GREAT SWAMP

WATERSHED MANAGEMENT PLAN

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Prepared for:

Ten Towns Great Swamp Watershed Committee

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Special thanks are also extended to all past and present members of the Ten Towns Great Swamp Watershed Committee for their assistance in developing this management plan.

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EXECUTIVE SUMMARY

The Ten Towns Great Swamp Watershed Committee was formed by Morris 2000 in 1995 to provide an effective mechanism to prepare and implement a Watershed Management Plan for the Great Swamp. This new 'grass roots' approach contrasts with previous 'top down' efforts of the state and federal governments which met with limited success.

The Ten Towns Committee used its first year to conduct a comprehensive fact-finding program on the Great Swamp and Watershed Management. The objectives of the fact-finding process was two-fold: to allow a full exchange of views by all interested parties, both the municipal members and private organizations; and to establish a uniform data base of factual information. The Committee was charged with the responsibility of developing and implementing a Watershed Management Plan for the Great Swamp Watershed.

GOALS

The Ten Towns Great Swamp Watershed Committee established specific goals for the Great Swamp and its watershed. These goals emphasize preserving the present ecological integrity of the Great Swamp and its watershed. The goals include the following:

Great Swamp: Maintain present ecological condition as a wildlife refuge.

Water Quantity: Maintain or decrease existing stormwater peak flows and volumes.

Water Quality: Maintain or improve existing water quality in Great Swamp and its tributaries.

Macroinvertebrates: Improve the macroinvertebrate population and diversity in all of the streams in the watershed.

Stream Stabilization: Return adversely affected areas of streams to a condition of stable, non-eroding streams.

Great Swamp Vegetation and Wetness: Maintain or improve the present vegetation and ecological function of the Great Swamp; maintain or reduce the present flooding of the Great Swamp.

Wastewater Management: Maintain properly functioning tertiary treatment at the existing treatment plants; properly maintain septic systems throughout the watershed.

OVERVIEW OF WATERSHED MANAGEMENT PLAN

The Great Swamp Watershed Management Plan consists of four major elements: general principles, establishing existing conditions, implementing strategies, and additional strategies for municipalities. An overview of the management plan is provided below:

General Principles

1. Using watershed-based planning throughout the Great Swamp watershed;
2. Developing a formal Ten Towns Great Swamp Watershed Management Committee to assist the municipalities in the Great Swamp watershed in implementing the Great Swamp Watershed Management Plan;
3. Evaluating present impervious cover limits to encourage developments with the minimal amounts of impervious land cover;
4. Encouraging open space planning at all levels from subdivision planning to municipal planning;
5. Developing and implementing a public education program for the Great Swamp watershed
6. Adopting a riparian stream corridor ordinance; and
7. Developing and implementing Resource Management Plans for agricultural lands in the watershed.

Establishing Existing Conditions

1. Performing watershed investigations to identify, evaluate, and prioritize, existing and potential nonpoint source pollution problems in the watershed;
2. Identifying and evaluating existing stormwater management facilities in the watershed that could be retrofitted to provide water quality as well as water quantity benefits; and
3. Implementing a strategic water quality monitoring program in the watershed to document water quality, water quantity, pollutant loadings, and the ecological condition of the Great Swamp and its watershed.

Implementing Strategies

1. Developing and implementing stormwater management policies and a stormwater management ordinance to control both the quantity and quality of stormwater runoff.
2. Developing and adopting a soil erosion and sediment control ordinance with strong inspection and enforcement procedures;
3. Developing and adopting an earth disturbance ordinance to ensure that all earth disturbance and soil removal activities are performed in a manner to minimize soil erosion, stormwater runoff, and degradation of water quality;
4. Developing and adopting a tree removal ordinance aimed at preventing significant soil erosion and stormwater runoff and at protecting riparian stream buffers;
5. Continuing to require Environmental Impact Statements (EIS) for all major subdivisions and site plans, and considering the use of a modified EIS for minor subdivisions;
6. Developing and adopting a steep slope ordinance to ensure that excessive erosion and stormwater runoff do not occur during or after construction; and
7. Developing and adopting a wetlands protection ordinance (or including wetlands protection provisions in existing ordinances) to ensure that new developments, construction or earth moving activities do not destroy regulated wetlands.

Additional Strategies for Municipalities

1. Identifying potential sites for regional stormwater management facilities such as wet ponds and constructed wetlands;
2. Developing and implementing a septic system management program which includes strict testing and design requirements, regular inspections, and periodic septage pumping;
3. Evaluating the performance of the existing wastewater treatment plants to ensure that they are operating properly and meeting all effluent requirements; and
4. Communicating with county, regional, state, and federal agencies to ensure that all construction and maintenance activities of the agencies are performed in such a manner as to minimize soil erosion, nonpoint source pollution, and degradation of water quality.

CHAPTER 1 - INTRODUCTION

GREAT SWAMP WATERSHED

The 7,450 acre Great Swamp National Wildlife Refuge in Morris County was the first wilderness area to be

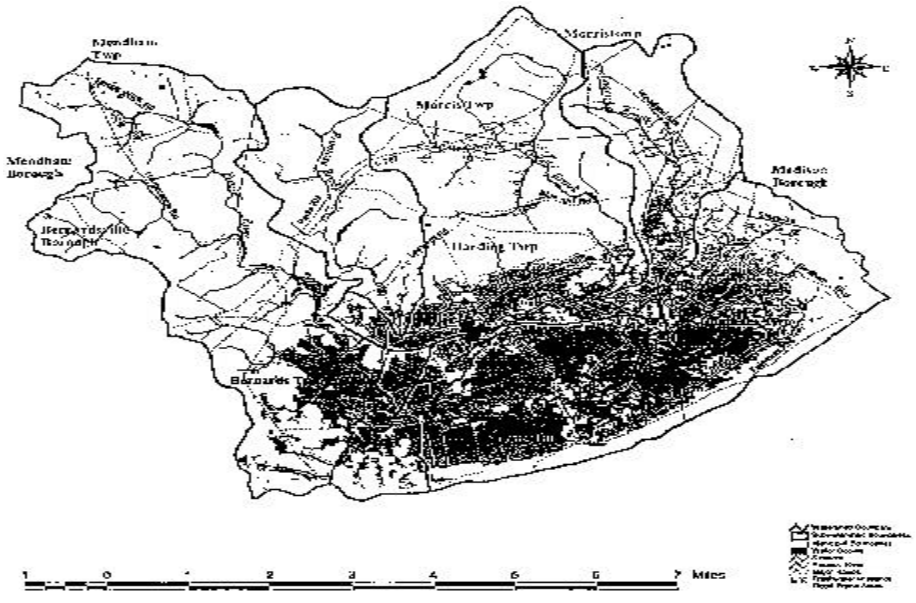
established by the Department of the Interior. The Great Swamp watershed is located in the Upper Passaic River Watershed. Results of numerous studies over past years have indicated that the Great Swamp is still a functioning, healthy wetlands ecosystem. However, stormwater runoff and soil erosion from development in its 57 square mile watershed has increased the amount of nonpoint source pollution and stormwater runoff entering the Great Swamp.

The Great Swamp Wildlife Refuge is a major environmental, social, economic and recreational asset to New Jersey and the country. It is visited by more than 300,000 people each year, not including visitors to the Raptor Trust and the Morris County and Somerset County park facilities which are also located in the Great Swamp. It is home to more than 220 bird and 1,000 plant species; and it provides many environmental functions. There are 26 state listed threatened and endangered species of wildlife in the Great Swamp including the bog turtle, wood turtle, blue-spotted salamander, great blue heron, red-shouldered hawk, barred owl, osprey, coopers hawk, cliff swallow, red-headed woodpecker, and bobolink. As a major functioning wetlands ecosystem, the Great Swamp provides a variety of benefits including flood control, groundwater recharge, stormwater filtration, wildlife habitat, ecological diversity, active and passive recreation, aesthetics, ecotourism, public education and scientific research. However, past studies have shown that development in the 56 square mile watershed has increased the amount of stormwater runoff and nonpoint source pollution entering the Great Swamp. The Great Swamp is wetter, it floods more frequently, and it receives higher loadings of sediments, nutrients, and other pollutants.

The 56 square mile Great Swamp watershed, shown in Figure 1, consists of five major sub-watersheds, as shown in Table 1.

Table 1
Sub-Watersheds of Great Swamp Watershed

Sub-Watershed	% of Watershed
Passaic River	28
Great Brook	25
Black Brook	27
Primrose Brook	10
Loantaka Brook	10



Source: Great Swamp Watershed Association (1997).

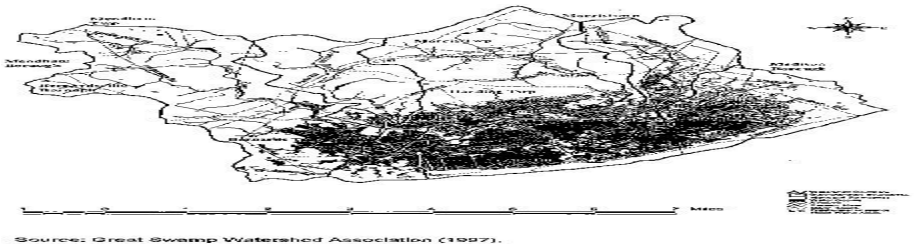


Figure 1. Great Swamp Watershed

There are two wastewater treatment plants in the Great Swamp watershed: the Chatham Township plant and the Morris Township plant; both have design capacities of 2 million gallons per day (mgd). Both of these plants have been upgraded to provide better treatment and to remove more nutrients. Past studies indicate that these two treatment plants contributed a significant amount of phosphorus and nitrogen to the Great Swamp, but since their upgrade, their significance has decreased. Nonpoint source pollution now appears to be the major threat to the Great Swamp.

A brief history of the Great Swamp Refuge is provided below:

1. Circa 1955: Private groups begin efforts to acquire land to preserve the Great Swamp.
2. December 1959: Port Authority of New York/New Jersey announces plan to construct a 'jetport' in the Great Swamp.
3. 1960: Great Swamp National Wildlife Refuge established.
4. 1960-64: Private efforts intensify to acquire land to preserve the Great Swamp.
5. 1964: First donation of 3,000 acres (the nucleus for the Great Swamp Refuge) presented to the U.S. Fish and Wildlife Service at a Refuge Dedication Ceremony.
6. 1964: U.S. Wilderness Act passed by Congress.
7. 1966: The Great Swamp Refuge designated as a National Natural Landmark.
8. 1968: A portion of the Great Swamp is the first designated Department of Interior Wilderness Area in the United States.
9. 1964-1997: Gradual land acquisition continues to establish the area of the Great Swamp Refuge to its present size of almost 7,410 acres.

The Great Swamp Watershed is roughly 56 square miles in size. As shown in Table 2, the Great Swamp watershed includes all or portions of ten municipalities.

Table 2
Municipalities in Great Swamp Watershed

Municipality	Percent of Watershed	Square Miles, Acres
Bernards Township	11.0	6.3 4,040
Bernardsville Borough	6.6	3.6 2,404
Chatham Township	13.2	7.6 4,835
Harding Township	34.5	19.8 12,655
Long Hill Township	12.8	7.3 4,696
Madison Borough	2.0	1.1 732
Mendham Borough	2.0	1.2 748
Mendham Township	4.4	2.5 1,631

Morris Township	7.6	4.4 2,787
Morristown	5.4	3.1 1,966
Total	96.6*	56.9 36,694

Source: U.S. Department of Agriculture, 1996.

*Does not include Chatham Borough which makes up 0.5% of the Great Swamp watershed.

The 1994 land use of the Great Swamp watershed is summarized in Table 3. Approximately 48 percent of the land in the Great Swamp is residential, commercial or industrial; approximately 36 percent is public or semi-public; and 16 percent is undeveloped farm or vacant land.

WATER QUALITY OF THE GREAT SWAMP AND ITS WATERSHED

Present and projected water quality and nonpoint source pollution problems in the Great Swamp and its watershed have been documented by numerous studies.

A 1988 NJDEP-funded study (Maquire Group, 1988) used the Hydrologic Simulation Program-Fortran (HSPF) model to evaluate water quality and water quantity in base year 1979 to year 2000. An intensive field program was performed. Conclusions of the study were:

1. At certain locations in the watershed, year 2000 storm peak flows would increase considerably over comparable storms for 1979 conditions. Baseflow would be reduced.
2. In-stream water quality would be degraded by projected year 2000 land use categories. Although the Great Swamp acts as a nutrient sink, it would be less effective at removing nutrient loads in the future.
3. Water quality in the lower reaches of the Black Brook appears to be strongly influenced by nonpoint source pollution.

Table 3
Land Use in the Great Swamp Watershed (1994)

ÝMunicipality	Residential		Commercial/ Industrial		Public/Semi-Public		Farm		Vacant		Total Acreage
Ý	Acreage	%	Acreage	%	Acreage	%	Acreage	%	Acreage	%	
Bernards Township	2699	66.8	258	6.4	618	20.2	106	2.6	161	4.0	4040
Bernardsville Borough	1371	57.0	Ý42	1.7	456	19.0	115	4.8	420	147.5	2404
Chatham Township	1749	36.2	245	5.1	2062	42.6	329	6.8	450	9.9	4835
Harding Township	4090	32.3	106	0.8	5728	45.3	2046	16.2	685	5.4	12655
Long Hill Township	1229	28.2	123	2.6	2801	59.6	221	4.7	322	6.9	4696
Madison Borough	Ý334	45.6	191	26.1	163	22.3	0	0.0	44	6.0	732
Mendham Borough	499	66.8	16	2.1	106	14.2	93	12.4	34	4.5	748
Mendham Township	660	38.1	170	9.3	493	26.9	359	19.6	149	8.1	1631
Morris Township	1318	47.3	740	26.6	390	14.0	20	0.7	319	11.4	2787
Morristown	1618	82.3	158	8.0	159	8.1	0	0.0	31	1.6	1966

TOTAL	15567	42.4	2047	5.6	13176	35.9	3289	9.0	2615	7.1	36694

A joint U.S. Fish and Wildlife Service and U.S. Soil Conservation Service Study (1984) evaluated the effects of changing land use on stormwater runoff to the Great Swamp. It used TR-20 to model stormwater for 1963, 1979, and 2000. Conclusions of the study were:

1. Stormwater runoff and nonpoint source pollution for Great Brook for year 2000 would increase 25-35% over 1979 conditions. This would have substantial adverse impacts on the Great Swamp.

2. Stormwater runoff and nonpoint source pollution for Loantaka Brook for year 2000 would increase 28-67% over 1979 conditions.

Other studies have shown that sediment and nutrient concentrations are increasing in the streams and in the Great Swamp. Observations, made over the past years by the U.S. Fish and Wildlife Service who operate the Great Swamp indicate that nonpoint source pollution and increased volumes of stormwater have resulted in the following:

1. Incidences of increased wildlife mortality,

2. Displacement of bog turtles (state endangered species) and their shallow-marsh habitat due to increasingly wet conditions and water pollution,

3. Excessive failure of fowl nesting, and

4. Changes in flora and fauna due to increases in stormwater runoff and nonpoint source pollution.

Sources of pollution can be categorized as nonpoint source pollution or point source pollution. Point sources include permitted discharges from municipal and industrial wastewater treatment plants. Nonpoint sources include everything else including stormwater runoff, dry-weather stream flow, and groundwater. Examples of nonpoint sources include stormwater runoff and erosion from agriculture, developed land, forests, industrial and commercial areas, and landfills. Leachate from septic systems is also considered a nonpoint source.

The most recent study 'A Status and Assessment Study of Stormwater Discharges within the Great Swamp Watershed (1997)', funded by NJDEP and the U.S. EPA, concluded that nonpoint source pollution is the major pollution problem in the Great Swamp watershed. The percentages of annual pollutant loads from various sources were determined to be as shown in Table 4. For example, 77.46 percent of the total annual phosphorus entering the Great Swamp comes from stormwater runoff. Only 5.24 percent of the total annual phosphorus comes from tributary streams during dry-weather, non-rain conditions. All of the wastewater treatment plants in the watershed contribute 17.34 percent of the annual total phosphorus load to the Great Swamp. Nonpoint sources, therefore, contribute 82.7 percent (stormwater flow and stream flow) of the total annual total phosphorus load to the Great Swamp.

Table 4

Point Source vs. Nonpoint Source Pollutant Loadings to the Great Swamp

Parameter	Nonpoint Sources	Point Sources

	Stormwater Flow	Dry Weather Flow	Wastewater Treatment Plant Discharges
BOD_5	97.03%	1.48%	1.49%
Ammonia-Nitrogen	65.33%	15.55%	19.12%
Nitrate-Nitrogen	31.13%	14.03%	54.84%
Organic Nitrogen	72.81%	2.79%	24.41%
Total Phosphorus	77.46%	5.24%	17.31%

Source: Najarian Associates and Maser, Sosinski & Associates (1997)

The study concluded that the imperviousness of the developed areas is probably the most important influence on nonpoint source pollution loads. For example, one acre of impervious land generates roughly five times more runoff and nonpoint source pollution than one acre of pervious land. The study also concluded that urban/commercial areas contributed more Biochemical Oxygen Demand (BOD), suburban areas contributed more total phosphorus, and rural areas contributed more organic matter. Other specific conclusions relative to pollutant loadings and land use included:

- A substantial load of nitrogen (in organic form) is generated from even the most undeveloped areas.
- The bulk of the nitrogen load is in terms of organic nitrogen for undeveloped to moderately developed areas.
- An increase in impervious coverage preferentially increases phosphorus loads more than nitrogen loads (on a percentage basis).
- An increase in impervious coverage preferentially increases inorganic nitrogen loads more than organic nitrogen loads.

Using the EPA Stormwater Management Model (SWMM), the authors of the 1997 DEP-funded study developed pollutant loading factors (in pounds per acre per year) as shown in Table 5.

Recent water quality studies of the Great Swamp watershed by the U.S. Fish and Wildlife Service and the Research Foundation of the State University of New York have shown elevated levels of nitrogen and phosphorus in the tributaries to the Great Swamp.

Table 5

Pollutant Loadings vs. Percent Impervious Cover for the Great Swamp Watershed

Percent Impervious Cover	BOD	Loading Factors (lbs/ac/yr)				
		Ammonia Nitrogen	Nitrate Nitrogen	Organic Nitrogen	Total Phosphorus	Total Nitrogen
0%	0.65	0.01	0.15	0.46	0.00	0.63
5%	2.48	0.02	0.21	0.51	0.04	0.74
10%	4.31	0.03	0.27	0.55	0.08	0.85
15%	6.14	0.04	0.33	0.59	0.12	0.95
20%	7.97	0.05	0.39	0.63	0.16	1.06
25%	9.80	0.05	0.45	0.67	0.19	1.17
30%	11.63	0.06	0.51	0.72	0.23	1.28
35%	13.46	0.07	0.56	0.76	0.27	1.39

40%	15.28	0.08	0.62	0.80	0.31	1.50
45%	17.11	0.08	0.68	0.84	0.35	1.61
50%	18.94	0.09	0.74	0.89	0.38	1.72
55%	20.77	0.10	0.80	0.93	0.42	1.83
60%	22.60	0.11	0.86	0.97	0.46	1.94
65%	24.43	0.12	0.92	1.01	0.50	2.05
70%	26.26	0.12	0.98	1.05	0.53	2.16
75%	28.09	0.13	1.04	1.10	0.57	2.27
80%	29.92	0.14	1.10	1.14	0.61	2.38
85%	31.75	0.15	1.16	1.18	0.65	2.49
90%	33.58	0.15	1.22	1.22	0.69	2.60
95%	35.41	0.16	1.28	1.27	0.72	2.71
100%	37.24	0.17	1.34	1.31	0.76	2.82

Source: Najarian Associates and Maser, Sosinski & Associates (1997)

Studies of benthic macroinvertebrates indicate that the macroinvertebrate populations are stressed due to point and nonpoint source pollution at many stream sites.

TEN TOWNS GREAT SWAMP WATERSHED COMMITTEE

The Ten Towns Great Swamp Watershed Committee was formed by Morris 2000 in 1995 to provide an effective mechanism to prepare and implement a Watershed Management Plan for the Great Swamp. This new "grass roots" approach contrasts with previous "top down" efforts of the state and federal governments which met with limited success.

The Ten Towns Committee used its first year to conduct a comprehensive fact-finding program on the Great Swamp and Watershed Management. The objectives of the fact-finding process was two-fold:

- To allow a full exchange of views by all interested parties, both the municipal members and private organizations;
- To establish a uniform data base of factual information that was acceptable to all participants in the project.

There has been long standing controversy about potential environmental harm to the Great Swamp and the best means of preserving this valuable natural resource. Although many efforts have been made in the past to prepare plans or regulations to protect the Great Swamp, these efforts have been largely unsuccessful. Morris 2000 conducted a study of the Great Swamp watershed management issues and facilitated adoption of the 'Great Swamp Watershed Intermunicipal Cooperative Agreement' in July 1995. The Cooperative Agreement developed a Committee consisting of three representatives from each of the ten municipalities within the Great Swamp Watershed. The Committee was charged with the responsibility of developing and implementing a Watershed Management Plan for the Great Swamp Watershed.

The Committee conducted its work in two phases:

- Fact-finding
- Preparation of Watershed Management Plan

The fact-finding phase of the Committee's work was very important; it established a foundation of common knowledge on which to prepare a Watershed Management Plan. This fact-finding phase concluded in June 1996 whereupon action was taken to begin preparation of the Watershed Management Plan.

Preparation of the Watershed Management Plan began at that time based on two key elements that highlight the approach and success of the Committee:

- Building the Plan in a systematic and logical manner
- Encouraging full discussion and involvement of all interested parties.

CHAPTER 2 - GOALS FOR THE GREAT SWAMP AND ITS TRIBUTARIES

The Ten Towns Great Swamp Watershed Committee established specific goals for the Great Swamp and its watershed. The general objective of these specific goals is to protect and enhance the ecological condition of the Great Swamp and its watershed. The specific goals established by the Committee are listed below.

Great Swamp National Wildlife Refuge

The Great Swamp is a natural ecosystem being maintained as a National Wildlife Refuge and should be maintained as a refuge. Although the Great Swamp, like other wetlands ecosystems, removes pollutants through physical, chemical, and biological processes, it is not a treatment system intended to purify water. The Great Swamp, therefore, should not be used as a treatment system. The present ecological integrity of the Great Swamp should be maintained. In the Passaic River downstream of the Great Swamp, flood crests should be reduced, baseflow should be maintained, and water quality should be enhanced.

Water Quantity

The existing stormwater peak flows and volumes of the tributaries and in the Great Swamp should be maintained or decreased.

Water Quality

The existing water quality in the major tributaries and in the Great Swamp should be maintained or improved. Specifically, the concentrations of phosphorus, nitrogen and total suspended solids in the tributaries and in the Great Swamp should be maintained or decreased.

Macroinvertebrates

The macroinvertebrate population and diversity in the streams should be improved to meet the potential of each stream based on its specific habitat.

A Beck's Biotic Index of 10 or greater should be achieved in all streams where the stream habitat should, in theory, support such an index.

Index Value	Water Quality

0	Grossly polluted
1-5	Moderately polluted
6-9	Stream clean, but with a monotonous habitat and instream velocity
10 or greater	Stream clean

In addition to the Beck's Biotic Index, a 'non-impaired' classification using other biological indexes contained in the EPA Rapid Bioassessment Protocol II or III should be achieved.

Stream Stabilization

Adversely affected areas of streams should be returned to a condition of stable, non-eroding streams.

Great Swamp Vegetation and Wetness

The present vegetation of the Great Swamp should be maintained, and the present flooding of the Great Swamp should be maintained or reduced. It is understood that natural processes of ecological succession will change the vegetation of the Great Swamp. The purpose of this goal is to maintain diverse, healthy vegetation in the Great Swamp so that the basic ecological and wildlife functions of the Great Swamp are maintained.

Wastewater Treatment and Disposal

Tertiary treatment in the existing wastewater treatment plants should be maintained and properly operated to reduce excessive nutrients from entering the Great Swamp. Individual septic systems should be properly maintained.

CHAPTER 3 - GENERAL PRINCIPLES

MANAGEMENT OF GREAT SWAMP

The U.S. Fish & Wildlife Service, in conjunction with the Great Swamp Watershed Management Committee, should ensure that the Great Swamp is properly managed to maintain or improve the present ecological integrity of the Great Swamp including its internal streams, ponds, vegetation and wildlife.

WATERSHED BASED PLANNING

All planning activities for the Great Swamp watershed should be performed on a watershed rather than a municipal or site-by-site basis.

The New Jersey Department of Environmental Protection published its draft rules on watershed based stormwater management in the March 3, 1997 New Jersey Register. The basic premise of the draft rules is 'that watershed based planning and program implementation for stormwater runoff control that moves beyond site-by-site calculations after land development projects are proposed and implemented, can more effectively manage runoff quantity and water quality at lower total cost.'

The draft rules provide the following technical solutions to stormwater runoff control:

1. Identify watershed specific technical standards for runoff quality which may reduce the need for structural solutions now necessary on every site;

2. Begin with an emphasis on maintaining natural drainage systems, creating new structural ones only when natural drainage systems are inadequate in providing the necessary environmental protection;

3. Tailor the level of stormwater runoff quantity and quality control to the assimilative capacity of the receiving waterbody;

4. Devise innovative methods to remediate existing flooding, water quality and erosion.

The draft rules state the following administrative advantages of managing stormwater runoff on a watershed basis:

1. Improved government coordination will result from watershed measures that are consistently developed and implemented by all levels of government throughout the watershed;

2. Watershed planning efforts should be based on sound science, oriented toward solving real problems, and implemented in response to assessments of comparative risks;

3. Cost-effective solutions to current runoff control problems can be solved or avoided in the future by analyzing and implementing runoff control measures throughout a drainage area, and relying less on end-of-pipe solutions and more on resource management techniques that will incorporate principles of source reduction, pollution prevention, conservation, and recycling.

4. Long term maintenance and operation of stormwater facilities should be addressed at the front end of the planning process.

In their draft rules, the DEP identifies several areas of technical needs required to control stormwater runoff on a watershed basis. The watershed should be characterized to assess and prioritize problems and to develop solutions. The hydrology and hydraulics of the watershed should be modeled. Nonstructural stormwater control measures should be developed, such as acquiring flood plains, wetlands and natural runoff storage areas, or limiting the amount of impervious surfaces to reduce the need for structural solutions. Policies should be developed to address the retrofit of existing drainage systems that do not properly manage stormwater quantity and quality. Point and nonpoint source pollution control strategies and activities should be coordinated.

The ten municipalities in the Great Swamp watershed, therefore, should implement a watershed based strategy throughout the watershed, using the proposed DEP watershed based stormwater management rules as a guide.

WATERSHED MANAGEMENT ORGANIZATION

A watershed management organization should be created to assist the municipalities in the Great Swamp watershed in effectively implementing the Great Swamp Watershed Management Plan. The basic goal of the organization should be to coordinate, not enforce, watershed management activities in the Great Swamp. This organization should have representation from:

Bernards Township
Bernardsville Borough
Chatham Township
Harding Township

Long Hill Township
Madison Borough
Mendham Borough
Mendham Township
Morris Township
Morristown
U.S. Fish and Wildlife Service

An Advisory Committee should be established and should be comprised of one member from each of the following organizations:

Morris County (as designated by the Board of Chosen Freeholders)
Somerset County (as designated by the Board of Chosen Freeholders)
The Great Swamp Watershed Association
The Passaic River Coalition
The Community Builders Association of New Jersey

The Advisory Committee should participate in all activities of the Ten Towns Great Swamp Watershed Management Committee, with the exception of voting. Members of the Advisory Committee should attend all meetings, receive all meeting materials, and participate in the discussion of all Management Committee business and activities. The membership of the Advisory Committee may be expanded or revised by the Ten Towns Great Swamp Watershed Committee from time to time.

A Technical Committee should be established and should be composed of nine members: the Chair of the Ten Towns Great Swamp Watershed Management Committee and one member each from the following organizations:

Morris County Soil Conservation District
Somerset-Union County Soil Conservation District
Morris County Planning Board
Somerset County Planning Board
United States Natural Resource Conservation Service (NRCS)
New Jersey Department of Environmental Protection (DEP)
New Jersey Department of Transportation (DOT)
Ten Towns Great Swamp Watershed Management Committee
U.S. Fish and Wildlife Service
Environmental Consultant

The purpose of the Technical Committee should be to provide technical information on nonpoint source pollution problems and solutions in the Great Swamp Watershed. The Technical Committee should be chaired by the chairperson of the Ten Towns Great Swamp Watershed Management Committee or his/her designated representative. The Technical Committee will meet as necessary at the discretion of the Chairperson; as a minimum, however, the Technical Committee should meet twice a year. The Chair of the Technical Committee may add new members to the Committee at his discretion as deemed appropriate.

Other groups such as other county agencies, state agencies, federal agencies, and private organizations such as Chambers of Commerce have involvement and interest in activities in the Great Swamp Watershed. The Management Committee, Advisory Committee, and Technical Committee should interact with all other agencies interested in the Great Swamp Watershed to implement the watershed management plan.

The Management Committee should create sub-committees, as needed, to undertake special activities.

Sub-Committees should initiate studies, complete investigations, prepare reports for the benefit of the full Committee.

The purposes of the Ten Towns Great Swamp Watershed Management Committee should be to monitor and assist in implementing the Great Swamp Watershed Management Plan. To accomplish these objectives, the Committee will undertake activities including:

1. Present the Watershed Management Plan to municipal officials in the Great Swamp Watershed, other governmental officials and the public.

2. Provide direction and coordination in the implementation of the Great Swamp Watershed Management Plan,

3. Provide a forum for open discussion of water quality, water quantity, groundwater, water supply, and watershed management issues,

4. Provide a vital communication link between the ten municipalities and two counties for ensuring that all watershed-related planning activities are performed on a watershed basis,

5. Provide technical assistance to the ten municipalities in the watershed on water quality, water quantity, and watershed management issues,

6. Establish a public education program to improve understanding of watershed management issues particularly in the Great Swamp Watershed,

7. Coordinate an on-going water quality, water quantity, and watershed monitoring program to document the ecological and hydrological condition of the Great Swamp and its tributaries,

8. Provide annual updates on water quality, water quantity, and watershed management activities in the watershed,

9. Perform, coordinate, and/or oversee scientific research projects on the Great Swamp and its watershed, and

10. Update the Watershed Management Plan from time to time as required and recommend these revisions and related regulatory measures for adoption by municipalities in the Great Swamp Watershed.

The watershed management organization should meet once each month to conduct organization business. The organization should have the power to fulfill the responsibilities stated above. The organization should have the power to seek and raise funds from a variety of sources including local, state, regional and federal programs, foundations, municipalities, counties and citizens. The organization should have the power to enter into contracts with professionals, contractors, associations, and other entities that will promote meeting the goals and responsibilities of the organization.

IMPERVIOUS COVER LIMITS

Past studies have shown that the hydrology and pollutant loadings in a watershed are directly related to the amount of impervious area in the watershed. The recent study of the Great Swamp watershed, "Status and Assessment Study of Stormwater Discharges within the Great Swamp Watershed" (1997), concluded that the imperviousness of developed areas is probably the most important influence on stormwater hydrology. The report concluded that, on a unit area basis, one acre of impervious surface generates roughly five times the cumulative runoff of one acre of previous surface. Modeling results indicated that an 11% area of impervious land generated 40% of the overall runoff volume.

Modeling results from the 1997 study of the Great Swamp showed a direct correlation between pollutant loadings and percent impervious cover. Figures 2 through 6 indicate the correlation of pollutant loadings with percent impervious

cover for biochemical oxygen demand and total phosphorus. The correlation for ammonia, nitrate, and organic nitrogen were fair to good. In general, however, the results of the 1997 study of the Great Swamp watershed agree with other scientific studies that indicate that nonpoint source pollutant loadings increase as the percent impervious cover increases.

Municipalities should review their existing guidelines for the amount of impervious area that should be allowed for new development based on zoning, density, and natural site conditions. Existing parking, driveway and other criteria that require impervious surfaces should be reviewed to determine if they can be reduced.

Critical areas of each municipality should be identified as part of the proposed on-going water quality monitoring program and the proposed watershed investigations. Once identified, each municipality should carefully evaluate these areas to determine whether impervious area limits should be modified to reduce the amount of impervious area allowed for new development.

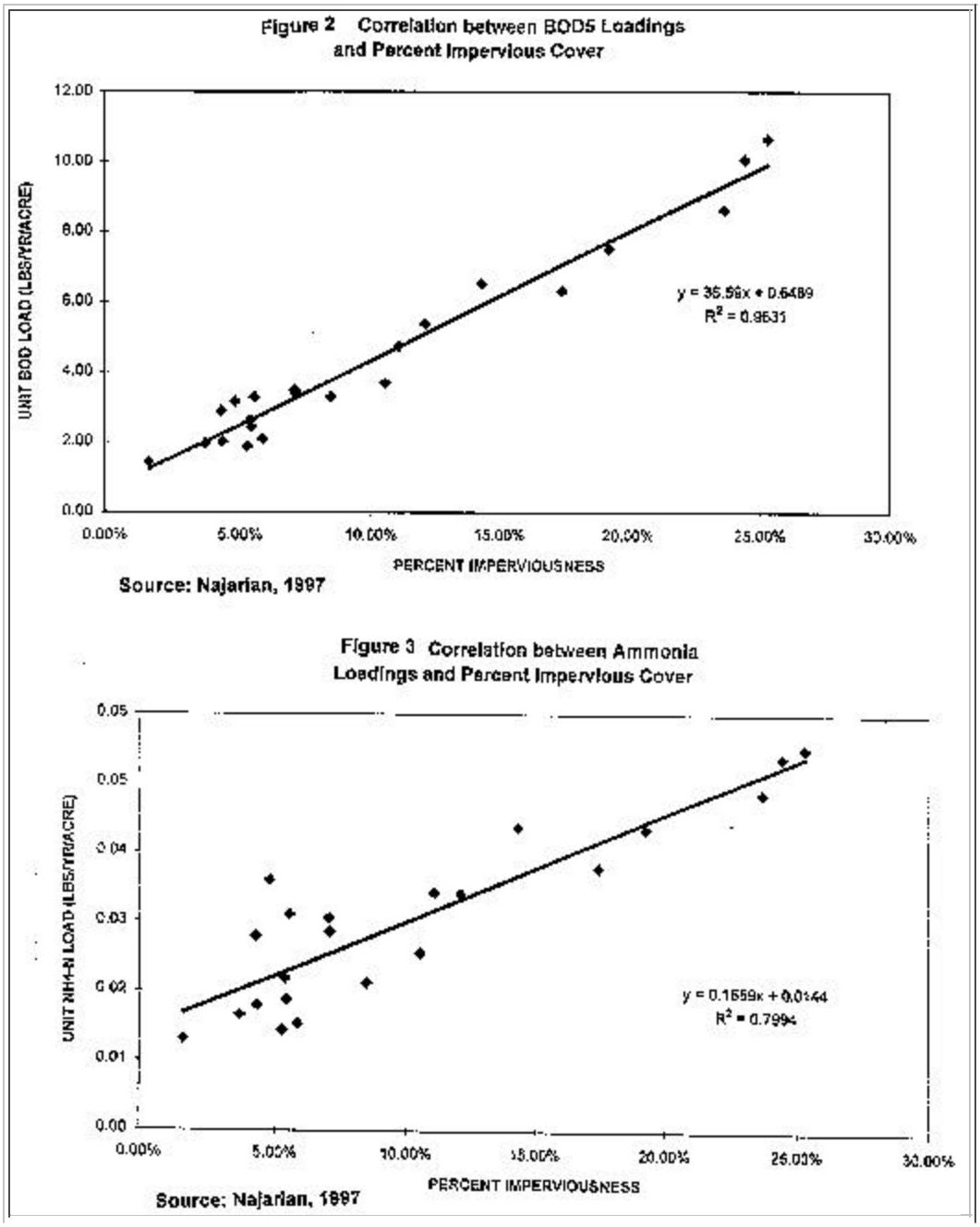
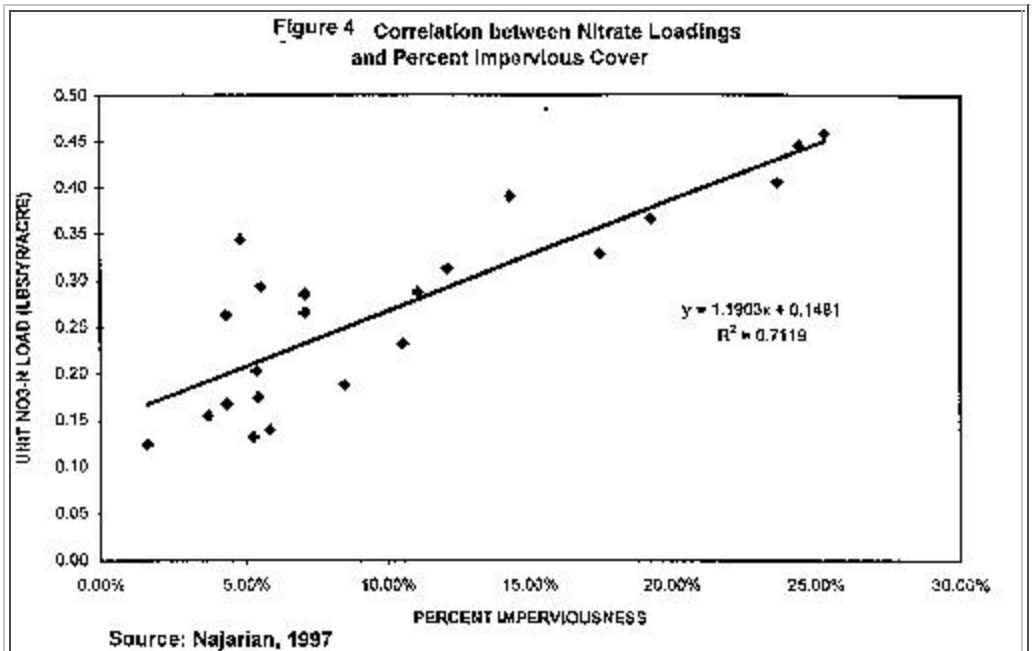


Figure 2 - Correlation Between BOD5 Loadings and Percent Impervious Cover
Figure 3 - Correlation Between Ammonia Loadings and Percent Impervious Cover



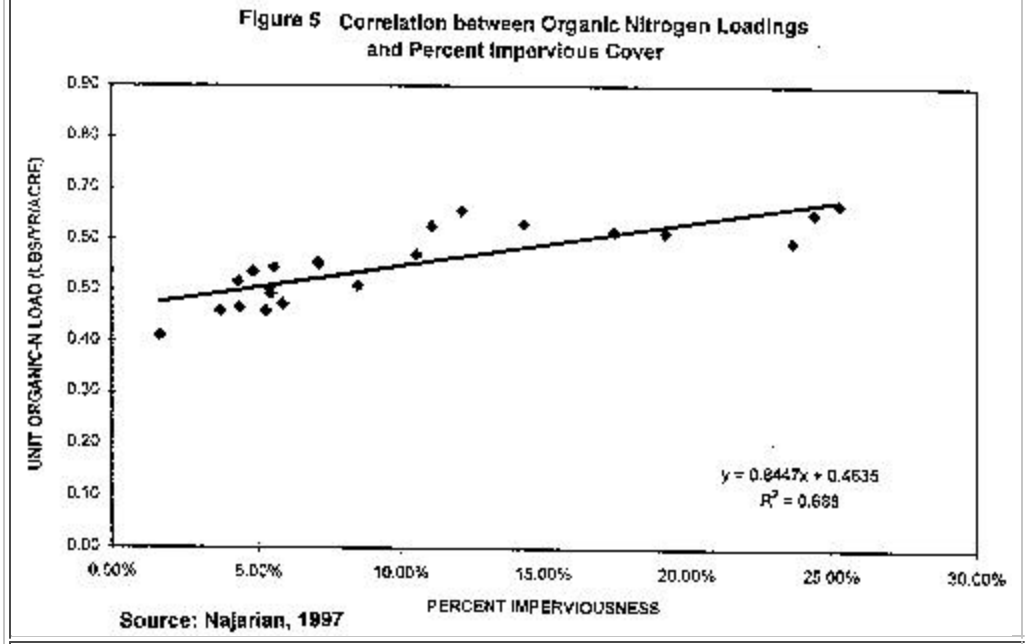
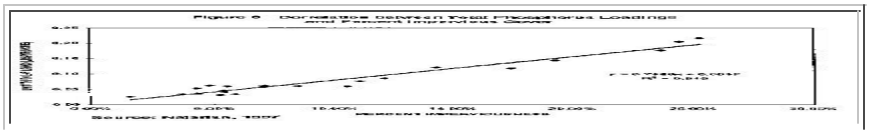


Figure 4 - Correlation Between Nitrate Loadings and Percent Impervious Cover
Figure 5 - Correlation Between Organic Nitrogen Loadings and Percent Impervious Cover



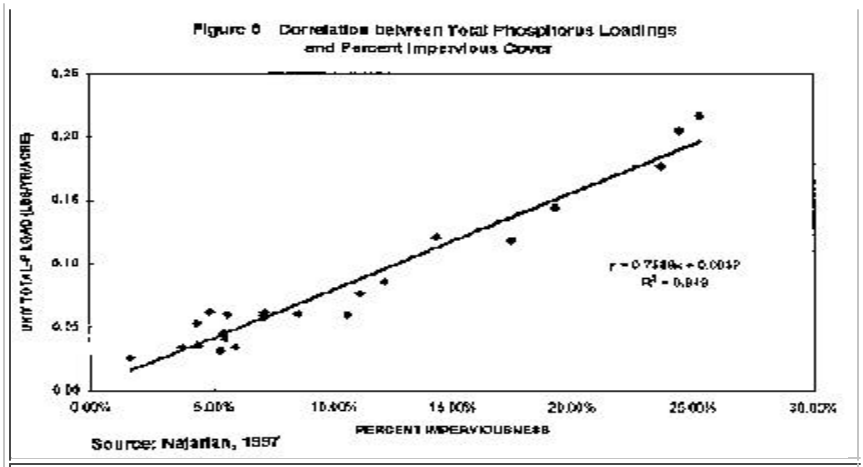


Figure 6 - Correlation Between Total Phosphorus Loadings and Percent Impervious Cover

OPEN SPACE PLANNING

As stated above, an increase in the amount of impervious land leads to a significant increase in nonpoint source pollution. One obvious way to reduce the amount of impervious land is to increase the amount of open space. Creation of open space has many benefits including:

- Increasing the infiltration of stormwater into the ground, resulting in reduced peak stormwater flows and volumes and increased groundwater flows,
- Decreasing nonpoint source pollutant loadings by (1) decreasing the amount of impervious area, and (2) increasing infiltration and overland treatment of stormwater runoff,
- Providing valuable wildlife habitat, resulting in an increase in the population and diversity of wildlife,
- Providing opportunities for active and passive recreation, and
- Increasing the aesthetics of an area, resulting in increased economic value.

The Great Swamp Watershed Association prepared the 'Great Swamp Watershed Greenway and Open Space Plan' (1997). The Plan addresses the need for open space preservation and water resources protection. It seeks to preserve environmentally sensitive areas such as headwaters, stream corridors, habitats for threatened and endangered species, critical soils, steep slopes, wetlands, and areas contiguous to existing public open spaces. It addresses the need to protect downstream areas from increases in stormwater volume and pollutants. It also seeks to address recreational needs in the watershed.

The Plan is a collaborative process in which nine of the ten watershed municipalities, citizen groups, members of natural resource and conservation organizations, and project staff worked together for two years to devise a set of strategies for long-term open space preservation in the region. The Plan is one of the first in the state to have made use of the Geographic Information System (GIS) for open space protection.

The Plan contains a range of options, from outright acquisition to purchase of conservation easements to best management practices.

The municipalities in the Great Swamp watershed should encourage open space planning on all levels, from subdivision planning to municipal planning. Open space planning should be an integral part of all new site developments. For new developments, the Four-Step Design Process for 'Open Space Subdivisions', formulated by Randall Arendt of the National Lands Trust, should be followed. The Four-Step Design Process includes the following:

1. Identify potential conservation or open space lands, both primary (unbuildable) and secondary (unconstrained

land such as prime agricultural soils, mature woodlands, ponds, streams, wetlands, historic/cultural features, and sensitive areas); then

2. Locate house or development sites at a respectful distance from resource lands; then

3. Align streets, driveways, and foot paths; then

4. Set the lot lines.

This Four-Step Process is different than the normal site development process in that the preservation of valuable open space is the first element of the site design process.

Municipalities in the Great Swamp watershed should re-evaluate their existing ordinances to ensure that open space planning is encouraged, not discouraged. If appropriate, municipal ordinances should be modified to encourage the creative use and protection of valuable open space areas.

An example of a typical "Open Space Subdivision" is shown in Figure 7.

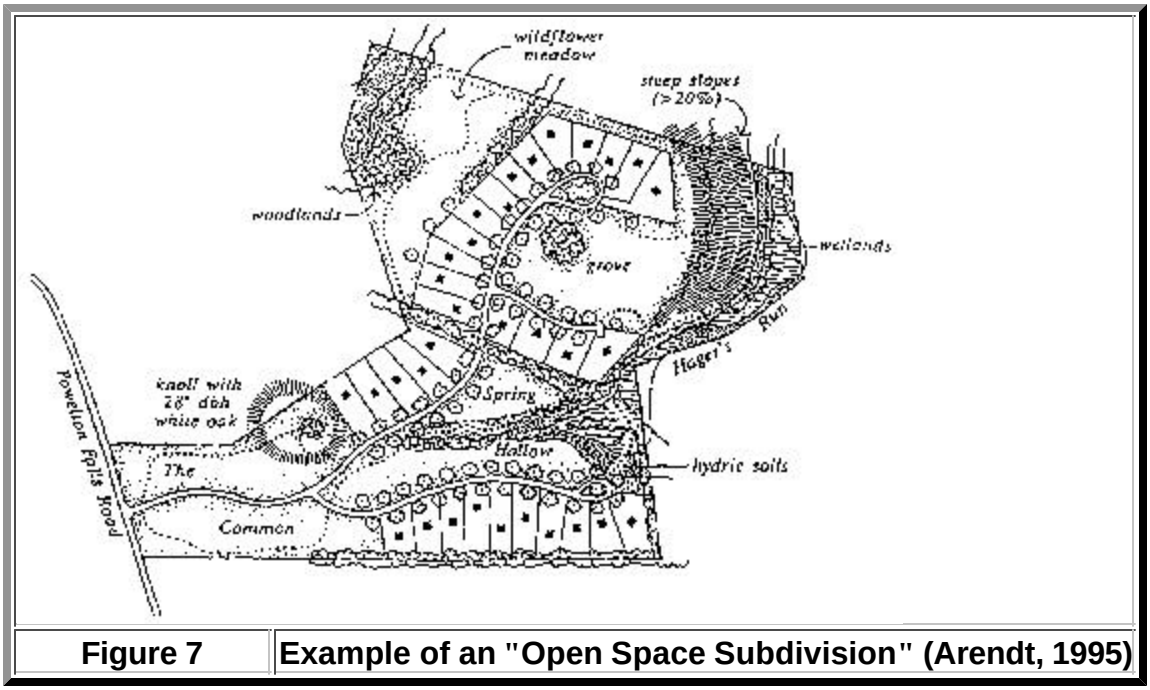


Figure 7 **Example of an "Open Space Subdivision" (Arendt, 1995)**

PUBLIC EDUCATION

A comprehensive public education program should be developed and implemented. Specific educational components should be developed for a wide variety of groups including the general public, public officials, engineers and planners, contractors, realtors, farmers, and students.

Good homeowner practices should be publicized and encouraged. These practices should include septic system maintenance, recycling of yard wastes, storage and disposal of toxic materials, and proper lawn maintenance.

The public education program should consist of a variety of programs and activities, including the following:

1. Develop fact sheets on water quality, water quantity, and watershed management topics.

2. Develop slide show and video on watershed management.

3. Consider developing an Internet home page to educate people about the Great Swamp and to distribute the public education information developed.

4. Develop and implement seminars on a variety of topics for township officials and staff, municipal engineers, consulting engineers, planners, surveyors, developers, and realtors.

5. Install signs throughout the watershed indicating that 'You are in the Great Swamp Watershed, etc.' to develop an awareness of the relationship of watershed to the condition of 6. Consider developing environmental education curriculums for school children in the watershed.

The watershed management organization should coordinate the public education program; however, the public education program should maximize the existing resources and materials of local, county, regional, state, and federal agencies, associations, universities, school districts, and other organizations.

RIPARIAN STREAM CORRIDOR BUFFERS

For both existing and new development, the protection, development and enhancement of stream buffers should be encouraged. A riparian stream conservation ordinance should be adopted.

Benefits of Stream Buffers

Riparian stream buffers have the following benefits:

1. Reduce water temperature in streams and lakes,

2. Remove sediments, nutrients, and other pollutants in stormwater runoff,

3. Help maintain stream flow during drier times of the years,

4. Stabilize streambanks and decrease streambank erosion.

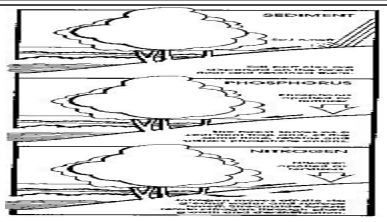
5. Provide valuable wildlife habitat for plants and animals by providing food, shelter, and water,

6. Provide better, more stable stream habitat resulting in improved fishery and other aquatic life,

7. Provide flood control resulting in less flooding, lower water velocities, and lower water depths in the stream, and

8. Provide visually appealing "greenbelts" in developed areas such as the Great Swamp.

One of the most important benefits of stream buffers is the removal of pollutants from stormwater runoff. Figure 8 illustrates the pollutant removal mechanisms of a stream buffer.



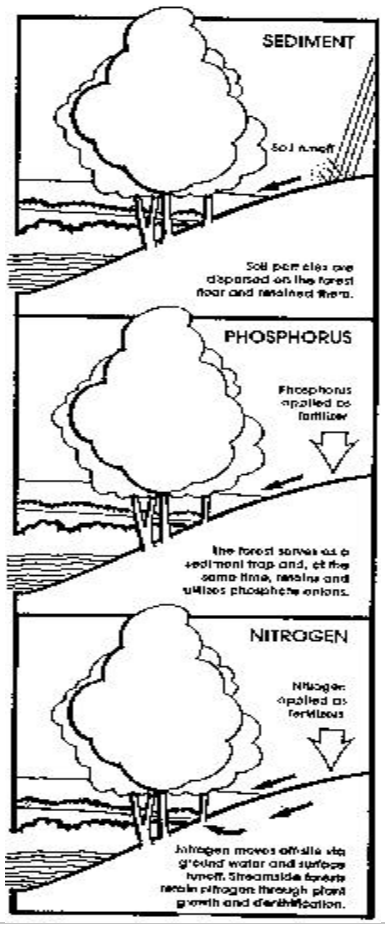


Figure 8 **Pollutant Removal Mechanisms of a Stream Buffer**

Effectiveness of Stream Buffers

Many studies have demonstrated the effectiveness of vegetated buffers on water quality. Doyle (1975) found that a 4 meter (12 foot) buffer significantly improved water quality. Roby et al (1977) found that a 30 meter (100 foot) buffer was effective in improving water quality. A 1995 study by Woodard and Rock found that a natural buffer of 15 meters (50 feet) was effective in reducing phosphorus concentrations in stormwater runoff. They found that the ground cover had a more significant impact on pollutant removal than slope. Some areas of exposed soil actually contributed suspended solids to the runoff passing through the buffer. Woodard and Rock concluded that buffer strips can be effective in reducing phosphorus and sediment concentrations in runoff from residential developments, with phosphorus removal rates ranging from 65 to 94 percent.

For the protection of water quality, the recommended riparian vegetated buffer width ranges from 25 to 100 feet (River Network, 1995). The United States Forest Service recommends a riparian forest buffer of 75 feet, divided into two zones. Zone 1, the undisturbed forest, would be 15 feet while Zone 2, the managed forest, would be 60 feet. The Canadian Ministry of Environmental Lands and Parks strongly recommends stream forest buffers but does not recommend a specific buffer width (Stream Stewardship, 1994).

Elements of a Stream Buffer Ordinance

An ordinance should be developed and adopted setting up a riparian corridor conservation buffers. It would consist of designated streams, intermittent watercourses, lakes and wetlands. The buffer would function to remove or buffer pollutants, provide wildlife habitat, control water temperature, and attenuate flood waters. It is recommended that the Riparian Corridor Conservation District model ordinance developed by Montgomery County, Pennsylvania be

adopted for use in the Great Swamp watershed. The basic elements of the recommended stream corridor ordinance are described below. The complete text of the model ordinance is provided in Appendix A.

Certain minimum principles should be adhered to (Montgomery County Planning Commission, 1997):

- Forested riparian corridors should be maintained, and reforestation should be encouraged where no wooded buffer exists. This is important for removing nutrients from the soil, stabilizing the soil, modifying water temperature, and providing food for aquatic organisms.
- The riparian corridor should not be interrupted. This will help reduce concentrated flow from entering the stream and provide continuous habitat for the passage of animals. This means that the riparian buffer should be continuous and not interrupted by impervious areas that would allow stormwater to concentrate and flow into the stream without first flowing through a vegetated buffer.
- Riparian corridors should extend at least 75 feet from the edge of the stream to perform properly. The 75 feet should include several distinct zones that perform specific functions. Ideally, the first zone should consist of undisturbed forest to provide food and shade for the stream. The second zone should consist of managed woodland that allows for infiltration of runoff, filtration of sediment and nutrients, and nutrient uptake by plants. Finally, flow into the buffer should be transformed from concentrated flow into sheet flow to maximize ground contact with the runoff.
- Recreation within the riparian corridor should be balanced with the impact it may have upon existing features. For example, physical invasion of a riparian corridor may be limited when it contains plant or animal species of concern or steep slopes or significantly impacts adjacent landowners.
- Development within the riparian corridor should be limited to structural facilities that are absolutely necessary. Agricultural activities would be permitted within the riparian corridor provided they were conducted in conformance with recognized soil conservation practices, which should include erosion, nutrient, fertilizer, herbicide and pesticide control. When construction activities occur within the riparian corridor, specific mitigation measures should be taken in the form of riparian corridor improvements.
- Generally, the riparian corridor should remain in its natural state. However, some maintenance is periodically necessary, such as minor landscaping to minimize concentrated flow and removal of exotic plant species when these species are detrimental to the vegetated buffer.

The riparian buffer should be a minimum of 75 feet from the defined edge of a watercourse at bankfull flow (see Figure 9). It should consist of two zones:

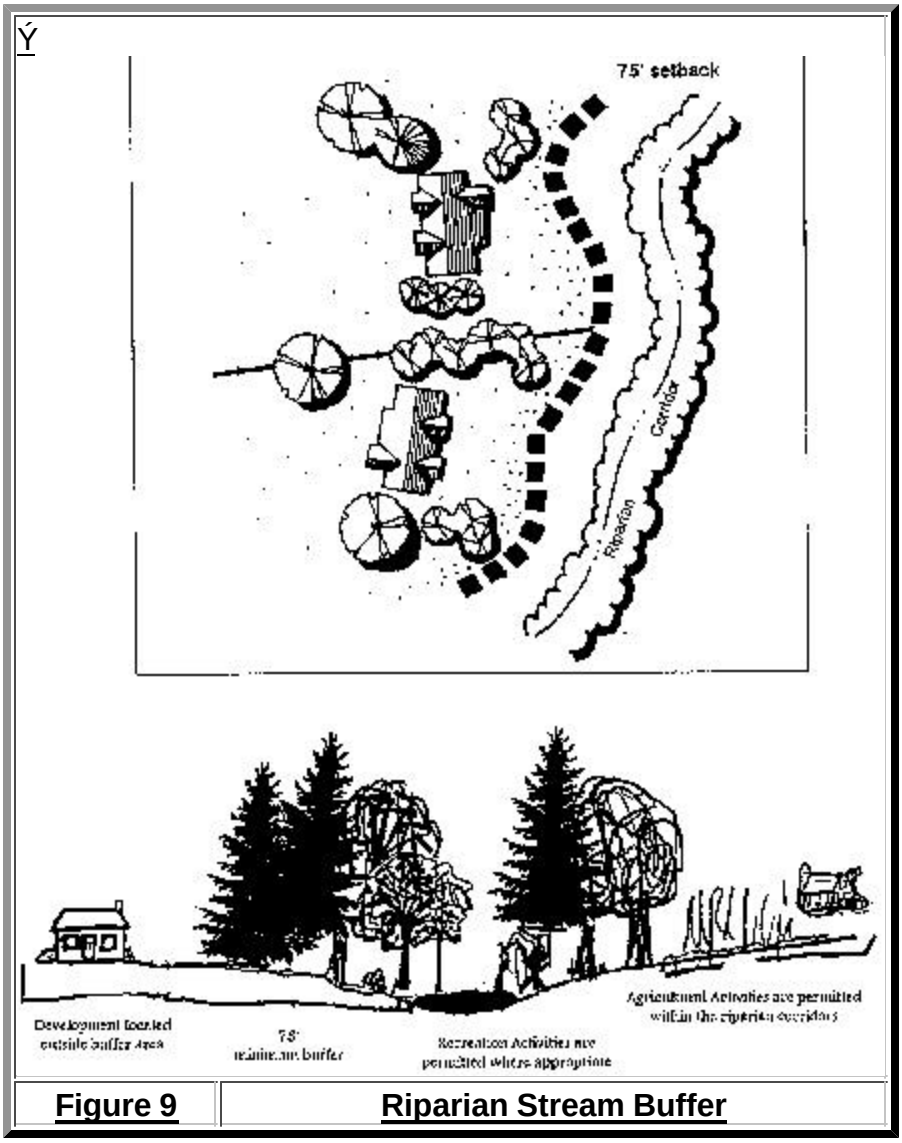


Figure 9 **Riparian Stream Buffer**

Zone One

- Minimum of 25 Feet from Edge of Waterway, Measured Horizontally from Edge, or
- Entire Distance of Area with Slope in Excess of 25%

Zone Two

- 50 Feet from Edge of Zone One.

Each zone would have uses that are permitted by right and permitted by conditional use. The permitted uses for each zone are listed below:

Permitted Uses - Zone One

1. Permitted by Right

- Preserves, Fishing Areas, Passive Parklands, and Reforestation
- Streambank Stabilization

2. Permitted by Special Permit

- Corridor Crossings by Farm Vehicles
- Livestock, Recreation Trails, Central Sewer & Water Lines, Utility Lines, Roads, Railroads. Disturbance Must be Offset by Corridor Improvement
- Selective Cutting of Specimen Trees

Permitted Uses - Zone Two

1. Permitted by Right

- Preserves, Passive Parklands, Recreation Trails
- Reforestation
- Minimum Yards on Private Lots - No Yard Setback May Extend into Zone Two More Than Half the Zone Two Width
- Existing Agricultural Uses with Conservation and Management Plan

2. Permitted by Special Permit

- New Agricultural Uses with Conservation Plan
- Selective Tree Cutting of High Economic Value Trees
- Passive Uses: Camps, Campgrounds, Picnic Areas, Golf Courses
- Active Uses: Ballfields, Playgrounds, Courts, etc. - without Concentrated Runoff
- Naturalized Stormwater Basins (minimum of 50' from waterway)

Uses Prohibited in Riparian Zones

- Clear Cutting of Trees
- Roads or Driveways Except As Permitted As Corridor Crossing
- Parking Lots
- Permanent Structures Except for Permitted Uses
- Subsurface Sewage Disposal
- Any Non-Permitted Use

Corridor Management Plan

All landowners and developers proposing subdivision or development of land within the riparian corridor should submit a corridor management plan. The corridor management plan should balance the intent of the corridor conservation ordinance with a site=s existing conditions and the landowners plans for the property. The management plan should identify specific goals for the riparian corridor and specific activities for achieving these goals. The management plan should contain the following elements:

1. Identification of existing condition

2. Description of landowners goals for the riparian corridor

3. Discussion of activities proposed for land in each zone and land adjacent to the corridor

4. Discussion of how the goals will be met by the proposed activities.

AGRICULTURE RESOURCE MANAGEMENT PLANS

All existing farms in the watershed should develop and implement Resource Management Plans which should include

Best Management Practices (BMPs) for erosion, nutrient, fertilizer, herbicide, and pesticide control. Farmers should develop these plans with assistance from the local conservation districts and the Natural Resource Conservation Service (NRCS).

CHAPTER 4 - ESTABLISH EXISTING CONDITIONS

WATERSHED INVESTIGATIONS

Watershed investigations should be performed to identify existing nonpoint source problem areas throughout the Great Swamp watershed. Since much of the watershed is already developed and since it was developed without the benefit of a comprehensive management plan, there are probably many existing areas that contribute to excessive stormwater runoff and soil erosion. These problem areas should be identified and prioritized so that retrofit efforts can be applied to correct the problems.

Areas to be investigated include, but should not be limited to, streambanks, culverts, roadways, roadway stream crossings, storm drainage pipes, and parking lots. Areas of excessive stormwater runoff and soil erosion should be investigated for all existing land uses including agriculture, commercial, industrial, public, residential, and institutional.

Once these nonpoint source problem areas have been identified, they should be prioritized and analyzed for possible retrofit opportunities. Examples of potential retrofit opportunities include (Schueler, 1995):

1. Retrofit existing older stormwater management facilities
2. Construct new stormwater controls at upstream end of road culverts.
3. Construct new stormwater controls at storm drainage pipe outfalls.
4. Construct small instream practices in open channels.
5. Construct on-site measures at the edges of large parking areas.
6. Construct new stormwater controls within highway rights-of-way

Retrofit controls, or best management practices (BMPs) can include a large variety of measures including small detention areas, wet ponds, constructed wetlands, small pocket wetlands, sand filters, peat filters, and bioretention systems. In some cases, retrofitting can consist of simple measures such as erosion control, soil stabilization, or stormwater diversion. Some nonpoint source problems can be eliminated by changing existing maintenance and operational procedures. For example, fertilization of lawns and golf courses could be modified to reduce nutrient runoff. Mowing of public areas could be modified to develop denser, taller, more natural vegetation, resulting in better control of stormwater runoff and increased removal of nutrients.

According to Thomas Schueler, Director of the Center for Watershed Protection (1995), elements to consider in stormwater retrofitting including the following:

- Ensure that retrofit site has adequate construction and maintenance access and sufficient construction staging area

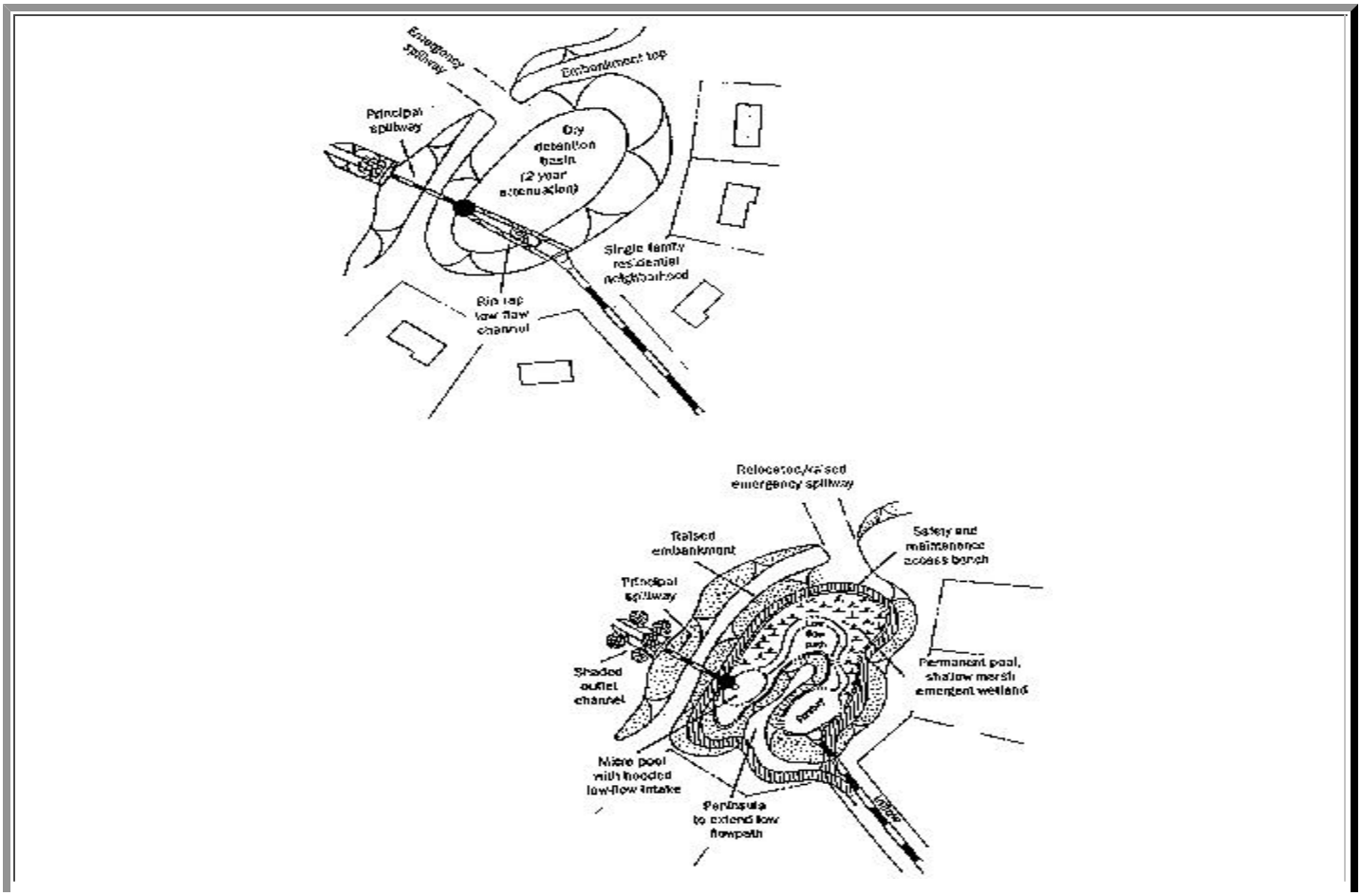
- Verify existing utility locations, assess likelihood for conflicts, avoidance or relocation potential
- Identify existing natural resources and estimate sensitivity, avoid and minimize impacts where possible, assess likelihood for conflicts and permit acquisition complications
- Identify adjacent land uses, select BMPs which will be compatible with nearby properties
- Look for opportunities to combine projects, such as combining stream stabilization and habitat restoration with retrofitting in a complementary manner
- Assess the difficulty of obtaining permits and identify necessary agencies to contact
- Define project purposes (i.e., is the retrofit intended to help stabilize the hydrologic regime in terms of quantity controls or is the retrofit more directed at pollutant removal in terms of quality controls?)

The watershed investigations should be coordinated by the watershed management organization. Initial investigations can be performed by volunteers. The prioritization of nonpoint source problem areas and the evaluation of retrofit opportunities, however, should be performed by professionals.

EXISTING STORMWATER MANAGEMENT FACILITIES

Existing stormwater management facilities, such as detention basins, should be identified and evaluated to determine whether they can be converted to control water quality in addition to water quantity.

Most, if not all, of the existing detention basins in the watershed were designed to control the peak rate of stormwater runoff. They were not designed to control the volume or quality of stormwater runoff. Many of the existing detention basins in the watershed can probably be converted into multi-functional stormwater control systems by modifying them to be stormwater wetlands, conventional wet ponds, or a combined wetlands-pond system. A typical retrofit of an existing stormwater detention basin is illustrated in Figure 10.



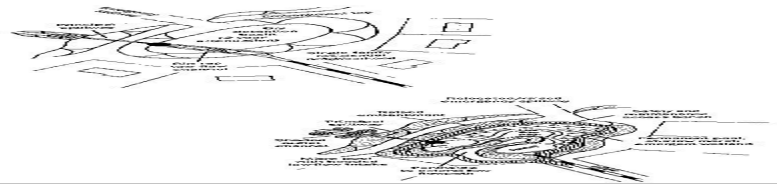


Figure 10	Existing dry detention basin [A] and shallow marsh stormwater wetland retrofit [B] (Schueler, 1995)

The goal of retrofitting an existing detention basin should be to maintain the original design purpose of the basin while providing pollutant treatment. Detention basins should be retrofitted to provide longer storage time, long flow paths, and biological treatment.

WATER QUALITY MONITORING PROGRAM

Introduction

A comprehensive water quality and biological monitoring program should be performed to document water quality, water quantity, pollutant loadings, and the ecological condition of the Great Swamp and its tributaries. The NJDEP rules on watershed based stormwater management indicates that action plans should be developed in three steps:

1. In step 1, current watershed conditions are characterized, risks and threats to beneficial uses are assessed, priority issues are defined and goals and objectives are developed;

2. In step 2, the stormwater management strategy is developed, consisting of a combination of voluntary, educational, non-regulatory and regulatory approaches to controlling the identified or potential sources of flooding and pollutants, and

3. In step 3, the implementation strategy is developed, including action steps related to the implementation of the management strategy, financing and monitoring that will support ongoing evaluation of the stormwater management plan.

The Ten Towns Great Swamp Watershed Committee has defined general goals and objectives in the preparation of this plan. However, the current watershed conditions have not been sufficiently characterized. Over the past several decades, numerous studies and investigations have been performed in the Great Swamp National Wildlife Refuge and its watershed. In general, however, most of the existing water quality and biological data for the Great Swamp and its watershed is piecemeal and therefore discontinuous, not focused, and not organized. This is because past studies were performed by different investigators, at different sites, using different methodologies, for different purposes.

Most of the past studies have concentrated on dry weather conditions and the existing wastewater treatment plants. Only a few studies collected water quality data during wet weather conditions. For example, the latest study 'A Status Assessment Study of Stormwater Discharges Within the Great Swamp Watershed' (1997) funded by the NJDEP monitored stormwater runoff from six outfalls within drainage areas ranging from 19 to 270 acres. Continuous hydrologic data were collected at these six sites during two one-month periods (April and October 1995). Water quality data were collected during two storm events. The data from these six sites and two storm events were then used to model the stormwater pollutants throughout the Great Swamp Watershed. One of the study recommendations is that additional water quality data be obtained.

"The need for downstream verification data: The model was adequately calibrated and verified on a micro-scale basis. However, data was not available to verify the extrapolation of this model to the entire watershed. Thus, the importance of in-stream processes (such as those related to flood storage or pollutant removal) could not be

evaluated. The collection of such data -- and the re-verification of the model on a watershed scale -- would lend additional credibility to all conclusions."

Several studies in the past also collected some stormwater data but the data collected are not sufficient to characterize the water quality, water quantity, and pollutant loadings in the Great Swamp watershed.

In spite of these limitations, past data are useful in providing some general information about the Great Swamp and its watershed. The existing data, however, do not provide sufficient information on annual nonpoint source pollution loadings to the Great Swamp, on the amount of stormwater entering the Great Swamp, or on the ecological condition of the Great Swamp. This information is needed in order to assess risks and threats to beneficial uses and define priority issues. A strategic monitoring program should be performed to obtain this information.

The NJDEP rules for watershed based stormwater management include the following elements for water quality and water quantity.

Water Quality

- Beneficial uses of the water bodies and/or stream segments impaired or threatened by pollution associated with stormwater runoff and the extent of the impairment or threat. The Department encourages use of the most recent Statewide Water Quality Inventory Report and source documentation, including biological assessments, used in its development;
- As feasible, the extent that water quality standards in the various water bodies are not being met or threatened.
- Impacts or potential impacts of pollution associated with existing or projected stormwater runoff on ground water and surface water;
- An inventory of existing or potential pollutants sources and pollutants related to stormwater runoff that threaten or impair beneficial uses or contribute to water quality degradation in each water resource.

Water Quantity

- Determine peak rate and velocity controls or reductions necessary to eliminate or prevent flooding in excess of natural levels within the watershed.

Strategic Monitoring Program

A comprehensive monitoring program should be implemented to meet the following objectives:

1. Develop baseline environmental conditions of the Great Swamp and its watershed,

2. Document long-term trends in environmental conditions of the Great Swamp and its watershed, and

3. Ensure that environmental goals are being met.

The monitoring program should consist of the following:

1. Water Quantity Monitoring

2. Water Quality Monitoring

3. Stream Macroinvertebrate Monitoring

4. Stream Macrophyte Monitoring

5. Stream Classification

6. Great Swamp Vegetation and Flooding Monitoring

7. Wastewater Treatment Plant Monitoring

Water Quantity Monitoring

Monitoring of the quantity of stream flow entering the Great Swamp will be performed to document the amount of stormwater entering the Great Swamp now and in the future. Water quantity monitoring will be performed to measure peak flows, stormwater volumes, and total annual flow to the Great Swamp. One of the goals of a management program will be to minimize the increase in the peak flows and volume of water entering the Great Swamp.

Automatic monitoring stations will be installed at the five major tributaries to the Great Swamp. Rating curves will be developed for each station. The automated stations will provide continuous streamflow data.

Stream Water Quality Monitoring

Water quality monitoring for the five major tributaries to the Great Swamp will be performed to document the quality of water entering the Great Swamp during dry (baseflow) and wet (stormwater runoff) conditions. The data will be used to determine the concentrations and annual loadings of key water quality parameters.

The water quality monitoring program will consist of the following:

Number of Stream Stations: 5

Dry Weather Monitoring: Monthly or Bimonthly

Wet Weather Monitoring: 8-12 times a year

Parameters: Total Phosphorus, Orthophosphorus, Total Nitrogen, Organic, Nitrogen, Nitrates, Ammonia, Total Suspended Solids, pH, Conductivity, Chloride, Biochemical Oxygen Demand

(Metals and organics should be measured on a dry and wet sample every 1-2 years)

Automatic samplers will be installed at each stream station. These samplers will collect samples during and after rain events to obtain representative composite samples. These automated samplers will be electronically tied into the automatic flow recorders so that water samples are collected at pre-programmed flow intervals.

Great Swamp Water Quality Monitoring

Water samples will be collected from representative pool areas in the Great Swamp National Wildlife Refuge to determine the chemical and biological characteristics of water in the Great Swamp.

Samples will be collected monthly from April through September at about five locations. Each sample will be analyzed for total phosphorus, orthophosphorus, total nitrogen, organic nitrogen, nitrates, ammonia, total suspended solids, chlorophyll a, phytoplankton, and zooplankton. Temperature and dissolved oxygen profiles will be measured at each location.

Stream Macroinvertebrate Monitoring

Macroinvertebrate monitoring will be performed on the five main tributaries to the Great Swamp to document the

impacts of water quality, water quantity, and habitat changes on stream biota. An EPA Level 2 Rapid Bioassessment Protocol will be performed two times each year. The data will be used to calculate the ecological indices contained in the Level 2 Protocol.

Stream Macrophyte Monitoring

Macrophyte (aquatic plants) monitoring will be performed at the five main tributaries to the Great Swamp. The macrophyte surveys will be performed at the same time and at the same stream stations that the macroinvertebrate surveys are performed.

Stream Classification

A stream classification study will be performed to classify the five major tributaries to the Great Swamp. The purpose of this classification will be to determine the present condition of the streams relative to stabilization and erosion and to predict future streambank erosion. A classification system such as the Rosgen method will be used.

Great Swamp Vegetation and Flooding Monitoring

Aerial photography of the Great Swamp using regular color and infrared photography will be performed approximately every five years to document changes in the vegetation and flooding of the Great Swamp.

Wastewater Treatment Plant Monitoring

Information from the self-monitoring of the wastewater treatment plants will be obtained and analyzed each year to determine the amount of pollutants being contributed to the Great Swamp by the treatment plants.

CHAPTER 5 - IMPLEMENTING STRATEGIES

INTRODUCTION

The municipalities in the Great Swamp have ordinances for stormwater management, erosion control, and other environmental issues. These existing ordinances, however, have limitations that limit their effectiveness in protecting the Great Swamp and its watershed. For example, the existing stormwater management ordinances do not address the volume or quality of stormwater runoff. The erosion control ordinances do not address the construction of individual homes. Also, the ordinances vary considerably from municipality to municipality. There is, therefore, a real need to develop model ordinances that will protect the quality of the Great Swamp and its watershed. It is the intent of this management plan to present basic elements that would be included in the development of model ordinances. The actual model ordinances will be developed in the near future. It is the ultimate goal of this management plan that each municipality in the Great Swamp watershed adopt these model ordinances.

STORMWATER MANAGEMENT

Stormwater runoff from new developments and from developments being modified should be controlled by following basic stormwater management polices that control both the quality and quantity of stormwater runoff. A stormwater management ordinance should be developed and adopted to implement these policies.

Basic Stormwater Policies

Stormwater management should not be something that is added to a plan after the plan has been developed. Stormwater management should be an integral part of the design of a development plan. Basic principles of stormwater management that should be followed for all new or modified developments include the following:

Reduce Site Runoff

Runoff at the site should be reduced using a variety of techniques including:

- Reducing site imperviousness
- Disconnecting impervious areas
- Using cluster development
- Reserving open space
- Grading the site to divert runoff onto pervious areas
- Avoiding the use of storm sewers and maximizing overland flow over pervious areas
- Infiltrating stormwater runoff

The best method of reducing runoff is to minimize the amount of impervious area on a site. Therefore, a major goal for proper stormwater management should be to minimize impervious areas and to maximize vegetated areas.

The amount of impervious area can be minimized by using a variety of techniques such as:

- Narrower residential road widths
- Shorter road lengths and networks
- Cul-de-sac with islands
- Smaller parking stalls
- Shared or shorter driveways
- Reduced lot frontage requirements
- Sidewalks on one side of street

Of course, the reduction in impervious areas should be balanced with police and fire safety, health concerns, and the social and economic needs of residents and users.

Maximize Use of Natural Drainage Systems

Natural drainage systems should be used in place of man-made storm sewer systems whenever feasible. Basic principles to follow include:

- Minimize disruption of natural channels and features
- Minimize the use of storm sewers and paved stormwater conveyance structures
- Promote filtering and infiltration of stormwater

Provide Pre-Treatment of Stormwater Runoff

It is important that coarse sediments be removed before the stormwater enters the primary treatment facility. Many structural treatment facilities fail because they become clogged with coarse sediments. Some basic pre-treatment techniques include:

- Sediment forebay or micropool
- Grass filter strips and grassed swales
- Catch basin pretreatment

- Sediment chambers

Provide Treatment of the Water Quality Storm

On-site stormwater treatment systems should be designed to treat the Water Quality Storm which is defined as the 1.25 inch, 24-hour storm. Basically, the first 1.25 inches of all storms should be treated. In the Great Swamp watershed, the 1.25 inch Water Quality Storm is approximately equal to 70 percent of the total annual rainfall (Tourbier & Walmsley, Inc., 1996). This means that the 1.25 inch Water Quality Storm has the property that 70 percent of the annual rainfall occurs in storms of equal or smaller magnitude. Runoff from the Water Quality Storm should be infiltrated into the ground.

Basic principles of stormwater treatment and infiltration include:

- Put runoff control measures near the source
- Create a series of treatment devices using the natural features of the site.

Stormwater Management Ordinance

Each municipality should adopt a stormwater management ordinance based on the environmental performance standard that post-development stormwater quantity and quality should not exceed pre-development conditions. Both the volume and peak flow of post-development stormwater runoff where feasible, should be controlled to pre-development conditions. Volume control, where feasible, should be controlled using infiltration practices. The ordinance should contain procedures for calculating both the quantity and quality of the projected stormwater runoff.

The basic objectives of a stormwater management ordinance include:

a. No net increase in nonpoint source pollution - Stormwater control systems should be designed to prevent the degradation of water quality in receiving watercourses from nonpoint source pollution associated with stormwater runoff. Specifically, the amount of total suspended solids, total phosphorus, and total nitrogen for post-development conditions should not exceed pre-development conditions.

b. No net increase in stormwater runoff rates and stream channel erosion - Stormwater control systems should be designed so that, to the maximum extent possible, the post-development stormwater runoff rates from the site and at any point in the watershed between the site and the Great Swamp are no greater than pre-development rates, in order to retain as closely as possible the pre-development hydrologic response of the site and the watershed.

c. No net increase in stormwater runoff volumes - If the soils are pervious, stormwater control systems should be designed so that all post-development stormwater runoff from impervious surfaces is infiltrated into the soil for the Water Quality Storm which is defined as the 1.25 inch, 24-hour storm, using Type III rainfall distribution recommended for New Jersey by the U.S. Natural Resource Conservation Service or the Somerset County 24-Hour Design Storm Distribution as shown on the Somerset County Storm Water Detention Basin Handbook. The first 1.25 inches of stormwater runoff from all larger storms should also be infiltrated into the ground.

Specific key elements of the ordinance should include the following:

1. The peak rate of runoff from a developed site at its point of discharge into a stream or into adjacent private or public property should not exceed 50 percent of the pre-development peak runoff rate for a 2-year storm, 70 percent for a 10-year storm and 75 percent for a 100-year storm.

2. If a regional stormwater plan is in effect, the project=s stormwater management system should be designed to comply with the regional system.

3. Nonstructural stormwater management practices should be utilized prior to the use of structural management measures unless it is demonstrated that these measures are not feasible. Nonstructural measures include elements of site design to reduce stormwater runoff and protect water quality. Examples of nonstructural measures include vegetated buffers, limitations on site disturbance, use of native vegetation, and use of natural site contours and characteristics to infiltrate stormwater.

4. A nonpoint source pollutant loading analysis should be prepared and submitted to the municipality for review. The analysis should demonstrate that the nonpoint source pollutant and sediment loadings resulting from the proposed land development or construction project do not exceed the pre-development pollutant loadings. A model such as Schueler's Simple Method should be used to calculate pre- and post-development pollutant loadings. When available, local pollutant loading data from the Great Swamp watershed should be used in these calculations.

5. For infiltration facilities proposed to meet the no net increase objective of the ordinance, the results of subsurface investigations and soil tests should be submitted to the municipality. These results should demonstrate that (1) the site is suitable for infiltration, and (2) the infiltration system is properly designed.

6. If on-site infiltration of stormwater is not practicable, based on soil permeability constraints or groundwater level considerations, off-site mitigation should be provided, subject to the approval of the Planning Board.

Options for mitigation may include:

a. Acquisition of privately owned lands, preferably adjacent to state open waters, located in the Great Swamp watershed, to be dedicated for preservation or reforestation, in equivalent size to off-set the increase in volume of the 1.25 inch Water Quality Storm from the proposed development;

b. Mitigation on previously developed properties, public or private, and preferably within the same drainage basin that currently lack proper stormwater management facilities designed and constructed in accordance with the goals of the ordinance;

c. Funding of other stormwater management measures in the same subbasin of the watershed to the extent that these other measures off-set the increase in volume of the 1.25 inch Water Quality Stormwater from the proposed development.

Watershed-based trading is being encouraged by the EPA and the states. In their publication 'Draft Framework for Watershed-Based Trading' (1996), the EPA states the following:

"Regardless of who trades and how, the common goal of trading is achieving water quality objectives, including water quality standards, more cost-effectively."

"Trading can produce environmental benefits by accelerating and/or increasing the implementation of pollution control measures in a watershed. Sources have more flexibility in their selection of pollution controls when they also can consider options at other sources."

"Where trading involves nonpoint source pollution reduction, it offers a mechanism to implement restoration and enhancement projects. Such projects improve water quality not only along

chemical parameters, but also along physical parameters, such as temperature and flow, which can help preserve and expand designated uses. Moreover, such projects provide an array of other habitat benefits for aquatic life, birds, and other animals."

"Beyond implementing trades, the process communities go through when they consider a trading option moves them toward more complete management approaches and more effective environmental protection. Identifying trading opportunities involves examining all pollution sources at once when evaluating technical and financial capability to achieve loading reductions."

7. Infiltration facilities should be designed to achieve the recharge of at least 70 percent (tabulated on an annual basis) of direct rainfall. This should be achieved by the implementation of measures which will retain and infiltrate all runoff generated for storms up to the 1.25 inch, 24-hour storm (the Water Quality Storm) using the Type III rainfall distribution recommended for New Jersey by the U.S. Natural Resource Conservation Service (formerly Soil Conservation Service) or the Somerset County 24-Hour Design Storm Distribution. In general, multiple infiltration facilities probably will be required to collectively satisfy the infiltration requirement.

8. Concentrations of stormwater volume should be minimized by designing small impervious surface drainage units. For example, large parking lots should be designed to avoid stormwater from the lot draining to one collection area. Small parking lot drainage units should be designed so that stormwater from small areas of the lot drain to a vegetated buffer area or other stormwater treatment facility.

9. Runoff should be attenuated at the source whenever possible.

10. Land uses should be classified into "Harmfulness Classes" as shown in "Stormwater Management for Water Quality Improvement and Infiltration in the Great Swamp Watershed," dated January 1996 prepared by Tourbier & Walmsley, Inc. Stormwater runoff from harmfulness Class 1 surfaces should be directed through one or more water quality devices prior to infiltration.

11. Water quality and infiltration device treatment trains should be designed that utilize the natural features of the site.

12. Detention/retention basins are generally not suitable as infiltration facilities. Therefore, retention volumes associated with basins should not be used to comply with the no net increase provisions of this ordinance as it regards runoff volume. However, retention basins ("wet basins") may be used to satisfy the water quality requirements of this ordinance.

13. A stormwater management plan should be prepared for all development and construction projects. The plan should include the following elements:

- Topographic Base Map
- Environmental Site Analysis
- Project Description and Site Plan
- Stormwater Management Facilities Plan
- Drainage Area Map
- Hydrologic and Hydraulic Calculations
- Water Quality Calculations
- Evaluation of Regional and Downstream Impacts
- Maintenance and Repair Plan
- Water Quality Monitoring Plan

14. The stormwater management plan for a specific project should be designed to minimize the need for long-term maintenance. A maintenance plan should be developed and should clearly indicate the party responsible for long-term maintenance.

15. The maintenance plan should provide a program of water quality and water quantity monitoring and reporting to measure the effectiveness of the stormwater management plan in achieving, to the extent practicable, the goal of no net increase. Where monitoring demonstrates that implementation of the plan has not achieved the results originally anticipated, a provision for review of and revision to the plan should be included.

16. Detailed technical guidance on engineering methods and BMPs should not be put into the ordinance. Instead, technical information, especially information that may change over time, should be put into a separate Stormwater Management Manual. The ordinance should refer to and incorporate the manual and all updates. This will allow the manual to be updated on a regular basis without requiring a change in the ordinance.

Stormwater Management Manual

A separate stormwater manual should be developed for use with the model Stormwater Management Ordinance. The manual should include goals, objectives, and procedures for calculating pre- and post-development stormwater quantity and quality. It should also include descriptions and design criteria for acceptable stormwater quantity and quality best management practices (BMPs), along with scientifically-based removal efficiencies for water quality BMPs.

For example, the manual should provide technical guidance and requirements for the proper design of BMPs such as dry wells, detention basins, wet pond/retention basins, constructed wetlands, vegetated and biofilter swales, infiltration, vegetated and biofilter swales, infiltration facilities, porous pavement, sediment traps, oil-grease separators, and other BMPs.

New and modified BMPs are being developed each year. Also, the effectiveness of BMPs in controlling water quantity and water quality is being investigated on a continuous basis. It is important, therefore, that the stormwater management manual be separated from the ordinance so that it can be updated on a regular basis as new information and BMPs become available.

Basically, the model Stormwater Management Ordinance would refer to the stormwater manual and require that procedures, pollutant removal efficiencies, guidelines, and other material in the manual be used in developing stormwater management plans.

SOIL EROSION AND SEDIMENT CONTROL

A model erosion and sediment control ordinance should be developed and adopted by all of the municipalities. Besides containing state-of-the-art erosion control procedures, it should contain strong inspection and enforcement procedures. Consideration should be given to requiring a modified E&S plan for all development, including single-family homes.

Most existing erosion and sedimentation control ordinances are adequate in the information required and the plan reviews performed by municipal engineers. The major weaknesses of existing ordinances are (1) they do not cover single family units and building additions, (2) they are not always properly enforced.

Key additions to existing erosion and sedimentation control ordinances should include:

1. Single family units and significant building additions should require a modified simple erosion and sedimentation control permit from the municipality.

2. Regular inspections should be performed at key times throughout the construction phase, including the following:

a. Prior to any construction or measures, in order to check details of location and field conditions.

b. Intermittently during construction and vegetative protection measures.

c. After completion of all construction and establishment of vegetation.

d. At least three (3) times during the maintenance period.

e. At other times as may be necessary because of unsatisfactory conditions.

3. An escrow fee should be required prior to issuance of a building permit. The fee should be used to pay for inspections by the municipality or its engineer. If additional inspections are required, the escrow account should be increased to cover the cost of these additional inspections.

4. Stop work orders should be included in all ordinances.

EARTH DISTURBANCE

Erosion of soil is one of the major sources of nonpoint pollution. The purpose of an earth disturbance ordinance is to ensure that all earth disturbance and soil removal activities are performed in a manner to minimize soil erosion, stormwater runoff, and degradation of water quality. For developments requiring site development or construction approvals, earth disturbance activities are controlled by the specific municipal ordinances. The intent, therefore, of an earth disturbance ordinance is to cover activities not presently covered by other municipal ordinances. Before a model earth disturbance ordinance is developed, an evaluation of existing ordinances should be performed to see if an earth disturbance ordinance is necessary.

Key elements of an earth disturbance ordinance would include the following:

- No person should excavate or otherwise remove soil, except in connection with the construction or alteration of a building on such premises and excavation or grading of a building on such, without permission from the designated municipal government entity.
- An application for earth disturbance should include a plan showing existing contour lines and proposed contour grades resulting from the disturbance or removal of soil.
- An owner granted permission for earth disturbance or soil removal should not take away the top layer of soil for a depth of twelve inches; such top layer should be set aside for retention on the premises and should be re-spread over the premises when the rest of the soil has been removed.

TREE REMOVAL

Removal of trees can adversely affect water quality in the Great Swamp watershed by increasing the amount of soil erosion and stormwater runoff. Tree removal can also adversely affect water quality by eliminating trees that provide shade for streams, resulting in degraded stream habitat. A model tree removal ordinance should be developed. The ordinance should be aimed not at controlling people=s rights to remove trees but at preventing significant soil erosion and stormwater runoff and at protecting riparian stream buffers. Additional research is required before specific elements of a tree removal ordinance can be formulated.

ENVIRONMENTAL IMPACT STATEMENTS

The municipalities in the watershed should continue to require Environmental Impact Statements for all major subdivisions and site plans. Consideration should be given to requiring a shorter, modified EIS for minor subdivisions. Consideration should also be given to requiring a brief environmental checklist or narrative/sketch plan for one-family dwellings.

STEEP SLOPES

Developing on steep slope areas has the potential to cause excessive soil erosion and stormwater runoff during and after construction. To some extent, the proposed stormwater management ordinance will, by its nature, include some protection of steep slopes via its rigorous water quality requirements. However, a steep slope ordinance is needed to ensure that excessive erosion and stormwater runoff do not occur during or after construction and to control all earth moving activities not covered by the stormwater management ordinance or other municipal ordinances.

Past studies by the SCS (now NRCS) and others have shown that soil erosion significantly increased on slopes of 15% or greater. Special consideration and review, therefore, should be given to proposed earth moving and development on slopes of 15% or greater.

A model steep slope ordinance, therefore, should be developed to control development and earth moving on areas with steep slopes.

The purpose of a steep slope ordinance is to regulate the intensity of use in areas of steeply sloping terrain in order to limit soil loss, erosion, excessive stormwater runoff, and the degradation of surface water. The steep slope ordinance should include the following:

- Applicant should prepare a steep slope map based on ten foot contour intervals showing slope classes of 0% - 14.9%, 15% - 25%, and greater than 25%. The map should also include a calculation of the area of proposed disturbance of each slope class on each existing and proposed lot, as well as within any proposed road right-of-way.
- Roads and driveways should be designed to follow the natural topography to the greatest extent possible to minimize the disturbance of steep slope areas.
- On slopes greater than 25%, no development, regrading, or stripping of vegetation should be permitted unless the disturbance is for roadway crossings or utility construction and it can be demonstrated that the roadway or utility improvements are necessary in the sloped area. The sloped area to be developed, regraded, or stripped of vegetation should be shown on the plat or plan.
- For earth moving or development on slopes of 15% or greater, the applicant should provide an in-depth analysis of control measures that will be used to control soil erosion, soil loss, and excessive stormwater runoff both during and after construction.

WETLANDS PROTECTION

Wetlands should be protected since they provide a variety of environmental benefits including groundwater recharge, filtration and treatment of stormwater runoff, flood attenuation, and wildlife habitat. The NJDEP has jurisdiction over wetlands in New Jersey. It is important, however, that new developments, construction, or earth moving activities not destroy regulated wetlands. To achieve this, municipalities must be aware if regulated wetlands exist on potential development sites and ensure that the proper permits and approvals are obtained.

The following key elements should be included in a wetlands protection ordinance or in existing subdivision and site development ordinances:

1. Wetlands delineation - A wetlands letter of interpretation (LOI) from the NJDEP should be submitted as part

of the application for any major subdivision or major site plan application. A Minor subdivision application should not be required to submit a LOI, however an on-site wetland delineation should be prepared by a qualified consultant. If wetlands are present that could impact the proposed improvements, a NJDEP approved LOI should be required to be submitted.

2. Documentation - All wetlands and transition areas required pursuant to N.J.A.C. 7:7A-1 et seq. (N.J. Freshwater Wetlands Protection Act Rules) should be clearly shown on all plats or site plans submitted for approval. All wetlands and transition areas should be shown on all plans. The DEP wetlands ID number should be shown on all plans. The name of the person who performed the wetlands survey should be shown on the plans. If wetlands are not present, the plans should indicate that a wetlands survey was performed, who performed the survey, and that no wetlands were identified on the site. All plans should also indicate the date the wetlands survey was performed and what method was used to perform the survey.

3. Wetlands protection standards - To prevent adverse impacts on delineated wetlands, the following guidelines should be employed:

a. A snow fence should be installed in the area of disturbance outside the final wetlands transition area boundary line prior to the commencement of on-site construction, so as to prevent encroachment into these regulated areas.

b. A silt fence and/or hay bales should be installed downstream from disturbance areas adjacent to the State-mandated wetland transition line (or buffer) so as to prevent the transport of silt into the wetlands areas.

c. All final plats or final site plans should include the wetland line(s) identification number as assigned by NJDEP, pursuant to the Freshwater Wetlands Protection Act.

d. The applicant should avoid encroachment into State-regulated wetland areas. All existing on-site vegetation within or adjacent to the wetland areas should be preserved.

e. Prior to signing of the final plat or site plan, the applicant should provide evidence of the filing of any deed restriction required by NJDEP to permit transition area modification.

f. All wetland boundaries on new sites should be delineated with a sufficient number of permanent markers to ensure that future encroachment and distinction of wetlands does not occur.

CHAPTER 6 - ADDITIONAL STRATEGIES FOR MUNICIPALITIES

REGIONAL STORMWATER MANAGEMENT FACILITIES

A study should be performed to identify potential sites for regional stormwater management facilities such as wet ponds and constructed wetlands. The economic, environmental and social aspects of regional facilities should be evaluated to determine if the construction of regional facilities is feasible.

WASTEWATER MANAGEMENT

Septic System Management

A septic system management program should be developed to include strict testing, design and permitting requirements. It should also include an on-going program of inspections and septage pumping.

The following should be considered relative to septic system failure:

1. Septic systems fail for many reasons

- Improper siting on unsuitable soils
- Improper design/installation
- Hydraulic overload
- Improper maintenance

2. Systems fail above and below ground

3. Pumping will not fix malfunctioning septic systems

A septic system management ordinance should include the following:

1. A permit or license should be required to install, construct, alter or repair a subsurface wastewater disposal system.

2. A permit or license should be required to operate a subsurface wastewater disposal system.

3. Site testing prior to system design should include an on-site inspection, soils testing, and any other tests deemed appropriate by the Board of Health.

4. A professional engineer, registered in New Jersey, should certify the system design.

5. Inspections should be performed during all stages of construction; the design engineer should certify that the system was installed according to the design plans.

6. Sludge should be pumped every 4 to 5 years.

7. Inspections of subsurface wastewater disposal systems should be performed by a licensed health officer, registered professional engineer, licensed sanitarian or other qualified individual. These inspections should be performed every 3 to 5 years.

8. Permits or licenses should be renewed every 3 to 5 years. A license fee should be charged at each renewal period.

9. Malfunctioning systems should be repaired or replaced.

Wastewater Treatment Facilities

The performance of the existing wastewater treatment plants should be monitored to ensure that they are operating properly and meeting all effluent requirements.

INTER-AGENCY COOPERATION

Since municipalities do not have control over the construction and maintenance activities of county, regional, and state agencies, cooperation between the municipalities and these agencies is important. The watershed management organization should act as the agent of the municipalities in the watershed to communicate with county, regional, and state agencies to ensure that all construction and maintenance activities of these agencies are performed in such a manner as to minimize soil erosion, nonpoint source pollution, and degradation of water quality.

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY

Best Management Practice (BMP) - A term used to describe a variety of environmental control technologies designed to control and treat stormwater runoff. Examples include detention basins, retention ponds, infiltration systems, constructed wetlands, sand filters, and bioretention systems.

Cluster Subdivision - Any subdivision in which the dwelling units or facilities are grouped together on small lots to preserve open space and/or natural features on the rest of the parcel.

Culvert - A pipe, conduit, or similar structure including appurtenant works which carries surface water.

Design Storm - The magnitude of precipitation from a storm event measured in probability of occurrence (e.g., 50-year storm) and duration (e.g., 24-hour), and used in computing stormwater management control systems.

Detention Basin - A basin designed to retard stormwater runoff by temporarily storing the runoff and releasing it at a specific rate (e.g., gallons per minute).

Effluent - The discharge of treated wastewater from a wastewater treatment plant into a stream.

Erosion - The removal of soil particles by the action of water, wind, ice, or other agent.

Evapotranspiration - A combined form of the words 'evaporation' and 'transpiration' used in reference to actions by vegetation which describe how they use and recycle water. Evaporation occurs through losses due to surface heat, and transpiration refers to the physiological process of plants when exchanging water back into the atmosphere.

First Flush - A term referring to that part of the total volume of stormwater runoff resulting from a rain event which collects and moves stormwater and pollutants during the first part of a rain event, normally carrying the highest concentration of those pollutants associated with stormwater runoff.

Groundwater - The water beneath the surface of the ground, consisting of surface water that has seeped down; the source of water in springs and wells.

Impervious Surface - Any material covering the surface of the land which prevents water from passing through it; encouraging the water to collect and move over it (e.g., pavement).

Infiltration - The downward movement of water through the uppermost or top layer of the soil surface.

Infiltration Rate - The speed or rate at which water moves through the top layer of soil.

Infrastrucuture - Permanent utility installations, including roads, water supply lines, sewage collection pipe, and power and communications lines.

National Pollution Discharge Elimination System (NPDES) - A federal permit program created under the Clean

Water Act which regulates wastewater/stormwater discharged to streams and other surface water bodies. An NPDES permit establishes effluent limitations for various pollutants.

Nonpoint Source Pollution - Pollution in surface waters not attributable to a specific point of entrance into the waterways. Examples include stormwater runoff from developments, streets, commercial areas, industries, and land fills. Septic system leachate is another example of nonpoint source pollution.

Peak Discharge - The maximum rate of flow of stormwater runoff at a given point and time resulting from a specific storm event.

Recharge - The natural or human-made occurrence whereby water moves through the soil into the underground aquifer to replenish normal water storage volumes.

Release Rate - The percentage of the pre-development peak rate of runoff for a development site to which the post-development peak rate of runoff must be controlled to protect downstream areas.

Retention Basin - A basin designed to retain stormwater runoff so that a permanent pool is established. A stormwater management pond is an example of a retention basin.

Riparian Stream Buffer - Vegetated buffer areas growing along the side of streams and other water bodies. An example of a riparian stream buffer is a forest area located adjacent to both sides of a stream.

Sediment - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its place of origin by water.

Storm Sewers - A system of pipes or other conduits which carries intercepted surface runoff, street water, and other waters, or drainage, but excludes domestic sewage and industrial wastes.

Stormwater Runoff - The portion of rainwater that flows over land into drainage swales, streams, and lakes. The remainder of the rain water either soaks into the soil, becoming groundwater, or evaporates back into the sky. Stormwater runoff usually contains pollutants such as sediments, nutrients, and metals.

Surface Water - That water which is found on the surface of the land, e.g., rivers, streams, lakes, and the oceans.

Watershed - The region or area drained by a river, etc.; a drainage area.

APPENDIX B

MODEL RIPARIAN STREAM CORRIDOR ORDINANCE

APPENDIX C

REFERENCES AND PAST STUDIES

REFERENCE

Arendt, R. (1995). "The Four-Step Design Process for Open Space Subdivisions" Land Development.

Arendt, R. (1994). "Rural by Design: Maintaining Small Town Character". American Planning Association, Washington, D.C.

Doyle, R.C. et.al. (1975). "Effectiveness of Forest Buffer Strips in Improving the Water Quality of Manure Polluted Runoff". Managing Livestock Wastes, Urbana, IL.

Great Swamp Watershed Association. (1997). "Saving Space: The Great Swamp Watershed Greenway and Open Space Plan".

Maquire Group. (1988). "Great Swamp Water Quality Monitoring Study Data Report". Environmental Impacts Branch, Office of Policy and Management, U.S. Environmental Protection Agency, Region II, New York.

Ministry of Environment. (1994). "Stream Stewardship - A Guide for Planners and Developers". Vancouver, BC.

Montgomery County Planning Commission (1997). "Guidebook for Riparian Corridor Preservation." Norristown, PA.

Najarian Associates and Maser, Sosinski & Associates. (1997). "A Status and Assessment Study of Stormwater Discharges within the Great Swamp Watershed, prepared for NJDEP".

River Network. (1995). "A Citizens Guide to Conserving Riparian Forests." Boston, MA.

Roby, K.B. et.al. (1977). "Biological Assessment of Timber Management Activity Impacts and Buffer Strip Effectiveness@" Earth Resources, Monograph No. 1, USDA, Region 5.

Schueler, T.R. (1995). "Stormwater Retrofits - A Tool for Watershed Enhancement" Watershed Protection Techniques, Volume 1, No. 4, Silver Springs, MD.

Thonet Associates. October 30, 1990. "Stormwater Management and Hydrology in the Great Swamp Watershed". Presentation to the Great Swamp Watershed Advisory Committee.

Tourbier & Walmsley. (1996) "Stormwater Management for Water Quality Improvement and Infiltration in the Great Swamp, January 1996."

U.S. Department of Agriculture, June 1995, "(Draft) U.S.D.A. Great Swamp Hydrologic Unit Area Project, Morris and Somerset Counties, New Jersey Final Report," (Final completed draft expected soon).

U.S. Environmental Protection Agency. (1996). "Draft Framework for Watershed-Based Trading" EPA 800-R-96-001 May 1996.

U.S. Fish and Wildlife Service and the Research Foundation of the State of New York. (1996 to 1997). "Water Chemistry Data for Samples Collected from 12 Stations in Great Swamp National Wildlife Refuge, New Jersey".

U.S. Fish and Wildlife Service. (1984). "Great Swamp National Wildlife Refuge Hydrology Study" (A Joint Study of the U.S. Fish and Wildlife Service and Morris County Conservation District with the U.S. Soil Conservation Service assisting), Basking Ridge, New Jersey.

U.S. Forest Service. (1991). "Riparian Forest Buffers" NA-PR-07-91, Radnor, PA.

University of Maryland. (1988). "Streamside Forests: The Vital, Beneficial Resource" Cooperative Extension Service, College Park, MD.

Woodard, S.E. and Rock, C.A. (1995). "Control of Residential Stormwater by Natural Buffer Strips" Lake and Reservoir Management II(1):37-45.

PAST STUDIES

1. U.S. Department of the Interior, Geological Survey. 1925-1991. "Water Resources Data". Prepared for U.S. Geological Survey Water Data in cooperation with New Jersey Department of Environmental Protection and with other agencies.

2. Stankowski, S.J. 1974. "Magnitude and Frequency of Floods in New Jersey with Effects of Urbanization". Special Report 38. U.S. Department of the Interior, Geological Survey. Prepared in cooperation with the NJDEP, Division of Water Resources.

3. U.S. Department of the Interior, Fish and Wildlife Service. 1977. "A Water Quality Study. Great Swamp National Wildlife Refuse - 1977".

4. New Jersey Department of Environmental Protection. 1979. "Draft Northeast New Jersey Water Quality Management Plan". Prepared by the Department of Environmental Protection under a grant from the U.S. Environmental Protection Agency under Section 208 of the Clean Water Act.

5. Dresdner Associates, P.A. Land Use and Environmental Consultants, June 1979, "Analysis of the Relationship of Environmental Characteristics and Land Use Development, Township of Chatham, New Jersey".

6. Van Abs, D.J., Ph.D. 1986. "The Buried Valley Aquifer Systems: Resources and Contamination", prepared for the Passaic River Coalition.

7 Gatter, R. January, 1986, "A Survey of the Benthic Macroinvertebrates of the Great Swamp National Wildlife Refuge and -Its Immediate Environs Morris County, New Jersey"; Graduate Thesis Rutgers, The State University of New Jersey.

8. U.S. Department of the Interior, Fish and Wildlife Service. 1987. "Final Environmental Impact Statement: Great Swamp National Wildlife Refuse Master Plan". Prepared by USFWS Region 5, Newton Corner, Massachusetts.

9. Trama, F.B. 1987. "Great Swamp Water Quality Study: Algal Bioassays-Final Report".

10. United States Environmental Protection Agency, Environmental Impacts Branch, Office of Policy and Management, Region 2, 1988. "Great Swamp Water Quality Monitoring Study Data Report".

11. DiLorenzo, J.L., H.S. Litwack, T.O. Najarian and G.R. Marino. 1988. "Adaptation of a Hydrologic and Water Quality Model to the Great Swamp Watershed: Generation of a Management Tool". Prepared for the Division of Water Resources, New Jersey Department of Environmental Protection.

12. Trama, Francesco B. and Galloway, Lisa M., July 1988, "Morristown National Historical Park Watershed Study,

Phase 11, Aquatic Resources" (4-02-8217 DI-NPS-0006 Morristown Study).

13. New Jersey DEP, Natural and Historic Resources Group. 1989. "Management of the Great Swamp Watershed".

14. Earth Technology Corporation. 1989. "Surface Water Quality Monitoring at Giralda Farms. Report No. 165." Prepared for GRC Management Corporation, Chatham, New Jersey.

15. Cook College Department of Environmental Resources, New Jersey Agricultural Experiment Station, Rutgers, The State University of New Jersey, April, 1989, "Watershed Management Strategies for New Jersey".

16. Hoffman, J.L. 1989. "Plan of Study for the Central Passaic River Basin Hydrogeologic Investigation", New Jersey Geological Survey, Open-File Report 88-4. New Jersey Department of Environmental Protection, Division of Water Resources, Geological Survey.

17. Nieder, William C., January, 1989, "Heavy Metals in the Great Swamp National Wildlife Refuge, Morris County, New Jersey", Masters Thesis.

18. Thonet Associates. October 30, 1990. "Stormwater Management and Hydrology in the Great Swamp Watershed". Presentation to the Great Swamp Watershed Advisory Committee.

19. U.S. Environmental Protection Agency, September, 1991, "Final Environmental Impact Statement on the Upper Passaic River Basin 201 Facilities Plan, In Morris, Somerset and Union Counties, New Jersey".

20. U.S. Department of the Interior, Fish and Wildlife Service. 1991. "Contaminants in Fish and Sediments of Great Swamp National Wildlife Refuse, Morris County New Jersey Results of 1988 Sampling Efforts".

21. CH2MHill, 1991. "Regulatory Review for a Study of the Great Swamp Watershed". Prepared for the Great Swamp

22. CH2MHill, 1992. "Data Report and Analysis for a Study of the Great Swamp Watershed". Prepared for the Great Swamp Watershed Advisory Committee.

23. CH2MHill, 1993. "A Great Swamp Advisory Committee Report, Volume 2, March 1993". Prepared for the Great Swamp Watershed Advisory Committee.

24. CH2MHill, 1992. "Data Needs Assessment and Recommendations for a Study of the Great Swamp Watershed". Prepared for the Great Swamp Watershed Advisory Committee.

25. U.S.D.A. Natural Resource Conservation Service, September, 1992, "1992 Water Quality Inventory: Macroinvertebrate Sampling Study," USDA Great Swamp Watershed Project, USDA, Morris County Soil Conservation District and Somerset-Union County Soil Conservation District.

26. U.S.D.A. Natural Resource Conservation Service, September 1993, "1993 Water Quality Inventory: Macroinvertebrate Sampling Study", USDA Great Swamp Watershed Project, USDA, Morris County Soil Conservation District and Somerset-Union County Soil Conservation District.

27. U.S.D.A. Great Swamp Watershed Project, USDA, Morris County Soil Conservation District and Somerset-Union County Soil Conservation District, March 1993, "Soil Phosphorus Levels: A Background Paper of the USDA Great Swamp HUA Project".

28. Smith, E.L. August 1993, "A Floristic Study of Plants in Two Areas of the Great Swamp Morris County, New

Jersey", Masters Thesis, Bard College.

29. U.S. Department of Agriculture, Forest Service, Palone, R.S., September, 1993, "Forest Resources Report of the Great Swamp Hydrologic Unit Area, Morris and Somerset Counties, New Jersey".

30. Great Swamp Watershed Advisory Committee, April 1993, "Final Report of the Great Swamp Watershed Advisory Committee to the New Jersey Department of Environmental Protection and Energy, Volume I".

31. New Jersey DEPE. 1993. "New Jersey 1992 State Water Quality Inventory Report".

32. Keller and Kirkpatrick, Inc., 1993. "The Great Swamp Revisited: A Review of the Background Material Used as a Basis for the Report of The Great Swamp Advisory Committee".

33. United States Department of Agriculture. 1994. "Best Management Practice Recommendations for the Great Swamp Watershed".

34. U.S.D.A. Natural Resource Conservation Service, September 1994, "1994 Water Quality Inventory: Macroinvertebrate Sampling Study", USDA Great Swamp Watershed Project, USDA, Morris County Soil Conservation District and Somerset-Union County Soil Conservation District.

35. New Jersey Department of Environmental Protection (NJDEP), December 1994, "Ambient Biomonitoring Network Arthur Kill. Passaic, Hackensack and Wallkill River Drainage Basins, 1993, Benthic Macroinvertebrate Data", NJDEP, Trenton, New Jersey.

36. U.S. Fish and Wildlife Service, December 5, 1994, "Response to the Great Swamp Revisited: A Review of the Background Material Used as a Basis for the Report of The Great Swamp Advisory Committee by Robert Kirkpatrick, Jr., Keller and Kirkpatrick Inc."

37. Record, J.A., May, 1995, "A Survey of Amphibians and Reptiles of the Great Swamp National Wildlife Refuse Emphasizing Threatened and Endangered Species With Management Recommendations", Masters Thesis, College of Environmental Science and Forestry of Syracuse University.

38. U.S. Department of Agriculture, 1996, "U.S.D.A. Great Swamp Hydrologic Unit Area Project, Morris and Somerset Counties, New Jersey Final Report".

39. Tourbier & Walmsley, 1996. "Stormwater Management for Water Quality Improvement and Infiltration in the Great Swamp"

40. Najarian Associates and Maser, Sosinski & Associates. 1997. "A Status and Assessment Study of Stormwater Discharges within the Great Swamp Watershed", prepared for NJDEP.