regional (Combined Site) Storage

Traditionally, the approach to storm water management has been to control the runoff on an individual site basis. However, there is a growing commitment to finding cost-effective comprehensive control techniques which both preserve and protect the natural drainage system. In other words, two developers developing sites adjacent to each other could pool their capital resources to provide for a community storm water storage facility in the most hydrologic advantageous location.

The goal should be the development and use of the most cost-effective and environmentally-sensitive storm water runoff controls which significantly improves the capability and flexibility of land developers and communities to control runoff consistent with the Mill Creek Management Plan and the release rates set forth.

An advantage to combining efforts is to increase the opportunity to utilize storm water control facilities to meet other community needs. For example, certain storm water control facilities could be designed so that recreational facilities such as fall fields, open space, volleyball, etc. could be incorporated. Natural or artificial ponds and lakes could serve both recreational and storm water management objectives.

To take this concept a step further, there is also the possibility that the storm water could be managed "off-site;" that is, in a location of the property(s) in question. There could be publicly owned detention, retention, lake, pond or other physical facilities to serve multiple developments. The design and release rate would need to be consistent with the Plan.

3. "No Harm Option"

For any proposed development site not located in a provisional no detention district, the developer has the option of using a less restrictive runoff control (including no

detention) if the developer can prove that “no harm” would be caused by discharging at a higher runoff rate than that specified by the Plan. Proof of “no harm” would have to be shown from the development site through the remainder of the downstream drainage network until there is no additional flow increase. Proof of “no harm” must be shown using the capacity criteria specified in Section 303.C of the Model Ordinance if downstream capacity analysis is a part of the “no harm” justification.

Attempts to prove “no harm” based upon downstream peak flow versus capacity analysis shall be governed by the following provisions:

- a. The peak flow values to be used for downstream areas for the design return period storms (2-, 5-, 10-, 25-, 50-, and 100-year) shall be the values from the calibrated TR-20 Model for the Mill Creek Watershed. These flow values would be supplied to the developer by the County upon request.
- b. Any available capacity in the downstream conveyance system as documented by a developer may be used by the developer only in proportion to his development site acreage relative to the total upstream undeveloped acreage from the identified capacity (i.e. if his site is 10% of the upstream undevelopment acreage, he may use up to 10% of the documented downstream available capacity).
- c. Developer-proposed runoff controls which would generate increased peak flow rates at documented storm drainage problem areas would, by definition, be precluded from successful attempts to prove “no harm,” except in conjunction with proposed capacity improvements for the problem areas consistent with Section 303.C. of the Model Ordinance.

Any “no harm” justifications shall be submitted by the developer as part of the Drainage Plan submission per Article IV of the Model Ordinance.

4. “Match Pre-existing Hydrograph”

Developers and/or landowners will have the option to provide infiltration facilities allowing the post-development hydrograph to match the pre-existing hydrograph for the site. This will be most useable for small subdivisions in the 50% pre-development runoff rate areas.

5. “Hardship Option”

The development of the Plan and its standards and criteria was designed to maintain existing peak flows throughout the Mill Creek Watershed as the watersheds become developed. There may be certain instances, however, where the standards and criteria established are too restrictive for a particular landowner or developer. The existing drainage network in some areas may be capable of

safely transporting slight increases in flows without causing a problem or increasing flows elsewhere. If a developer or homeowner cannot reasonably meet the storm water standards due to lot conditions or if conformance would become a hardship to an owner and the developer/homeowner can demonstrate "no harm" if the hardship waiver is granted, the hardship option may be applied. The landowner would have to plead their case to the municipal officials with the final determination made by the municipality. Any landowners pleading the "hardship option" will assume all liabilities that may arise due to exercising this option. In cases where the hardship option is requested, it will be the applicant's responsibility to notify adjacent and/or affected property owners and municipalities and provide written proof of the notification. Financial obligations are not considered a hardship.

Pequea Township and the City of Lancaster will not be required to update the current Storm Water Management Ordinances for the areas which flow to the Mill Creek. Pequea Township has only 80 acres which flow to the Mill Creek. These 80 acres are located on a preserved farm. All areas which are within the City of Lancaster which flows to the Mill Creek and not developed are owned by the County and are located in Central Park. Any structures constructed by the County of Lancaster in Central Park must meet the standards set forth in the existing Lancaster City Ordinance for storm water management.

B. Watershed Level Runoff Control Philosophy

One option in watershed-wide storm management is to control runoff using regional facilities. Developers could pool their capital to build a regional detention basin at a strategic location in place of installing basins on each individual site.

It has been concluded that due to the existing development and road patterns in the watershed, wetlands and land ownership considerations, there are no potentially viable regional basin locations available.

SECTION VI

ALTERNATE RUNOFF CONTROL TECHNIQUES AND THEIR EFFICIENCY IN THE WATERSHED

A. Storm water Controls

As indicated in Volume I, each developer must not allow the runoff from his site to exceed the applicable release rate applied to the subwatershed in which the site is located. This runoff control can be obtained in a number of different ways. Table VI-1 indicated a general overview of measures that can be applied to reduce or delay storm water runoff while Table VI-2 shows the advantages and disadvantages for several types of runoff control measures. It will be up to the developer or the developer's engineer to select the technique that is the most appropriate to the type of project and physical

characteristics of the site. Effective measures for reducing peak rates of runoff are not limited to those listed in Table VI-1.

In determining what measures or combination of measures to install, the following parameters should be considered:

- Soil characteristics (hydrologic soil group, [i.e. permeability], erodibility, etc.)
- Subsurface conditions (depth to seasonal high water table, bedrock, etc.)
- Topography (steepness or slope, earthcut)
- Existing drainage patterns (nearby streams, swales, and flooding potential)
- Economics
- Advantages and disadvantages of each technique.

Infiltration structures are encouraged for soils with an A or B hydrologic rating (see Plate III). Innovative approaches are encouraged to aid in meeting the applicable release rate percentage. The general suitability of individual runoff control measures in the Mill Creek Watershed are listed in Table VI-3.

TABLE VI-1		
VARIOUS ON-SITE STORM WATER CONTROL METHODS		
AREA	REDUCING RUNOFF	DELAYING RUNOFF
Large Flat Roof	<ol style="list-style-type: none"> 1. Cistern storage 2. Rooftop gardens 3. Pool storage or fountain storage 	<ol style="list-style-type: none"> 1. Ponding on roof by constricted downspouts 2. Increasing roof roughness <ol style="list-style-type: none"> a. Rippled roof b. Graveled roof
Parking Lots	<ol style="list-style-type: none"> 1. Porous pavement <ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measures for impervious areas <ol style="list-style-type: none"> a. Rippled pavement b. Depressions c. Basins
Residential	<ol style="list-style-type: none"> 1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Ground-water recharge <ol style="list-style-type: none"> a. Perforated pipe b. Gavel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions 	<ol style="list-style-type: none"> 1. Reservoir of detention basin 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters, diversions, etc.
General	<ol style="list-style-type: none"> 1. Gravel alleys 2. Porous sidewalks 3. Mulched planters 	<ol style="list-style-type: none"> 1. Gravel alleys

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

TABLE VI-2

**ADVANTAGES AND DISADVANTAGES OF VARIOUS
ON-SITE STORM WATER CONTROL METHODS**

MEASURE	ADVANTAGES	DISADVANTAGES
A. Cisterns and Covered Ponds	<ol style="list-style-type: none"> 1. Water may be used for: <ol style="list-style-type: none"> a. Fire protection b. Watering lawns c. Industrial processes d. Cooling purposes 2. Reduce runoff while only occupying small area 3. Land or space above cistern may be used for other purposes 	<ol style="list-style-type: none"> 1. Expensive to install 2. Cost required may be restrictive if the cistern must accept water from large drainage areas 3. Requires slight maintenance 4. Restricted access 5. Reduces available space in basements for other uses
B. Rooftop Gardens	<ol style="list-style-type: none"> 1. Esthetically pleasing 2. Runoff reduction 3. Reduce noise levels 4. Wildlife enhancement 	<ol style="list-style-type: none"> 1. Higher structural loadings on roof and building 2. Expensive to install and maintain
C. Surface Pond Storage (usually residential areas)	<ol style="list-style-type: none"> 1. Controls large drainage areas with low release 2. Esthetically pleasing 3. Possible recreation benefits <ol style="list-style-type: none"> a. Boating b. Ice skating c. Fishing d. Swimming 4. Aquatic life habitat 5. Increases land value of adjoining property 	<ol style="list-style-type: none"> 1. Requires large areas 2. Possible pollution from storm water and siltation 3. Possible mosquito breeding areas 4. May have adverse algae blooms as a result of eutrophication 5. Possible drowning 6. Maintenance problems
D. Ponding on Roof by constricted Downspouts	<ol style="list-style-type: none"> 1. Runoff delay 2. Cooling effect for building <ol style="list-style-type: none"> a. Water on roof b. Circulation through 3. Roof ponding provides fire protection for building (roof water may be trapped in case of fire) 	<ol style="list-style-type: none"> 1. Higher structural loadings 2. Clogging of constricted inlet requiring maintenance 3. Freezing during winter (expansion) 4. Waves and wave loading 5. Leakage of roof water into building (water damage)

<p>E. Increased Roof Roughness</p> <ul style="list-style-type: none"> a. Rippled roof b. Gravel on roof 	<ul style="list-style-type: none"> 1. Runoff delay and some reduction (detention in ripples or gravel) 	<ul style="list-style-type: none"> 1. Somewhat higher structural loadings
<p>F. Porous pavement (parking lots and alleys)</p> <ul style="list-style-type: none"> a. Gravel b. Holes in impervious pavements (¼ in. diameter) filled with sand 	<ul style="list-style-type: none"> 1. Runoff reduction (a and b) 2. Potential groundwater recharge (a and b) 3. Gravel pavements may be cheaper than asphalt or concrete (a) 	<ul style="list-style-type: none"> 1. Clogging of holes or gravel pores (a and b) 2. Compaction of earth below pavement or gravel decreases permeability of soil (a and b) 3. Ground-water pollution from salt in winter (a and b) 4. Frost heaving for impervious pavement with holes (b) 5. Difficult to maintain 6. Grass or weeds could grow in porous pavement (a and b)
<p>G. Grassed channels and vegetated strips</p>	<ul style="list-style-type: none"> 1. Runoff delay 2. Some runoff reduction (infiltration recharge) 3. Esthetically pleasing <ul style="list-style-type: none"> a. Flowers b. Trees 	<ul style="list-style-type: none"> 1. Sacrifice some land area for vegetated strips 2. Grassed areas must be mowed or cut periodically (maintenance costs)
<p>H. Ponding and detention measures on impervious pavement</p> <ul style="list-style-type: none"> a. Rippled pavement b. Basins c. Constricted inlets 	<ul style="list-style-type: none"> 1. Runoff delay (a, b, and c) 2. Runoff reduction (a and b) 	<ul style="list-style-type: none"> 1. Somewhat restricted movement of vehicle (a) 2. Interferes with normal use (a and c) 3. Damage to rippled pavement during snow removal (a) 4. Depressions collect dirt and debris (a, b, and c)

<p>I. Reservoir or detention basin</p>	<ol style="list-style-type: none"> 1. Runoff delay 2. Recreation benefits <ol style="list-style-type: none"> a. Ice skating b. Baseball, football, etc. if land is provided 3. Esthetically pleasing 4. Could control large drainage areas with low release 	<ol style="list-style-type: none"> 1. Considerable amount of land is necessary 2. Maintenance costs <ol style="list-style-type: none"> a. Mowing grass b. Herbicides c. Cleaning periodically (silt removal) 3. Mosquito breeding area 4. Siltation in basin
<p>J. Converted septic tank for storage and ground-water recharge</p>	<ol style="list-style-type: none"> 1. Low installation costs 2. Runoff reduction (infiltration and storage) 3. Water may be used for: <ol style="list-style-type: none"> a. Fire protection b. Watering lawns and gardens c. Ground-water recharge 	<ol style="list-style-type: none"> 1. Requires periodic maintenance (silt removal) 2. Possible health hazard 3. Sometimes requires a pump for emptying after storm
<p>K. Ground-water recharge <ol style="list-style-type: none"> a. Perforated pipe or hose b. French drain c. Porous pipe d. Dry well </p>	<ol style="list-style-type: none"> 1. Runoff reduction (infiltration) 2. Ground-water recharge with relatively clean water 3. May supply water to garden or dry areas 4. Little evaporation loss 	<ol style="list-style-type: none"> 1. Clogging of pores or perforated pipe 2. Initial expense of installation (materials)
<p>L. High delay grass (high roughness)</p>	<ol style="list-style-type: none"> 1. Runoff delay 2. Increased infiltration 	<ol style="list-style-type: none"> 1. Possible erosion or scour 2. Standing water on lawn in depressions

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

TABLE VI-3

**SUITABILITY OF RUNOFF CONTROL MEASURES
IN THE MILL CREEK WATERSHED**

1. Cisterns and Covered Ponds

Recommended in industrial parks where water could be used for fire protection; expensive to install with limited benefit. Low maintenance costs (usually requires periodic sediment removal); good for receiving stream's water quality since no outflow.

2. Rooftop Gardens

Not recommended in this watershed due to its rural nature.

3. Surface Pond Storage

Recommended where pond sites exist or on more porous soils (A and B) for groundwater recharge. Relatively inexpensive to install and maintain. Helps entrap sediment to improve water quality of receiving stream.

4. Ponding on Roof, Constricted Downspouts

Possible in the Borough of New Holland or on large public buildings. Required structure modifications usually expensive. Low maintenance costs unless leaks occur. Typically "warms" water that could affect receiving water.

5. Increased Roof Roughness

Possible for industrial, commercial and public buildings. Relative effectiveness minimal on a watershed-wide basis. Moderate installation costs; little maintenance costs. "Warms" runoff.

6. Porous Pavement

Highly recommended where possible, especially in A and B soils and large parking facilities. Promotes groundwater recharge. Moderate in expense compared with typical paving, however, less land intensive if surface detention would be required. Low maintenance costs.

7. Grassed Channels and Vegetated Strips

Recommended wherever possible throughout the watershed to slow velocity and reduce erosion. Minimal slopes (greater than 0.5%) recommended; could entrap

sediment to improve water quality. Low installation and maintenance costs. Promotes infiltration.

8. Ponding and Detention on Pavement

Recommended in entire watershed except in "no detention" areas. Tends to warm water that could affect receiving water. Very inexpensive with low maintenance costs. Freezing should be considered. Entraps some pollutants.

9. Reservoir or Detention Basin

Recommended in entire watershed except in "no detention" areas. Relatively easy to implement. Moderate installation and maintenance costs. Aids in entrapping some sediment which improves water quality.

10. Groundwater Recharge

Recommended in A and B soils and in broad flat valleys where minor elevation drops preclude typical detention basin outlets.

11. High Delay Grass and Routing Flow Over Lawns

Recommended in the entire watershed. Delays runoff, entraps sediment, reduces velocities, reduces erosion potential and improves water quality of receiving watercourse. Relatively inexpensive installation and maintenance costs.

B. Best Management Practices

Water quality problems resulting from storm water runoff have necessitated the development of innovative pollution and runoff control practices termed best management practices (BMP's). Current literature offers many examples of such practices proposed to solve specific storm water quality problems. Below is a summary of recommended practices based upon three separate categories. In addition, detailed information and standards are included in Appendix D of the Model Ordinance, which follows. Additional information on effects of storm water on ground water quality can be found in the Water Resources part of the Lancaster County Comprehensive Plan.

1.0 Pollution Source Controls are practices intended to improve water quality by reducing the generation and accumulation of potential runoff at or near their sources. These would include:

1.1 Street Sweeping - Sweeping, vacuuming, controlled flushing or otherwise cleaning streets, parking lots and other paved vehicular traffic areas. This removes dry-weather accumulations of pollutants before they are washed into streams.

- 1.2 Solid Waste Collection and Disposal - Municipal collections of refuse such as leaves which would otherwise be dumped in a place which would wash into the stream. Public education is important.
 - 1.3 Fertilizer Application Control - Preventing fertilization near streams, waterways, lakes and ponds, and insuring that lawns are not over-fertilized keeps nutrients from entering the streams. Public education, the need for soil testing to determine fertilizer needs, and application timing are important factors in reducing nutrient loads to surface waters.
 - 1.4 Pesticide Use Control - Again, public education on proper use, application rates, equipment cleaning, disposal of unused chemicals and containers, storage and alternate pest control compounds is recommended with limitations placed on their use.
 - 1.5 Highway Deicing Compound Control - Highway deicing compounds in storage and application sites run off the land and pollute streams. Proper storage and application of deicing compounds is recommended with limitations placed on their use.
 - 1.6 Nonpoint Source Pollution Control on Construction Sites - Proper erosion and sediment pollution control on construction sites is important in reducing solids and phosphorus transported to receiving waters. Such concepts may include sedimentation basins, storm sewer inlet protection, proper refuse disposal, dust control, designated equipment cleaning areas, etc.
- 2.0 Runoff Controls are practices aimed primarily at runoff rate and volume control, however, they also provide some degree of storm water treatment. Many typical runoff control measures can be easily modified to provide a higher degree of pollution control. Described below are the quality control aspects of runoff control measures.
- 2.1 Dry Detention Basin - A typical detention basin remains dry between periods of rain events. Its primary purpose is to reduce the peak rate of runoff to that which occurred prior to development. The ponding time during a storm event allows a portion of the pollutants to settle out.
 - 2.2 Extended Detention Basin - Extended detention basins are designed to allow an extended ponding time, thus allowing a larger volume of pollutants to settle out. These basins are typically designed to reduce peak rates of runoff for a much greater frequency storm, i.e., the one-year storm.
 - 2.3 Wet Detention Basin - A wet detention basin is essentially a wet pond which has a permanent pool of water. The pool allows an extended detention time allowing pollutants to settle. Aquatic plants and organisms utilize the nutrients in the water preventing escape of those pollutants.

- 2.4 Infiltration Basins - An infiltration basin is an excavated impoundment with a relatively permeable bottom soil. The purpose is to temporarily store the surface runoff for a selected design storm and then allow the stored water to infiltrate into the groundwater. This method prevents surface water pollution but care to prevent groundwater pollution should be exercised.
 - 2.5 Infiltration Trenches - Trenches excavated in porous soils and filled with aggregate allow runoff from small drainage areas to infiltrate into the ground.
 - 2.6 Dry Wells - Pits excavated in porous soils and filled with aggregate. These are typically used to control roof runoff.
 - 2.7 Filter Strips - Grass filter strips accept runoff from roofs or parking areas and filter pollutants before the runoff can enter the receiving water.
 - 2.8 Grassed Waterways and Seepage Areas - Grassed waterways and seepage areas reduce runoff velocities, enhance infiltration and filter runoff pollutants, thus improving runoff quality.
 - 2.9 Concrete Grid and Modular Pavement - Concrete grid and modular pavement promotes infiltration and retards runoff thereby improving runoff quality. These are typically promoted in overflow parking areas.
 - 2.10 Porous Asphalt Pavement - Special asphaltic paving material allows storm water to infiltrate through the pavement through an aggregate base and into the soil thus reducing runoff and in turn pollutant wash-off to streams. Runoff temperatures are also reduced from conventional pavement since the initial rainfall (which typically generates the warmest runoff) infiltrates as opposed to running off into receiving waters.
 - 2.11 Constructed Wetlands - Are excavated basins into which wetland vegetation is planted to enhance pollutant removal. Similar to wet detention basins, they are typically much shallower, thus allowing rooted vegetation to grow. Much larger surface areas are therefore required to store the required volume of storm water runoff.
- 3.0 Collection and Treatment deals with collecting and treating urban storm water runoff. It typically applies to more heavily developed areas with defined collection systems.
- 3.1 New Sewer System Control - Involves the planning of proposed storm sewer systems to incorporate storm water treatment of some sort before being discharged into the receiving waters.
 - 3.2 Storm Sewer System Storage - Incorporates storage capabilities (detention) in storm sewers for pollutant deposition and "clean" water discharge.

- 3.3 Flow Regulators - Involves installing mechanized devices in storm water conveyance and storage facilities to control runoff volumes, velocities and directions of flows.
- 3.4 Treatment - Involves considering methods of treatment for storm water runoff to remove solids and contaminants. Such processes may be filtration, settling, screening, flocculation or disinfection.
- 3.5 Water Quality Inlets (Oil and Grease Separators) - Designed to remove sediment and hydrocarbons from parking lot runoff before they are conveyed to the storm sewer or infiltration structure. They are typically multi-chambered and are limited to small drainage areas due to their small storage volume.

SECTION VII

THE DEVELOPMENT OF THE MODEL ORDINANCE

The implementation of the runoff control strategy for new development will be through municipal adoption of the appropriate ordinance provisions. As part of the preparation of the Mill Creek Watershed Storm Water Management Plan, a model municipal ordinance has been prepared which would implement the Plan provisions presented in the ordinance as a single purpose ordinance. This could be adopted essentially "as is" by the municipalities. Provisions would also be required in the Subdivision and Land Development Ordinance to ensure that activities regulated by the ordinance were appropriately referenced. The Mill Creek Watershed Act 167 Storm Water Management Ordinance will not completely replace the existing storm drainage ordinance provisions currently in effect in the municipalities. The reasons for this are as follows:

Not all of the municipalities in the Mill Creek Basin are completely within the watershed. For those portions of the municipality outside the Mill Creek Watershed, the existing ordinance provisions would still apply.

Permanent and temporary storm water control facilities are regulated by the Act 167 Ordinance. Storm water management and erosion and sedimentation control during construction would continue to be regulated under the existing storm water ordinance and Chapter 102 Erosion and Sediment and Pollution Controls, Title 25 of DER. Regulations.

The Act 167 Ordinance contains only those minimum storm water runoff control criteria and standards which are necessary or desirable from a total watershed perspective. Additional storm water 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. (Section 303 are suggested criteria.)

The Act 167 Ordinance contains only those storm water runoff controls required from new development which are the minimum criteria from a watershed perspective.

The text of the ordinance is organized into nine articles as follows:

- I - General Provisions
- II - Definitions
- III - Drainage Plan Requirements
- IV - Drainage Plan Submittal and Review Procedures
- V - Permit Requirements and Procedures
- VI - Inspections
- VII - Fees and Expenses
- VIII - Financial Guarantees and Maintenance
- IX - Enforcement and Penalties

Although the actual storm water control provisions, as shown in Tables VII-1 and VII-2, may change significantly from an existing municipal ordinance, the structure of the ordinance itself is very similar to many existing ordinances.

Within six months following adoption and approval of the watershed storm water plan, each municipality shall adopt or amend, and shall implement such ordinances and regulations, including zoning, subdivision and development, building code, and erosion and sedimentation ordinances, as are necessary to regulate development within the municipality in a manner consistent with the applicable watershed storm water plan and the provisions of this act.

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

An Occupancy Permit shall not be secured or issued unless the Storm Water Management and Earth Disturbance Ordinance of the Mill Creek Watershed have been complied with. The occupancy permit shall be required for each lot owner and/or developer of all subdivisions and land development in the municipality, unless exempt under the exemption criteria.

For municipalities without an occupancy permit, they may want to adopt the above draft and also include other regulatory items in the occupancy permit requirement for their own purpose and use.

TABLE VII-1

TYPICAL STORM WATER MANAGEMENT AND EARTH DISTURBANCE PERMIT

ARTICLE I - General Provisions	ARTICLE II - Definitions	ARTICLE III - Drainage Plan Requirements	ARTICLE IV - Drainage Plan Submittal and Review Procedures
Statement of Findings Purpose Statutory Authority Applicability Repealer Severability Comparability with Other Permit Ordinance Requirements Disclaimer of Liability		General Requirements Drainage Plan Content	General Requirements Exemptions Plan Submission Drainage Plan Approval Modifications of Plans
ARTICLE V - Permit Requirements and Procedures	ARTICLE VI - Inspections	ARTICLE VII - Fees and Expenses	ARTICLE VIII - Financial Guarantees and Maintenance
Permit Requirements and Exemptions Permit Issuance Modification of Drainage Plans Application of Permit Expiration and Renewal Suspension and Revocation	Schedule of Inspections	General Modification of Plans Expenses Covered by Fees	Performance Guarantees Maintenance Guarantees Improvements Agreement Maintenance by Individual Lot or Multiple Ownership(s)
ARTICLE IX - Enforcement and Penalties			
Right-of-Entry Enforcement Notification Penalties Enforcement Remedies			

TABLE VII-2

SPECIAL STORM WATER MANAGEMENT PROVISIONS

<p><u>Impervious Cover Limitations</u></p> <ul style="list-style-type: none"> - Use of pervious materials - Standards based upon soil permeability - Limitations in high groundwater areas 		<p><u>Disturbance of Natural Areas</u></p> <ul style="list-style-type: none"> - Prohibit disturbance of wetlands area - Improve where possible removal of vegetation or trees - Prohibit sediment pollution 	
<p><u>Plan Review</u></p> <ul style="list-style-type: none"> - Establish review fees <ul style="list-style-type: none"> . Fixed-fee payments . Actual costs (Schedule of Fees and Application) 	<p><u>Maintenance of Facilities</u></p> <ul style="list-style-type: none"> - Establish one or two year maintenance bond - Applicant priority maintenance fund for perpetual care of facility 	<p><u>Runoff Control</u></p> <ul style="list-style-type: none"> - Design storm as specified - Release rate application for no increase in runoff 	
<p><u>Reduce Size of Facilities</u></p> <ul style="list-style-type: none"> - Encourage on-lot recharge - Allow generous standards for calculation of infiltration when in a naturally porous area - Encourage grass-lined low gradient channels and check dams 		<p><u>Special Geologic Conditions</u></p> <ul style="list-style-type: none"> - Special consideration needs in the design of storm water detention, retention and conveyance facilities in sensitive areas such as: <ul style="list-style-type: none"> . Limestone areas . Landslide-prone areas . Abandoned mining areas 	
<p><u>Nonpoint Source Pollution Controls</u></p> <ul style="list-style-type: none"> - Zero increase in nutrient runoff - Use of extended detention or wet ponds - Increase infiltration or use vegetation for nutrient uptake - 2-year design storm 			

SECTION VIII

MODEL

ORDINANCE

**STORM WATER MANAGEMENT
ORDINANCE**

ORDINANCE NO. _____

[Name of Municipality] LANCASTER COUNTY, PENNSYLVANIA

Adopted at a Public Meeting Held on

_____, 19 ____

TABLE OF CONTENTS

ARTICLE I - GENERAL PROVISIONS

- Section 101 - Statement of Findings
- Section 102 - Purpose
- Section 103 - Statutory Authority
- Section 104 - Applicability
- Section 105 - Repealer
- Section 106 - Severability
- Section 107 - Compatibility with Other Ordinance Requirements

ARTICLE II - DEFINITIONS

ARTICLE III - DESIGN CRITERIA FOR STORM WATER MANAGEMENT FACILITIES

- Section 301 - General Requirements
- Section 302 - Storm Water Management Performance Standards
- Section 303 - Design Criteria for Storm Water Management Facilities
- Section 304 - Calculation Methodology
- Section 305 - Use of Performance Standards & Criteria
- Section 306 - Floodplain

ARTICLE IV - DRAINAGE PLAN REQUIREMENTS

- Section 401 - General Requirements
- Section 402 - Exemptions
- Section 403 - Drainage Plan Contents
- Section 404 - Plan Submission
- Section 405 - Drainage Plan Review
- Section 406 - Modifications of Plans
- Section 407 - Resubmission of Disapproved Drainage Plans

ARTICLE V - INSPECTIONS

- Section 501 - Schedule of Inspections

ARTICLE VI - FEES AND EXPENSES

- Section 601 - General
- Section 602 - Plan Administrator Drainage Plan Review Fee
- Section 603 - Expenses Covered by Fees

ARTICLE VII - MAINTENANCE RESPONSIBILITIES

Section 701 - Maintenance Responsibilities

Section 702 - Maintenance Agreement for Privately Owned Storm Water Facilities

Section 703 - Municipal Storm Water Maintenance Fund

ARTICLE VIII - ENFORCEMENT AND PENALTIES

Section 801 - Right-of-Entry

Section 802 - Notification

Section 803 - Public Nuisance

Section 804 - Penalties

Section 805 - Appeals

APPENDICES

- A. Exemption Criteria & Samples
- B. Storm Water Management Criteria
- C. Sample Drainage Permit Application
- D. Sample Occupancy Permit Application
- E. Subwatershed Boundary Map

**MILL CREEK WATERSHED
ACT 167 STORM WATER MANAGEMENT ORDINANCE**

**ARTICLE I
GENERAL PROVISIONS**

Section 101. Statement of Findings

The governing body of the Municipality finds that:

- A. Inadequate management of accelerated storm water 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 storm water, undermines floodplain management and flood reduction efforts in upstream and downstream communities, reduces groundwater recharge, and threatens public health and safety.
- B. A comprehensive program of storm water management, including reasonable regulation of development and activities causing accelerated erosion, is fundamental to the public health, safety, welfare, and the protection of the people of the Municipality and all the people of the Commonwealth, their resources, and the environment.

Section 102. Purpose

The purpose of this Ordinance is to promote health, safety, and welfare within the Mill Creek Watershed by minimizing the damages described in Section 101.A of this Ordinance through provisions designed to:

- A. Manage accelerated runoff and erosion and sedimentation problems at their source by regulating activities that cause these problems.
- B. Utilize and preserve the existing natural drainage systems.
- C. Encourage recharge of groundwater where appropriate and prevent degradation of groundwater quality.
- D. Maintain existing flows and quality of streams and watercourses in the Municipality and the Commonwealth.
- E. Preserve and restore the flood-carrying capacity of streams.
- F. Provide proper maintenance of all permanent storm water management facilities that are constructed in the Municipality.

- G. Provide performance standards and design criteria for watershed-wide storm water management and planning.

Section 103. Statutory Authority

The Municipality is empowered to regulate land use activities that affect runoff by the authority of the Act of October 4, 1978, 32 P.S. P.L. 864 (Act 167), Section 680.1, as amended, the "Storm Water Management Act," [and the applicable Municipal Code].

Section 104. Applicability

This Ordinance shall only apply to those areas of the Municipality that are located within the Mill Creek Watershed, as delineated in the Subwatershed Boundary Map of this Ordinance located in Appendix F.

This Ordinance shall only apply to permanent storm water management facilities constructed as part of any of the Regulated Activities listed in this Section. Storm water management and erosion and sedimentation control during construction activities are specifically not regulated by this Ordinance, but shall continue to be regulated under Chapter 102, "Clean Streams Law."

This Ordinance contains only the storm water management performance standards and design criteria that are necessary or desirable from a watershed-wide perspective. Local storm water management design criteria (e.g., inlet spacing, inlet type, collection system details, outlet structure design, etc.) shall continue to be regulated by the applicable Municipal Ordinances or at the municipal officials' or engineer's discretion.

The following activities are defined as "Regulated Activities" and shall be regulated by this Ordinance:

- A. Land Development
- B. Subdivision
- C. Construction of new or additional impervious or semi-pervious surfaces (driveways, parking lots, etc.).
- D. Construction of new buildings or additions to existing buildings.
- E. Diversion or piping of any natural or man-made stream channel.
- F. Installation of storm water management facilities or appurtenances thereto.

Section 105. Repealer

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

Section 106. 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 107. Compatibility With Other Ordinance 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.

ARTICLE II DEFINITIONS

For the purposes of this chapter, 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 those of feminine gender and vice-versa.
- 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, 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 or occupied."

Accelerated Erosion - The removal of the surface of the land through the combined action of man's activity and the natural processes at 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 and installation of conservation measures.
Construction of new buildings or impervious areas 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 landowner or developer who has filed an application for approval to engage in any Regulated Activities as defined in Section 104 of this Ordinance.

Channel Erosion - The widening, deepening, and headward cutting of small channels and waterways, due to erosion caused by moderate to large floods.

Cistern - An underground reservoir or tank for storing rainwater.

Conservation District - The Lancaster County Conservation District.

Culvert - A structure with appurtenant works which carries a stream under or through an embankment or fill.

Dam - An artificial barrier, together with its appurtenant works, constructed for the purpose of impounding or storing water or another fluid or semifluid, or a refuse bank, fill or structure for highway, railroad or other purposes which does or may impound water or another fluid or semifluid.

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

Designee - The agent of Lancaster County 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.

Detention Basin - An impoundment structure designed to manage storm water runoff by temporarily storing the runoff and releasing it at a predetermined rate.

Developer - A person, partnership, association, corporation, or other entity, or any responsible person therein or agent thereof, that undertakes any Regulated Activity of this Ordinance.

Development Site - The specific tract of land for which a Regulated Activity is proposed.

Downslope Property Line - That portion of the property line of the lot, tract or parcels of land being developed located at the topographically lowest point of the parcel such that some or all overland or pipe flow from the site would be directed toward it.

Drainage Conveyance Facility - A storm water management facility designed to transmit storm water runoff and shall include streams, channels, swales, pipes, conduits, storm sewers, etc.

Drainage Easement - A right granted by a landowner to a grantee, allowing the use of private land for storm water management purposes.

Drainage Permit - A permit issued by the municipal governing body after the drainage plan has been approved. Said permit is issued prior to or with the final municipal approval.

Drainage Plan - The documentation of the storm water management system, if any, to be used for a given development site, the contents of which are established in Section 403.

Earth Disturbance - Any activity including, but not limited to, construction, mining, timber harvesting and grubbing which alters, disturbs, and exposes the existing land surface.

Erosion - The movement of soil particles by the action of water, wind, ice, or other natural forces.

Erosion and Sediment Pollution Control Plan - A plan which is designed to minimize accelerated erosion and sedimentation.

Existing Conditions - The initial condition of a project site prior to the proposed construction.

Flood - A general but temporary condition of partial or complete inundation of normally dry 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 delineated by applicable Department of Housing and Urban Development, Federal Insurance Administration Flood Hazard Boundary - Mapped as being a special flood hazard area. Also, the area of inundation which functions as a storage or holding area for floodwater to a width required to contain a base flood of which there is a one percent (1%) chance of occurring in any given year. The floodplain contains both the floodway and the flood fringe.

Floodway - The channel of the watercourse and those portions of the adjoining floodplains which 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 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 50 feet from the top of the bank of the stream.

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

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

Grade - A slope, usually of a road, channel or natural ground specified in percent and shown on plans as specified herein. **(To) Grade** - to finish the surface of a roadbed, top of embankment or bottom of excavation.

Grassed Waterway - A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from cropland.

Groundwater Recharge - Replenishment or existing natural underground water supplies.

Impervious Surface - A surface that prevents the percolation of water into the ground.

Impoundment - A retention or detention basin designed to retain storm water runoff and release it at a controlled rate.

Infiltration Structures - A structure designed to direct runoff into the ground (e.g. french drains, seepage pits, seepage trench).

Inlet - A surface connection to a closed drain. A structure at the diversion end of a conduit. The upstream end of any structure through which water may flow.

Land Development - Any of the following activities:

- (1) The improvement of one lot or two or more contiguous lots, tracts or parcels of land for any purpose involving:
 - (i) a group of two or more residential or nonresidential buildings, whether proposed initially or cumulatively, or a single nonresidential building on a lot or lots regardless of the number of occupants or tenure; or
 - (ii) the division or allocation of land or space, whether initially or cumulatively, between or among two or more existing or prospective occupants by means of, or for the purpose of streets, common areas, leaseholds, condominiums, building groups or other features.
- (2) A subdivision of land.
- (3) Development in accordance with section 503 (1.1).

Landowner - The legal or beneficial owner or owners of land including the holder of an option or contract to purchase (whether or not such option or contract is subject to any condition), a lessee if he is authorized under the lease to exercise the rights of the landowner, or other person having a proprietary interest in land.

Land Disturbance - Any activity involving grading, tilling, digging, or filling of ground or stripping of vegetation or any other activity that causes an alteration to the natural condition of the land.

Main Stem (Main Channel) - Any stream segment or other runoff conveyance facility used as a reach in the Mill Creek hydrologic model.

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.

Memorandum of Understanding - An agreement between [Name of Municipality] and the Lancaster County Conservation District to provide for cooperation between the Lancaster County Conservation District and the [Name of Municipality] officials, Lancaster County, to include within its ordinances, and to jointly promote conservation of natural resources within [Name of Municipality] on lands both public and private, for the purposes of preventing accelerated soil erosion and sedimentation of streams, reducing storm water damage, and promoting the health, safety and general welfare of the residents of [Name of Municipality].

Municipality - [The Borough or Township of (name)], Lancaster County, Pennsylvania.

NRCS - Natural Resources Conservation Service (previously SCS).

Nonpoint Source Pollution - Pollution that enters a body of water from diffuse origins in the watershed and does not result from discernible, confined, or discrete conveyances.

Open Channel - A drainage element in which storm water flows with an open surface. Open channels include, but shall not be limited to, natural and man-made drainage ways, swales, streams, ditches, canals, and pipes flowing partly full.

Outfall - Point where water flows from a conduit, stream, or drain.

Outlet - Points of water disposal from a stream, river, lake, tidewater or artificial drain.

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

Peak Discharge - The maximum rate of storm water runoff from a specific storm event.

TR-20 (calibrated) - The computer-based hydrologic modeling technique adapted to the Mill Creek Watershed for the Act 167 Plan. The model has been "calibrated" to reflect published flow values by adjusting key model input parameters.

Pipe - A culvert, closed conduit, or similar structure (including appurtenances) that conveys storm water.

Plan - The storm water management and erosion and sediment pollution control plans and narratives.

Plan Administrator - The entity set up specifically to review Act 167 Drainage Plans, inspect storm water management structures, and otherwise enforce all regulations as outlined in the

Mill Creek Watershed Act 167 Storm Water Management Ordinance.” The Plan Administrator shall be appointed by the municipality.

Planning Commission - The planning commission of [Name of Municipality], Lancaster County, Pennsylvania.

PMF - Probable Maximum Flood - The flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in any area. The PMF is derived from the probable maximum precipitation (PMP) as determined on the basis of data obtained from the National Oceanographic and Atmospheric Administration (NOAA).

Present Worth - (Optional, only needed if Section 703.A.3, also optional is used). The equivalence of any future amount to any present amount.

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

Regulated Activities - Actions or proposed actions that have an impact on storm water runoff and that are specified in Section 104 of this Ordinance.

Retention Basin - An impoundment in which storm water is stored and not released during the storm event. Stored water may be released from the basin at some time after the end of the storm.

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 once every twenty-five 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.

Rooftop Detention - Temporary ponding and gradual release of storm water falling directly onto flat roof surfaces by incorporating controlled-flow roof drains into building designs.

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

SCS - U.S. Department of Agriculture, Soil Conservation Service (now known as NRCS).

Sediment Basin - A barrier, dam, retention or detention basin located and designed to retain rock, sand, gravel, silt, or other material transported by water.

Sediment Pollution - The placement, discharge or any other introduction of sediment into the waters of the commonwealth occurring from the failure to design, construct, implement or maintain control measures and control facilities in accordance with the requirements of this Ordinance.

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

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 ground.

Sheet Flow - Runoff which flows over the ground surface as a thin, even layer, not concentrated in a channel.

Soil-Cover Complex Method - A method of runoff computation developed by the SCS that is based on relating soil type and land use/cover to a runoff parameter called Curve Number (CN).

Soil Group, Hydrologic - A classification of soils by the Soil Conservation Service 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.

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

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 convey intercepted runoff and storm water from other sources, but excludes domestic sewage and industrial wastes.

Storm Water - The total amount of precipitation reaching the ground surface.

Storm Water Management Facility - Any structure, natural or man-made, that, due to its condition, design, or construction, conveys, stores, or otherwise affects storm water runoff. Typical storm water management facilities include, but are not limited to, detention and retention basins, open channels, road gutters, swales, storm sewers, pipes, and infiltration structures.

Storm Water Management Plan - The Plan for managing storm water runoff in the Mill Creek Watershed adopted by Lancaster County as required by the Act of October 4, 1978, 32 P.S. P.L. 864, (Act 167) as amended, and known as the Mill Creek Watershed Act 167 Storm Water Management Plan.

Storm Water Management Site Plan - The Plan prepared by the Developer or his representative indicating how storm water runoff will be managed at the particular site of interest according to this Ordinance.

Stream Enclosure - A bridge, culvert or other structure in excess of 100 feet in length upstream to downstream which encloses a regulated water of this Commonwealth.

Subwatershed Area - The smallest drainage unit of a watershed for which storm water management criteria have been established in the Storm Water Management Plan.

Subdivision - The division or redivision of a lot, tract or parcel of land by any means into two 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 acres, not involving any new street or easement of access or any residential dwelling, shall be exempted.

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

Timber Operations - See Forest Management.

Time of Concentration (Tc) - The time 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.

Watercourse - A stream of water; river; brook; creek; or a channel or ditch for water, whether natural or manmade.

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 this commonwealth.

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

ARTICLE III STORM WATER MANAGEMENT

Section 301. General Requirements

- A. Storm water drainage systems shall be provided in order to permit unimpeded flow along natural watercourses, except as modified by storm water management facilities or open channel consistent with this Ordinance.

- B. The existing points of concentrated drainage that discharge onto adjacent property shall not be relocated and shall be subject to any applicable discharge criteria specified in this Ordinance.
- C. Where a Development Site is traversed by watercourses other than permanent streams, a drainage easement shall be provided conforming substantially to the line of such watercourses. The terms of the easement shall prohibit excavation, the placing of fill or structures, and any alterations that may affect adversely the flow of storm water within any portion of the easement. Also, maintenance and mowing of vegetation within the easement shall be required.
- D. The PADEP, Chapter 105, Rules and Regulations, apply to the construction, modification, operation or maintenance of both existing and proposed water obstructions and encroachments throughout the watershed, including work in wetlands. Inquiries on permit requirements or other concerns shall be addressed to PADEP's Regional Office. Permit requirements or inquiring on dam safety should be addressed to the PADEP, Bureau of Dams, Waterways & Wetlands - Harrisburg.
- E. When it can be shown that, due to topographic conditions, natural drainageways on the site cannot adequately provide for drainage, open channels may be constructed conforming substantially to the line and grade of such natural drainageways. Work within natural drainageways shall be subject to approval by PADEP through the Joint Permit Application process, or, where deemed appropriate by PADEP, through the General Permit process.
- F. Carbonate Geology - In areas of carbonate geology, a registered professional geologist shall certify the following:
 - 1. No storm water facilities shall be placed in, over or immediately adjacent to the following features:
 - a. sinkholes
 - b. closed depressions
 - c. lineaments in carbonate areas
 - d. fracture traces
 - e. caverns
 - f. intermittent lakes
 - g. ephemeral streams
 - h. bedrock pinnacles (surface or subsurface)
 - 2. Storm water management basins shall not be located closer than one hundred (100) feet from the rim of sinkholes or closed depressions, nor within one hundred (100) feet from disappearing streams; nor shall these basins be located closer than fifty (50) feet from lineaments or fracture traces; nor shall these basins be located closer than twenty-five (25) feet from surface or identified subsurface pinnacles.

3. Stormwater resulting from land development activities shall not be discharged into sinkholes.

Section 302. Storm Water Management Performance Standards

A. General

The following general standards shall be applied to all development within the Mill Creek Watershed to promote flow attenuation, erosion and sediment control and flood control.

1. All site developments in the Mill Creek Watershed which do not fall under the exemption criteria in Appendix A shall submit a drainage plan consistent with the Mill Creek Watershed Storm Water Management Plan to the municipality for review.

The exemption criteria in Appendix A shall apply to the total proposed development even if development is to take place in stages. Impervious cover shall include, but not be limited to, any roof, parking or driveway areas and any new streets and sidewalks. Any areas designed to initially be gravel or crushed stone shall be assumed to be impervious.

2. All storm water management plans shall be designed and certified by individuals registered in the Commonwealth of Pennsylvania and qualified to perform such duties.
3. Runoff from impervious areas shall be drained to pervious areas of the property.
4. Roof drains shall not be connected to streets, sanitary or storm sewers or roadside ditches.
5. Where applicable, storm water management facilities shall comply with the requirements of Chapter 105 (Water Obstructions and Encroachments) of Title 25, Rules and Regulations of the Pennsylvania Department of Environmental Protection.
6. Storm water management facilities which involve a State Highway shall be subject to the approval of the Pennsylvania Department of Transportation.
7. Storm water management facilities located within or affecting the floodplain or any watercourse shall also be subject to the requirements of Section 306. Floodplain Management, of this Ordinance, the [Name of Municipality] Zoning Ordinance, any Ordinance which regulates construction and development within areas of the [Name of Municipality] subject to flooding, and any other

applicable requirements of Act 166, the Pennsylvania Floodplain Management Act.

8. Storm water runoff from a project site shall flow directly into a natural watercourse or into an existing storm sewer system, or onto adjacent properties in a manner similar to the runoff characteristics of the pre-development flow. Maximum use shall be made of the existing on-site natural and man-made storm water management facilities.
9. Storm water runoff shall not be transferred from one watershed to another unless the watersheds are sub-watersheds of a common watershed which join together within the perimeter of the property, or the effect of the transfer does not alter the peak discharge onto adjacent lands, or drainage easements from the affected landowners are provided.
10. All storm water runoff flowing over the project site shall be considered in the design of the storm water management facilities.
11. When Final Plan applications are submitted in sections, and if temporary facilities are required for construction of a section, such facilities shall be included in the submitted plans for that section.

B. Detention/Infiltration Standards

1. Post-development rates of runoff from any regulated activity shall not exceed the peak rates of runoff prior to development for the design storms specified on Subwatershed Boundary Map, Appendix F.
2. Innovative methods for the detention and control of storm water runoff are encouraged. Various combinations of methods should be tailored to suit the particular requirements of the type of development and the topographic features of the project site. The following is a partial listing of detention and control methods which can be utilized in storm water management systems where appropriate:
 - a. Detention basins
 - b. Retention basins (subject to prior Township approval)
 - c. Roof-top storage
 - d. Parking lot ponding
 - e. Seepage pits, seepage trenches or other infiltration structures
 - f. Concrete lattice block surfaces
 - g. Grassed channels and vegetated strips.
 - h. Cisterns and underground reservoirs
 - i. Routed flow over grass
 - j. Decreased impervious surface coverage

3. The following principles shall be applied to the design plan and construction schedule to minimize soil erosion and sedimentation:
 - a. Stripping of vegetation, grading, or other soil disturbance shall be done in a manner which will minimize soil erosion.
 - b. Whenever feasible, natural vegetation shall be retained and protected.
 - c. The extent of the disturbed area and the duration of its exposure shall be kept to a minimum, within practical limits.
 - d. Either temporary seeding, mulching, or other suitable stabilization measures shall be used to protect exposed critical areas during construction.
 - e. Drainage provisions shall accommodate the storm water runoff both during and after construction.
 - f. Soil erosion and sedimentation facilities shall be installed prior to any on-site grading.

Section 303. Design Criteria for Storm Water Management Facilities

(These are suggested criteria that should be adopted with input from the municipal engineer.)

- A. Any storm water management facility (i.e. detention basin) designed to store stormwater runoff and requiring a berm or earthen embankment shall be designed to provide an emergency spillway to handle the 100-year post-development conditions. The height of embankment must be set as to provide a minimum 1.0 foot of freeboard above the maximum pool elevation computed when the facility functions for the 100-year post-development inflow with the outlet structure closed. However, criteria for design and construction of storm water management facilities are not the same criteria that are used in the permitting of dams under the PADEP Dam Safety Program. Depending upon the physical characteristics of a dam, a dam permit may be required and the design will have to meet the provisions of Chapter 105 of the Dam Safety and Encroachments Act. Depending on the physical characteristics of a dam, the design could require that anywhere from a 100-year to a PMF storm event be considered. The following minimums shall be required:
 1. The maximum water depth shall not exceed six (6) feet, unless approved by a waiver granted by the municipal officials.
 2. The minimum top width of all dams 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 which enters the basin after development, in a manner which 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 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.
 6. A cutoff trench of relatively impervious material shall be provided within all basin embankments.
 7. All structures passing through basin embankments shall have properly spaced concrete cutoff collars and "O-ring" rubber gaskets.
 8. All discharge control devices and piping with appurtenances shall be made of reinforced concrete and stainless steel.
 9. Low flow channels shall be provided from each water carrying facility to the outlet structure. Low flow channels shall be one (1) percent minimum slope and shall be designed to enable ease of maintenance.
 10. Minimum slope within a basin 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.
 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.
- B. 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 storm water

ponding on the structure and water-proofing and/or flood-proofing design information shall be submitted for approval.

- C. All storm sewer pipes, culverts and bridges (excluding detention and retention basin outfall structures) conveying water originating only from within the boundaries of the project 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 project site. Easements shall begin at the furthest upstream property line of the proposed development in a watershed.
- D. A concentrated discharge of storm water to an adjacent property shall be within an existing watercourse or otherwise an easement shall be required.
- E. 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.
- F. 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.
- G. 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.
- H. Curves in pipes or box culverts without an inlet or manhole are prohibited. Tee joints, elbows and wyes are also prohibited.
- I. Manholes, inlets, headwalls and endwalls proposed for dedication or located along streets or subject to vehicular traffic, shall conform to the requirements of the Pennsylvania Department of Transportation, Bureau of Design, Standards for Roadway Construction in effect at the time the design is submitted, or as otherwise modified by the Township.
- J. Headwalls and endwalls shall be used where storm water runoff enters or leaves the storm sewer horizontally from a natural or manmade channel. PADOT Type "DW" headwalls and endwalls shall be utilized.
- K. Storm water roof drains, sump pumps, and pipes, shall not directly discharge water into a street right-of-way or sanitary sewer.
- L. 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 Township and any other necessary approving body.

- M. Flow velocities from any storm sewer may not result in erosion of the receiving channel.
- N. 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.
- O. 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 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).

All vegetated swales shall have a minimum slope of one (1) percent unless otherwise approved by the municipal engineer.
 - (b) 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.
- P. Manning "n" values used for design of pipes and culverts shall be in accordance with Appendix B7.

- Q. All storm sewer crossings of streets shall be perpendicular to the street centerline.
- R. Storm facilities not located within a public right-of-way shall be contained in and centered within an easement.
- S. Capacity Improvements - If the Developer can prove that it would be feasible to provide capacity improvements to relieve the capacity deficiency in the existing drainage network, the adequate capacity improvements could be provided by the Developer in lieu of storm water management facilities on the development site. Any capacity improvements would be designed based on development of all areas tributary to the improvements and the capacity criteria specified in this Ordinance. The type and amount of development that the Developer must consider shall be either based on the current zoning or established by the municipality, whichever results in a greater amount of impervious surface. It shall be assumed that all new development upstream of a proposed capacity improvement would implement applicable storm water management techniques, consistent with this Ordinance.
- T. Adequate erosion protection shall be provided along all open channels, and at all points of discharge.

Section 304. Calculation Methodology

Storm water runoff from all development sites shall be calculated using either the modified rational method or a soil-cover-complex methodology.

- A. Any storm water runoff calculations involving drainage areas greater than 50 acres, including on- and off-site areas, shall use generally accepted calculation technique that is based on the SCS soil cover complex method. Table VIII-1 summarizes acceptable computation methods. It is assumed that all methods will be selected by the design professional based on the individual limitations and suitability of each method for a particular site.

The municipality or it's designee may approve the use of the modified Rational Method to estimate peak discharges from drainage areas that contain more than 50 acres.

TABLE VIII-1**ACCEPTABLE COMPUTATION METHODOLOGIES FOR STORM WATER
MANAGEMENT PLANS**

METHOD	METHOD DEVELOPED BY	APPLICABILITY
TR-20 (or commercial package based on TR-20)	USDA SCS	Applicable where use of full hydrology computer model is desirable or necessary.
TR-55 (or commercial computer package based on TR-55)	USDA SCS	Applicable for land development plans within limitations described in TR-55.
HEC-1	US Army Corps of Engineers	Applicable where use of full hydrologic computer model is desirable or necessary.
PSRM	Penn State University	Applicable where use of a hydrologic computer 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 50 acres, or as approved by the Municipal Designee.
Other Methods	Varies	Other computation methodologies approved by the Municipal Designee.

- B. If the Soil-Cover-Complex Method is used, storm water runoff shall be based on the following 24-hour storm events: (Antecedent Moisture Content 1 must be assumed)

Storm Event	Inches-of-Rainfall
2 years	3.1
5 years	4.1
10 years	5.0
25 years	5.5
50 years	6.2
100 years	7.0

If the Rational Method is used, the Region 5, Pennsylvania Department of Transportation Storm Intensity - Duration - Frequency Chart (PDT-IDF), dated May 1986 shall be used to determine the rainfall intensity in inches per hour. See chart in Appendix B1.

- C. Runoff calculations shall include a hydrologic and hydraulic analysis indicating volume and velocities of flow and the grades, sizes, and capacities of water carrying structures, sediment basins, retention and detention structures and sufficient design information to construct such facilities. Runoff calculations shall also indicate both pre-development and post-development rates for peak discharge of storm water runoff from the project site.
- D. For the purpose of calculating pre-development peak discharges, all runoff coefficients shall be based on actual land use assuming summer or good land conditions. Runoff coefficients for off-site discharges used for design of facilities shall be based on actual land use assuming winter or poor land conditions.
- E. Criteria and assumptions to be used in the determination of storm water runoff and design of management facilities are as follows:
- (1) Runoff coefficients should be based on the information contained in Appendix B2 and B3 if the actual land use is listed in those Appendices. If the actual land use is not listed in these Appendices, runoff coefficient shall be chosen from other published documentation, and a copy of said documentation should be submitted with the storm water management report.
 - (2) Times of concentration shall be based on the following design parameters:
 - (a) Sheet flow: The maximum length for each reach of sheet or overland flow before shallow concentrated or open channel flow develops is one hundred fifty (150) feet. Sheet flow may be determined using the

nomograph in Appendix B4, or the Manning's kinematic solution shown in the Sheet Flow section of Worksheet No. 1 in Appendix B5.

- (b) Shallow concentrated flow: Travel time for shallow concentrated flow shall be determined using Figure 3-1 from TR-55, Urban Hydrology for small watersheds, as shown in Appendix B6.

A sample worksheet for calculating times of concentration is provided in Appendix B5.

- (c) Open Channel flows: At points where sheet and shallow concentrated flows concentrate in field depressions, swales, gutters, curbs, or pipe collection systems, the travel times and downstream end of the site between these design points shall be based upon Manning's Equation and/or acceptable engineering design standards as determined by the municipal engineer.

Section 305. Use of Performance Standards and Criteria

The methodology for determining required storm water controls for a regulated activity is shown in Figure VIII-1 and outlined below.

A. Compute:

1. Pre-development hydrograph at the site discharge point for the required 24-hour design storm.
2. Post-development hydrograph at the site discharge point incorporating any "non-detention" techniques such as pervious areas, swales, infiltration trenches, etc.

Note: Hydrographs may be obtained from SCS methods such as TR-55, or from use of the "modified" rational formulas.

B. Compare:

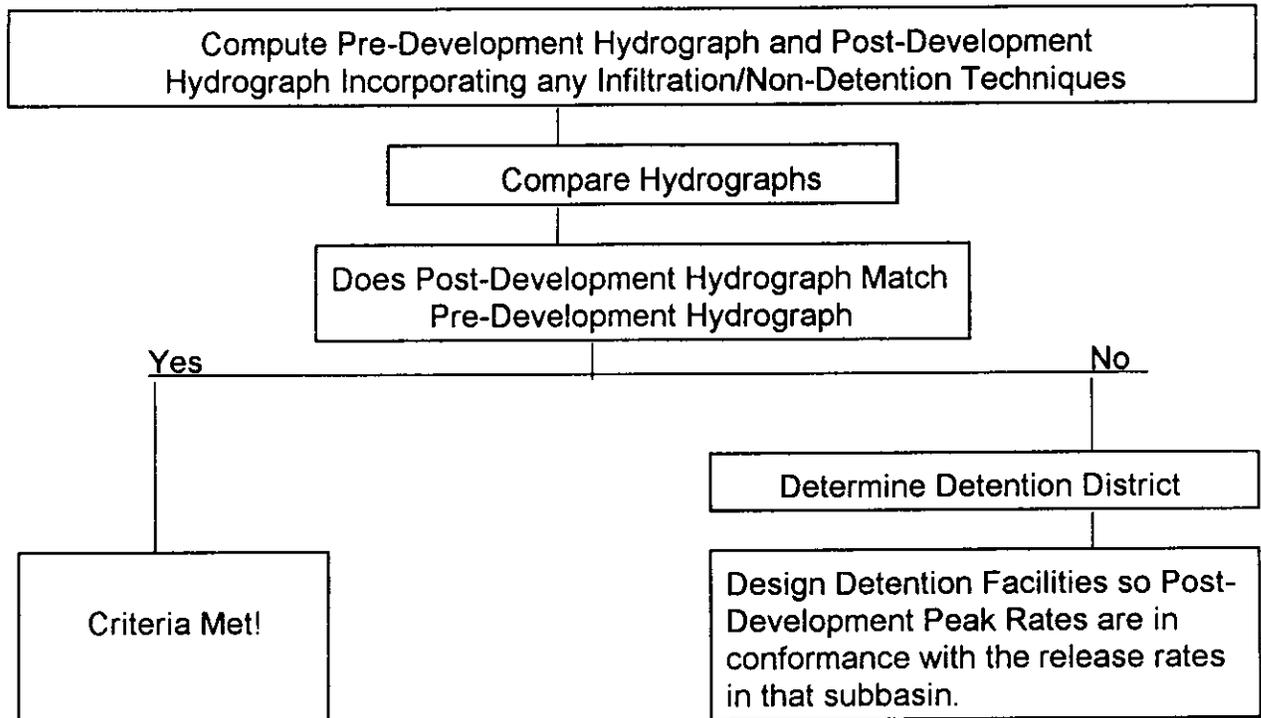
Post-development hydrographs with pre-development hydrographs. If the peak rate of runoff and the shape of the hydrographs are nearly identical to the same significant figure, storm water management has been achieved. Detention will not be required. If not, proceed to Item C.

C. Design:

Detention/retention facilities, in conjunction with any non-detention techniques, such that post-development peak rates from the site will not exceed permissible levels for required design storms.

FIGURE VIII-1

STORM WATER CONTROL DETERMINATION FLOW CHART



Section 306. Floodplain.

(This section is highly recommended, but can not be required under Act 167.)

Floodplain areas shall be established and preserved as provided below:

- A. A one hundred (100) year floodplain shall be established for all watercourses and shall be delineated by one of the following methods.
 - (1) A hydrologic report prepared by an individual registered in the Commonwealth of Pennsylvania to perform such duties.
 - (2) A hydrologic report prepared by an agency of the County, State, or U.S. Government.
- B. Whenever a floodplain is located within or along a lot, the plan shall include the boundary of the floodplain, along with the elevation and locational dimensions from the centerline of the watercourse; a plan note that the floodplain shall be kept free of structures, fill, and other encroachments; and a plan note that floor elevations for all

structures adjacent to the floodplain shall be two (2) feet above the Q100 year flood elevation.

- C. The above provision shall not be construed as a prohibition of the following, provided they comply with Section 306.D:
- (1) Storm water management facilities.
 - (2) Stream improvements whose sole purpose is to improve aquatic life habitat and which are approved by the Pennsylvania Fish Commission.
 - (3) Farm ponds.
 - (4) Flood-proofing and flood hazard reduction structures to protect existing buildings.
 - (5) Public and private utility facilities, except buildings.
 - (6) Water-oriented uses (except building), e.g. docks, piers, boat launching ramps, hatcheries.
 - (7) Water monitoring devices.
 - (8) Culverts, bridges, and their approaches for floodplain crossings by streets, access drives, and driveways.
- D. Plans for any of the eight uses within a floodplain permitted under C shall demonstrate that the the proposed uses do not increase the height or frequency of flooding; are installed so as to withstand the maximum volume, velocity, and force of floodplain water; are flood and flotation proof; do not create unhealthy or unsanitary conditions; and do not degrade quality of surface water, or groundwater.

ARTICLE IV DRAINAGE PLAN REQUIREMENTS

Section 401. General Requirements

For any of the activities regulated by this Ordinance, the final approval of subdivision and/or land development plans, the issuance of any building or occupancy permit, or the commencement of any land disturbance activity may not proceed until the Property Owner or Developer or his/her agent has received written approval of a Drainage Plan from the municipality or it's designee.

Section 402. Exemptions

- A. Any Regulated Activity that meets the exemption criteria in Ordinance Appendix A is exempt from the Drainage Plan preparation provisions of this Ordinance. This criteria shall apply to the total development even if 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" in which future subdivision and respective impervious area computations shall be cumulatively considered.

Exemption shall not relieve the applicant from providing adequate storm water management to meet the purpose of this Ordinance.

- B. Land disturbance associated with existing one and two family dwellings, subject to conditions described in A. of this Section.
- C. Use of land for gardening for home consumption.
- D. Agriculture when operated in accordance with a conservation plan or erosion and sedimentation control plan found adequate by the Conservation District. The agricultural activities such as growing crops, rotating crops, tilling of soil and grazing animals and other such activities are specifically exempt from complying with the requirements of this Ordinance.
- E. Forest Management operations which are following the Department of Environmental Resources' management practices contained in its publication "Soil Erosion and Sedimentation Control Guidelines for Forestry" and are operating under an erosion and sedimentation control plan.

No exemption shall be provided for Regulated Activities as defined in Section 104.E and 104.F of this Ordinance.

Section 403. Drainage Plan Contents

The Drainage Plan shall consist of all applicable calculations, maps and plans. A note on the maps shall refer to the associated computations and erosion and sedimentation control plan by title and date. The cover sheet of the computations and erosion and sedimentation control plan shall refer to the associated maps by title and date. All Drainage Plan materials shall be submitted to the municipality or it's designee in a format that is clear, concise, legible, neat and well organized; otherwise, the Drainage Plan shall be disapproved and returned to the Applicant.

The following items shall be included in the Drainage Plan:

- A. General
 - 1. General description of project.
 - 2. General description of permanent storm water management techniques, including construction specifications of the materials to be used for storm water management facilities.
 - 3. Complete hydrologic, hydraulic, and structural computations for all storm water management facilities.

- B. Drawings or map(s) of the project area shall be submitted on 24-inch x 36-inch sheets and shall be prepared in a form that meets the requirements for recording for the office of the Recorder of Deeds of Lancaster County. These drawings shall be in conformance with the applicable subdivision regulations. The contents of the map(s) shall include, but not be limited to:
1. The location of the project relative to highways, municipalities or other identifiable landmarks.
 2. Existing contours at intervals of two feet. In areas of steep slopes (greater than 15 percent), five-foot contour intervals may be used.
 3. Existing streams, lakes, ponds, or other bodies of water within the project area.
 4. Other physical features including flood hazard boundaries, wetlands, sinkholes, streams, 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 50 feet of property lines.
 6. An overlay showing soil names and boundaries.
 7. Proposed changes to the land surface and vegetative cover, 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 feet. In areas of steep slopes (greater than 15 percent), five-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.
 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 two hundred (200) feet beyond the property boundary that could be affected by the project.
17. Horizontal and vertical profiles of all open channels, including hydraulic capacity.
18. Overland drainage paths.
19. A minimum twenty (20) foot wide access easement around all storm water management facilities that would provide ingress from and egress to a public right-of-way.
20. A note on the Plan indicating the location and responsibility for maintenance of storm water management facilities that would be located off-site. All off-site facilities shall meet the performance standards and design criteria specified in this Ordinance.
21. A statement, signed by the landowner, acknowledging the storm water management system to be a permanent fixture that can be altered or removed only after approval of a revised Plan by the municipality or it's designee.
22. The following signature block for the municipality or it's designee:

"I, [municipality or it's designee], on this date [date of signature], have reviewed and hereby certify that the Drainage Plan meets all design standards and criteria of the Mill Creek Watershed Act 167 Storm Water Management Ordinance."
23. The location of all erosion and sedimentation control facilities.

C. Supplemental Information

1. A written description of the following information shall be submitted:
 - a. The overall storm water management concept for the project.
 - b. Storm water runoff computations as specified in this Ordinance.
 - c. Storm water management techniques to be applied both during and after development.
 - d. Expected project time schedule.
2. A soil erosion and sedimentation control Plan, including all reviews and approvals, as required by PADEP or the Lancaster County Conservation District (LCCD).

3. The effect of the project (in terms of runoff volumes and peak flows) on adjacent properties and on any existing municipal storm water collection system that may receive runoff from the project site.
4. A Declaration of Adequacy and Highway Occupancy Permit from the PADOT District Office when utilization of a PADOT storm drainage system is proposed.

D. Storm Water Management Facilities

1. All storm water management facilities must be located on a map and described in detail.
2. When groundwater recharge methods such as seepage pits, beds or trenches are used, the locations of existing and proposed septic tank infiltration areas and wells must be shown. A minimum fifty (50) foot separation from On Lot Disposal System (OLDS) infiltration areas is required. Infiltration rates shall be based upon perk and probe tests conducted at the site of the proposed facility.
3. All calculations, assumptions and criteria used in the design of the storm water management facilities must be shown.

Section 404. Plan Submission

For all activities required by this Ordinance, the steps below shall be followed for submission. For any activities that require a PADEP Joint Permit Application and regulated under Chapter 105 (Dam Safety and Waterway Management) or Chapter 106 (Floodplain Management) of PADER's Rules and Regulations, require a PADOT Highway Occupancy Permit, or require any other permit under applicable state or federal regulations, the permit(s) shall be part of the Plan.

1. The Drainage Plan shall be submitted by the Developer as part of the Preliminary Plan submission for the Regulated Activity.
2. Four (4) copies of the Drainage Plan shall be submitted.
3. Distribution of the Drainage Plan will be as follows:
 - a. Two (2) copies to the Municipality accompanied by the requisite Municipal Review Fee, as specified in this Ordinance.
 - b. One (1) copy to the Municipal Engineers.
 - c. One (1) copy to the Lancaster County Planning Commission.

Section 405. Drainage Plan Review

- A. The municipality or its designee shall review the Drainage Plan for consistency with the adopted Mill Creek Watershed Act 167 Storm Water Management Plan. The municipality or its designee shall require receipt of a complete plan, as specified in this Ordinance.
- B. The Municipal Engineer shall review the Drainage Plan for any submission or land development against the municipal subdivision and land development ordinance provisions not superseded by this Ordinance.
- C. For Regulated Activities requiring a PADEP Joint Permit Application, the municipality or its designee shall notify PADEP whether the Drainage Plan is consistent with the Storm Water Management Plan and forward a copy of the review letter to the Municipality and the Developer. PADEP may consider the municipality or its designee's review comments in determining whether to issue a permit.
- D. The Municipality shall not approve any subdivision or land development for Regulated Activities specified in Sections 104.A and 104.B of this Ordinance if the Drainage Plan has been found to be inconsistent with the Storm Water Management Plan. All required permits from PADEP must be obtained prior to approval.
- E. The Municipal Building Permit Office shall not issue a building permit for any Regulated Activity specified in Section 104 of this Ordinance if the Drainage Plan has been found to be inconsistent with the Storm Water Management Plan. All required permits from PADEP must be obtained prior to issuance of a building permit.
- F. The Developer shall be responsible for completing an "As-Built Survey" of all storm water management facilities included in the approved Drainage Plan. The As-Built Survey and an explanation of any discrepancies with the design plans shall be submitted to the Plan Administrator for final approval. In no case shall the municipality or its designee approve the As-Built Survey until the municipality or its designee receives a copy of an approved Declaration of Adequacy, Highway Occupancy permit from the PADOT District Office, and any applicable permits from PADEP.
- G. The municipality or its designee's approval of a Drainage Plan shall be valid for a period of not to exceed one (1) year. This one-year time period shall commence on the date that the municipality or its designee signs the approved Drainage Plan. If storm water management facilities included in this approved Drainage Plan have not been constructed, or if an As-Built Survey of these facilities has not been approved within this one-year time period, then the municipality or its designee may consider the Drainage Plan disapproved and may recommend that the Municipality revoke any and all permits. Drainage Plans that are considered disapproved by the

municipality or it's designee shall be resubmitted in accordance with Section 407 of this Ordinance.

Section 406. Modification of Plans

A modification to a submitted Drainage Plan for a development site that involves a change in storm water management facilities or techniques, or that involves the relocation or re-design of storm water management facilities, or that is necessary because soil or other conditions are not as stated on the Drainage Plan (as determined by the municipality or it's designee or the Municipal Engineer), shall require a submission of the modified Drainage Plan consistent with Section 404 of this Ordinance and be subject to review as specified in Section 405 of this Ordinance.

A modification to an already approved or disapproved Drainage Plan shall be submitted to the municipality or it's designee, accompanied by the applicable Plan Administrator Review Fee. A modification to a Drainage Plan for which a formal action has not been taken by the municipality or it's designee shall be submitted to the municipality or it's designee, accompanied by the applicable municipality or it's designee Review Fee.

Section 407. Resubmission of Disapproved Drainage Plans

A disapproved Drainage Plan may be resubmitted, with the revisions addressing the municipality or it's designee's concerns documented in writing, to the municipality or it's designee in accordance with Section 404 of this Ordinance and be subject to review as specified in Section 405 of this Ordinance. The applicable municipality or it's designee Review Fee must accompany a resubmission of a disapproved Drainage Plan.

ARTICLE V INSPECTIONS

Section 501. Schedule of Inspections

- A. The municipality or it's designee or his assignee shall inspect all phases of the installation of the permanent storm water management facilities.
- B. During any stage of the work, if the municipality or it's designee determines that the permanent storm water management facilities are not being installed in accordance with the approved Storm Water Management Plan, the Municipality shall revoke any existing permits until a revised Drainage Plan is submitted and approved, as specified in this Ordinance.

ARTICLE VI FEES AND EXPENSES

Section 601. General

The fees required by this Ordinance are the Municipal Review Fee and the municipality or it's designee Review Fee. The Municipal Review Fee shall be established by the Municipality to defray review costs incurred by the Municipality and the Municipal Engineer. The municipality or it's designee Review Fee shall be established by the municipality or it's designee to defray the municipality or it's designee's review costs. All fees shall be paid by the Applicant.

Section 602. Expenses Covered by Fees

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

- A. The review of the Drainage Plan by the municipality or it's designee.
- B. The site inspection.
- C. The inspection of storm water management facilities and drainage improvements during construction.
- D. The final inspection upon completion of the storm water management facilities and drainage improvements presented in the Drainage Plan.
- E. Any additional work required to enforce any permit provisions regulated by this Ordinance, correct violations, and assure proper completion of stipulated remedial actions.
- F. Defray administration and clerical costs.

Section 603. Improvement Security

An improvement security (bond or letter of credit) for storm water related improvements shall be supplied by the Developer in conjunction with the subdivision/land development approval.

ARTICLE VII MAINTENANCE RESPONSIBILITIES

Section 701. Maintenance Responsibilities

- A. The storm water management plan for the development site shall contain an operation and maintenance Plan prepared by the developer and approved by the

municipal engineer. The operation and maintenance Plan shall outline required routine maintenance actions and schedules necessary to insure proper operation of the facility(ies).

- B. The Storm Water Management Plan for the development site shall establish responsibilities for the continuing operating and maintenance of all proposed storm water control facilities, consistent with the following principals:
 - 1. If a development consists of structures or lots which are to be separately owned and in which streets, sewers and other public improvements are to be dedicated to the municipality, storm water control facilities should also be dedicated to and maintained by the municipality or by an approved private entity.
 - 2. If a development site is to be maintained in a single ownership or if sewers and other public improvements are to be privately owned and maintained, then the ownership and maintenance of storm water control facilities should be the responsibility of the owner or private management entity.
- C. The governing body, upon recommendation of the municipal engineer, shall make the final determination on the continuing maintenance responsibilities prior to final approval of the Storm Water Management Plan. The governing body reserves the right to accept the ownership and operating responsibility for any or all of the storm water management controls.

Section 702. Maintenance Agreement for Privately Owned Storm Water Facilities

- A. Prior to final approval of the site's Storm Water Management Plan, the property owner shall sign and record a maintenance agreement covering all storm water control facilities which are to be privately owned. The agreement shall stipulate that:
 - 1. The owner shall maintain all facilities in accordance with the approved maintenance schedule and shall keep all facilities in a safe and attractive manner.
 - 2. The owner shall convey to the municipality easements and/or rights-of-way to assure access for periodic inspections by the municipality and maintenance, if required.
 - 3. The owner shall keep in file with the municipality the name, address and telephone number of the person or company responsible for maintenance activities; in the event of a change, new information will be submitted to the municipality within ten (10) days of the change.

4. If the owner fails to maintain the storm water control facilities following due notice by the municipality to correct the problem(s), the municipality may perform the necessary maintenance work or corrective work and the owner shall reimburse the municipality for all reasonable costs. Failure to reimburse the municipality may lead to a lien being placed against any or all properties which utilize the facility.
- 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 703. Municipal Storm Water Maintenance Fund

(NOTE: This provision is an example of one way that a municipality could establish a special fund to finance its maintenance and inspection activities for storm water retention/detention facilities. It is an optional provision of the ordinance. If a municipality is interested in establishing such a fund, it is recommended that it consult with its solicitor for legal requirements and procedures.)

- A. Persons installing storm water storage facilities shall be required to pay a specified amount to the Municipal Storm Water 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 storage facility 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 storage facility 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 storage facility is proposed that also serves as a recreation facility (e.g. ballfield, lake), the municipality may reduce or waive the amount of the maintenance fund deposit based upon the value of the land for public recreation purpose.
- C. If at some future time a storage facility (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.

ARTICLE VIII ENFORCEMENT AND PENALTIES

Section 801. Right-of-Entry

Upon presentation of proper credentials, duly authorized representatives of the municipality may enter at reasonable times upon any property within the municipality to investigate or ascertain the condition of the subject property in regard to any aspect regulated by this Ordinance.

Section 802. 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 set forth the nature of the violation(s) and establish a reasonable 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 preclude by the municipality from pursuing any and all other remedies. It shall be 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 803. Public Nuisance

- A. Any violation of any provision of this Ordinance is deemed to be a public nuisance.
- B. Each day that a violation of any provision continues constitutes a separate violation.

Section 804. Penalties

- A. Any person who or which has violated any provisions of this Ordinance, shall, upon a judicial determination thereof, be subject to civil judgment for each such violation of not less than or more than _____ and 00/100 dollars (\$ _____), plus costs of suit. Each day that a violation occurs shall constitute a separate offense. All fines shall be paid to the _____ [Name of Municipality].
- B. In addition, the _____ [Name of Municipality] 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 805. Appeals

- A. Any person aggrieved by any action of the [Municipality] 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 or Common Pleas] within thirty (30) days of that decision.

ENACTED and ORDAINED at a regular meeting of the [Name of the municipal governing body] on the _____th day of _____, 19____. This Ordinance shall take effect immediately.

[Name], [Title]

[Name], [Title]

[Name], [Title]

ATTEST:

[Name], Secretary (type or print)

I hereby certify that the foregoing Ordinance was advertised in the [name of newspaper] on [date], a newspaper of general circulation in the municipality and was duly enacted and approved as set forth at a regular meeting of the [name of municipal governing body] held on [date].

[name], Secretary

SECTION IX

THE DEVELOPMENT OF PRIORITIES FOR IMPLEMENTATION OF ACTION WITHIN THE PLAN

The Mill Creek Watershed Storm Water Management Plan preparation process is completed with Lancaster County's adoption of the draft Plan and submission of the Final Plan to PADEP for approval. Procedures for the review and adoption of the Plan are Included in Section X. Subsequent activities to carry out the provisions of the Plan are considered by PADEP to be part of the implementation of the Plan. PADEP approval sets in motion the mandatory schedule of adoption of municipal ordinance provisions to implement the storm water management criteria. Mill Creek Watershed municipalities would have six months from PADEP approval within which to adopt the necessary ordinance provisions.

A. PADEP Approval of the Plan

Upon adoption of the watershed Plan by Lancaster County, the Plan is submitted to PADEP for approval. A draft of the Storm Water Management Plan and Draft Model Ordinance will be sent to PADEP prior to adoption of the watershed Plan. The PADEP review process involves determination that all of the activities are completed in the Plan. Further, the Department will only approve the Plan if it determines the following:

1. That the Plan is consistent with municipal floodplain management plans, State programs which regulate dams, encroachments and other water obstructions, and State and Federal flood control programs; and
2. That the Plan is compatible with other watershed storm water plans in which the watershed is located and is consistent with the policies and purposes of Act 167.

PADEP action to either approve or disapprove the Plan must take place within ninety (90) days of receipt of the Plan by the Department. Otherwise, the Plan would be approved by default.

B. Publishing the Final Plan

Consistent with the Mill Creek Scope of Study, the Lancaster County Planning Commission will publish 46 copies of the Watershed Plan after PADEP approval. At minimum, two copies of the Text of the Plan will be provided to each municipality. Additional separate copies of the Mill Creek Watershed Act 167 Storm Water Management Ordinance will be published for use by the municipalities.

C. Municipal Adoption of Ordinance Provisions to Implement the Plan

The key ingredient for implementation of the Storm Water Management Plan is the adoption of the necessary ordinance provisions by the Mill Creek Watershed municipalities. Provided as part of the Plan is the Mill Creek Watershed Act 167 Storm Water Management Ordinance which is a single purpose storm water ordinance that could be adopted by each municipality essentially "as is" to implement the Plan. The single purpose ordinance was chosen for ease of incorporation into the existing structure of municipal ordinances. All that would be required of any municipality would be to adopt the ordinance itself and adopt the necessary provisions for tying into the existing subdivision and land development ordinance and zoning ordinance. The tying provisions would simply refer any applicable regulated activities within the Mill Creek Watershed from the other ordinances to the single purpose ordinance. It is recommended that the delineation of the watershed subareas and the release rate percentages assigned to each subarea be enacted as part of each municipality's zoning or subdivision ordinance so that the requirements for management of storm water will be applicable to all changes in land use and not limited only to activities which are subject to subdivision and land development regulations.

The proposed model ordinance provisions include the technical standards of the Mill Creek Watershed Storm Water Management Plan as well as recommended procedures for review and approval of development applications and for the financing and maintenance of storm water control facilities constructed in conjunction with development and land alteration activities. These technical, procedural and administrative provisions are summarized in this section and Section V, Criteria and Standards.

D. Level of Government Involvement in Storm Water Management

The existing institutional arrangements for the management of storm water include federal, state, and county governments, as well as every municipality within the watershed. Table IX-1 indicates the major areas of involvement of each of these agencies - prior to the adoption of the Watershed Storm Water Management Plan.

In the absence of a single entity with responsibility for all aspects of storm water management within a watershed, it is clear that the "management" which occurs is primarily a function of a multiple permitting process in which a developer attempts to satisfy the requirements of all of the permitting agencies. Each public agency has established its own regulations based on its own objectives and legislative mandates as well as its own technical standards, applicable to its particular storm water concerns.

The minimum objectives of this Plan and the minimum mandates of ACT 167 can be accomplished without significant modification of existing institutional arrangements - by action taken at the municipal level (in combination with continuing voluntary

coordination at the watershed level), participation by the county in the technical review of storm water management plans, maintenance and operation of the computer model (as necessary) and compilation of data required for periodically updating the Plan. In addition, upon adoption and approval of the watershed Plan, all future public facilities, facilities for the provision of public utility services, and all facilities owned or financed by state funds will have to be consistent with the watershed Plan, even though they might not otherwise be subject to municipal regulation.

1. Municipal/Watershed Level Activities

Adoption or amendment of development regulations by each municipality to incorporate watershed storm water management standards. ACT 167 requires that this be accomplished within six months of the Plan's adoption and approval. Model ordinance provisions have been distributed to all of the watershed Municipalities. The Lancaster County Engineering Office will be available upon request to assist Municipalities in the adoption of the model ordinance provisions to fit particular municipal ordinance structures.

**TABLE IX-1
Public Involvement in Storm Water Management**

<u>Government Level and Agency</u>	<u>Area of Involvement</u>
<u>Federal</u>	
Environmental Protection Agency	Clean Water Act - concerned with water quality including runoff quality and wetlands
Soil Conservation Service or Natural Resources Conservation Service	Erosion and sediment pollution control - agriculture.
Corps of Engineers	Floodplain management, navigation and flood control, wetlands.
U.S. Fish & Wildlife Service	Wetlands, land use.
<u>State</u>	
Dept. of Environmental Protection	Clean Streams Law - concerned with runoff quality, specifically erosion and sedimentation.
	Dam Safety and Encroachments Act - regulates dams, obstruction and encroachments on streams, flood plains, and wetlands.

Storm Water Management Act - administers law; approves watershed management plans.

Administers Flood Plain Management Act; reviews watershed plans.

County

Conservation District

Approves erosion and sediment pollution control plans under agreement with PADEP and Municipalities.

Engineer's Office

Prepares watershed plans. Reviews municipal subdivision regulations.

Municipalities

Enact and administer zoning, subdivision and land development, building code, site alteration regulations. In addition, the State, County and Municipalities all construct and maintain a variety of public facilities - such as roads, bridges, culverts, storm sewers and other storm control facilities, which affect and are affected by storm water flows.

The watershed Municipalities will also enter into a Memorandum of Understanding (M.O.U.) with the Lancaster County Conservation Districts. The M.O.U. will allow for cooperation between both parties for the review of erosion and sediment pollution control plans and on-site inspection and enforcement of applicable regulations.

In developing a proposal for the ongoing management of storm water in the Mill Creek Watershed, the Task Force should also consider issues of the repair, maintenance and improvement of existing municipal storm water facilities in order to ensure the proper functioning of the total system and to address the correction of existing problems.

2. County Level Activities

- a. Establishment of review procedures. The model ordinance calls for review of storm water management plans for development sites by the Lancaster County Planning Commission, and Erosion and Sediment Pollution Control Plans by the Lancaster County Conservation District. Evidence is also required that the appropriate State and Federal agencies responsible for administering wetland regulatory programs have been contacted for land development sites containing regulated wetlands. The purpose is to ensure that plan standards have been applied appropriately and that downstream

impacts have been adequately addressed. Procedures and capabilities for performing the review function exist within the governmental agencies.

- b. Maintenance of data for performance of review and of no-harm evaluation.
The materials initially prepared by the consultants during the Plan preparation process which are needed or which may be needed in the development of site specific storm water management plans, including data needed to perform the no-harm evaluation as detailed in Volume I, must be maintained in a place and form which is accessible to users. This material includes the computer model tabular printouts and the TR20 input files on disc.

E. County Wide Coordination

1. Regional Storm Water Management Board

There are possible situations of storm water management functions and concerns which may not be adequately addressed within the structure of the existing institutional arrangements or by the adoption and enforcement of new regulations at the municipal level, as outlined above.

For example, the construction of regional storage facilities may offer a very economic and technically sound alternative to the construction of individual, on-site detention basins. There is, however, no organization at the present time which is capable of implementing such a concept. To do so would require a multi-municipal entity capable of planning, financing, constructing, operating and maintaining the shared storage facilities in a manner similar to the management required for the collection, treatment and disposal of sanitary wastes.

The Mill Creek Watershed is a drainage system. All of its parts are interrelated. What happens upstream affects what happens downstream, and what happens downstream places limitation on what happens upstream. If runoff is not controlled in upstream communities, downstream communities will flood. But, if in a downstream community, the capacity of a drainage channel can be safely increased, more upstream runoff may be released, thus reducing to some degree the cost of required upstream control facilities.

The standard proposed in this Plan is the primary standard for managing storm water on a watershed basis and is a very simple concept which can be implemented on a property-by-property basis. It is equitable and can be used to achieve the law's "no-harm" mandate. But the same technical tool which allowed the modeling of rainfall routing throughout the watershed and the development of a usable standard for property-level control is capable of testing numerous, technically feasible solutions which would work for combinations of properties and for combinations of subareas. Some of these potential solutions may be

preferable to those which would result from the application of release rates to individual properties.

There are, of course, ways to work out agreements on a case-by-case basis to permit the accomplishment of almost any objective, whether a public or a private undertaking. But, as the number of storm water detention and control facilities increases during future years, continuing maintenance to ensure the integrity of structures and their performance will become very important. A proliferation of "special agreements" to handle special situations may make future accountability very difficult.

An ideal structure for the management of storm water on a watershed basis would be an entity capable of dealing with all of the interrelated elements of the system in order to achieve the following:

- o the best possible technical solutions in the most effective manner;
- o the efficient and competent review of Storm water management components of development plans;
- o the continued maintenance and proper functioning of all elements of the system;
- o the repair and replacement of system components as necessary;
- o continuing monitoring and evaluation of the performance of the drainage system;
- o updating and revision of system requirements and standards as necessary;
- o coordination of storm water management in the watershed with other actors and concerns such as water quality and supply, recreation, conservation and environmental objectives; and responsible financial management including an equitable apportionment of operating and capital costs among the system's users and beneficiaries.

It is clear that not all of these objectives can be achieved on a watershed basis through municipal implementation of the storm water plan, but that the existence of an inter-municipal entity capable of continuous action at the system or watershed level is required.

An optimum management system would be an entity capable of performing similar functions for multiple watersheds - a county-level Storm water management institution. There are a variety of models for such an entity, ranging from assigning new responsibilities to a coordinated team of existing county departments to the creation of a regional Storm water management board to

include storm water functions. Further, under any management system, some of the elements in the process could be contracted out to a private vendor.

2. Financing

The essential concept is that storm water can be managed like a public utility and that the costs for planning, construction, operation and maintenance, monitoring and evaluation can be equitably shared by all of the system's users.

A basic assumption underlying the concept of user financing of Storm water management is that damage caused by existing and potential storm water runoff without controls is intolerable. Therefore, it is in the public interest to undertake Storm water management immediately, and such management should not be delayed until federal and state funding is available.

Another way in which the completion and implementation of this plan can be of assistance in addressing storm drainage problems is by opening the avenue of funding assistance through the PENNVEST program. The PENNVEST Act of 1988, as amended, provides low interest loans to governmental entities for the construction, improvement or rehabilitation of stormwater projects including the transport, storage and infiltration of stormwater and best management practices to address point or non-point source pollution associated with stormwater.

In order to qualify for a loan under PENNVEST, the municipality or county:

1. 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,
2. Must have enacted a stormwater control ordinance consistent with the Storm Water Management Act.

Based on storm water management experience elsewhere, users (defined to include beneficiaries also) can finance the full cost of storm water management inexpensively and equitably. The cost to each user is calculated on the basis of user's property characteristics. Because this method is based on a formula, it has the advantage of being objective in its application.

3. Recommendations for Institutional Arrangements

In order that the technical standards for control of storm water in the Mill Creek Watershed can be implemented within the time period specified by the law (six months after approval to the adopted Plan by PADEP, it is recommended that the technical criteria and standards outlined in Section V together with those management standards to implement the technical standards at the municipal level outlined in Volume I, be adopted.

F. Development of a Systematic Approach for Correction of Existing Storm Drainage Problem Areas

Correction of the existing storm drainage problem areas in the watershed is not specifically part of the ACT 167 planning process. However, the development of the watershed Plan has provided a framework for their correction for the following reasons: (1) existing storm drainage problems have been documented through interaction with the Watershed Plan Advisory Committee (WPAC); (2) implementation of the runoff control criteria specified in the Plan will prevent the existing drainage problems from becoming worse (and prevent the creation of new drainage problem areas); and (3) the hydrologic model developed to formulate the runoff control criteria could be used as an analytical tool for designing engineering solutions to existing drainage problems.

With the above in mind, each municipality within the Mill Creek Basin should take the following steps to implement solutions to the existing storm drainage problem areas:

1. Prioritize the list of storm drainage problems within the municipality based on frequency of occurrence, potential for injury to persons or property, damage history, public perception of the problems, and other appropriate criteria.
2. For the top priority drainage problems in the Municipality, conduct detailed engineering evaluations to determine the exact nature of the problems (if not known), determine alternative solutions, provide cost estimates for the alternative solutions, and recommend a course of municipal action. The number of drainage problems to be evaluated by a municipality as a first cut from the priority list should be based on a schedule commensurate with completing engineering studies on all problem areas within approximately 10 years.
3. On the priority and cost basis, incorporate the implementation of recommended solutions to the drainage problems in the annual municipal capital budget or the municipal maintenance budget as funds are available. The number of drainage problems corrected in a given year should be based on a maximum 15 year schedule of resolving all existing documented drainage problems in the Municipality for which cost-effective solutions exist.

The above-stated procedure for dealing with existing storm drainage problem areas is not a mandatory action placed on municipalities with the adoption of the watershed Plan. Rather, it represents one systematic method to approach the problems uniformly throughout the watershed and attempt to improve the current runoff situation in the basin. The key elements involved in the success of the remedial strategy will be the dedication of the Municipalities to construct the corrective measures and the consistent and proper application of the runoff control criteria specified in the Plan. The latter element is essential to ensure that remedial measures do not become obsolete (under designed) by increasing peak flows with new development.

SECTION X

PLAN REVIEW ADOPTION AND UPDATING PROCEDURES

A. County Adoption

Prior to Plan completion, Lancaster County transmitted a draft of the proposed Storm Water Ordinance for review to affected local governing bodies and the Watershed Plan Advisory Committee.

Lancaster County then transmitted the Plan for review to the municipal planning agency and the governing body of each involved Municipality, the County Planning 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 will be submitted to the County by official correspondence. The County will receive, tabulate and respond to the comments and will revise the Plan as appropriate.

Lancaster County held a public meeting. 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 modification to the Plan made.

The Plan was passed as a resolution by the Lancaster County Commissioners for the purpose of adoption. The resolution included references to Volume I - Executive Summary and Volume II - Text of the Plan including maps and the model ordinance. The Technical Appendix is supporting data and not part of the adopted Plan. The County resolution was recorded in the minutes of a regular meeting of the Lancaster County Commissioners.

Lancaster County will submit to the Department of Environmental Protection a letter of transmittal and three copies of the adopted Plan, the review by each affected municipal planning agency and local governing body and the County Planning Commission, public hearing notice and minutes, and the resolution of adoption of the Plan by the County. The letter of transmittal will state that Lancaster County has complied with all procedures outlined in Act 167 and will request that the Department of Environmental Protection approve the adopted Plan.

B. Provisions for Plan Revision

Section 5 of the Storm Water Management Act requires that the Storm Water 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 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 Storm water management facility.

The following recommendations deal with the minimum requirements that will have to be undertaken to maintain an effective technical position for periodically reviewing, revising and updating the Plan.

1. It is recommended that the Lancaster County Board of Commissioners authorize the County Engineer's Office to undertake the task of collecting and organizing storm water management plans and supporting documentation and data submitted for review and to assume responsibility for periodically reviewing, revising, and updating the Storm Water Management Plan.
2. It is recommended that the Lancaster County Planning Commission prepare a workable program for the identification, collection and management of the required data. The program should not be limited to the cooperative efforts of the constituent member Municipalities within the Mill Creek watershed, but should also include both State and County agencies concerned with storm water management.
3. It is recommended that The Watershed Plan Advisory Committee convene bi-annually or as needed to review the Storm Water Management Plan and determine if the Plan is adequate for minimizing the runoff impacts of new development. At minimum, the information (to be reviewed by the Committee) will be as follows:
 - (a) Development activity data as monitored by the Lancaster County Planning Commission.
 - (b) Information regarding additional storm drainage problem areas as provided by the municipal representatives to the Advisory Committee.
 - (c) Zoning and Subdivision amendments within the watershed.
 - (d) Impacts associated with any regional or sub-regional detention alternatives implemented within the watershed.
 - (e) Adequacy of the administrative aspects of regulated activity review.

- (f) Additional hydrologic data available through preparation of the Storm Water Management Plan for the Mill Creek Watershed.

The Committee will review the above data and make recommendations to the County for revisions to the Mill Creek Storm Water Management Plan. Lancaster 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 preparation. 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 and forward the resolution to PADEP.

ORDINANCE APPENDIX A
EXEMPTION CRITERIA

APPENDIX A

ACT 167 STORM WATER MANAGEMENT EXEMPTION CRITERIA

Effective Agricultural Zones and Conservation Zones:

The following criteria shall apply to all existing lots in conservation zones and effective agriculture** areas (1 lot per 20 acres or larger).

Total Parcel Size	Minimum Distance* (Feet)	Impervious Areas Exempt from Ordinance
0-0.5 acre	10	500 sq. ft.
0.5-1 acre	50	2,500 sq. ft.
1-2 acres	100	10,000 sq. ft.
2-5 acres	250	15,000 sq. ft.
>5 acres	500	20,000 sq. ft.

* The minimum distance between the proposed impervious area and/or storm water controls/structure discharge point to the down slope property line. In lieu of meeting the minimum distance criteria, the applicant may provide documentation from a Registered Professional in the state of Pennsylvania that the increased flows from the site leaves the site in the same manner as the pre-development condition and that there will be no adverse effects to adjacent property, or the increased flows reach a natural drainage way or existing storm water management structure before affecting adjacent property.

** All farms for which an exemption is requested shall have a Conservation Plan approved by the appropriate officials.

Existing Developed Properties:

Lands improved with existing structures may be exempted for an additional 1000 square feet of impervious surface in all zones provided that flows from the site after development leave the site in the same manner as the pre-development condition.

ORDINANCE APPENDIX B

DESIGN CRITERIA

APPENDIX NO B-1

PA-DOT REGION 5 STORM IDF DATA BASE
 RAINFALL INTENSITY (Inches/Hour)

TIME (Min.)	STORM FREQUENCY (Years)					
	2	5	10	25	50	100
5.0	4.63	5.40	6.02	6.70	7.51	8.19
6.0	4.34	5.15	5.70	6.39	7.22	7.90
7.0	4.12	4.95	5.42	6.10	6.95	7.62
8.0	3.92	4.70	5.17	5.85	6.70	7.36
9.0	3.75	4.50	4.95	5.62	6.47	7.12
10.0	3.59	4.30	4.75	5.41	6.26	6.90
11.0	3.45	4.15	4.58	5.22	6.07	6.70
12.0	3.32	4.00	4.42	5.05	5.88	6.50
13.0	3.21	3.85	4.27	4.89	5.71	6.33
14.0	3.10	3.70	4.16	4.74	5.56	6.16
15.0	3.00	3.55	4.00	4.60	5.40	6.00
20.0	2.60	3.10	3.50	4.03	4.78	5.34
25.0	2.31	2.65	3.15	3.61	4.30	4.83
30.0	2.09	2.45	2.82	3.27	3.92	4.41
40.0	1.76	2.05	2.39	2.78	3.34	3.79
50.0	1.53	1.77	2.08	2.42	2.92	3.33
60.0	1.35	1.60	1.85	2.15	2.60	2.98

APPENDIX NO. B-3

RUNOFF CURVE NUMBERS "CN" FOR
SCS METHOD

Runoff Curve Numbers "CN" for SCS Method												
Soil Group	A			B			C			D		
	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Land Use												
Cultivated Land winter conditions	48	60	65	62	73	73	68	78	79	77	81	88
	35	51	61	48	55	70	57	65	77	64	69	80
Fallowed Fields poor conditions	45	54	76	56	63	85	64	74	90	69	77	93
	30	44	74	43	48	83	48	54	88	56	60	90
Forest/Woodland	30	30	40	42	48	55	45	50	70	50	56	77
Grass Areas good conditions	35	39	51	48	54	81	56	59	74	62	63	80
	45	49	53	52	55	69	60	63	79	65	69	84
	48	55	68	56	67	79	68	74	86	73	81	89
Impervious Areas	96	97	98	96	97	98	96	97	98	96	97	98
Weighted Residential lot size 1/8 acre	71	75	77	74	76	85	78	80	90	81	83	92
	61	62	67	66	69	75	67	69	83	75	78	87
	57	59	65	64	66	72	65	66	81	74	77	86
	54	57	63	62	64	70	63	65	80	72	76	85
	51	55	62	61	63	68	61	64	79	71	75	84

APPENDIX NO. B-3

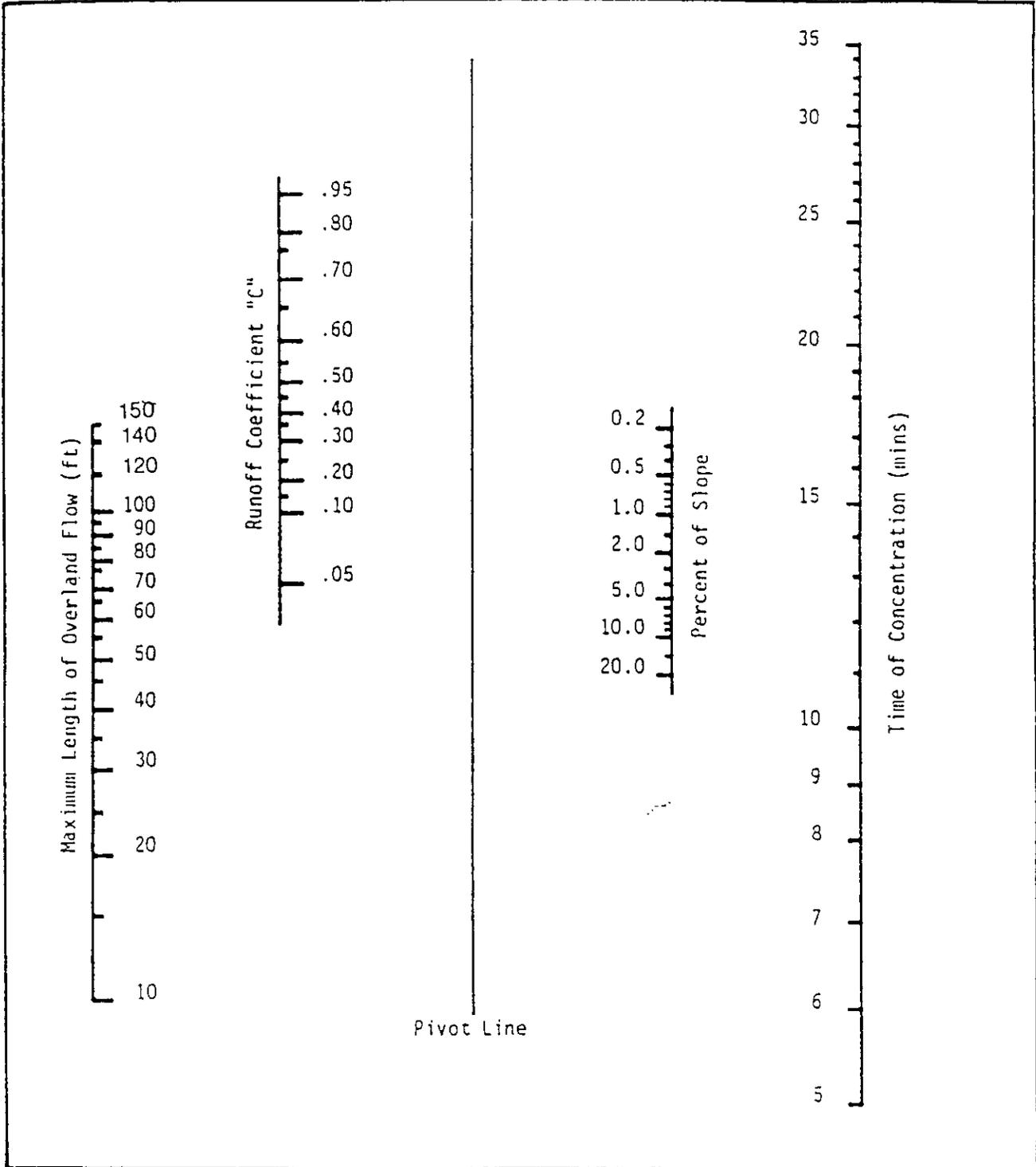
**RUNOFF CURVE NUMBERS "CN" FOR
SCS METHOD**

Runoff Curve Numbers "CN" for SCS Method												
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												
Cultivated Land winter conditions	48	60	65	62	73	73	68	78	79	77	81	88
summer conditions	35	51	61	48	55	70	57	55	77	64	39	80
Fallowed Fields poor conditions	45	54	76	56	63	85	64	74	90	69	77	93
good conditions	30	44	74	43	48	83	48	54	88	56	60	90
Forest/Woodland	30	30	40	42	46	55	45	50	70	50	56	77
Grass Areas good conditions	35	39	51	48	54	61	56	59	74	62	63	80
average conditions	45	49	53	52	55	69	60	63	79	65	69	84
poor conditions	48	55	68	56	67	79	66	74	86	73	81	89
Impervious Areas	96	97	98	96	97	98	96	97	98	96	97	98
Weighted Residential lot size 1/8 acre	71	75	77	74	76	85	78	80	90	81	83	92
lot size 1/4 acre	61	62	67	66	69	75	67	69	83	75	78	87
lot size 1/2 acre	57	59	65	64	66	72	65	66	81	74	77	86
lot size 3/4 acre	54	57	63	62	64	70	63	65	80	72	76	85
lot size 1 acre	51	55	62	61	63	68	61	64	79	71	75	84

APPENDIX NO. B-4

NOMOGRAPH FOR DETERMINING SHEET FLOW

(for use with the Rational Method)



APPENDIX NO. B-5

Worksheet #1: Time of concentration (T_c) or travel time (T_t)

Project _____ By _____ Date _____

Location _____ Checked _____ Date _____

Circle one: Present Developed _____

Circle one: T_c T_t through subarea _____

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only) Segment ID

- 1. Surface description (table 3-1)
- 2. Manning's roughness coeff., n (table 3-1)
- 3. Flow length, L (total L ≤ **150 ft). ft
- 4. Two-yr 24-hr rainfall, P₂ in
- 5. Land slope, s ft/ft
- 6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t hr

		+		=

Shallow concentrated flow Segment ID

- 7. Surface description (paved or unpaved)
- 8. Flow length, L ft
- 9. Watercourse slope, s ft/ft
- 10. Average velocity, V (figure 3-1). ft/s
- 11. $T_t = \frac{L}{3600 V}$ Compute T_t hr

		+		=

Channel flow Segment ID

- 12. Cross sectional flow area, a ft²
- 13. Wetted perimeter, P_w ft
- 14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r ft
- 15. Channel slope, s ft/ft
- 16. Manning's roughness coeff., n
- 17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft/s
- 18. Flow length, L ft
- 19. $T_t = \frac{L}{3600 V}$ Compute T_t hr

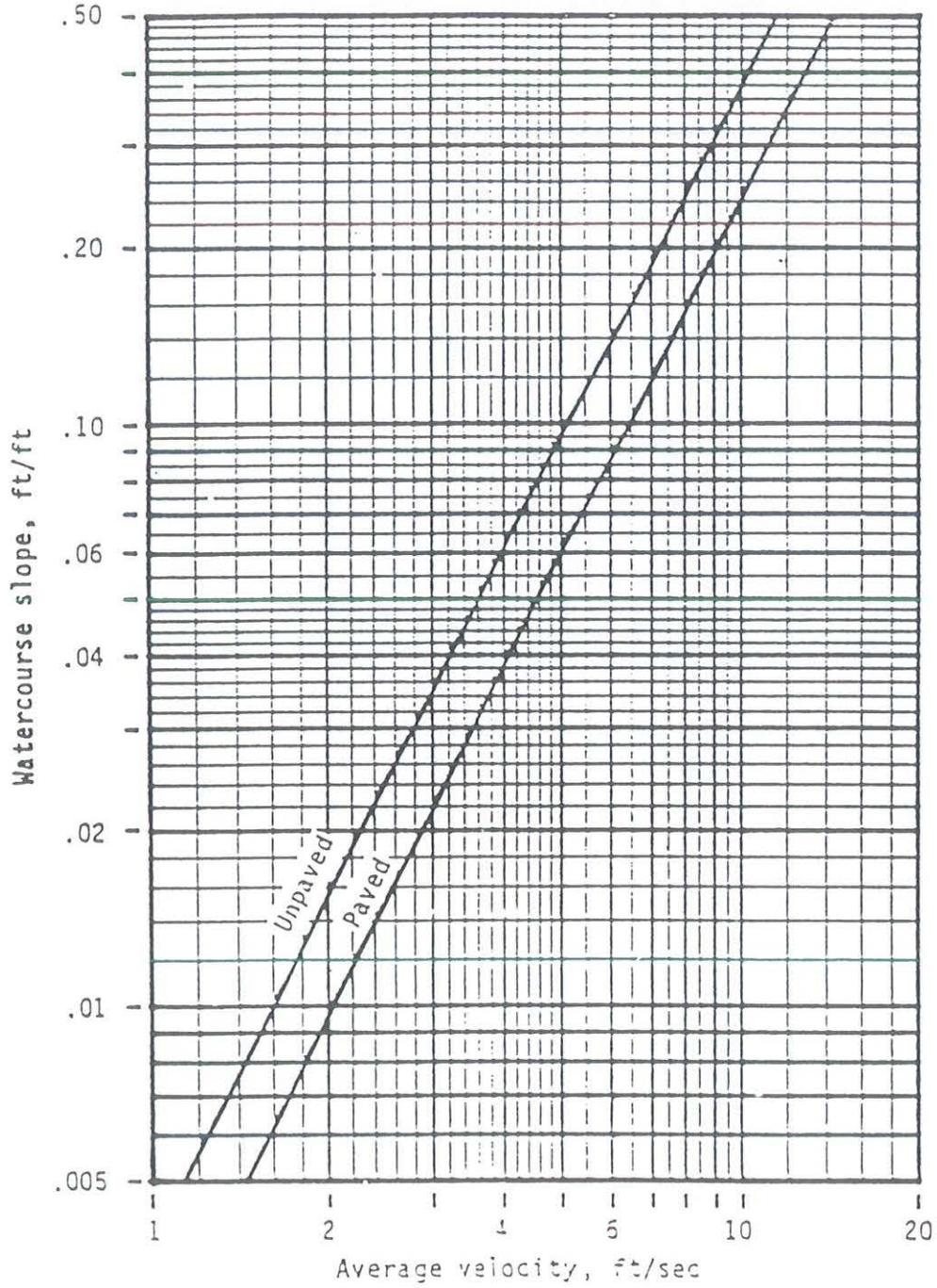
		+		=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr

*Table 3-1 per latest TR-55, Urban Hydrology for Small Watershed
 **150' sheet flow length per latest TR-55 revision

APPENDIX NO. B-6

AVERAGE VELOCITIES FOR ESTIMATING TRAVEL TIME FOR SHALLOW CONCENTRATED FLOW



APPENDIX NO. B-7

MANNING "n" VALUES FOR PIPES

Manning 'n' Values for Pipes	
PIPE MATERIAL	MANNING "n"
Helical corrugated steel/aluminum 2 ² / ₃ x 1 ¹ / ₂ corrugations diameter (inches)	
15	0.014
18	0.015
21	0.016
24	0.017
27	0.018
30	0.019
36	0.020
42	0.021
48	0.021
Reinforced Concrete All diameters	0.013
Corrugated Polyethylene Smooth lining All diameters	0.012

Note: Arch pipe shall have the Manning "n" of an equal periphery of circular pipe.

ORDINANCE APPENDIX C
SAMPLE DRAINAGE PERMIT APPLICATION

ORDINANCE APPENDIX C

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 STORM WATER MANAGEMENT AND EROSION AND SEDIMENTATION CONTROL PLAN AND RELATED DATA AS SUBMITTED HERewith IN ACCORDANCE WITH THE _____ TOWNSHIP STORM WATER MANAGEMENT AND EARTH DISTURBANCE 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 CORPORATIONS NAME AND THE NAMES OF TWO OFFICERS OF THE CORPORATION) ADDRESS _____ ZIP _____

APPLICANT'S INTEREST IN SUBDIVISION OR DEVELOPMENT (IF OTHER THAN PROPERTY OWNER GIVE OWNERS 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. LINEAL FEET OF NEW ROAD PROPOSES? _____ L.F.

7. AREA OF PROPOSED AND EXISTING IMPERVIOUS AREA ON ENTIRE TRACT. A. EXISTING (TO REMAIN) _____ L.F. B. PROPOSED _____ L.F.

8. STORM WATER

A. DOES THE PEAK RATE OF RUNOFF FROM PROPOSED CONDITIONS EXCEED THAT FLOW WHICH OCCURRED FOR PREDEVELOPMENT CONDITIONS FOR THE DESIGNATED DESIGN STORM? _____

B. DESIGN STORM UTILIZED (ON-SITE CONVEYANCE SYSTEMS) (24 HR.)
(CHECK ONE)

___ NO. OF SUBAREA _____

___ WATERSHED NAME _____

___ OTHER _____

EXPLAIN: _____

C. IS THE PROPOSED RUNOFF REDUCED TO THE ALLOWABLE RELEASE RATE FOR THE SUBAREA IN WHICH THE SITE IS LOCATED FOR THE 2.33- AND 50-YEAR DESIGN STORM?

D. NUMBER OF SUBAREA FROM PLATE 1, VOLUME 1 TECHNICAL MANUAL OF THE MILL CREEK WATERSHED STORM WATER MANAGEMENT PLAN. _____

E. TYPE OF PROPOSED RUNOFF CONTROL _____

F. DOES THE PROPOSED STORM WATER CONTROL CRITERIA MEET THE REQUIREMENTS/GUIDELINES OF THE STORM WATER ORDINANCES? _____
- IF NOT, WHAT VARIANCES/WAIVERS ARE REQUESTED? _____

- REASONS WHY _____

G. DOES THE PLAN MEET THE REQUIREMENTS OF ARTICLE III OF THE STORM WATER ORDINANCES? _____

- IF NOT, WHAT VARIANCES/WAIVERS ARE REQUESTED _____

- REASONS WHY _____

H. WAS TR-55, JUNE 1986, UTILIZED IN DETERMINING THE TIME OF CONCENTRATION?

I. IS A HYDRAULIC ROUTING THROUGH THE STORM WATER CONTROL STRUCTURE SUBMITTED? _____

J. IS A CONSTRUCTION SCHEDULE OR STAGING ATTACHED? _____

K. IS A RECOMMENDED MAINTENANCE PROGRAM ATTACHED? _____

L. WHO WILL HAVE ULTIMATE MAINTENANCE RESPONSIBILITY OF THE STORM WATER CONTROL FACILITIES? _____

9. EROSION AND SEDIMENT POLLUTION CONTROL (E&S)

A. HAS THE STORM WATER MANAGEMENT AND E&S PLAN, SUPPORTING DOCUMENTATION AND NARRATIVE BEEN SUBMITTED TO THE LANCASTER 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 WETLAND LINES 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 WHOM WILL BE MAKING THE INSPECTIONS _____

- D. GENERAL COMMENTS ABOUT STORM WATER MANAGEMENT AT DEVELOPMENT

CERTIFICATE OF OWNERSHIP AND ACKNOWLEDGMENT OF APPLICATION:
COMMONWEALTH OF PENNSYLVANIA COUNTY OF LANCASTER SS

On this the _____ day of _____, 19____, before me, the undersigned officer, personally appeared _____

who being duly sworn, according to law, desposes and says that _____ 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

Property Owner

My Commission Expires _____, 19____

Notary Public or Officer

THE UNDERSIGNED HEREBY CERTIFIES THAT TO THE BEST OF HIS KNOWLEDGE AND BELIEF THE INFORMATION GIVEN ABOVE ARE TRUE AND CORRECT.

SIGNATURE OF APPLICANT _____

.....

(INFORMATION BELOW THIS LINE TO BE COMPLETED BY THE TOWNSHIP)

_____ TOWNSHIP OFFICIAL SUBMISSION RECEIPT.

DATE COMPLETE APPLICATION RECEIVED _____ PLAN NUMBER _____

FEES _____ DATE FEES PAID _____ RECEIVED BY _____

OFFICIAL SUBMISSION RECEIPT DATE _____

RECEIVED BY _____

ORDINANCE APPENDIX D
SAMPLE OCCUPANCY PERMIT APPLICATION

_____ TOWNSHIP
 DRAINAGE PLAN
 PROPOSED SCHEDULE OF FEES

SUBDIVISION NAME _____ SUBMITTAL NO. _____

OWNER _____ DATE _____

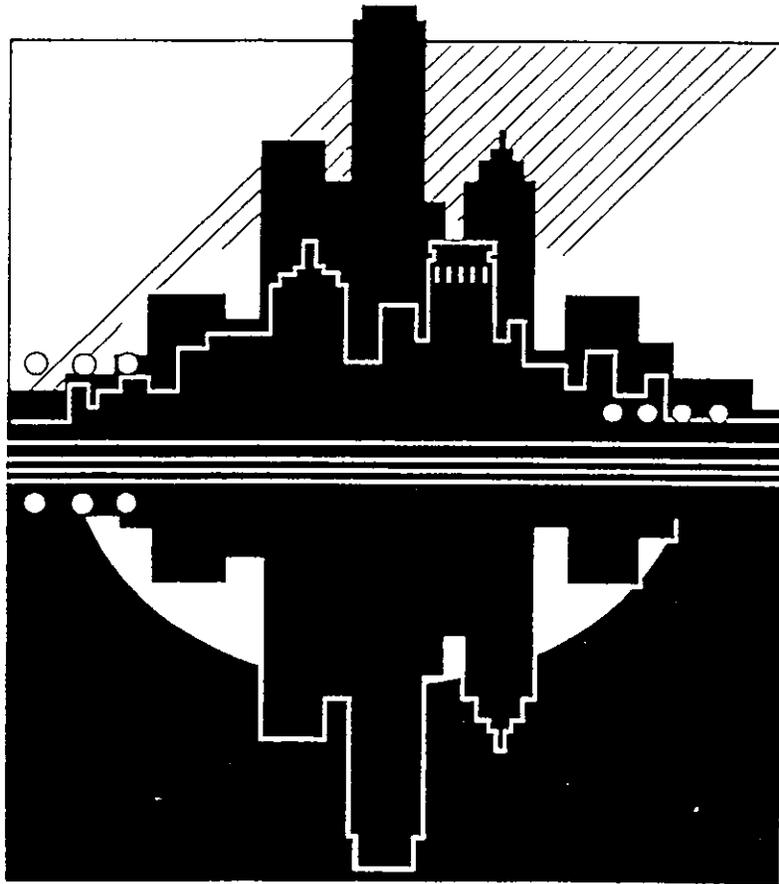
ENGINEER _____

1.	FILING FEE	\$ _____
2.	LAND USE	
	2A. SUBDIVISIONS, CAMPGROUNDS, MOBILE HOME PARKS, AND MULTI-FAMILY DWELLINGS 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	\$ _____
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	\$ _____
5.	STORM WATER CONTROL MEASURES	
	5A. DETENTION BASINS & 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 ¼ THE AMOUNT OF THE INITIAL REVIEW FEE UNLESS A NEW APPLICATION IS REQUIRED AS PER SECTION 505 OF THE STORM WATER ORDINANCE. A NEW FEE SHALL BE SUBMITTED WITH EACH REVISION IN ACCORDANCE WITH THIS SCHEDULE.

ORDINANCE APPENDIX E
BEST MANAGEMENT PRACTICES

Summary Report on
Urban Stormwater
Nonpoint Source Pollution
Controls and Practices



Executive Summary

The purpose of this report is to summarize, for individuals and local government officials, the latest information on issues surrounding urban nonpoint source pollution, introduce how BMPs work and are applied and to assist local officials in developing management strategies and ordinances that would include BMPs to maintain or improve water quality. This report is not intended to be a design manual. All information contained in this report is based on available publication from Federal and State agencies as well as private organizations.

Chapter 1 introduces the relationship of urbanization and stormwater runoff, how land development within a watershed affects peak discharges, volumes, sedimentation, discharges of pollutants and other environmental indicators. As an example, increased imperviousness within a watershed often translates into increased peak rates of runoff as less rainfall is able to infiltrate into the ground. Additional pollutant loadings are carried by stormwater resulting in degradation to water bodies. This chapter provides details on sources of pollutants found in stormwater runoff and their impacts.

Chapter 2 describes the benefits of Best Management Techniques or BMPs in addressing the impacts of runoff on water quality as well as descriptions and applications of various structural and non-structural BMPs.

Chapter 3 discusses the options available to municipalities for implementation of BMPs. Included are examples of ordinance language for amending existing ordinances by reference and sample provisions for direct amendment of existing ordinances. Steps are presented on determining the applicability of a BMP based on physical conditions of a site and other considerations. Also provided are two sample development layouts, one residential and another commercial, demonstrating how a multiple number of BMPs may be applied to achieve maximum water quality and quantity benefits. The chapter ends with information on the Commonwealth's Pennvest loans that are available to municipalities in resolving existing stormwater problems.

The document also includes a listing of referenced Information and Publications available for further study and a glossary of terms.

Table of Contents

<u>EXECUTIVE SUMMARY</u>	<u>2</u>
<u>INTRODUCTION</u>	<u>5</u>
EFFECTS ON THE COMMUNITY	5
<u>CHAPTER 1 - URBANIZATION AND STORMWATER RUNOFF</u>	<u>6</u>
EFFECTS OF URBANIZATION	7
STORMWATER QUANTITY	7
STORMWATER QUALITY	8
THE COMMON POLLUTANTS OF STORMWATER AND THE IMPACTS	8
<u>CHAPTER 2 - BEST MANAGEMENT PRACTICES</u>	<u>13</u>
BENEFITS OF BMPs	13
ENVIRONMENTAL IMPROVEMENT	13
AESTHETICS/LAND VALUES/RECREATION	13
EDUCATIONAL VALUE	14
PREVENTION OF FLOODING AND WATER QUALITY PROBLEMS	14
NONSTRUCTURAL BMPs	14
COMPREHENSIVE PLANNING	15
SUBDIVISION/LAND DEVELOPMENT ORDINANCES	15
SINGLE PURPOSE ORDINANCES	15
ZONING PRACTICES	16
MAINTENANCE PRACTICES	19
POLLUTION PREVENTION/SOURCE CONTROLS	20
STRUCTURAL BMPs:	21
VEGETATIVE PRACTICES	22
INFILTRATION PRACTICES	26
BASIN PRACTICES	29
WATER QUALITY INLETS	33
<u>CHAPTER 3 - MUNICIPAL IMPLEMENTATION OF BMPs</u>	<u>37</u>
INTRODUCTION	37
IMPLEMENTATION THROUGH ORDINANCES	37
STAND-ALONE ORDINANCES	37
AMENDMENT OF EXISTING ORDINANCES	37
PUBLIC EDUCATION	40
SELECTION OF BMPs	40
SAMPLE DEVELOPMENT SITE PLANS	41

ADDRESSING EXISTING WATER QUALITY PROBLEMS
INFORMATION AND PUBLICATIONS

45
47

GLOSSARY

52

Introduction

The relationship of stormwater management and water quality is gaining greater attention from Federal, State, County and local governments across the country. As water quality management agencies improve the point source pollution discharges (i.e., sewage treatment and industrial discharges), increased attention is being paid to nonpoint sources of pollution. In urban and developing areas, changes to drainage patterns, increased impervious surfaces and human activities add sediment, pesticides, fertilizers, animal waste, oil, grease, heavy metals and other pollutants into stormwater systems that feed into waterways and groundwater.

Effective and practical means to prevent or reduce the impact of urban nonpoint source pollution include the application of techniques known as Best Management Practices or "BMPs". These BMPs, often categorized as either structural or nonstructural, include nonstructural practices of pollution prevention at their source, pollution reduction and various structural treatment measures such as basins and infiltration trenches. BMPs may be utilized during construction of new developments as preventative measures or constructed or "retrofitted" into existing development areas as ways of improving water quality in areas having documented water quality problems.

This report summarizes, for individuals and local government officials, the latest information on issues surrounding urban nonpoint source pollution, how BMPs work and are applied to assist local officials in developing management strategies and ordinances that would include BMPs to maintain or improve water quality. This report is not intended to be a design manual.

Effects On The Community

In the past, communities treated water pollution only from point sources by building treatment plants without knowing the extent of nonpoint sources to water pollution problems. Stormwater management systems were built primarily to convey away surface runoff without consideration to the relationship of water pollution and stormwater runoff. Today, communities across the country are recognizing the importance on nonpoint sources of pollution and its relationship with stormwater runoff.

Many communities can no longer use and enjoy their natural resources due to water pollution directly attributed to nonpoint sources. When pollution is present, they can no longer participate in the activities such as, swimming, boating, fishing, having a picnic, or just enjoying a lake or river. Pollution also causes property values to fall, eroding the tax base. With this increased awareness and knowledge, communities of all sizes can build two-pronged water quality programs: (1) identifying and correcting existing problems, and (2) focusing on preventing future problems created by land development. Communities have found that a comprehensive nonpoint source management program will help them avoid many of the problems created by pollutants from land development before they occur.

Chapter 1 - Urbanization and Stormwater Runoff

Land development may significantly impact stormwater runoff quantity and quality. Impervious surfaces reduce natural infiltration of rainfall and stormwater conveyance systems concentrate collected runoff with resulting increases in volume and velocity. Water quality degradation is also associated with land development as the increased volumes of runoff carry with it higher concentrations of pollutants from sources such as automobiles, lawn care products, materials discharged into storm sewers and sedimentation from erosion. The effects in a typical moderately developed watershed include the following:

- Increased peak discharges
- Increased runoff volumes
- Decreased travel time of runoff
- Increased runoff velocities
- Increased frequency and severity of flooding
- Reduced stream flow in dry weather periods
- Increased discharge of pollutants
- Increased sedimentation
- Increased levels of bacteria
- Introduction and/or increased loading of toxic substances
- Increased inputs of trash and debris
- Lower levels of dissolved oxygen
- Increased stream temperature.
- Reduced biodiversity

In the past, stormwater runoff was not recognized as a major pollution contributor. Nonpoint source sources are now recognized as major contributors to the degradation of the nation's waters. Documentation about the negative impacts, from land development, on water quality is reported in a number of sources. Two examples include: The Nationwide Urban Runoff Program (NURP) and the State's reports written in response to the requirements of section 305(b) and section 319 of the Clean Water Act (North Virginia SWCD, 1994). The NURP report states that urban runoff and storm sewers are the second leading source of water quality impacts on lakes and estuaries, and the third leading source of water quality degradation on rivers in the United States (North Virginia SWCD, 1994). There are four major sources of nonpoint source pollutants:

- agriculture
- land development
- forestry operations
- mining sources

Non-urban sources of pollutants vary from agricultural sources including runoff from eroded croplands, overgrazed pastures, animal feedlots and dairies, salts from irrigation practices, discharges from rural septic tanks, and nitrates from atmospheric deposition into water bodies. Forestry operations, if they involve improperly constructed logging roads and poorly managed tree harvesting, can lead to erosion. Mining sources include acid drainage from abandoned mines, mine tailing sites, and pollution from resource extraction activities, such as contamination from improperly sealed oil and gas wells.

Urban runoff often contains oily residues and other pollutants deposited on impervious surfaces such as streets and paved parking lots, in addition to sediment eroded from road and land development construction sites. Other sources include discharges from improperly maintained suburban septic tanks, leachate from landfills and hazardous waste sites, salts from road de-icing operations, and atmospheric deposition of contaminants produced by burning fossil fuels, such as coal.

Effects Of Urbanization

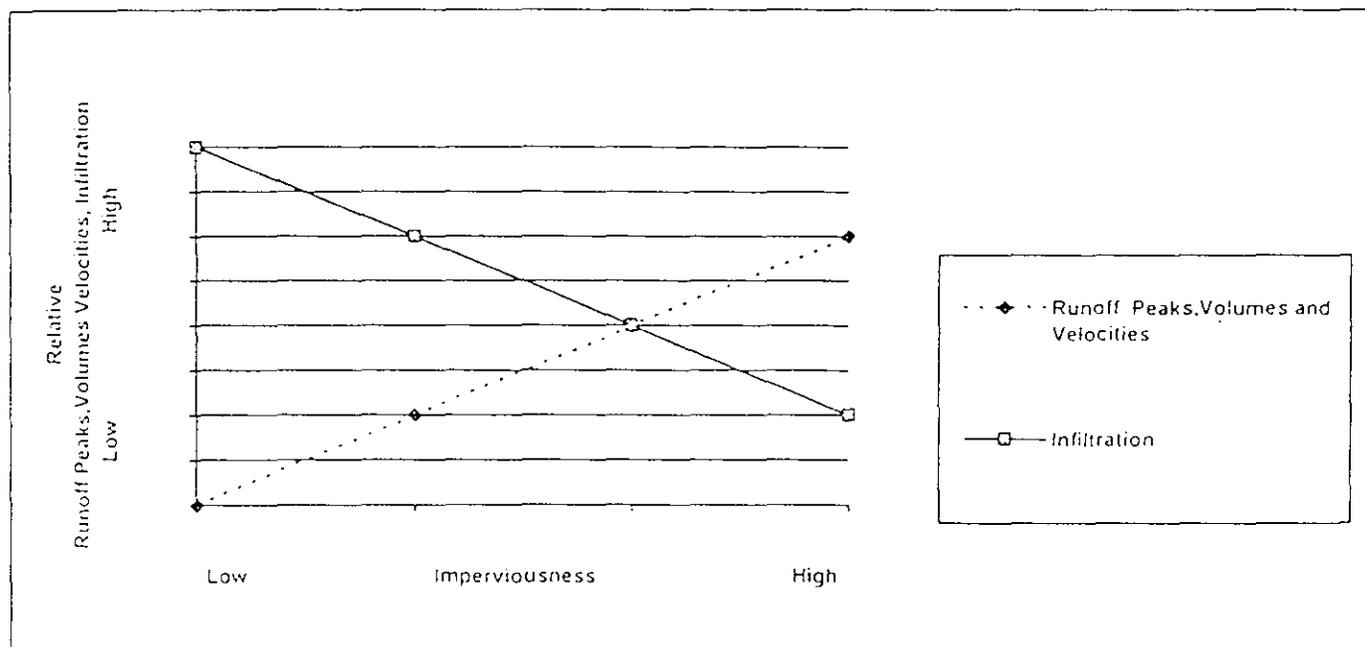
The volume of stormwater runoff generated by a rain storm depends upon the total amount of rainfall, after losses from infiltration, transpiration, evaporation, and surface storage are considered. The amount of these losses is a function of climate, soils, geology, topography, vegetative cover and land use.

Changes in land use affect the hydrology of an area in four ways: changes in peak flow characteristics of runoff; changes in runoff volume, changes in water quality, and changes in the hydrologic amenities of a community. The hydrologic amenities are the appearance or the impression of a water body and its adjacent lands leave with the observer. Of all the land use changes that affect an area's hydrology, land development is the most important.

Stormwater Quantity

As an area urbanizes, streets, sidewalks, parking lots and buildings alter natural ground cover. The process removes natural vegetation and compacts the soil. The land's surface becomes more impervious. Rainfall no longer soaks into the ground as readily as before. This causes an increase in runoff and accelerates the speed at which runoff flows (peak discharge rate), as seen in **FIGURE 1**.

FIGURE 1- Imperviousness and Runoff



Historically, the primary concern about stormwater was to remove it from a developed area as quickly as possible for flood protection. Unfortunately, this led to drainage systems that maximized local convenience and protection, without considering cumulative impacts downstream such as flooding and water pollution.

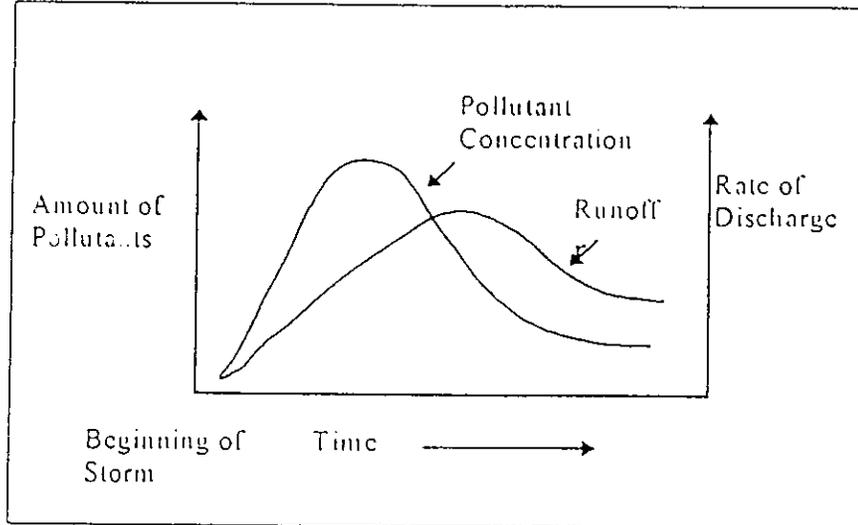
floodplain and channel erosion, loss of property, decreased wildlife habitat and decreased natural vegetation.

In an undeveloped area, a natural stream normally adjusts so that the cross sections and slope are in approximate equilibrium. Increased volumes and peak discharge rates of stormwater cause drastic changes in the natural stream channel. Eroded banks and frequent flooding are not only unsightly but cause damage to adjacent property and homes. Structures are undermined, homes are damaged, recreational areas are threatened and aesthetic values are destroyed. Accelerated channel erosion also creates downstream damages by the deposition of eroded sediment. Lakes and reservoirs fill, storm sewers and culverts become clogged causing flooding, areas adjacent to streams and lakes become covered with mud and debris left after the storm. Increased volumes and velocities associated with the stormwater from land development produce more frequent stream flooding. Areas that previously flooded only once in five years may flood every year, or several times each year. Floodplain erosion and damage to structures and vegetation, are the results of increased land development without proper stormwater controls.

Stormwater Quality

Land use directly affects water quality. In an undeveloped area, physical, chemical and biological processes interact to recycle most of the materials found in stormwater. As land development increases, the natural hydrologic processes are altered and disrupted. With land development comes high pollutant loadings from leaves, litter, animal wastes, oil, grease, trace metals, fertilizers, and pesticides washed off by rainfall and are carried by stormwater to our lakes, rivers, and bays.

FIGURE 2- First Flush



The First Flush (FIGURE 2) is referred to as the washing action that stormwater runoff has on accumulated pollutants in a watershed. In the early stages of the stormwater flow, the land surface, especially the impervious surfaces like streets and parking areas, is flushed clean by the stormwater. This creates a shock loading of pollutants.

The Common Pollutants Of Stormwater And The Impacts

Nonpoint source pollutants are as varied and numerous as the sources themselves. Nonpoint source pollutants are the cause of many of the same water quality problems as point sources (those from

industry and commercial activities). Stormwater runoff from nonpoint water pollutant sources such as, streets, parking lots, and lawns can contain sediment, nutrients, metals, toxins, bacteria, and salt. Nonpoint source pollution is not limited to urban land development. A certain amount results from natural processes, such as land slides and the weathering of rocks and minerals. Land development activities increase the quantity and rate of pollutant runoff and water quality problems adversely affect the environment. These problems have frequently occurred due to the lack of understanding between the relationships of the water resource and the associated land development activities with those resources within the surrounding watershed.

The impact of higher levels of pollutants is felt by adjacent streams and on downstream receiving water bodies such as lakes, rivers and estuaries (see Table 1). Government officials, planners and designers should become familiar with these situations to determine the pollutants of greatest concern to the community and then choose the most appropriate measures to control the negative effects.

TABLE 1- Pollutants, Their Source and Impact on the Environment

POLLUTANTS	SOURCE	NONPOINT SOURCE IMPACTS
Sediment	Grass & Leaf Cuttings Construction Logging Operations	When silt and suspended solids enter water bodies, they can reduce water depth, smother plants and aquatic organisms, destroy fish habitat. Decomposition of organic material uses up dissolved oxygen, making it difficult for fish to breathe.
Nutrients	Nitrates in Sewage, Animal Wastes, Fertilizers Phosphates from Detergents & Fertilizers	Excess levels of nutrients overstimulate growth of aquatic plants and cause algal blooms. Excessive plant growth clogs navigable waters, impairs recreational activities such as swimming and boating, and decreases plant and animal diversity, with the decrease in sunlight. Nitrates in groundwater are a principal contaminant, leading to well closures.
Bacteria	Stormwater Runoff, Human & Animal Waste	Cause illnesses such as typhoid and dysentery. Presence of indicator bacteria such as fecal coliforms suggest the possibility of more dangerous organism being present.
Hydrocarbons	Stormwater Runoff, Service Stations	Toxicity contributes to the decline of aquatic organisms. They accumulate in organisms and pose a health threat to humans who eat them.
Trace Metals	Automobiles, Roofing Materials and Pipes	Toxic to aquatic organisms, a contaminant of drinking water, and accumulates in aquatic organisms posing a health risk, if eaten. Restricts sports fishing.
Toxic Wastes	Stormwater Runoff, Stream modifications, Lawn Fertilizers	Source is runoff from home gardens and lawns. Can bioaccumulate in organisms and create toxic health hazards within the food chain. Observed levels are currently below standards.
Thermal Energy	Construction, Stream Modifications	Reduces vigor and growth of fish, decreases dissolved oxygen, promotes eutrophication of water resources, and accelerates corrosion of water supply pumps and equipment.
Chlorides	Road Salting, Irrigation	Toxic to freshwater organisms, creates increased stress on plants, and reduces drinking water quality.
Trash and Debris	Stormwater Runoff, Careless Disposal Practices	Lowers dissolved oxygen in water bodies.
Acids	Stormwater Runoff, Incomplete Combustion	Increases toxicity to animals and fishery resources that can result in their death.

Sediment is one of the most significant pollutants transferred by stormwater. Sediment consists mostly of soil materials eroded as a result of natural processes and human activities. Sediment loads increase with accelerated stormwater runoff, certain agriculture practices and deforestation from logging operations. Sediment clogs storm drains, fills in waterbodies, reduces hydraulic capacities of bridges and culverts, and fills in water supply reservoirs resulting in costly dredging and/or development of new water resources.

High concentrations of suspended solids in water bodies cause many adverse consequences including increased turbidity, reduced light penetration, reduced prey capture for sight-feeding predators, clogged gills of fish and reduced angling success. Additional impacts can result after sediment is deposited in slower moving waters including the smothering of benthic communities, alterations in the composition of the bottom substrate, the rapid filling-in of small impoundments which creates the need for costly dredging and reductions in the overall aesthetic value of the water resource. Sediment is an efficient carrier of toxins and trace metals. Once deposited, pollutants can be remobilized under suitable conditions, posing a risk to aquatic life. The increased surface water temperature decreases the dissolved oxygen concentration in the water decreasing the value of aquatic habitats. Sediment can carry other materials, such as nutrients, pesticides, and trace metals, that can harm both aquatic life and human health (Terrene Institute, 3/1994).

Nutrients are phosphorus and nitrogen, which plants use in various forms in the process of photosynthesis. Pollution from inorganic phosphorus and inorganic nitrogen are of chief concern.

Excessive levels of inorganic phosphorus and inorganic nitrogen pose a severe problem as urban development intensifies (Terrene Institute, 3/1994). Fertilizer spread on lawns during the winter contribute nutrients to runoff in the springtime. Similarly, animal waste contributes nutrients to stormwater runoff on a year-round basis. Other pollutants include detergents, and raw sanitary wastewaters.

Nutrients encourage undesirable algae blooms and excessive aquatic weed growth (Terrene Institute 3/1994). This process is eutrophication and it greatly decreases the water's quality. In lakes, for example, decomposing plants can cause surface scum, unpleasant odors, discoloration of water, release of toxins, and decreased oxygen. This breakdown of plant matter can limit swimming, boating, fishing and other recreational uses; reduce fish and wildlife habitat; and contaminate water supplies. It can, also, reduce tourism and property values.

Bacteria results from runoff that often contains high levels of harmful bacteria and viral strains, including fecal streptococcus and fecal coliform from human and animal wastes (Terrene Institute, 3/1995). In humans, gastroenteritis is the leading waterborne infectious disease in the United States (NJ-DEP, 1994). Deficient water treatment and ground water contamination of wells are responsible for most of the outbreaks and cases. Eating shellfish harvested from contaminated waters can also lead to disease.

Older more intensively developed areas produce the most bacteria from organic wastes and sewer overflows. As a result, the cost of treating drinking water supplies is increased.

Hydrocarbons, petroleum hydrocarbons in water are considered to be very harmful to the natural ecology. Some constituents are not only toxic to humans but are also carcinogenic (NJ-DEP, 1994). Oil and grease are not considered especially dangerous, with the exception of petroleum hydrocarbons and therefore control efforts are mainly directed at the hydrocarbons. Some are harmful to sensitive animal species (i.e., geese and ducks) and aquatic life (e.g. fish and photoplankton). Oil and grease problems are highest in runoff from parking lots, roads, and service stations. Residential land uses generate less hydrocarbon export, although illegal disposal of waste oil into storm sewers is a local problem (Scheuler, 1987).

Hydrocarbons are lighter than water and are initially found by the rainbow colored film on the water's surface (Scheuler, 1987). Hydrocarbons are attracted to sediment and settle to the bottom in water bodies. Once in the bottom sediments of a water body, harm to bottom dwelling organisms (i.e., benthic organisms) occurs and is transferred through the food chain. Hydrocarbons tend to rapidly accumulate in the bottom sediments of water bodies, where they persist for long periods of time, and eventually seep through to groundwater supplies and are carried to local streams. They lower dissolved oxygen levels by limiting the interaction of water and air.

Trace Metals found in water can have adverse effects upon public health and aquatic life. Lead, copper, cadmium, mercury, arsenic and some forms of chromium are all metals of concern. Among the sources of metals are roofing materials, down spouts, galvanized pipes, metal plating, paints, wood preservatives, catalytic converters, brake linings, and tires.

Metals occur naturally in soil and arise from man-made sources. The amount of these metals that leach into water from natural sources is influenced largely by the water's pH. Acid rain and the low pH water often found in swamps may increase the solution of metals into water. Although mercury and copper have been shown to cause serious health problems, lead is the metal of primary public health concern. It has a cumulative, toxic neurologic effect and may be particularly harmful to children. One of the principal sources of lead in stormwater runoff has been the lead in gasoline. However, pollution from this source is rapidly declining due to stringent federal controls over lead in gasoline.

Some trace metals found in stormwater runoff come from corroding, decaying metals (i.e., copper, automobiles, and drain spouts). The decaying process is often accelerated by acid rain, and the leaching of materials (i.e., land disposal operations).

Trace metals accumulate in sediments, posing a risk to bottom feeding organisms and their predators. Bioaccumulation of metals occurs in fish tissue, a risk to humans who eat them and restricts angling success. Trace metals affect the reproductive rates and life span of aquatic organisms, and hinder photosynthesis in aquatic plants. Trace metals can cause a health hazard if toxic metals contaminate the water supply.

Toxic Wastes are found in pesticides, fertilizers, herbicides, and household substances such as paints and cleaning materials. Toxic wastes result from stormwater runoff coming from lawns and golf courses treated with pesticides and fertilizers. Toxic wastes accumulate in sediments, posing a risk to bottom feeding organisms and their predators. Toxic wastes bioaccumulate in fish tissue and can kill fish and other aquatic organisms. The reproductive rates and life spans of fish and other aquatic organisms are affected. Photosynthesis is hindered in aquatic plants. Some toxic organics are carcinogens and create increased public health risk.

Thermal Energy is a rise in water temperature due to three events that occur together. First, the urban landscape heats up and in turn heats any runoff passing over it. Second, fewer trees are present on the streambank to shade the stream channel, adding to the warming effect. Third, runoff stored in shallow wet ponds and other impoundments is heated in between storm events, and is then released in a rapid pulse, following a storm (Scheuler, 1987)

An increase in temperature of only a few degrees can reduce or eliminate sensitive stream insects and fish species (i.e., mayflies and trout) (Scheuler, 1987). This is particularly true of streams that alternate seasonally between cold and warm water. In general, sustained summertime water temperatures in excess of 21 degrees Celsius (70 degrees Fahrenheit) is considered to be stressful, if not lethal, to many cold water organisms (Scheuler, 1987).

Increased stream temperatures reduce the vigor and growth of fish, and their resistance to disease. The dissolved oxygen decreases as stream temperature increases. As temperature increases the water supply is affected by increased corrosive action in drinking water pumps and equipment. The water quality is decreased by the production of odors and objectionable taste, and the favorable conditions for bacterial growth. Recreation is affected by the promotion of eutrophication of lakes and rivers; increased algae and weed growth that creates a public health risk, reduces fishing activities, and boating activities; decreased aesthetic value; and reduction of tourism and property values.

Chlorides or salts are a result of road salting to remove ice and snow. Chlorides run off roads, parking lots, and sidewalks, and flow into surface water bodies and ground water supplies. Salt levels in snow melt runoff have been reported to exceed several thousand milligrams per liter (about as salty as the Chesapeake Bay) (Scheuler, 1987). Due to salt's extreme solubility, almost all the chloride applied for snow removal ends up in surface and ground water resources (Scheuler, 1987).

Chlorides are toxic to many freshwater aquatic organisms, which can tolerate only a certain level of salinity. Increased levels of salt in surface and ground waters affect the soil, which creates stress on plant respiration and reduces plant viability. Excessive salt in water supplies also reduces drinking water quality.

Trash and Debris are floatable wastes that collect at impasses in streams and lakes, disturbing water flow and impairing the aesthetic quality of the environment. This debris, from street litter and careless disposal practices, washes into water bodies both over land and through the stormwater drainage systems. An increase of trash and debris in water bodies lowers dissolved oxygen levels, which results in the release of other pollutants into the water column.

Chapter 2 - Best Management Practices

Best Management Practices (BMPs) are techniques, often categorized as either structural or non-structural, to control the quantity and quality of stormwater runoff. Nonstructural practices are routines, procedures or land management planning strategies to prevent or reduce pollutants washed off by rainfall. In contrast, structural practices are treatment devices that reduce the amount of pollutants leaving a site by treating the runoff. The following information is provided to brief municipalities on available technology. Refer to "Literature Cited" for references that provide specific information on design, installation, and operation specifications. The following are the basis for applying BMPs:

- To establish a baseline control to reduce pollutants in stormwater runoff;
- To sufficiently reduce pollutant levels to eliminate or mitigate an existing water quality problem;
- To avoid the creation of future problems where no problems currently exist.

Benefits of BMPs

The community benefits in many ways when BMP techniques are incorporated into the land development tools (comprehensive plan, subdivision and land development regulations, and zoning ordinances). When implemented with new development activities, BMPs will function to minimize the impact of NPS pollution from the development. When installed as a treatment technique in existing developed areas, levels of NPS pollution reaching receiving streams may significantly be reduced. Each community may consider utilizing specific techniques or a combination of techniques to match the needs and maximum benefits to their community. It is important to understand that site specific use of BMP techniques and land use tools are required for effective control of stormwater runoff.

Environmental Improvement

- Quality and quantity of surface water and groundwater are maintained and improved.
- Increased water habitats/ increase aquatic wildlife.
- Buffer zones, provide vegetative cover that enhances wildlife and vegetative diversity.
- Vegetative areas help to stabilize water temperatures, as well as provide food, cover, and nesting sites for wildlife.
- Trees along streams prevent channel erosion, absorb noise - reducing noise pollution, provide shade - reducing stream temperatures and moderate air temperatures, and improve the landscaping value of the site.

Aesthetics/Land Values/Recreation

- Lands set aside for floodplains can double as playing fields, and hunting and fishing areas during dry periods.

- Aerators, fountains or cascades installed in ponds to increase dissolved oxygen can double as scenic also provide aesthetic enhancements to office and industrial complexes, residential communities.
- Land values may increase when natural settings are provided or enhanced within the residential areas of the community.
- Shopping areas are more appealing to the consumer when innovative BMP techniques are utilized in the commercial areas of the community.
- When water front properties are provided through the use of BMP basins, people are more likely to move into the area increasing the tax base with property taxes.

Educational Value

- BMPs can be utilized as a teaching tool, from elementary students learning about nature to college students learning ecology and biology
- The community can learn how nature works to take care of man-made pollutants. Developing tools to enhance the environment is a great way to teach community residents about the environment and get them involved in community development.
- Learning about our watershed helps people to understand the need to protect water resources.
- Government agencies can foster water stewardship by forming partnerships with stakeholder groups to encourage voluntary compliance with the community's water quality goals.
- Implementation of BMPs is an extension of water management on a watershed wide basin in that management of NPS pollution not only benefits the community at the project site but also benefits communities downstream.

Prevention of Flooding and Water Quality Problems

- The use of BMPs can help to prevent the flooding of downstream communities by managing the quantity, velocity, and direction of stormwater runoff.
- The use of BMPs can prevent the contamination of downstream water bodies by trapping pollutants.
- Downstream channel erosion is prevented when both the magnitude and frequency of the post-development storms are adequately managed with BMP technology.
- The downstream community's water quality is maintained when upstream communities use BMPs.

Nonstructural BMPs

Nonstructural best management practices prevent, reduce or eliminate pollutants before they are washed off a site by stormwater runoff. Nonstructural BMPs will reduce pollutant loadings on their own and enhance the performance when used with structural BMPs. The ability to reduce pollutants increases as BMPs are used together as a system. Public education and outreach in explaining these techniques and their benefits is important since they may involve changes to local government land use regulation and planning.

Nonstructural BMPs include:

- Comprehensive Planning
- Subdivision/Land Development Ordinances
- Single Purpose Ordinances
- Zoning Practices
- Maintenance Practices
- Pollution Prevention/Source Control

Comprehensive Planning

Land use planning in Pennsylvania is primarily a municipal and county government function. Local governments have the legal authority to develop comprehensive plans and programs to prevent pollution problems by protecting water quality, open spaces, stream valleys, and floodplains. This must be accomplished by balancing environmental needs with local economic needs.

Land use planning reduces pollutant loads in two ways: by managing the type, size, and location of development in a given area, and by reducing pollution generated at specific levels of development. Comprehensive planning provides general guidance in managing nonpoint source pollution. Specific practices are put in place through zoning laws that regulate development.

Subdivision/Land Development Ordinances

Stormwater management and water quality provisions may be introduced into municipal subdivision and land development ordinances providing specific regulations on how much runoff is to be controlled and how. These ordinances may include water quality requirements such as the need for extended detention of the first flush from a rain event and combining of BMP techniques. Sample language is provided in Chapter 3, Municipal Implementation of BMPs to amend an existing ordinance to include water quality provisions.

Single Purpose Ordinances

- Stormwater Ordinances outline the specific requirements for both the management of runoff and the protection of water quality from activities that may affect stormwater runoff. Similar to the requirements under a subdivision and land development ordinance, they may include water quality requirements such as the need for extended detention of the first flush from a rain event and combining of BMP techniques. Sample ordinance language is provided in Chapter 3, Municipal Implementation of BMPs.
- Erosion and Sedimentation Regulations provide for water quality protection by minimizing sediment from entering streams and other water bodies. They often require contractors at

construction sites to post bonds to cover potential damages from erosion, inspect and enforce the program.

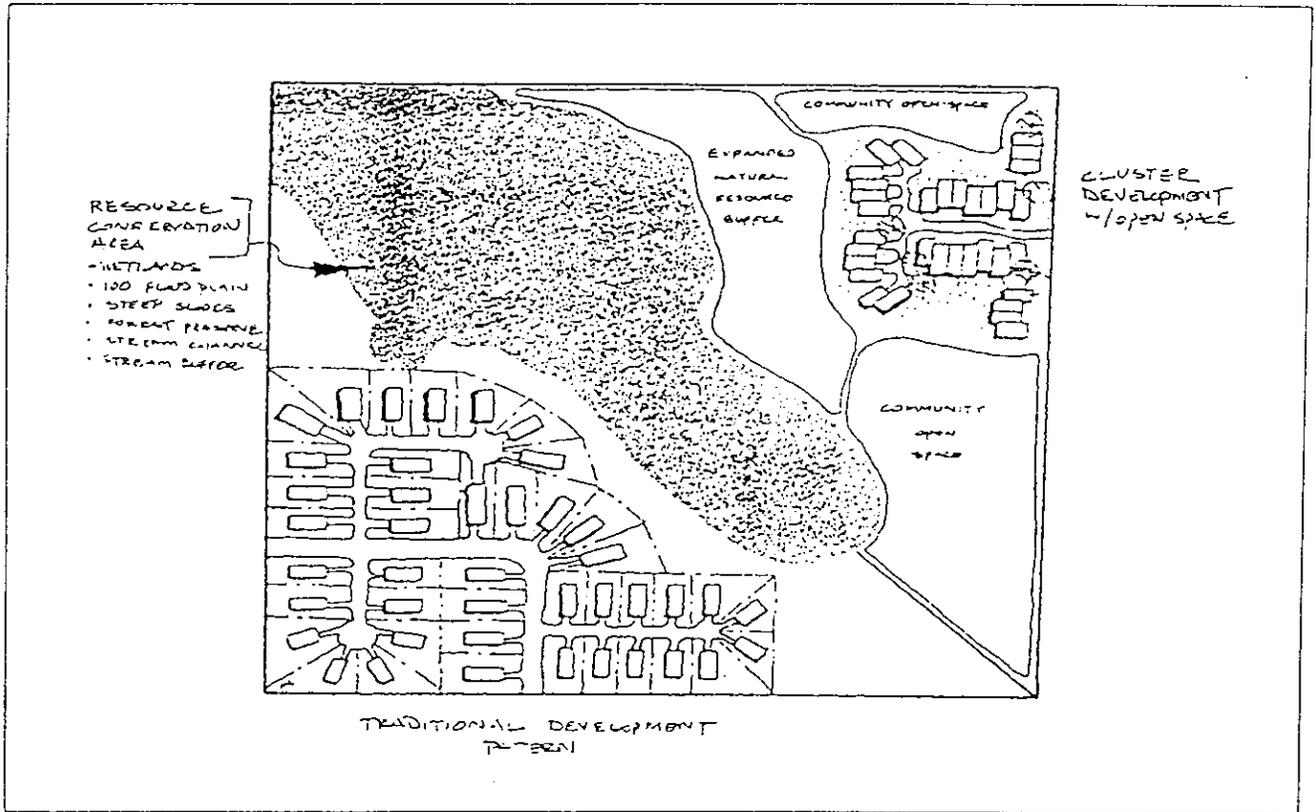
Zoning Practices

The zoning process specifies the density and type of land use that can occur in a given area. Zoning is the working arm of a comprehensive plan that controls overall local development and considers water quality and other environmental goals along with a myriad of community concerns. Zoning ordinances apply only to uses that begin after the ordinance is enacted, and therefore affect only future practices. Because zoning ordinances also regulate authorized uses (i.e. building, lot sizes, designs), they can be structured to control nonpoint source pollution. This control is particularly relevant on highly erodible steep slopes and shores or in high-density areas where developers must provide adequate drainage systems for their projects. Several types of zoning apply to water quality issues:

- Open Space (Cluster) Development (FIGURE 3) preserves the existing topography and open green space by concentrating residential development on a limited (and least sensitive) portion of the site. This leaves substantial area for amenities such as playgrounds, parks, and woods while preserving natural features such as steep slopes and timber stands.

Preserving open space and the existing tree canopy minimizes impervious surfaces and the resulting runoff. Also by following the land's natural contours, open space development may result in less earth disturbance as compared to traditional developments thereby reducing the potential for erosion, improving aesthetics, and preserving sensitive habitats. Open space development reduces the lengths of paved roadways and utilities needed, by keeping the same population density.

FIGURE 3- Open Space Development



(Metropolitan Washington Council of Governments, 1993)

Open space development minimizes the need to convert agricultural land to residential use. It also allows development to match actual site capacity. Homeowners and the public can enjoy many of the amenities of rural living within an urban environment. Open space development also helps maintain property values, one of zoning's basic goals.

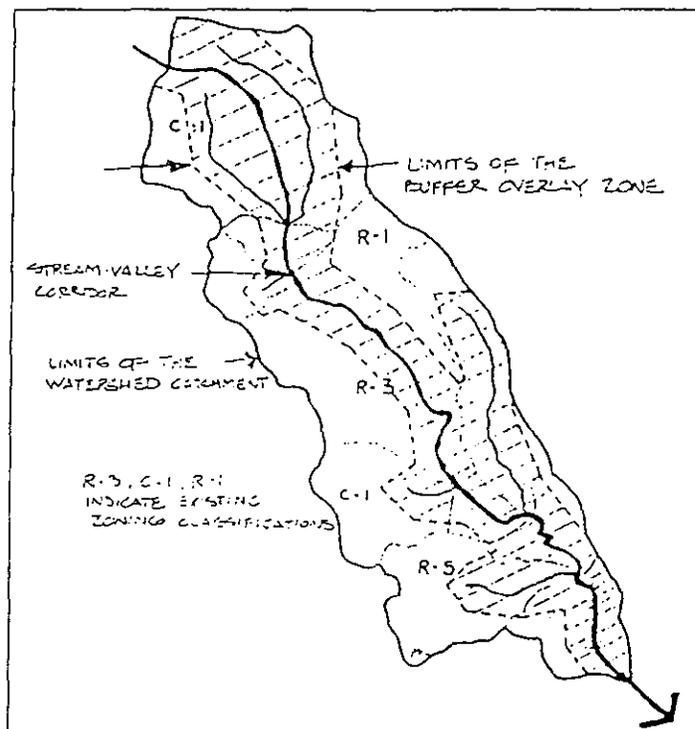
- Planned Unit Developments (PUDs) provide a mix of zoning classifications so that commercial, residential, and light industrial all occur within the same development. PUDs blend varying uses to create an attractive, interrelated unit that preserves both property values and aesthetics. A PUD's goal is to maintain density while maximizing open space. Communities may meet open space and recreation needs by ensuring that developers (who create the demand) providing for these needs rather than burdening the community with the responsibility. The ideal PUD locates residences and offices within walking distance of each other, reducing traffic.

A PUD's main water quality benefit is large-scale urban runoff management planning. Local governments control PUDs through negotiations between the developer, and the public review

authority. PUDs must maintain open space to facilitate stormwater drainage and may require developers to provide special structures to handle runoff.

- Incentive Zoning is used to promote open space development. It permits the developer to utilize higher density than normal in another area of development while maximizing open and/or public use of space or other amenities in a different location.
- Downzoning changes an established zone to a lower density level or to a less intense use. Typically, industrial zoning permits the most intense land use, followed by light industrial, commercial, and residential. Downzoning is used on strips of land adjacent to waterways to provide a buffer area between industrial sites and the streambank or on a whole area surrounding a waterbody to reduce or prevent pollution.
- Phase-in zoning is used when present development is incompatible with water quality goals, so that abrupt change would be too disruptive to the economy and the community. For example, a community may close and decontaminate an industrial area that is adversely affecting a lake in the area, rather than allow the land to continue as an industrial area.

FIGURE 4- Overlay Zoning



(Metropolitan Washington Council of Governments, 1993)

- Floating Zone is defined by characteristics rather than geographical location. The proposed use must be compatible with the surrounding uses and conform to the zone's expressed purposes. For example, multi-family dwellings that conform to specific code requirements regarding septic tanks, grading, and open space preservation could be acceptable in an area zoned for single family dwellings. Alternatively, a floating zone might restrict certain development in a wetland or around a well or aquifer recharge zone. A developer would need to show that the project does not fall within the area subject to floating zones or take adequate steps to protect water quality within the zone.

- Overlay Zoning (FIGURE 4) is a mapped district that places restrictions or requirements in addition to those of the underlying zone. Overlay zones are used to meet a special public interest that is not met by the existing zone or by rezoning. For example, these zones can protect specific water sources such as ponds, wells, or wetlands lying within residential, commercial, or industrial

zones. Stream valley corridor buffer overlay zones provide special protection for water resources located within the existing zones, reducing the impact of uses on water and natural habitat.

- Floodplain Zoning is an area where development is restricted, except for roads or other transportation facilities. Building in the floodplains is considered unsafe.
- Buffer zones around sensitive water resource areas can reduce the impact of stormwater runoff. Forested and grassed areas around water bodies can trap pollutants, encourage infiltration, and reduce erosion. Buffer zone regulations can be part of a community's and/or state's wetland protection laws, wellhead protection programs, and public surface drinking water programs. Benefits also include:
 - Reduces watershed imperviousness
 - Provides for effective flood control
 - provides streambank protection
 - improves habitat for wildlife
 - increases property values
- Setback requirements are discrete distances traditionally administered by boards of health and zoning boards to protect human health needs. They can also be used to protect resource areas, ensure ecological integrity, and avoid concentration of flood flows.
- Conservation Easements are an alternate method to protect land around critical resource areas. Easements are an effective tool to use along with designated buffer zones and setbacks. Traditionally, easements are negotiated between individual landowners, conservation organizations, or governments and included as part of the deed to the property. These easements limit users of all or portions of a property while leaving ownership to current landowners.
- Impervious Surface Reduction, can increase infiltration, which reduces pollution and flooding. Pollution from urban runoff increases when areas are covered with impervious materials that collect pollutants and then release them during rainstorms or snow melts. Impervious areas can be reduced by incorporating open spaces in urban areas, protecting wetlands, and using alternatives to impervious surfaces, such as gravel or porous pavement (discussed under the structural BMPs section). An important goal for every community is to minimize impervious areas that are directly connected to stormwater system. The minimization will help reduce storm flow volumes and velocity, and with proper implementation techniques, pollutant loadings. Zoning regulations can be used to ensure that new development includes vegetated open space areas.

Maintenance Practices

- Institute programs to remove accumulations of litter and debris. For example sponsor streambank cleanup and street sweeping
- Institute environmentally protective road maintenance practices. For example, cover salt storage areas, avoid excessive application rates, and consider low maintenance vegetation

instead of herbicide use. Deicing salts used on roadways can adversely effect water resources. Stormwater management programs should specify low salt application or salt substitutes such as sand or magnesium chloride in especially sensitive areas.

- Neighborhood recycling programs are designed to remove pollutants from urban and rural households. This can include recycling cans, bottles, and plastics, which often end up as floatable litter in water resources, and composting yard wastes (grass clippings and leaves). Also, household hazardous waste collection and proper disposal of wastes, such as used oil and antifreeze, ensure that these pollutants do not enter the stream.

Pollution Prevention/Source Controls

- Exclude Inappropriate Discharges to Stormwater Systems: Encourage proper use and disposal of materials by homeowners. The contaminants addressed by this control activity include materials, such as fertilizers, pesticides and herbicides, oil and antifreeze, paints, and solvents. Specific actions for preventing discharge include educating the public about the proper storage and use; developing and implementing programs for recycling; strengthen and enforce existing regulations; and label storm drain inlets.
- Use of pesticides and fertilizers in developed areas are at an application rate of two or three times greater than that used for agriculture. This increases the likelihood that pollutants may enter the water resource area. Communities can lower the impact of these substances on receiving water by reducing their use and switching to slow release fertilizers.
- Reduce Street and Land Surface Sources of Pollutants: Controlling litter and improper waste disposal practices. This program will improve the general aesthetic appearance of the area along with pollution control. Specific actions include educating about nonpoint source pollution, providing funds for research, strengthen and enforce existing regulations, develop and implement community clean up days, and provide and maintain litter receptacles.
- Control animal waste. Animal waste is a source of bacteria in stormwater runoff. The level of bacteria can be lowered by reducing or eliminating waste left where it can be washed into stormwater runoff. Regulations requiring collection and proper disposal of pet wastes from yards, parks, and roadways, and other developed areas can prevent this problem.

Implementing the nonstructural BMPs requires a strong commitment from local officials and extensive planning and community cooperation. Community review boards must investigate development plans closely to determine the nonstructural BMPs that can be included in their community land use control mechanisms. Residents living in areas close to water resource areas must also be aware of their responsibility to protect these resources. Nonstructural BMPs can be used in conjunction with well-planned structural BMPs. Comprehensive stormwater runoff control needs to include nonstructural BMPs to be successful.

Structural Bmps:

The structural BMPs outlined in this report are a sampling of current devices being utilized. These devices have evolved from single purpose stormwater quantity control to ones exhibiting both quantity and quality benefits.

Structural stormwater BMPs fall under four categories:

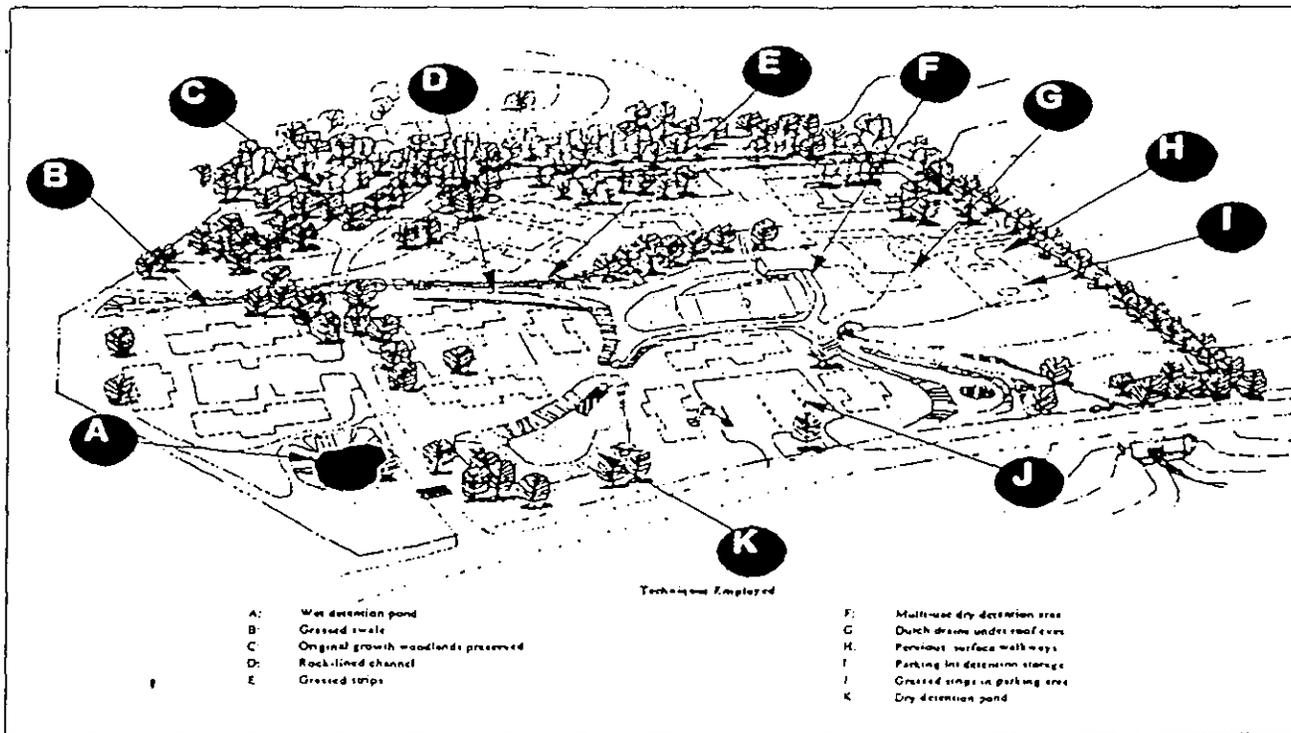
- Vegetative Practices
- Infiltration Practices
- Basins
- Water Quality Inlets/Treatment Devices

The success or failure of BMPs are tied to factors occurring within three stages of its life: design, construction, and maintenance. For example, although a structure may be designed correctly for volume control and water quality, it will still fail if the design is not adhered to during construction or if it is not maintained as designed. Experience has shown that even small changes in the life stages of BMPs can lead to performance failure concerning the designed function.

General information about the design, pollutant removal mechanisms, and maintenance is described in this section. Although the physical site suitability of a BMP is an important component, this report could not present details on this due to the complexity and specificity of physical site suitability. We recommend consulting references presented under Literature Cited for more information.

An important concept to remember is that Structural BMPs are best utilized in combination or in conjunction with nonstructural BMPs. Since no single BMP is 100% effective in removing pollutants, the most effective water quality control for a site can be accomplished using BMPs together in a system. For example, a vegetative filter strip may be placed in front of a wet basin. Structural BMPs should be viewed as a means to reduce pollutants only and not a means of eliminating pollutants entirely. FIGURE 5 illustrates how various techniques can be integrated on a development site.

FIGURE 5- Integrating BMP Techniques



Chester Engineers, 1996

Vegetative Practices

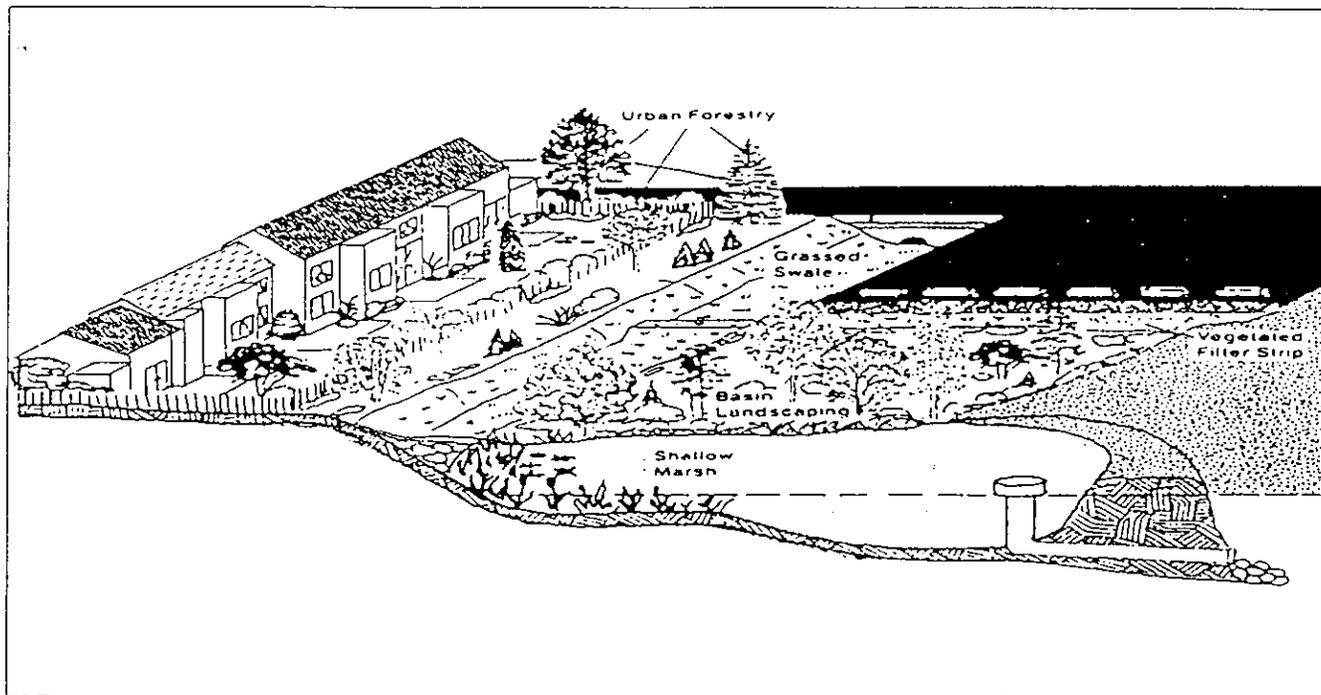
Vegetative BMPs (FIGURE 6) are used primarily to reduce the velocity of stormwater runoff, thereby preventing erosion, promoting infiltration and settling of suspended solids. Less costly than other control practices, vegetative practices enhance the attractiveness and value of sites. Using vegetative controls to pre-treat runoff improves the operation and maintenance of other BMPs.

Vegetative practices may be effective in removing up to 50% of suspended solids during small storms. Vegetation practices also remove trace metals, organic material, and nutrients. Removal rates are achieved by infiltration, settling, plant uptake, and microbial processes. These are important when combined with other BMPs in a system. The success of vegetative practices relies on proper construction and maintenance.

All of these practices rely on various forms of vegetation to enhance the pollutant removal, habitat value or appearance of a development site. While each practice by itself is not generally capable of entirely

controlling the increased runoff and pollutant export from a site, they can improve the performance and amenity value of other BMPs and are considered an integral part of every site plan.

FIGURE 6- Vegetative BMPs

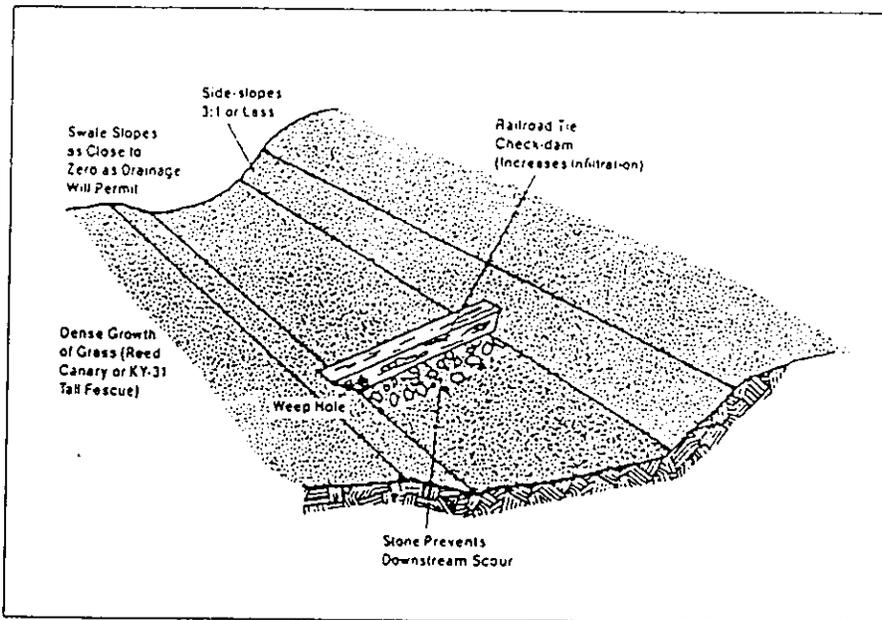


(Schueler, 1987)

Typically, the costs for vegetative BMPs are very small in relation to those incurred when constructing ponds and basins. Also, vegetative BMPs are applicable during any stage of development and in some instances, may be retrofitted to improve water quality in a degraded area. These practices may last an indefinite period of time if properly designed, periodically mowed, and if removal of sediment deposits occurs from time to time.

- Grassed Swales (FIGURE 7) are a common vegetative practice used in many modern single family residential developments and highway medians. A grassed swale is a linear area of grass. The purpose of a grassed swale is to retard or impound concentrated runoff, to induce infiltration, and decrease velocities. Grassed swales utilize check dams to provide stormwater management for small design by infiltration and flow attenuation (Maryland Water Resources Administration, 1984). A BMP train utilizes swales downstream to meet stormwater management requirements.

FIGURE 7- Grassed Swale



(Schueler, 1987)

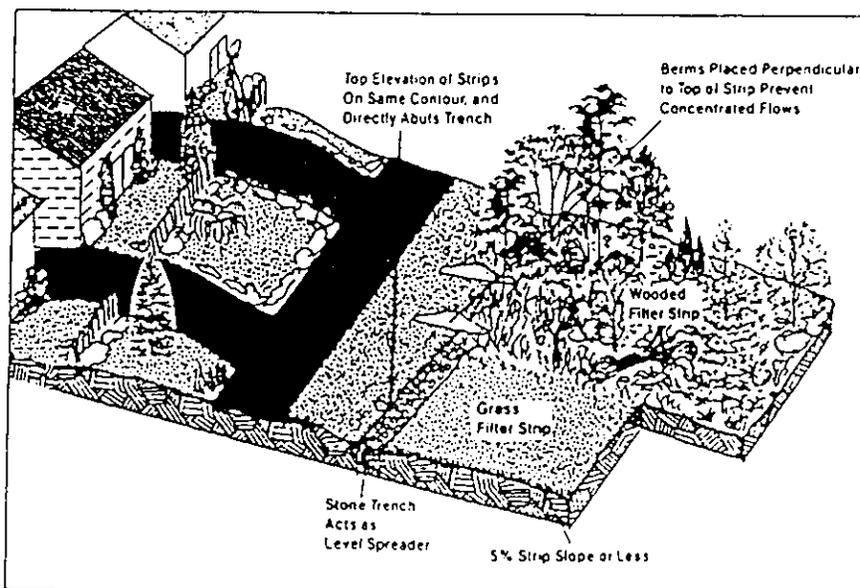
Grassed swales are usually less expensive than the curb and gutter alternatives, but may require more land. Swale maintenance is performed by adjacent homeowners and basically involves normal lawn care activities, such as mowing and periodic sediment removal.

Modeling efforts and field studies indicate mixed results of grassed swales to filter out particulate pollutants under certain site conditions. Trace metals can be leached from grassed swale culverts and nutrients leached from intensive lawn fertilization may actually increase the export of these pollutants. Pollutant removal occurs by the filtering action of the grass, deposition in low velocity areas, or by infiltration into the subsoil.

Grassed swales are usually less expensive than the

- Filter Strips (FIGURE 8) are similar in many respects to grassed swales, except that they only accept overland sheet flow. Runoff from an adjacent impervious area must be evenly distributed across the filter strips. Their purpose is to reduce the velocity of stormwater runoff.

FIGURE 8- Filter Strips



(Schueler, 1987)

They remove sediments and pollutants by filtering, adsorption, and gravity sedimentation. To work properly, a filter strip must be equipped with some sort of level spreading device; be densely vegetated with a mix of erosion resistant plant species that effectively bind the soil; graded to a uniform, even and relatively low slope; and be at

They remove sediments and pollutants by filtering, adsorption, and gravity sedimentation. To work properly, a filter strip must be equipped with some sort of level spreading device; be densely vegetated with a mix of erosion resistant plant species that effectively bind the soil; graded to a uniform, even and relatively low slope; and be at

least as long as the contributing runoff area.

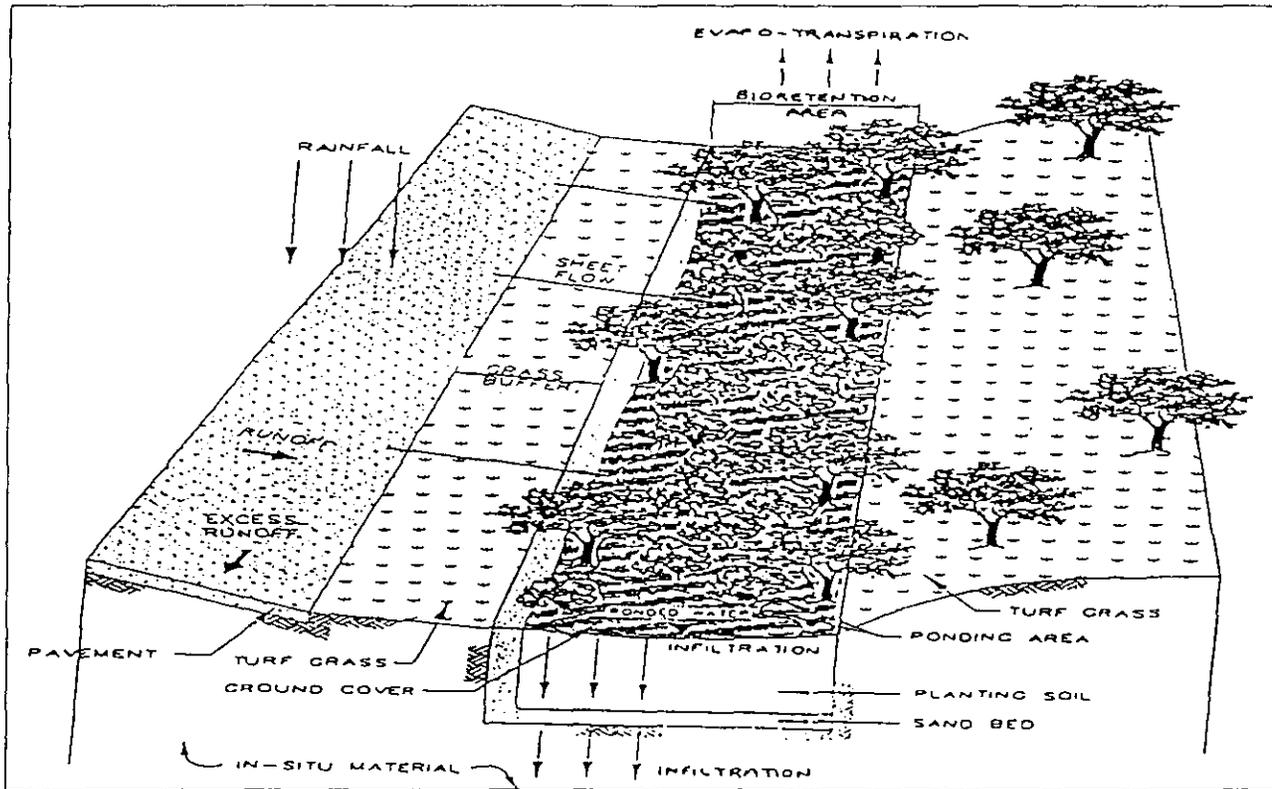
Modeling studies indicate that filter strips can remove a high percentage of particulate pollutants. Filter strips are relatively inexpensive to establish and cost almost nothing if preserved before the site is developed. A creatively landscaped filter strip can become a valuable community amenity providing wildlife habitat, screening and stream protection.

- Urban Forestry involves preserving trees during construction, planting them after site clearance, or allowing landscaping by homeowners after the site is fully developed. Careful landscape design can provide as much as 50% of a residential lot to be converted into an attractive natural setting of trees, shrubs and ground covers. The runoff from these landscaped areas is generally 30-50% less than those from lawn areas. The cost and maintenance requirements for most urban forestry practices are quite low, with a high environmental amenity.

Urban forestry removes pollutants through plant uptake and storage, reducing the volume of storm runoff (and associated pollutants) delivered from the site and preventing soil erosion. When planted along streams, they prevent channel erosion, absorb noise - reducing noise pollution, provide shade - reducing stream temperatures and moderating air temperatures, and improve the landscaping value of the site.

- Basin Landscaping is a critical element in the design of stormwater basins. The variety of plant species used to stabilize a basin has a profound influence on the basin's removal performance, appearance, habitat value, and maintenance requirements. Landscaping around a basin reduces the amount of impervious surface area, provides an attractive, green buffer along stream banks, and protects and enhances the use of existing wetlands. Proper landscaping can route stormwater runoff through green areas and away from erosion prone steep slopes and other areas.
- Bioretention (FIGURE 9) facilities are designed to be used in urban and suburban areas as off-line systems (locate away from a water body or system) to treat the first flush of runoff. The facility is a combination of three types of treatment processes - filtration, infiltration, and plant uptake - designed into one system. Vegetation selected for Bioretention will assimilate pollutants, survive in harsh conditions, and tolerate fluctuating water levels and soil moisture conditions.
- Riparian Buffers are areas (buffers, zones, and corridors) located immediately adjacent to water resources. Riparian zones contribute to the integrity of a resource area by influencing the quality of the water and habitat as well as the amount of water and energy entering the system. As such, they are a multi-purpose practice for watershed management. From a water quality perspective, they are effective as treatment devices to be incorporated into the overall management system. Implementation of riparian areas occurs through several methods including site planning, enhancement of an existing area, or restoration of a disturbed area.

FIGURE 9- Bioretention



(Prince George's County, MD)

Riparian areas along streambanks can stabilize soil, cool water, and benefit many forms of aquatic life. Pollutant removal includes suspended solids, phosphorus, nitrates, trace metals, litter, pesticides, and hydrocarbons. The primary removal mechanisms are filtering and attenuation.

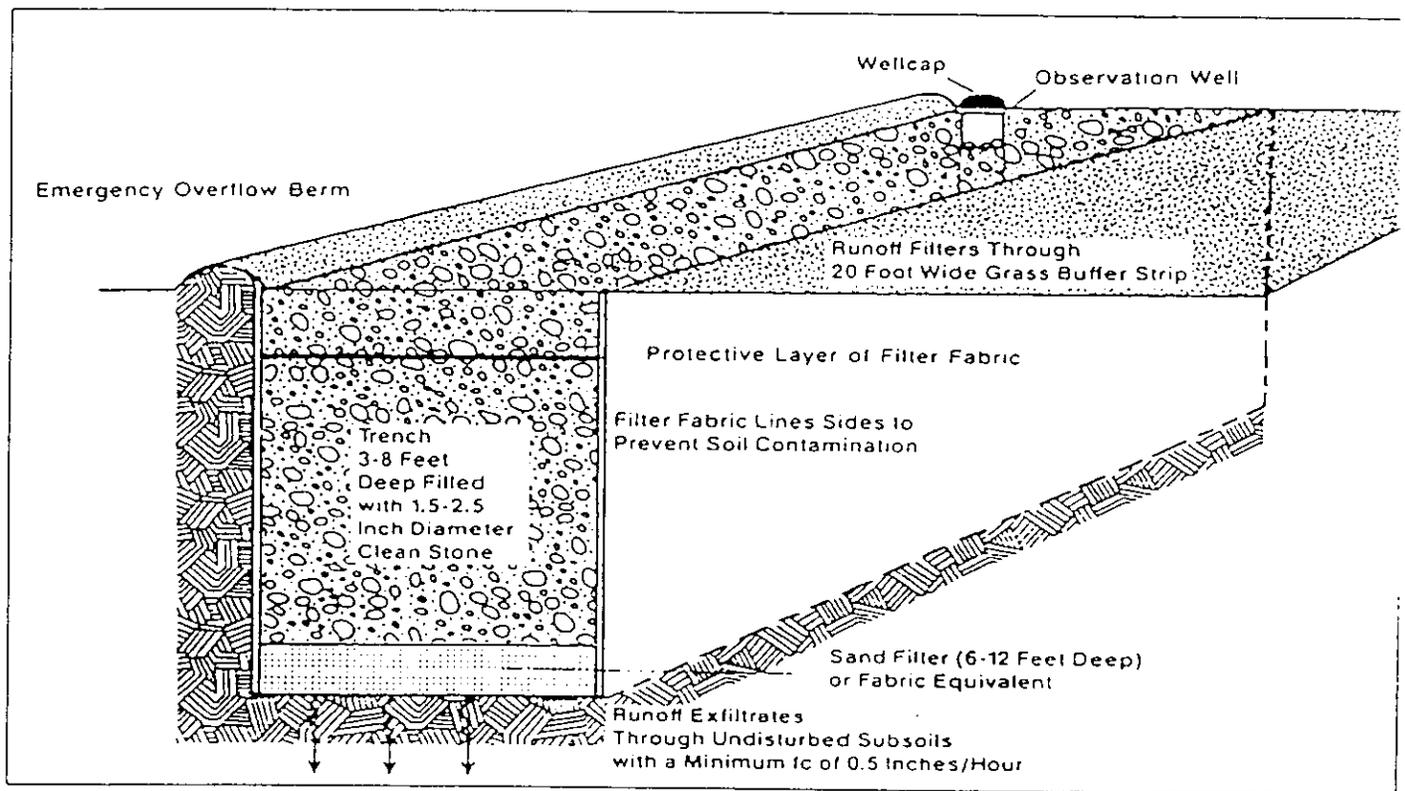
Infiltration Practices

Infiltration practices remove pollutants from stormwater runoff. Specific types of infiltration BMPs include infiltration trenches, infiltration basins, and porous pavement. It is important to note that the concept of infiltration practices, although accepted, have variable efficiency and longevity. Careful planning and consideration need to precede implementation of infiltration practices. Infiltration practices that are poorly planned and installed have failed completely.

The infiltration and adsorption mechanisms trap many pollutants - particularly suspended solids, bacteria, heavy metals, and phosphorous - in the upper soil layers and prevents them from reaching the water table.

- Infiltration Trenches (FIGURE 10) are an adaptable BMP that effectively removes both soluble and particulate pollutants. As with other infiltration systems, trenches are not intended to trap coarse sediments. Grass buffers, or special inlets, installation is to capture sediment before it enters the trench. Depending on the degree of water storage achieved, trenches can provide groundwater recharge, low flow augmentation, and localized streambank erosion control.

FIGURE 10- Infiltration Trench



(Schueler, 1987)

Individual trenches are primarily an on site control, and are seldom practical or economical on sites larger than 5 or 10 acres. Trenches are only feasible when soils are permeable and the water table and bedrock are situated well below the bottom of the trench. Besides regular inspections and more rigorous sediment and erosion control, trenches have limited routine maintenance requirements. However, trenches will prematurely clog if sediment gets into the trench before, during, and after construction of a site. If a trench does become severely clogged, partial or complete replacement of the structure may be required.

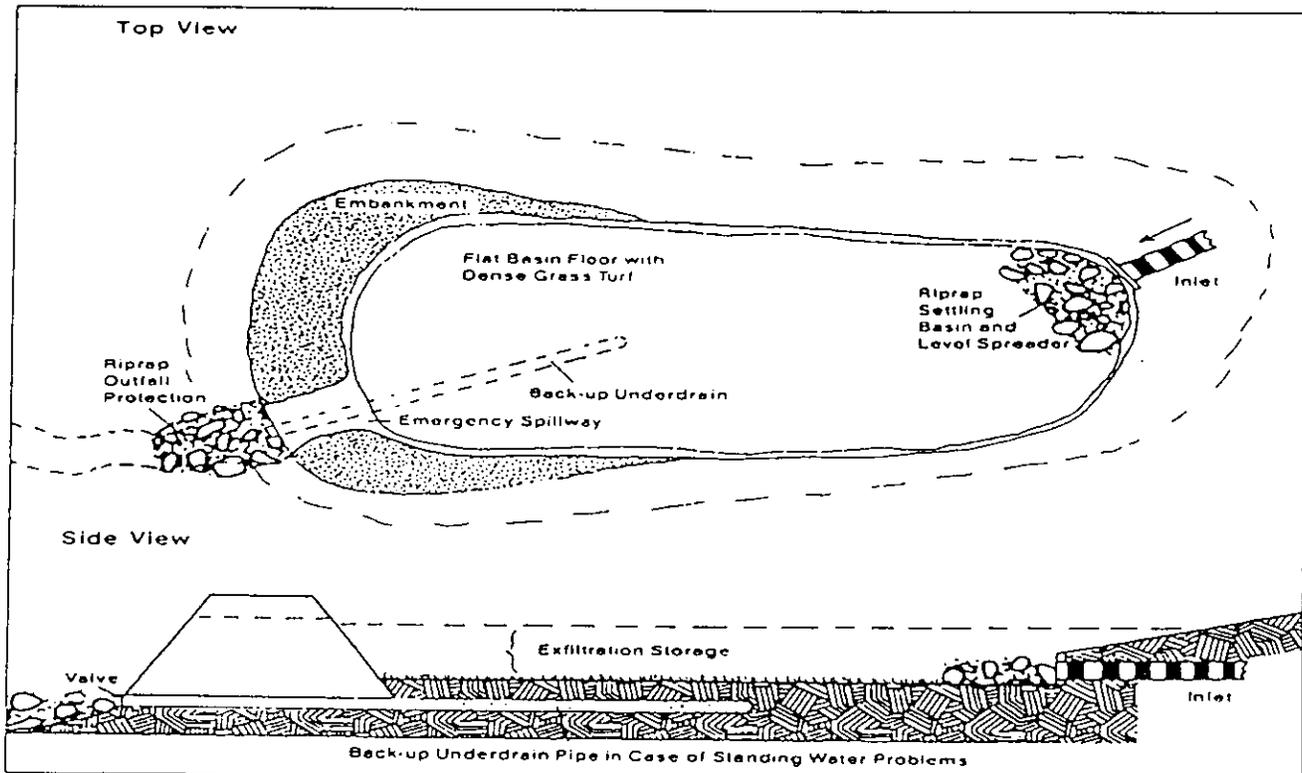
Infiltration trenches preserve the natural groundwater recharge capabilities of the site, are relatively easy to fit into the margins, perimeters and other annualized areas of a development site. They are one of the few BMPs that provide pollutant removal on small sites or infill developments.

Infiltration trenches include practical difficulties in keeping sediment out of the structure during site construction (particularly if development occurs in phases) and the need for careful construction of the trench and regular maintenance thereafter. There is also a possible risk of groundwater contamination.

- . Infiltration Basins (FIGURE 11) have the potential to effectively remove both soluble and fine particulate pollutants from in urban runoff. Coarse grained pollutants should generally be removed before they enter a basin. Unfortunately, these basins are notoriously short lived. Studies have shown that few basins surveyed were capable of infiltrating runoff after five years and often revert into a marsh system. Unlike other infiltration systems, basins can be easily adapted to provide full control of peak discharges for large design storms. Also, basins can serve relatively large drainage areas, up to 50 acres. Depending on the degree of water storage achieved in the basin, significant groundwater recharge, low flow augmentation and localized streambank erosion control can be achieved.

Basins are a feasible option where soils are permeable and where the water table and bedrock are situated well below the soil surface. Both the construction costs and maintenance requirements for basins are similar to those for conventional dry ponds (discussed later in the basin section). Infiltration basins do need to be inspected regularly to check for standing water.

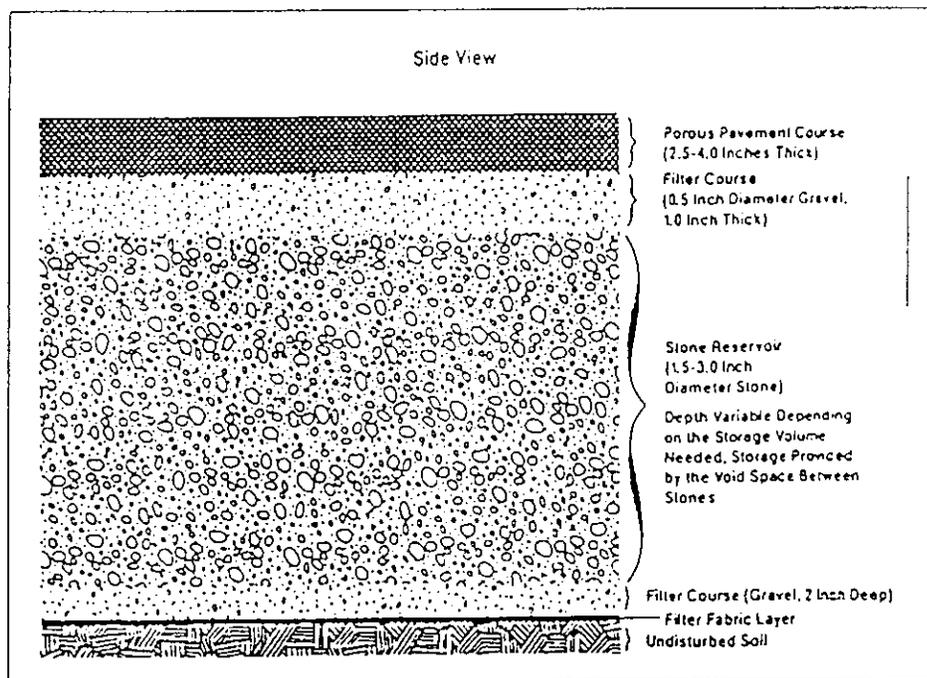
FIGURE 11- Infiltration Basin



(Schueler, 1987)

- Porous Pavement (FIGURE 12) is capable of removing both soluble and fine particulate pollutants in urban runoff. It also provides groundwater recharge, low flow augmentation, and streambank erosion control. Porous pavement's use is generally restricted to low volume parking areas, although it can accept runoff from rooftop storage or adjacent conventionally paved areas. Porous pavement is only feasible on sites with gentle slopes, permeable soils, and relatively deep water table and bedrock levels.

FIGURE 12- Porous Pavement



The major drawback associated with porous pavement is that if it becomes clogged it is difficult and costly to restore. The risk of premature clogging of porous pavement is fairly high, and can be prevented only if sediment is kept off the pavement before, during and after construction.

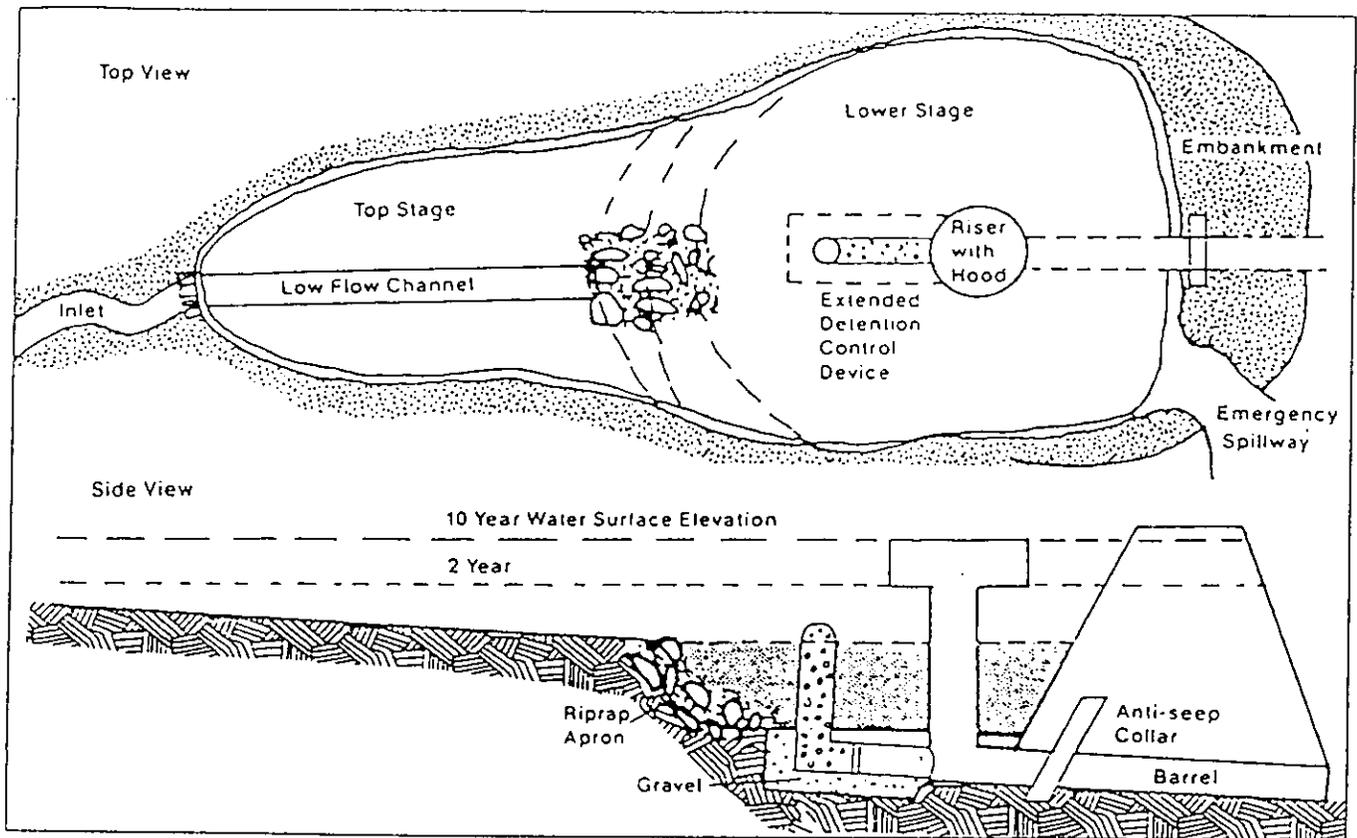
Schueler, 1987

Basin Practices

Basin practices control stormwater by retaining runoff and slowly releasing it to surface waters. Basin practices rely heavily on settling of particulate for pollutant removal. Regular maintenance of these facilities is critical, but cost is low. Basin practices include detention ponds, extended detention ponds, wet basins, and constructed wetlands.

- Detention Ponds temporarily store excess runoff from a site and slowly release it to the surface's natural drainage system. A detention basin has no permanent water pool and is considered a dry basin except during periods of stormwater runoff. It provides settlement of particulate pollutants.
- Extended Detention Basins (FIGURE 13) or dual purpose ponds extend the detention time of dry or wet ponds. It is an effective, low cost means of removing particulate pollutants and controlling increases in downstream bank erosion. However, extended detention only slightly reduces levels of soluble phosphorus and nitrogen found in urban runoff. Removal of these pollutants can be enhanced if the normally inundated area of the pond is managed as a shallow marsh or a permanent pool.

FIGURE 13- Extended Detention Basin



(Schueler, 1987)

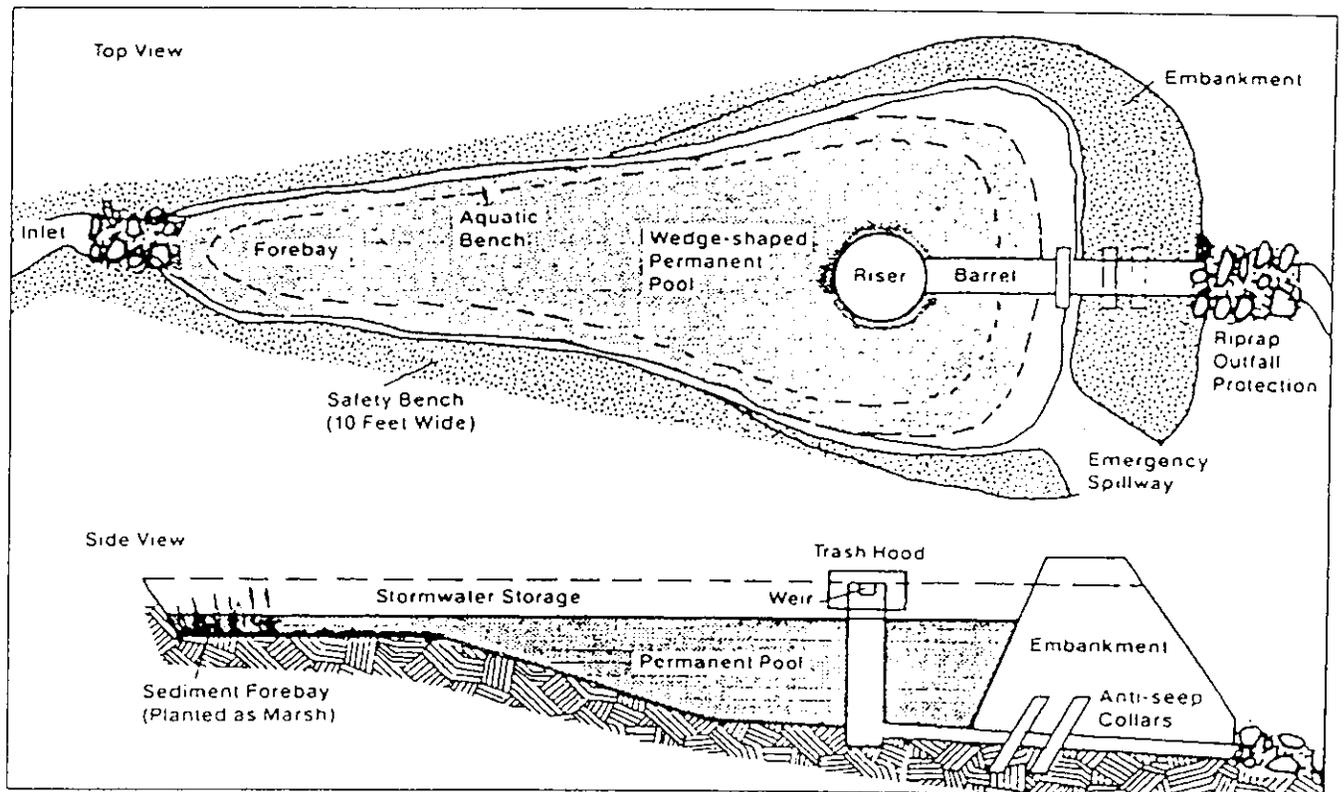
Extended detention ponds are effective in controlling post development discharge rates to the desired pre-development levels for the design storm specified. The optimum level of flood control is achieved when multiple design storms are controlled. Recent modeling analyses suggest that control of both the 2 and 10 year design storms may be sufficient to adequately control the entire range of expected flood frequencies (Schueler, 1987). Extended detention ponds are also capable of managing smaller floods that contribute to channel erosion problems occurring more frequently than the one or two year flood. The desired downstream reduction in peak discharge associated with the two year flood may not be achieved in watersheds if the ponds are randomly sited, due to the location and timing of individual releases (Schueler, 1987). Generally, watershed timing problems are not a concern during smaller, more frequent storms because of the low discharge rates of extended detention ponds.

Traditionally, detention ponds have reduced the extent of downstream channel erosion. Research has demonstrated that bank-full discharges control the shape and form of natural channels. Many local governments have subsequently adopted stormwater management policies that require the post-development peak discharge for the two year storm be controlled to pre-development levels. However, keeping the post-development two year design storm within the streambanks are normally insufficient in preventing downstream bank erosion, because the two year flood is itself an erosion condition mechanism.

Extended detention ponds have moderate to high routine maintenance requirements, and the eventual need for sediment removal. They are applied in most new development sites, and is an attractive option when retrofitting dry ponds in older urbanized areas.

- Wet Basins (FIGURE 14) or retention ponds are earthen embankments or excavated ponds that contain a permanent pool and temporarily stores excess runoff. The excess stormwater is then released to an existing stream channel at a rate that is no greater than the peak pre-development discharge rate. The existing stream system will not experience a greater flooding than would have occurred before development took place. However, longer duration flows may cause some stream degradation. Retention basins generally do not decrease the volume of runoff, but do decrease the rate of runoff. Excess runoff is discharged through an outlet or emergency spillway. The main purpose is the retention of stormwater runoff and for the settlement of particulate pollutants.

FIGURE 14- Wet Pond



(Schueler, 1987)

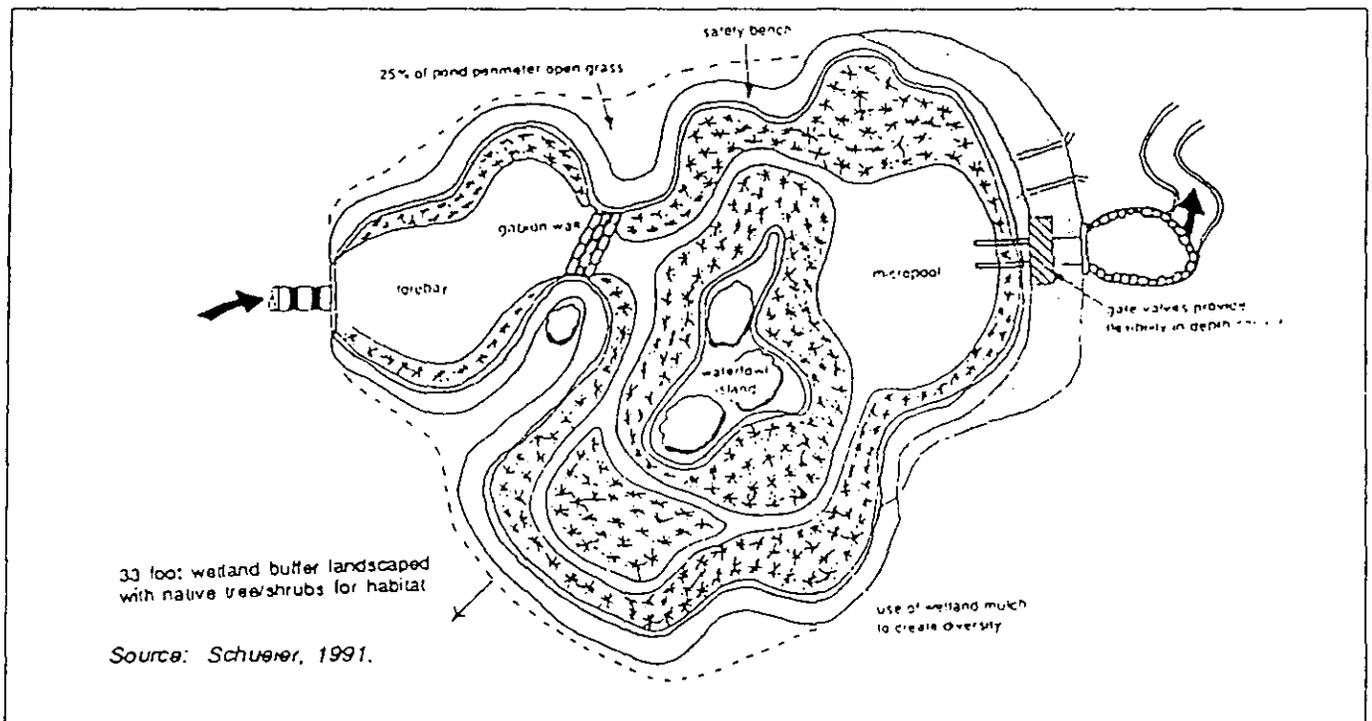
Wet ponds are capable of removing a high rate of sediment, BOD, organic nutrients and trace metals. Wet ponds are most cost-effective in larger, more intensively developed sites (Schueler, 1987). They have the potential to provide a great deal of storage volume to control flood waters and attenuate peak flows if enough space exists to accommodate a larger pond

Impacts can include higher property values due to aesthetics, and recreation. Other impacts can include upstream and downstream habitat degradation; potential safety hazards; nuisance problems like odor, algae and debris; and the eventual need for sediment removal or maintenance cost.

Wet basins should not be confused with wetlands. Wet ponds have a deeper permanent pool, less emergent vegetation and an outlet structure. They should be used in areas where infiltration techniques due to poor soil infiltration or permeability cannot be implemented.

- Constructed Wetlands, or created or artificial wetlands, artificial marshes, and artificial wetland systems, (FIGURE 15) can treat stormwater runoff effectively by combining the pollutant removal capabilities of structural stormwater controls with the flood storage provided by natural wetlands. Careful design, the choice of vegetation, and potential pre-treatment requirements are crucial to this systems effectiveness.

FIGURE 15- Constructed Wetland



(Met. Wash. Council of Governments, 1992)

A constructed wetland consists of a properly designed basin that contains water, a substrate, and, most commonly, vascular plants. Hydrology is the most important design factor in constructed wetlands. Hydrology links all of the functions in a wetland and it is often the primary factor in the success or failure of a constructed wetland. Substrates used to construct wetlands include soil, sand, gravel, rock, and organic materials such as compost. Both vascular plants and non-vascular plants are important in constructed wetlands. A fundamental characteristic of wetlands is that their functions are largely regulated by microorganisms and their metabolism. The microbial biomass is a major sink for organic carbon and many nutrients. Invertebrate animals, such as insects and worms contribute to the

treatment process. Constructed wetlands also attract a variety of amphibians, turtles, birds, and mammals that enhance its aesthetic value.

Constructed wetlands can remove suspended solids, nutrients, oil and grease, bacteria, and trace metals. The wetland's system pollutant removal mechanisms are settling, and plant uptake. The mechanisms that are available to improve water quality are numerous and often interrelated. These mechanisms include:

- settling of suspended particulate matter
- filtration and chemical precipitation through chemical transformation, adsorption and ion exchange
- breakdown and transformation of pollutants
- uptake and transformation of nutrients
- predation and natural die-off of pathogens

The treatment of stormwater by constructed wetlands can be a low-cost, low-energy process requiring minimal operational attention. The use of constructed wetlands to improve water quality is a developing technology. Constructed wetlands for water treatment are complex, integrated systems of water, plants, animals, microorganisms, and the environment. Wetlands are transitional areas between land and water. Under appropriate circumstances, constructed wetlands can provide:

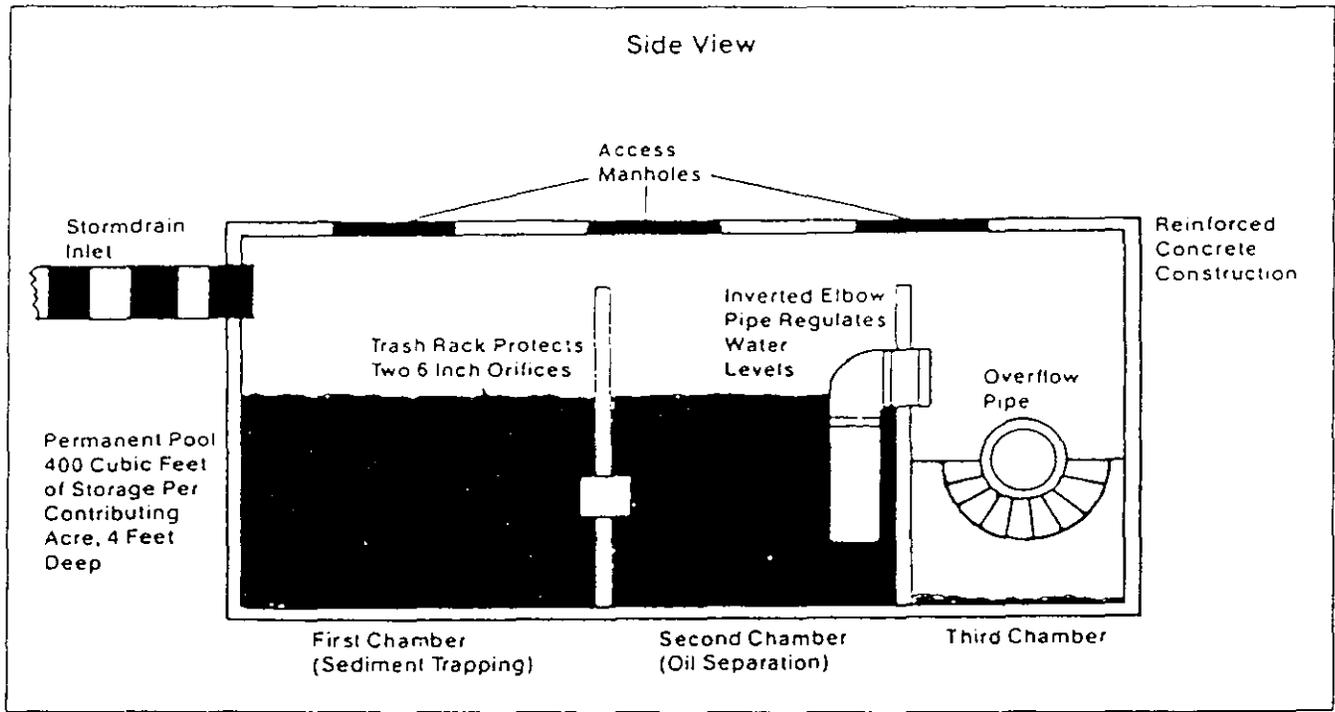
- water quality improvement
- flood storage
- cycling of nutrients and other materials
- habitat for fish and wildlife
- passive recreation, such as bird watching
- active recreation, such as hunting
- education and research
- aesthetics and landscape enhancement

Constructed wetland systems can combine with conventional treatment technologies. Species diversity increases as ecosystems mature. It is generally assumed that decomposition of contaminants in sediments and litter are long-term sinks for contaminants.

Water Quality Inlets

- Oil and grit separators (FIGURE 16) are designed to remove sediment and hydrocarbon loadings from parking lot runoff in a three stage underground retention system, before they are conveyed to the storm drain network or to an infiltration BMP. Separators generally serve parking lots of one acre or less in size, and are particularly appropriate for sites that are expected to receive a great deal of automobile traffic or petroleum inputs (i.e., gas stations, roads, loading areas). Routine maintenance costs are high since the inlets must be cleaned out at least twice a year to permanently dispose of trapped pollutants and to ensure proper inlet function.

FIGURE 16- Water Quality Inlet



(Shueler, 1987)

Separators are compatible with the storm drain network, easy to access and capable of pre-treating runoff before it enters an infiltration BMP. Water quality inlets are capable of removing coarse-grained sediments, litter, and hydrocarbons. The primary removal mechanisms are settling, and separation. Limited information exists on the efficiency of these structures. Results generally depend on the volume of water detained permanently, the velocity of flow, and the design of the tank. Well-maintained separators are capable of removing up to 25% suspended solids, 75% oil and grease, and 25% trace metals.

These separators are relatively small, so they can be placed throughout a drainage system to capture coarse sediments, floating wastes, and accidental or illegal spills of hazardous wastes and thus reduce maintenance of infiltration systems or detention basins. Separators can be adapted to all regions.

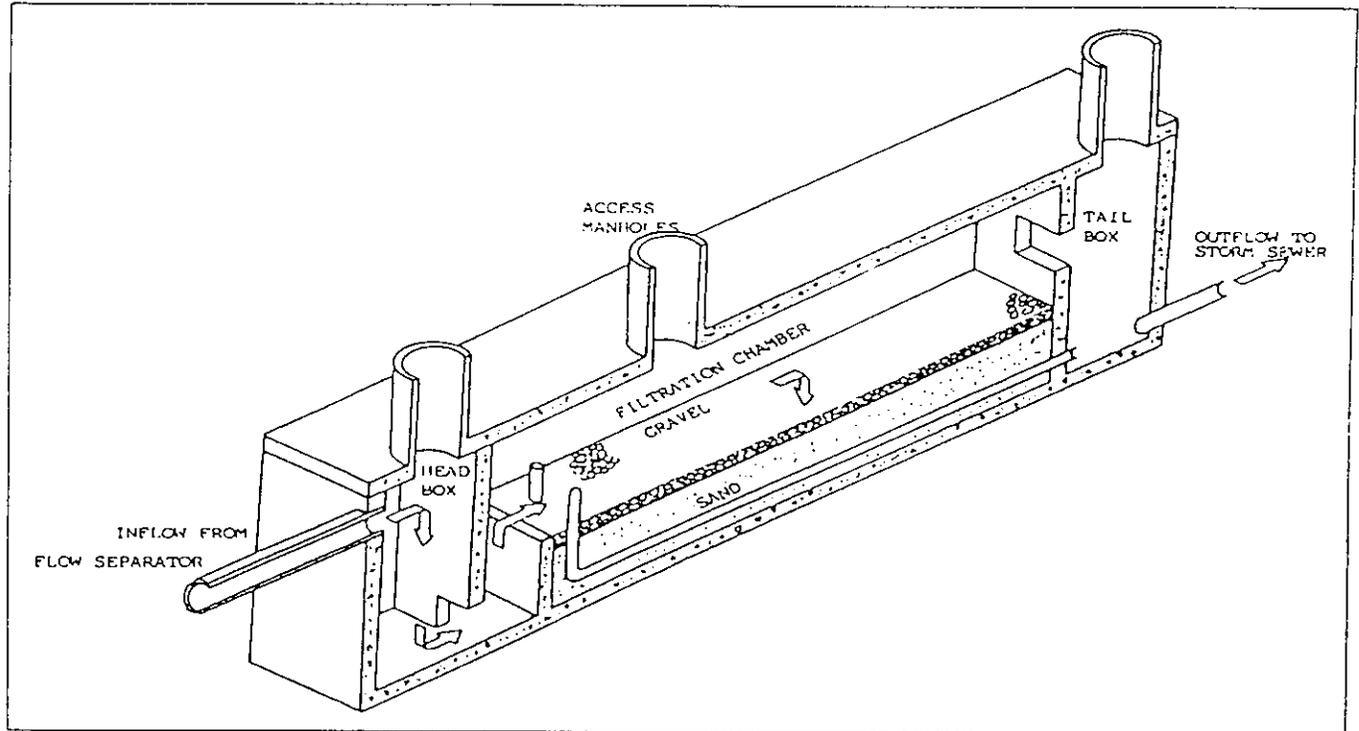
- Sand Filters (FIGURE 17) pre-treat stormwater runoff before it enters another stormwater structure. They are suitable for small sites in highly impervious areas and retrofit into existing urban areas. Erosion control devices need to be in place, due to clogging

Sand filter design is mainly to enhance water quality. However, sand filters are used to control first flush water quantity in smaller drainage areas. First flush examples include densely developed downtown areas, gas stations, commercial and industrial sites, and parking lots.

The removal efficiency for sand filters is relatively high for some pollutants, while variable and in some cases a net exporter of others. This overall variability suggests that the sand filter should be used as

part of a treatment system to achieve maximum pollutant removal efficiently. Sand filters have average removal rates for suspended solids, nitrogen, dissolved phosphorus, fecal coliform, and trace metals. Sand filters to date suggest that the nitrification process occurs in the system, producing a net export of nitrates.

FIGURE 17- Sand Filter



(Amini, Truong & Chang)

Most of the maintenance requires manual labor, such as raking, disposal of contaminated sand, and trash, debris, and leaf litter removal. The design should accommodate appropriate access for maintenance to occur. The removed contaminants can be landfilled because they are non-toxic. Sand filters are costly, but live long and possess a reasonable maintenance burden. Periodic sand removal is required and annual inspections should take place.

Sand filters are adaptable to most development sites and have few constraining factors. They can be used in areas of poor soil infiltration or where groundwater concerns restrict the use of infiltration techniques.

- Advanced Treatment Devices are recent innovations that have evolved from earlier water quality inlet technologies. Two major variations of these devices exist which separate out and retain pollutant laden sediment and grit, floatables and oils by either passing flow through baffles with pollutants collecting into a lower storage compartment or by passing flow in a vortex-like path with pollutants collected in a circular grit chamber. As in water quality inlets, periodic cleaning is required usually by vacuum through manholes. It has reported by the manufacturers that these devices provide significant

improvements in efficiency in trapping pollutants and maintenance as compared to older oil/grit separators and other water quality inlet designs. Other reported benefits include wider ranges of applications and flexibility in locations.

Chapter 3 - Municipal Implementation of BMPs

Introduction

This chapter provides ideas on how the BMPs presented in Chapter 2 can be implemented for new land development activities through ordinances and regulations. Sample ordinance provisions to amend existing municipal ordinances are provided along with two sample development layouts incorporating BMPs for a residential and commercial application.

Implementation through Ordinances

Stand-alone ordinances

The development of a single purpose, stand-alone ordinance for water quality is not necessary or desirable. Alternatively, a municipality may consider amending an existing single purpose stormwater management ordinance to include water quality provisions, or incorporate these provisions into existing subdivision and land development ordinances or zoning regulations.

Amendment of existing ordinances

Municipalities with comprehensive stormwater ordinances or good subdivision and land development ordinances with stormwater management provisions may opt to amend them to include water quality, BMP provisions. Suggested provisions would include: 1) general legal declarations of what ordinance is being amended, why and how 2) specific requirements 3) appendices providing technical assistance to those needing to comply with the ordinance.

Sample of an "amending ordinance" amending an existing ordinance (Incorporating by Reference)

ORDINANCE NO. _____

An Ordinance amending [municipal name] Ordinance No. _____ known as the [name of ordinance], in order to reference and include water quality requirements.

WHEREAS, the [name of municipal governing body] has recommended to amend [municipal name] Ordinance No. _____, known as the [name of ordinance] in order to include and reference water quality requirements; and

WHEREAS, the [municipal name] Planning Commission after public hearing and due notice, has recommended that [name of municipality] Ordinance No. _____ be amended as set forth herein; and

WHEREAS, after due and timely notice by publication, as required by law, public hearing upon the proposed amendment making the change as set forth herein.

NOW, THEREFORE, BE IT ORDAINED AND ENACTED, by the [name of municipal governing body] of [municipal name], _____ County, Pennsylvania, that [municipal name] Ordinance No. _____, known as the [name of ordinance], be and the same hereby amended as follows:

Section _____, Water Quality Requirements.

In addition to the water quantity requirements of this ordinance, the land developer SHALL:

- A. Design stormwater detention / retention basins so that the outlet of the basin SHALL, in addition to any other stormwater requirements imposed by the municipal stormwater regulations, discharge the runoff from the 1 year, 24 hour storm over a period of 24 hours.
- B. As an alternative to the requirements of subsection A., the water quality objectives MAY be achieved through a combination of BMP's including, but not limited to, infiltration structures, detention / retention basins, vegetation filter strips and buffers or any combination of BMP's listed in Appendix A. The combination of BMP's shall be designed according to the requirements listed under BMP Selection Criteria and in consultation with the Municipal Engineer.
- C. In lieu of A. and B. above, the land developer MAY submit innovative designs to the Municipal Engineer for review and approval prior to implementation.

Section _____, BMP Selection Criteria.

- A. In selecting the appropriate BMP's or combinations thereof, the land developer SHALL consider the following:
 - Total contributing area
 - Permeability and infiltration rate of the site soils
 - Slope and depth to bedrock
 - Seasonal high water table
 - Proximity to building foundations and well heads
 - Erodibility of soils
 - Land availability and configuration of the topography
- B. The following additional factors SHOULD be considered when evaluating the suitability of the BMP's used to control water quality at a given development site:
 - Peak discharge and required volume control
 - The volume of runoff that will be effectively treated
 - Efficiency of the BMP's to mitigate potential water quality problems
 - The nature of the pollutant being removed
 - Maintenance requirements
 - Erosion of receiving streams and watercourses
 - Creation / protection of aquatic and wildlife habitat
 - Recreational value
 - Enhancement of aesthetic and property value

BE IT ENACTED AND ORDAINED, this ____ day of ____, 19__.
Name of municipal governing body]

[name and title]

[name and title]

[name and title]

Attest:

[name], Secretary (type or print)

I hereby certify that the foregoing Ordinance was advertised in the [name of newspaper] on [date], a newspaper of general circulation in the municipality and was duly enacted and approved as set forth at a regular meeting of the [name of municipal governing body] held on [date].

[name], Secretary

Example Ordinance Provisions (Direct amendment into an Ordinance)
(ARTICLE OR CHAPTER (INSERT NUMBER)) WATER QUALITY

Section ____. Applicability.

In addition to the performance standards and design criteria requirements of Article III of this Ordinance, the land developer **SHALL** implement the following water quality requirements of this Article unless otherwise exempted by the provisions of this Ordinance.

Section ____. Water Quality Requirements.

In addition to the water quantity requirements of this ordinance, the land developer **SHALL**:

- A. Design stormwater detention / retention basins so that the outlet of the basin **SHALL**, in addition to any other stormwater requirements imposed by the municipal stormwater regulations, discharge the runoff from the 1 year, 24 hour storm over a period of 24 hours
- B. As an alternative to the requirements of subsection A., the water quality objectives **MAY** be achieved through a combination of BMP's including, but not limited to, infiltration structures, retention / retention basins, vegetation filter strips and buffers or any combination of BMP's listed in Appendix A. The combination of BMP's shall be designed according to the requirements listed under BMP Selection Criteria and in consultation with the Municipal Engineer.
- C. In lieu of A. and B. above, the land developer **MAY** submit innovative designs to the Municipal Engineer for review and approval prior to implementation.

Section ____. BMP Selection Criteria.

- A. In selecting the appropriate BMP's or combinations thereof, the land developer **SHALL** consider the following:
 - Total contributing area
 - Permeability and infiltration rate of the site soils
 - Slope and depth to bedrock
 - Seasonal high water table
 - Proximity to building foundations and well heads
 - Erodibility of soils
 - Land availability and configuration of the topography
- B. The following additional factors **SHOULD** be considered when evaluating the suitability of the BMP's used to control water quality at a given development site
 - Peak discharge and required volume control
 - The volume of runoff that will be effectively treated
 - Efficiency of the BMP's to mitigate potential water quality problems

- The volume of runoff that will be effectively treated
- The nature of the pollutant being removed
- Maintenance requirements
- Erosion of receiving streams and watercourses
- Creation / protection of aquatic and wildlife habitat
- Recreational value
- Enhancement of aesthetic and property value

Public Education

Public education and citizen participation is an important part of a overall community program regarding water quality management. Many people are not aware of the impacts of nonpoint source pollution and how it affects their community. Education of citizens and political representatives will not only heighten awareness about pollution problems and their prevention, but also help broaden support for other stormwater and nonpoint source pollution management strategies.

Education efforts would include: public meetings and presentations; program materials such as newsletter, fact sheets, brochures, and posters; homeowner education programs; press releases; coordination with interest groups and community events and demonstration projects.

Citizen participation may include providing input, collecting data and identifying problem areas all of which may help avert potential water quality problems and building overall support for remedial action to improve conditions.

Selection of BMPs

An important consideration is the selection of a BMP or combination of BMPs for a particular site. Municipal regulations may require a specific BMP application, such as an extended detention pond as a minimum criteria or may allow a combination of BMPs. Achieving the goal of minimal impact by a development is not necessarily achieved through the application of a single BMP as a "treatment", but through thoughtful layout of a development. Utilization of non-structural techniques such as impervious surface minimization and clustering of units along with techniques such as buffers, grassed swales, pervious parking areas and others may, if a conventional pond is still required, reduce the ponds size or perhaps eliminate the need for a pond entirely thus reducing the cost of a project.

Following are a few steps that may be followed in determining the applicability of a BMP or combination of BMPs. More specific information on a BMP's effectiveness and applicability may be found under a number of references found under "Information and Publications" following this chapter. Keep in mind that the following steps are applicable when no specific effluent limits or water quality standards have been established. Under those regulatory conditions, a more rigorous prioritization or selection procedure would need to be implemented.

Step 1 Identify which BMPs are suitable for the physical conditions of the site.

Consider:

- Total contributing area
- Permeability and infiltration rate of the site soils
- Slope and depth to bedrock
- Seasonal high water table
- Proximity to building foundations and well heads
- Erodibility of soils
- Land availability and configuration of the topography

Step 2 Screen BMP's based on stormwater benefits:

Consider:

- Peak discharge and required volume storage requirements
- Streambank erosion potential or existing problems

Step 3 Screen for pollutant removal benefits

Consider:

- BMP pollutant removal efficiencies

Step 4 Additional considerations

- groundwater recharge
- aquatic and wildlife habitats
- landscaping
- recreation safety
- aesthetic value
- community acceptance
- maintenance requirements
- project and BMP construction cost

Sample Development Site Plans

The following figures provide conceptual layouts of residential and commercial developments that illustrate how various BMPs may be applied. Not all development will be able utilize these techniques at the same time due to site conditions, land use and soils. The goal for a development is to minimize the impacts of runoff by thoughtful consideration of the natural conditions of the site by maintaining natural grades, providing open spaces, minimizing impervious surfaces and maximizing use of techniques such as

vegetate swales, wet ponds, infiltration and buffers. Avoid, to the maximum extent, the use of piping systems and conventional dry basins that concentrate runoff and do nothing for water quality.

Figure 18- Sample Residential Application of BMPs

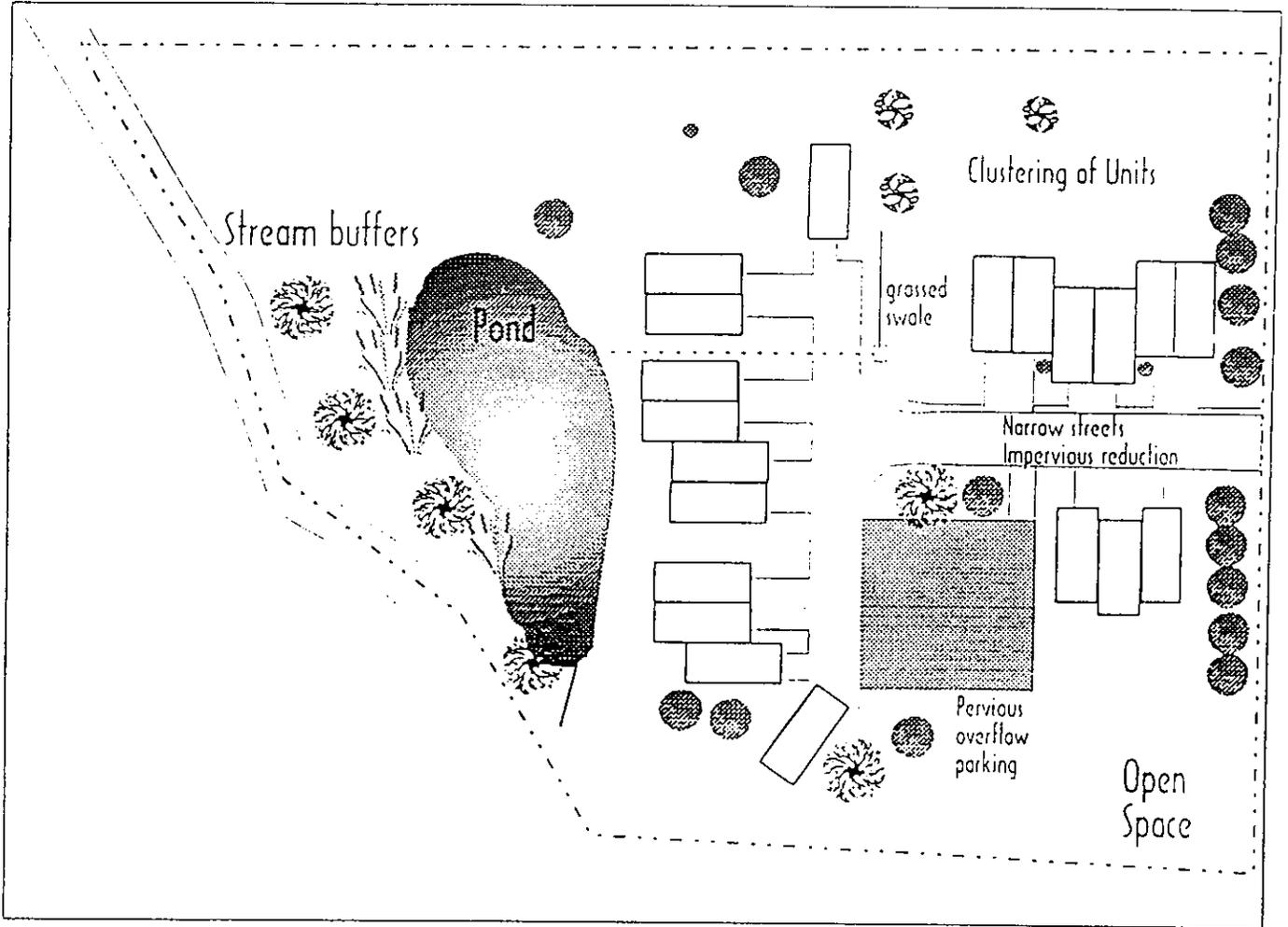
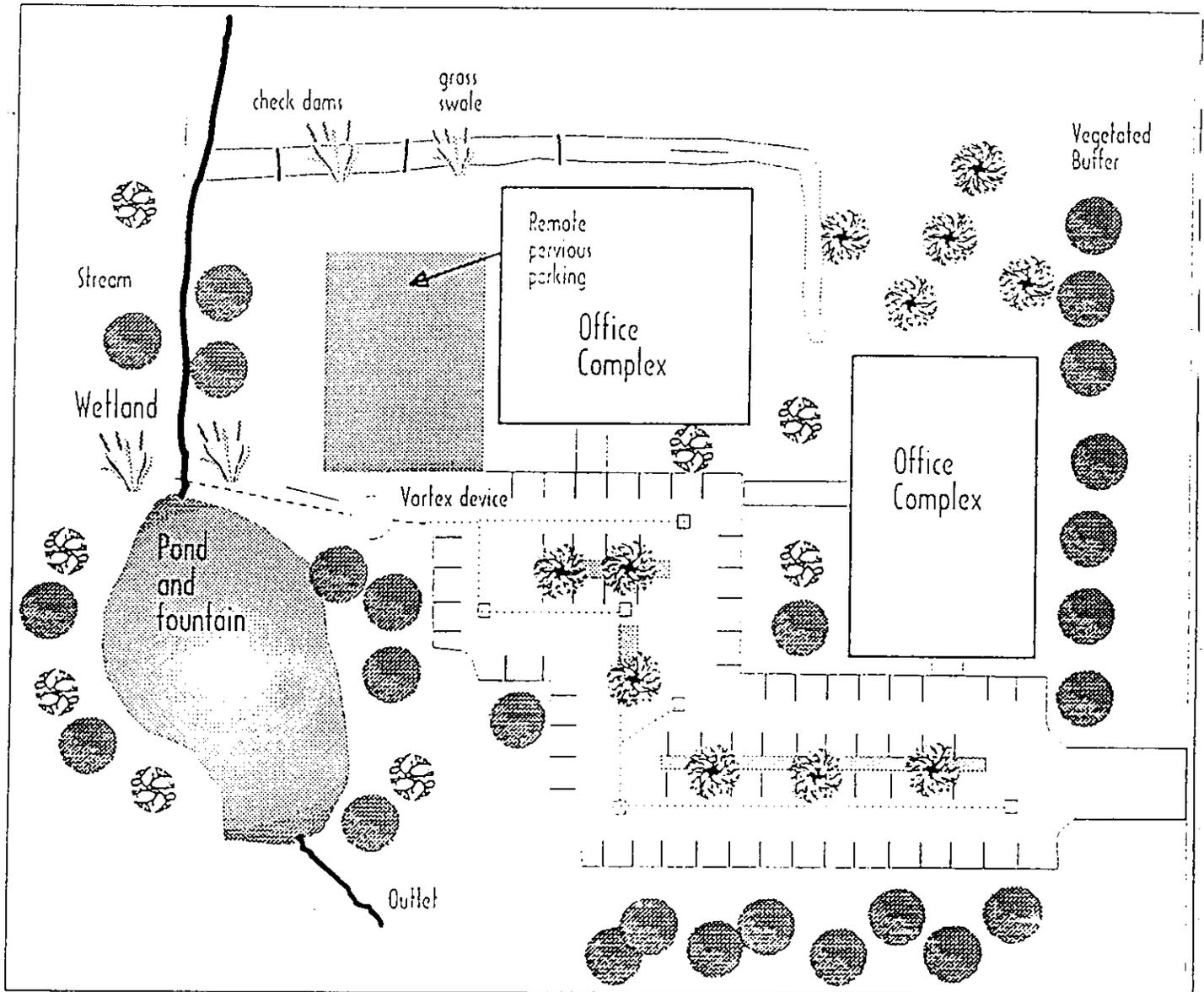


Figure 19- Sample Commercial Application of BMPs



Addressing Existing Water Quality Problems

Addressing water quality problems, from non-point sources is a major effort for state and municipal governments. Programs established through the 1987 amendments to the Federal Clean Water Act provides assistance to States in abatement of water quality problems. Many of the efforts under this initiative are not implemented by individual municipalities, but by multi-jurisdictional watershed-wide organizations. Municipalities in Pennsylvania desiring to improve the quality of their water resources on their own are limited by legal authority and finances. Some success may be achieved by municipalities in improving existing conditions through the enactment of ordinances requiring the installation of BMPs on existing development sites at the time major changes are made to the site, such as during urban renewal projects or during major additions to buildings and parking areas.

Although comprehensive, non-point source water quality restoration programs are beyond the means of most municipalities, local governments do have the availability of loan moneys through the Pennsylvania Infrastructure Investment Authority (PENNVEST) to improve or rehabilitate public stormwater facilities including installation of BMPs. Projects eligible for these low-interest loans may include construction of detention ponds and basins to address both peak rates of runoff as well as water quality improvements, water quality inlets and new technologies such as swirl/vortex concentrator devices. Further information on the PENNVEST Stormwater Project Program may be obtained from:

PA Infrastructure Investment Authority
Keystone Building, 4th floor
22 South Third Street
Harrisburg, PA 17101
(717)787-8138

Information and Publications

Aldrich, John. 1993. Promoting Consistent Stormwater Management. *Water Environment & Technology*, Vol. 5, No. 7, July 1993.

Amani, F., Truong, H.V. and Chang, F.F.M. Effect of Filter Media Particle Size Distribution on Filtration Efficiency. University of the District of Columbia, Washington, DC.

Bailey, Bob. 1993. Surviving the Stormwater Permit Process. *Water Environment & Technology*, Vol. 5, No. 7, July 1993.

Bitter, Susan D. and J. Keith Bowers. 1994. Bioretention as a Water Quality Best Management Practice. *Watershed Protection Techniques*, Vol. 1, No. 3, Fall 1994.

Boutiette, Laurence N., and Christine L. Duerring. 1994 Massachusetts Nonpoint Source Management Manual: A Guidance Document for Municipal Officials. Massachusetts Department of Environmental Protection, Office of Watershed Management Nonpoint Source Program, Boston, Massachusetts.

Brummer, Craig W. and Robert H. Kadlec. 1993. Effluent Restores Wetland Hydrology. *Water Environment & Technology*, Vol. 5, No. 7, July 1993.

Charma, Joseph G. Fibrous Filter System will Create Quality Stormwater. 1995. *Emerging Technology*, April-May, 1995.

Chester Engineers. 1996. Lake Erie/Elk Creek Watershed, Act 167 Stormwater Management Plan, Volume 3: Training Manual. Prepared for Erie County Planning Commission, Pennsylvania.

Davis, Luise. 1994. A Handbook of Constructed Wetlands for the Northeastern United States. Volume 5, Stormwater Runoff, Draft.

Environmental Protection Agency. 1995. Riparian Forest Buffers in the Chesapeake Bay Watershed. The Chesapeake Bay Program, Annapolis, Maryland, 1995.

Gali, John. 1992. Analysis of Urban BMP Performance and Longevity. In Prince George's County, Maryland. Metropolitan Washington Council of Governments, Washington, DC.

- Gilliam, J.W. 1994. Riparian Wetlands and Water Quality. *Journal of Environmental Quality*, Vol. 23, September-October, 1994.
- Graine, Captain Jammichael, Jim Mayer, and Linda Taylor. 1993. Department of the Army Chesapeake Bay Initiative FY 92 Progress Report. US Army Environmental Center, Maryland.
- Green, Ben. 1994. Constructed Wetlands are Big in Small Communities. *Water Environment & Technology*, Vol. 6, No. 2, February, 1994.
- Hadden, Deborah, and David A. Murphy. 1994. A New Slant on Wetlands. *Water Environment & Technology*, Vol. 6, No. 2, February, 1994.
- Harris, Rhonda E.; Paulette Johnsey; Brent Larsen; and Monica Berrell. 1993. Promoting Stormwater Education. *Water Environment & Technology*, Vol. 5, No. 7, July 1993.
- Horner, Richard R. and Charles R. Horner. 1995. Design, Construction, and Evaluation of a Sand Filter: Stormwater Treatment System, Part II, Performance Monitoring. Seattle, Washington.
- Jackson, Donald R. and Herbert N. Flippo. 1993. Development of Technical Procedures for Managing Nonpoint Source Pollution. Prepared by the Susquehanna River Basin Commission for the Department of Environmental Protection.
- Jacobs, E. Lowell. 1995. Environment Now high Priority in Development. *New Castle Business Ledger*, April 1995.
- James, William. New Techniques for Modeling the Management of Stormwater Quality Impacts, Lewis Publishers, CRC, Press, Inc., 2000 Corporate Blvd., N. W., Boca Raton, Florida.
- Jorling, Thomas C. 1992. Reducing the Impacts of Stormwater Runoff from new Development. New York Department of Conservation.
- Bucks County Planning Commission, Pennsylvania. 1992. Neshaminy Creek Watershed Stormwater Management Plan.
- Kuo, Chin Y. 1994. Stormwater Runoff and Quality Management: Proceedings of the 1994 Stormwater Management Symposium. The Pennsylvania State University, Pennsylvania.
- Lekven, Craig C.; Chuck R. Williams; Robert D. Charney; and Ron W. Crites. 1994. Wetlands Put to the Test. *Water Environment & Technology*, Vol. 6, No. 2, February, 1994.

- Maryland Department of Natural Resources. 1984. Standards and Specifications for Infiltration Practices. Annapolis, Maryland.
- Maryland Department of the Environment. Fairland Stormwater Management Demonstration Area in Prince George's County, Maryland.
- Mineart, Phillip and Sujatha Singh. 1994. The Value of More Frequent Cleanouts of Storm Drain Inlets. *Watershed Protection Techniques*, Vol. 1, No. 3, Fall 1994.
- Minnick, Edwin L., and H. Tillman Marshall. Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire. Rockingham County Conservation District, Exeter, NH.
- National Resource Conservation Service. 1986. Soil and Water Conservation: Technical Guide, Pennsylvania.
- New Jersey Department of Environmental Protection. 1994. Stormwater and Nonpoint Source Pollution Control BMPs Manual. New Jersey DEP and New Jersey Department of Agriculture.
- New York State Department of Environmental Conservation, Division of Water. 1994. Urban/Stormwater Runoff Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State.
- Northern Virginia Soil and Water Conservation District. 1994. Developing Successful Runoff Control Programs For Urbanization Areas. Fairfax, Virginia.
- Paterson, Robert G. 1994. Construction Practices: The Good, The Bad, and The Ugly. *Watershed Protection Techniques*, Vol. 1, No. 3, Fall 1994.
- Patrick, William H. 1994. From Wastelands to Wetlands. *Journal of Environmental Quality*, Vol. 23, September-October, 1994.
- Pennsylvania Department of Environmental Protection. 1978. Flood Plain Management Act, Act of October 4, 1978, P.L. 851, No. 166, 32 P.S. § 679.101 et seq. Harrisburg, Pennsylvania.
- Pennsylvania Department of Environmental Protection. 1978. Storm Water Management Act, Act of October 4, 1978, P.L. 864, No. 167, 32 P.S. § 680.1 et seq. (As amended by Act 63). Harrisburg, Pennsylvania.
- Pennsylvania Department of Environmental Protection. 1985. Stormwater Management Guidelines, Harrisburg, Pennsylvania

- Pennsylvania Department of Environmental Protection. 1994. 1994 Water Quality Assessment (Section 305(b), Federal Clean Water Act). Harrisburg, Pennsylvania.
- Pitt, Robert. 1994. The Risk of Groundwater Contamination from Infiltration of Stormwater Runoff. *Watershed Protection Techniques*, Vol. 1, No. 3, Fall 1994.
- Plafkin, James L., Michael T. Barbour, Kimberly D. Porter, Sharon K. Gross, and Robert M. Hughes. 1989. Rapid Bioassessment Protocols for use in Streams and Rivers: Benthic Macroinvertebrates and Fish. US Environmental Protection Agency, Washington, DC.
- Schueler, Thomas R.; Peter A. Kumble; and Maureen A. Heraty. 1992. A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone. Department of Environmental Programs, Metropolitan Washington Council of Governments, Washington, DC.
- _____. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Department of Environmental Programs, Metropolitan Washington Council of Governments, Washington, DC.
- _____. 1992. Design of Stormwater Wetland Systems: guidelines for creating diverse and effective stormwater wetlands in the Mid-Atlantic Region. Nonpoint Source Subcommittee of the Regional Water Committee, Washington, DC.
- Shaver, Earl and John Maxted. Education Research Program Development and Implementation. Watershed Management Institute, Ingleside, Maryland.
- Strecker, Eric W., Joan M. Kersnar, Eugene D. Driscoll, and Richard R. Horner. 1992. The Use of Wetlands for Controlling Stormwater Pollution. The Terrene Institute, Washington, DC.
- Terrene Institute. 1995. Decisionmakers Stormwater Handbook: Considerations for Watershed Management, draft. Prepared for Region 5, U. S. Environmental Protection Agency, Chicago, IL.
- _____. 1990. Urban Runoff and Stormwater Management Handbook. Prepared for the Environmental Protection Agency, Washington, DC.
- _____. 1994. Urbanization and Water Quality: A Guide to Protecting the Urban Environment. Washington, DC, 1994.
- Thelen, Edmund, and L. Fielding Howe. 1978. Porous Pavement: including the principles of development and a porous pavement design manual. The Franklin Institute Press, Philadelphia, Pennsylvania.

- Thompson, Jennifer N., and Don L. Green. 1994. Riparian Restoration and Streamside Erosion Control Handbook. Nonpoint Source Water Pollution Management Program for the State of Tennessee, Nashville, Tennessee.
- Urbonas, Ben and Peter Stahre. 1993. Stormwater: Best Management Practices and Detention for Water Quality, Drainage, and CSO Management. PTR Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
- Wells, Cedar. 1994. Impervious Surface Reduction Study, Draft Report. City of Olympia, Public Works Department, Water Resources Program, Olympia, Washington.
- _____. 1994. The Importance of Imperviousness. *Watershed Protection Techniques*, Vol. 1, No. 3, Fall 1994.
- _____. 1994. Skinny Streets and One-sided Sidewalks: A Strategy for not Paving Paradise. *Watershed Protection Techniques*, Vol. 1, No. 3, Fall 1994.
- Whalen, Paul J., and Michael G. Cullum. 1988. An Assessment of Urban Land Use/Stormwater Runoff Quality Relationships and Treatment Efficiencies of Selected Stormwater Management Systems. Water Quality Division, Resource Planning Department, South Florida Water Management District.
- Woodward-Clyde Consultants. 1990. Urban Targeting and BMP Selection: An Information and Guidance Manual for State Nonpoint Source Program Staff Engineers and Managers. Prepared for Region V, U.S. Environmental Protection Agency, Chicago, Illinois.

Glossary

ABSORPTION: The process of taking up one substance into the body of another, such as a sponge absorbing water.

ACCELERATED EROSION: The removal of the surface of the land through the combined action of man's activities and natural processes at a rate greater than would occur because of the natural processes alone.

ACID RAIN: Precipitation that has a low pH; the precipitation becomes acidic when moisture in the air reacts with sulfur and nitrogen pollutants in the atmosphere; because of its low pH, acid rain has a harmful effect on some plants, soils and surface waters, buildings, and, indirectly, on some organisms that live in surface waters.

ADSORPTION: Attraction and holding of one substance on the surface of another; this often involves the attraction of molecules in gases and liquids to the surface of a solid.

AEROBIC: Living of active organisms only in the presence of oxygen.

AGGREGATE: The stone or rock gravel needed to fill in an infiltration BMP, such as a trench or porous pavement. Clean washed aggregate is simply aggregate that has been washed clean so that no sediment is associated with it.

ALGAE: Non-vascular plants, usually aquatic and capable of using carbon dioxide by photosynthesis.

ALGAL BLOOM: Large, readily visible, masses of algae found in bodies of water (usually ponds and lakes) during warm weather.

ANAEROBIC: Non-vascular plants, usually aquatic and capable of using carbon dioxide by photosynthesis.

ANTI-SEEP COLLAR: A plate, attached to the barrel running through an embankment of a pond, that prevents seepage of water around the pipe.

BMP (best management practices): Stormwater structures and facilities designed or used to maintain or improve the water quality of surface runoff. BMPs may be structural (basins, seepage pits), nonstructural (vegetated filter strips, buffers) or managerial techniques (maintenance practices) that may be used singly or in combination to achieve water quality.

BMP FINGERPRINTING: A series of techniques for locating BMPs (particularly ponds) within a development site so as to minimize their impacts to wetlands, forest, and sensitive stream reaches.

BASEFLOW: That portion of stream flow that is not due to storm runoff, and is supported by groundwater seepage into a channel.

BIOASSAY: Laboratory tests used to determine the response of organisms to specified conditions relating to the natural environment (i.e., water quality).

BIOCHEMICAL OXYGEN DEMAND (BOD): A laboratory measurement of the "strength" or potency of an organic or inorganic waste; the test determines the amount of oxygen used by microorganisms as they biochemically degrade (reduce to simple by-products) the waste. BOD values provide a somewhat standard measure of how much oxygen will be required to degrade a waste, and therefore reflect the effect the waste may have on fish or other aquatic organisms that require oxygen to live.

BIOFILTRATION: The use of a series of vegetated swales to provide filtering treatment for stormwater as it is conveyed through the channel. The swales can be grassed, or contain emergent wetlands, or high marsh plants.

BIOLOGICAL MONITORING: Periodic surveys of aquatic biota as an indicator of the general health of a waterbody. Biological monitoring surveys can span the trophic spectrum - from macro-invertebrates to fish species.

BUFFER STRIPS: Strips of grass or other close growing vegetation that separates a waterway from an intensive land use area; also referred to as filter strips, vegetated filter strips, and grassed buffers.

CHECK DAM: (a) A log or gabion structure placed perpendicular to a stream to enhance aquatic habitat. (b) An earthen or log structure, used in grass swales to reduce water velocities, promote sediment deposition, and enhance infiltration.

CHEMICAL OXYGEN DEMAND (COD): An indirect measurement of the amount of oxygen used by organic and inorganic matter in water. The measurement is a laboratory test based on a chemical oxidant and therefore does not necessarily correlate with the biochemical oxygen demand.

CLUSTERED DEVELOPMENT: A development design technique that arranges buildings on a specific area of a site so as to preserve a portion of the entire site for common open space, recreation, or preservation of environmentally sensitive areas in perpetuity.

COMPREHENSIVE LAND USE PLANS: A plan adopted by the local government to guide the physical growth and improvement of a city or county, including any future amendments and revisions.

CONTRIBUTING WATERSHED AREA: Portion of the watershed contributing its runoff to the BMP in question.

DENITRIFICATION: A biological process in which nitrate (NO_3), a compound of nitrogen often found in sewage or water, is turned into nitrogen gas, which can dissipate into the atmosphere.

DEPARTMENT: The Department of Environmental Protection of the Commonwealth of Pennsylvania formerly the Department of Environmental Resources.

DESIGN STORM: Is a rainfall event of specified size and return frequency (i.e., a storm that occurs only once in 2 years) that is used to calculate the runoff volume and peak discharge rate of BMP.

DETENTION: The temporary storage of storm runoff in a BMP, which is used to control the peak discharge rates, and which provides gravity settling of pollutants.

DETENTION TIME: The amount of time a parcel of water actually is present in a BMP. Theoretical detention time for a runoff event is the average time parcels of water reside in the basin over the period of release from the BMP.

DISCHARGE POINT: Places where groundwater flows out of an aquifer. Springs are visible discharge points. Discharge points also occur as seepage into wetlands, lakes, and streams.

DRAINAGE EASEMENT: A right granted by a land owner to a grantee, allowing the use of private land for stormwater management purposes.

DRAWDOWN: Gradual reduction in water level in a pond BMP due to the combined effect of infiltration and evaporation.

EROSION: Is the removal of soil particles by the action of water, wind, ice, and other geological agents.

EUTROPHICATION: The natural aging process of surface waters (such as rivers, streams, reservoirs) through enrichment by nutrients. Eutrophication is accelerated by people's activities; in the end, eutrophication results in the complete filling in and drying up of a water body.

EVAPOTRANSPIRATION: Is the combined loss or movement of moisture from the surface of the earth through evaporation and transpiration processes.

EVENT MEAN CONCENTRATION (EMC): The average concentration of an urban pollutant measured during a storm runoff event. The EMC is calculated by flow-weighting each pollutant sample measured during a storm event.

EXFILTRATION: The downward movement of runoff through the bottom of an infiltration BMP into the soil layer.

FECAL COLIFORM BACTERIA: Minute living organisms associated with human or animal feces that are used as an indirect indicator of the presence of other disease causing bacteria.

FILTER FABRIC: Textile of relatively small mesh or pore size that is used to (a) allow water to pass through while keeping sediment out (permeable), or (b) prevent both runoff and sediment from passing through (impermeable).

FIRST FLUSH: Is the delivery of a disproportionately large load of pollutants during the early part of storms due to the rapid runoff of accumulated pollutants. The first flush of runoff has been defined several ways (i.e., one-half inch per impervious acre).

FOREBAY: An extra storage area provided near an inlet of a BMP to trap incoming sediments before they accumulate in a pond BMP.

GROUNDWATER RECHARGE: Replenishment of existing natural underground water supplies by the process of the hydrologic cycle.

HYDROGRAPH: Is a graph showing variation in the water depth or discharge in a stream or channel, over time, at a specified point of interest

IMPERVIOUS AREA: Impermeable surfaces, such as pavement or rooftops, which prevent the infiltration of water into the soil.

INFILTRATION: (a) Is the downward movement of water from the surface to the subsoil. (b) The infiltration capacity is expressed in terms of inches per hour.

INTERCEPTION: Precipitation that is retained by the leaves and stems of vegetation.

LAND DEVELOPMENT: (I) the improvement of one lot or two or more contiguous lots, tracts or parcels of land for any purpose involving (a) a group of two or more buildings, or (b) the division or allocation of land or space between or among two or more existing or prospective occupants by means of, or for the purpose of streets, common areas, leaseholds, condominiums, building groups or other features; (II) a subdivision of land.

LAND DISTURBANCE: Any activity involving grading, tilling, digging or filling of ground, or stripping of vegetation, or any other activity that causes land to be exposed to the danger of erosion.

LOADING: Is the quantity of a substance entering the environment (soil, water, or air).

NUTRIENTS: Chemical elements or substances, such as nitrogen and phosphorus, that are essential for plant and animal growth.

NUTRIENT POLLUTION: Contamination of water resources by excessive inputs of nutrients; in surface waters, excess algae or aquatic plant production is a result of elevated nutrient concentrations.

OVERFLOW RATE: Detention basin release rate divided by the surface area of the basin. It can be thought of as an average flow rate through the basin.

PEAK DISCHARGE: Is the maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.

PEAK RATE OF STORMWATER RUNOFF: Is the maximum rate of flow of stormwater runoff at a given point and time resulting from a storm event.

PEAK SHAVING: Controlling post development peak discharge rates to pre development levels by providing temporary detention in a BMP.

RETENTION: Is the holding of runoff in a basin without release except by means of evaporation, infiltration, or emergency bypass.

RETROFIT: The creation or modification of stormwater management systems in developed areas through the construction of wet ponds, infiltration systems, wetland plantings, stream bank stabilization, and other BMP techniques for improving water quality and creating aquatic habitat. A retrofit can consist of the construction of a management structure, or a combination of improvement and new construction.

RIPARIAN: A relatively narrow strip of land that borders a stream or river, often coincides with the maximum water surface elevation of the one hundred year storm.

RIPARIAN REFORESTATION: The replanting of the banks and floodplain of a stream with native forest and shrub species to stabilize erodible soils, improve both surface and ground water quality, increase stream shading, and enhance wildlife habitat.

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

RUNOFF CHARACTERISTICS: The surface components of any watershed that affect the rate, amount and direction of stormwater runoff. These may include, but not limited to: vegetation soils, slopes and man-made landscape alterations.

SEDIMENT: Solid materials, both mineral and organic, that are in suspension are being transported, or has been moved from its site of origin by water.

SHEETFLOW: Runoff that flows over the ground surface as a thin, even layer, not concentrated in a channel.

SORPTION: Is the physical or chemical binding of pollutants to sediment or organic particles.

SPILLWAY: A depression in the embankment of a pond or basin that is used to pass peak discharges greater than the maximum design storm controlled by the pond.

STORMSEWER: A system of pipes or other conduits that carries intercepted surface runoff, street water and other wash waters, or drainage, but excludes domestic sewage and industrial wastes.

STORMWATER COLLECTION SYSTEM: Natural or man-made structures that collect and transport stormwater.

STORMWATER RUNOFF: That part of precipitation that flows over the land. The rate of stormwater runoff is the instantaneous measurement of water flow expressed in a unit of volume per unit of time, also referred to as Discharge.

SUBDIVISION: The division or re-division of a lot, tract or parcel of land by any means into two 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, transfer of ownership or building or lot development: provided, however, that the division of land for agricultural purposes into parcels of more than ten acres, not involving any new street or easement of access, shall be exempt.

TRANSPIRATION: The process by which plants release water vapor into the air

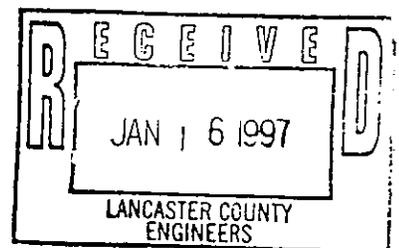
WATERSHED: The entire region or area drained by a river or other body of water whether natural or artificial. A Designated Watershed is an area delineated by the Department of Environmental Protection and approved by the Environmental Quality Board for which counties are required to develop watershed stormwater plans.

WATER QUALITY BMP: A BMP specifically designed for pollutant removal.

WEIR: A structure that extends across the width of a channel and is intended to impound, delay or in some way alter the flow of water through the channel. A CHECK is

a type of weir as is any kind of dam. A PORTED WEIR is a wall or dam that contains openings through which water may pass. Ported weirs slow the velocity of flow and therefore, can assist in the removal of pollutants in runoff by providing opportunities for pollutants to settle, infiltrate or be adsorbed.

WETLAND MITIGATION: Regulatory requirement to replace wetland areas destroyed or impacted during the land development process. Mitigation seeks to replace structural and functional qualities of the natural wetland type that has been destroyed. Stormwater wetlands typically do not count for credit as mitigation, because their construction does not replicate all the ecosystem functions of a natural wetland.



ORDINANCE APPENDIX F
SUBWATERSHED BOUNDARY MAP

E. EARL TWP.

EARL TWP.

UPPER LEACOCK TWP.

E. LAMPETER TWP.

LEACOCK TWP.

W. LAMPETER TWP.

ROAD CENTERLINE (TYP.)
MUNICIPAL BOUNDARY (TYP.)

SUPAREA BOUNDARY (TYP.)

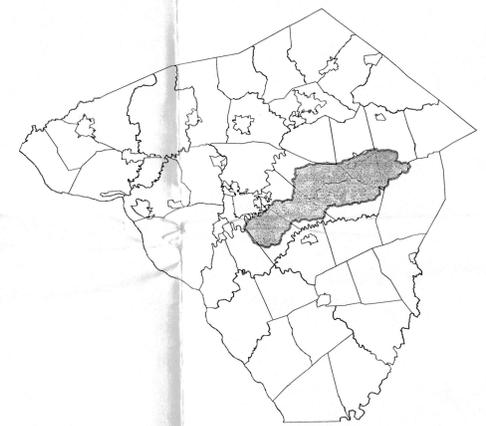
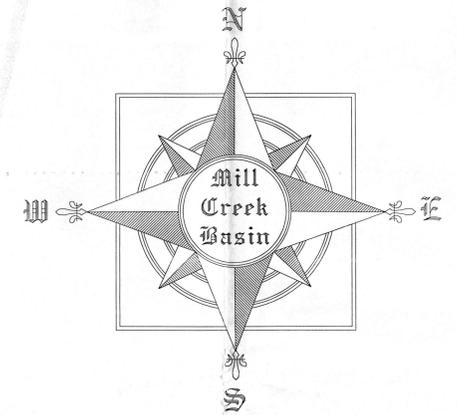
ROAD CENTERLINE (TYP.)

MUNICIPAL BOUNDARY (TYP.)

POST DEVELOPMENT
REDUCTION FACTORS

-  REDUCE POST DEVELOPMENT PEAK FLOW TO 50% OF THE PRE DEVELOPMENT PEAK FLOW
-  REDUCE POST DEVELOPMENT PEAK FLOW TO 75% OF THE PRE DEVELOPMENT PEAK FLOW
-  REDUCE POST DEVELOPMENT PEAK FLOW TO 100% OF THE PRE DEVELOPMENT PEAK FLOW

SCALE IN FEET
0 2000 4000 6000 8000



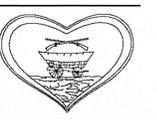
LANCASTER COUNTY, PA.
(NOT TO SCALE)

SUBWATERSHED BOUNDARIES

MILL CREEK

LANCASTER COUNTY ACT 167
STORM WATER MANAGEMENT PLAN
PHASE II AGREEMENT # ME 92428

L ANCASTER
C OUNTY
E NGINEER'S
O FFICE



DATE: MAY 24, 1996 SCALE: 1" = 2,000' DRAWN BY: ACW.