written guidance document for municipalities for storm water permitting in Gloucester County

Krista Lee Fritz
Rowan College of New Jersey

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WRITTEN GUIDANCE DOCUMENT FOR MUNICIPALITIES FOR
STORM WATER PERMITTING IN GLOUCESTER COUNTY

by

Krista Lee Fritz

A THESIS

Submitted in partial fulfillment of the requirements of the
Master of Arts Degree in the Graduate Division of Rowan State College
Fall 1996

Approved by ______________  PROFESSOR

Date Approved 5/1/96
ABSTRACT

Krista Lee Fritz
WRITTEN GUIDANCE DOCUMENT FOR MUNICIPALITIES FOR STORM WATER PERMITTING IN GLOUCESTER COUNTY 1996
Professor Gary Patterson
Master of Arts Degree in Environmental Education and Conservation

To date, no such general permit has been issued to an individual municipality for stormwater dischargers. This thesis focused on the design of a stormwater characterization plan that was acceptable to the New Jersey Department of Environmental Protection and provided the basis for municipal stormwater permitting by municipalities within Gloucester County.

The author produced a written guidance document that enabled individual municipalities located in Gloucester County to research data on and design on their own, using this step-by-step approach to stormwater permitting, a plan that is acceptable to NJDEP for a "General Municipal Stormwater" permit to control stormwater discharges within their geographical areas.

The production of this guidance document involved establishing a working definition of nonpoint source pollution and creating for municipal officials a list of available resources on NPS as approved by the USEPA, NJDEP, and NJDOA. An intensive examination and critique of all resources enabled the author to produce a written guidance document for stormwater permitting processes to be used by municipal officials located in Gloucester County. It was envisioned that this document will be adoptable to all municipalities located throughout the State of New Jersey.
Jersey for stormwater permitting and watershed planning.

Computer modeling was performed as an evaluation exercise to show that the data was both meaningful and useful in the overall development of this guidance document.
MINI-ABSTRACT

Krista Lee Fritz
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To date, no such general permit has been issued to an individual municipality for stormwater dischargers. This thesis focused on the design of a stormwater characterization plan that was acceptable to the New Jersey Department of Environmental Protection and provided the basis for municipal stormwater permitting by municipalities within Gloucester County.

It was envisioned that this document will be adoptable to all municipalities located throughout the State of New Jersey for stormwater permitting and watershed planning.
New Jersey
Department of Environmental Protection

"The mission of the New Jersey Department of Environmental Protection is to conserve, protect, enhance, restore and manage our environment for present and future generations. We strive to prevent pollution, ensure the efficient use of safe, environmentally friendly sound and reliable energy sources, provide opportunities for recreation and enjoyment of natural and historical resources; and promote a healthy and sustainable ecosystem." (Whippany River Watershed Characterization Report, September 1995, p. ii).

and

New Jersey Department of Agriculture

"The mission of the Soil Conservation Service (SCS) in New Jersey is to provide technical leadership for the effective management of the State's soil, water, and related resources; and the "mission of the New Jersey Conservation Partnership is to provide leadership and administer programs to help people conserve, improve and sustain our national resources and the environment." (copied from Display placard at the Gloucester County Soil Conservation Service, Pitman, NJ)
ACKNOWLEDGEMENTS

Hunter Birkhead, Erosion Control Engineer, New Jersey Department of Agriculture

Gloucester County Solid Waste Complex, Mark Dev, Authority Engineer and Kim Kayser, Environmental Technician

Wheelabrator Gloucester Company, Linwood Bubar, Plant Manager

Kimberly A. Cano, Principal Geologist
NJDEP, Office of Environmental Planning

Gary Patterson, Program Advisor, Graduate Professor of Environmental Ed.

The author genuinely thanks Mr. Edward H. Post, P.E., Chief, Southern Bureau of Water and Hazardous Waste Enforcement, and my friend, Lewis G. Klaudi, and supervisor Michael Pagano, for their cooperative support and flexibility in allowing the author to produce this written guidance manual. A sincere thank you was extended to all persons at the Gloucester County Soil Conservation Service (SCS) who contributed their time, guidance and support in this endeavor, Gerald Reker, Robin Bergman, and Steven Quesenberry, who provided all the rainfall data necessary to execute the SCS's computer models.
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9, 10. USDA. SCS, Engineering Division (June 1986). Urban Hydrology for Small Watersheds, p.1-3, 1-4, respectively.


12. SCS Gloucester County.

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14, 15 SCS Gloucester County. TR-55 Model. Author designed graphs.

16. SCS Gloucester County. TR-55 Model. Author designed graphs.
"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect. There is no other way for land to survive the impact of mechanized man, nor for us to reap from it the aesthetic harvest it is capable, under science, of contributing to culture."

Aldo Leopold
March 4, 1948
CHAPTER 1

INTRODUCTION

This thesis proposal outline concentrated on preparing a stormwater characterization plan for individual municipalities located in the County of Gloucester. A characterization plan was provided by the author to describe the current natural features, rainfall, and general infrastructures associated with the watersheds contained within Gloucester County.

The purpose was to create background data that was reliably and consistently recorded as measurable record rainfall and to alter or redesign the database to include parameter identification of pollutants discharged during a storm event. The information was then mathematically and statistically manipulated to calculate runoff rates commonly associated with the current infrastructures located within Gloucester County. The author further assumed that this data will help other municipalities located in New Jersey to calculate, design and implement their own stormwater programs and to apply to the State of New Jersey for a municipal storm water permit. There is not currently such a program in place within the NJDEP.

STATEMENT OF FACT

The Clean Water Enforcement Act, P.L.1990, c.28, modified the Water Pollution Control Act. The New Jersey Pollutant Discharge Elimination Systems ("NJPDES") regulations were incorporated into the Water Pollution Control Act (Chapter 14) and were amended by the Clean Water Enforcement Act (Effective April 1991). Incorporated into the NJPDES regulations, were the inclusion of individual industrial and general
stormwater dischargers in the State of New Jersey. The Federal Clean Water Act also takes into account municipal stormwater dischargers within the State of New Jersey.

**PROBLEM**

To date, no such general permit has been issued to an individual municipality for stormwater dischargers. This thesis focused on the design of a stormwater characterization plan that was acceptable to the New Jersey Department of Environmental Protection and provided the basis for municipal stormwater permitting by municipalities within Gloucester County.

**PURPOSE OF THE STUDY**

The author produced a written guidance document that enabled individual municipalities located in Gloucester County to research data on and design on their own, using this step-by-step approach to stormwater permitting, a plan that is acceptable to NJDEP for a "General Municipal Stormwater" permit to control stormwater discharges within their geographical areas.

**SIGNIFICANCE OF THE STUDY**

The NJPDES permitting program and enforcement elements within the New Jersey Department of Environmental Protection have been instrumental in moving forward with the "relatively" new regulations promulgated under the Clean Water Enforcement Act ("CWEA") of 1991, specifically as the NJPDES section mandated that mandatory minimum civil administrative penalties be assessed for violations of this Act and that stormwater dischargers of industrial regulated activities that did not formally have a NJPDES permit, apply for an stormwater permit based on the business's Standardized Industrial Classification Code, as registered within the State of New Jersey. Four years later, the
Department has revised the Clean Water Enforcement Act (April 1994) and its approach to be more friendly to the environment and to businesses has resulted in the recognition of less enforcement and more pollution prevention measures.

Therefore, there existed the need to not only establish at a minimum, the guidance that municipalities need to be knowledgeable about the program, but to set forth a program that may be implemented to make the NJDEP permit application process less complex. The guidance document needed to show how to collect data, sample for data, understand the data, etc., all in an effort to extend public education through such outreach programs by making the necessary information available.

Municipal guidelines have not yet been established to help the non-regulated community design and implement such a plan. The information that the author provided was both meaningful to the NJDEP permitting and enforcement programs, and useful to the non-regulated communities; whose task and great undertaking it will be to comply.

**REVIEW OF RELATED LITERATURE**

Stormwater runoff as a result of past and present land use practices in New Jersey has had a detrimental affect on both the quality and quantity of life. Farmers never believed that the addition of toxic chemicals and carcinogenic fertilizers that were land applied, would ever reach the fields and streams that our cattle graze on and replenish their thirsts; nor would it end up in the milk that our children drink! These are some very disturbing and alarming thoughts.

Environmental protection and regulation in the State of New Jersey was very prominent in addressing all of the regulated industrial activities that occurred throughout the state and have been forthright in bringing a great percentage of these polluters into compliance with their permit. It is commonly perceived that the Department, however,
has been chastised and criticized to some extent that New Jersey has
over-regulated industrial activities. In response to public opinion,
the Department had to readdress the stormwater regulations under the
NJPDES permitting process and focus on pollution prevention strategies.

Pitt et al. have conducted a study of toxic pollutants and have
compiled data charts and has made inferences to the sources of these
pollutants, the degree of destruction, and has proposed methods of its
treatability (Pitt, 1995). Numerous studies have been conducted across
the U.S. to show how storm water degradation occurs.

The review of related literature that I prepared to use to produce
this guidance document focused mainly on the sampling, collecting and
managing the data in such a way that abstract findings in quantitative
terms enabled me to design a plan to predict and prevent the stormwater
problems associated within Gloucester County. It also aided in helping
municipalities within Gloucester County to comply with the NJDEP's
Bureau of Stormwater Permitting program.

PROCEDURES/METHODOLOGY

The author has contacted several key people to elicit comment and to
gather rainfall data at different locations within Gloucester County.
The site locations were site specific in order to develop a
characterization plan based on the collected data. Using the available
data, the author attempted to predict flows and to construct computer
models comprised of all needed variables. The compilation of all
materials and the related literature enabled the author to design,
construct and operate prevention measures by providing planning
incentives which may be adopted or adapted by different municipalities
for implementing stormwater programs. The purpose of the study was to
help the locals get involved in the permitting process to insure
compliance with the NJPDES regulations.
ASSUMPTIONS AND LIMITATIONS

It is assumed that the author has sufficient knowledge of the program and its requirements given her professional experience.

It is assumed that internal input may be forthcoming as to comments from both colleagues and peers that may add or take away from thesis intent.

It is assumed that such a general plan may be envisioned for municipal permitting.

It is assumed that the author will work directly with the Bureau of Stormwater Permitting to stay apprised of all changes in the permit requirements.

The data collected and inferences made to the study will be meaningful and useful.

It is assumed that the sampling techniques implored will be field test only due to the expense of precision sampling and lack of sophisticated tools.

A limitation of the study may be collecting reliable and ample data to perform the analysis.

A limitation of the study is the target audience, local officials (money, politics, restraints, etc.).

A limitation is that the plan must be written at the local official's level of interpretation.

The study is limited to Gloucester County. However, the study may be modified or adapted to other municipalities located in New Jersey.

BACKGROUND

The author possessed the professional experience of data collection and sampling in the field during rainfall events and was knowledgeable about the direction and rate of flow which discharged from an outfall or overland flow. The author was an employee of the New Jersey Department
of Environmental Protection for over six years in regulatory compliance of the NJPDES and other regulations. The author has worked at Municipal Waste Water Assistance Element for two years, and was familiar with the National Environmental Protection Act (NEPA 1970) and has produced several environmental impact statements. The author has the aptitude to view plans, blueprints, etc. to ascertain if an combined sewer, design flow, or an infiltration/inflow equation results in higher conductivity of surface water flow than the original design.

The author has worked within the Bureau of Standard Permitting for 6 months and has had the responsibility to consistently confer with peers in enforcement to determine what measures were appropriate to facilitate compliance with a permit. And, the author, currently with the Southern Bureau of Water and Hazardous Waste Enforcement, was the compliance monitor and sampling coordinator for many different regulated facilities and activities. Field experience was maintained by going out in the field on routine inspections at a minimal of two times per week. And, most importantly, as an internal employee, the author was at a greater advantage to prepare something for the Department and the municipalities of Gloucester County that warrants review.
CHAPTER 2

Review of Related Literature

This chapter is a review of related literature on the Federal Clean Water Act, formerly referenced as the Federal Water Pollution Control Act, and the 1987 and 1991 amendments to the Act, as amended by United States Congress and the State of New Jersey. The review concentrated on the historical aspects of the federal Clean Water Act, the Water Quality Act, the Clean Water Enforcement Act, the National Pollutant Discharge Elimination System (NPDES) and the New Jersey Pollutant Discharge Elimination Systems (NJPDES) rules and regulations. The legislative history of the Clean Water Act was reviewed and presented so that a relationship between the previous practices of regulation for the control of pollutants and the revised methods for control pollution prevention strategies can be established. A literature review was also performed on comparing and contrasting various guidance documents and training modules to show the similarities and differences between the approaches. Curriculum design for writing guidance documents was reviewed as well.

This review focused on five subject areas:

1. Legislative History of the Federal Water Pollution Control Act and its role in establishing regulations for compliance with pollutant discharges;

2. Clean Water Act(s) and the Water Quality Act(s) as amended to show the effect that these regulations have on the regulated communities;

3. NPDES and NJPDES Program requirements and their direct relationship to establishing guidelines contained within the guidance document.
4. A literature review comparing and contrasting various guidance documents as a principle means for disseminating information about permitting processes; and

5. Review of curriculum development and objective based goals.

Federal Water Pollution Control Act

This chapter is a review of related literature on the Federal Clean Water Act, formerly referenced as the Federal Water Pollution Control Act and the 1987 and 1991 amendments to the Act, as amended by United States Congress and the State of New Jersey. "The Federal Water Pollution Control Act as we know it today is a highly evolved statute. Its legislative roots stretch back to the Rivers and Harbors Act of 1899, over ninety-four years ago" (CWA of 1987, 1993, Preface). Due to its voluminous administrative and legislative amendments emanating in 1899 through 1993 (reauthorized April 21, 1994), the author decided to utilize the form and style depicted by the reference titled, The Clean Water Act of 1967, to summarize the importance of the Act and explain how it led to the National Pollutant Discharge Elimination System (NPDES) regulations governing stormwater permitting.

The legislative findings of the Federal Clean Water Act (CWA) were summarized using a historic approach for easy referencing. Contained within this Act, the 1987 Amendments authorized Title IV, "establishing the National Pollutant Discharge Elimination System (NPDES) permit program that is the heart of the Act" (CWA of 1987, 1993, p.48). "The NPDES permits are the key to enforcing the effluent limitations and water quality standards of the Act" (Ibid.). It is through the NPDES permit section that point source and nonpoint sources of pollution are discussed. In evaluating the effectiveness of the CWA over the past two reauthorizations, the United States Environmental Protection Agency
(US EPA) and the New Jersey Department of Environmental Protection (NJDEP) have joined forces in a collaborative effort to strengthen the Act through a "watershed" permitting approach (Statewide Watershed Management Course, 1995).

The literature review contained within this written guidance document was prepared for municipal utilities and officials with the intent to facilitate compliance with the Federal Clean Water Act. This literature review was intended to familiarize the municipal officials with the NPDES permit regulations pursuant to the CWA. Also, it was intended to explain in great detail the NPDES regulations pursuant to the stormwater rules governing municipal discharges to separate storm sewers and define nonpoint source pollution (NPS).

Nonpoint source pollution as it relates to land use and watershed boundaries were discussed and methodologies were employed in Chapter 3 for establishing localized stormwater management guidance document planning for the municipalities located in Gloucester County. The US EPA and the NJDEP have created various databases containing vast retrievable information that municipalities can utilize to complete their stormwater management plan in accordance with the watershed monitoring pilot plan.

The Clean Water Act has seen over one hundred years of changes since its initial attempt to provide environmental protection of our natural resources. The historical data for the Federal Water Pollution Control Act legislation all started with the 1899 Rivers and Harbor Act (Klaudi, 1995, p.74). The Water Pollution Control Act (WPCA) of 1948 marks the first significant legislation passed by the United States Congress for water pollution control. As the legislation was written and was in the process of implementation, numerous questions were encountered with its enforceability and interpretation of the Federal statute. There became an urgent need to make amendments to the WPCA (the Act) for clarification
purposes. As such, the Act was again amended in the Water Pollution
Control Act Extension of 1952, the Federal Water Pollution Control Act
of 1956, and the Federal Water Pollution Control Act Amendments of 1961
(Klaudi, 1995, p. 18).

Now that guidelines and rules governing the discharges of municipal
treatment facilities were in place, federal funding was afforded to
provide capital and revenues to build treatment facilities within
specific design criteria guidelines established by the federal
regulations. Individual State authorities who adopted the Federal
Statutes in its entirety and demonstrated to have a State program at
least as stringent as the Federal program for water quality control were
awarded grant monies for the construction and operation of publicly
owned treatment works (POTWs). This federal money was made possible
with the passage of the Water Quality Act of 1965 described below.

Water Pollution Control Act of 1965 (P.L. 84-568) together sought to
"provide federal assistance" and "federal enforcement programs for all
municipal dischargers" (CWA of 1987, 1993, p. 5) in a concerted effort to
help municipalities build publicly owned treatment facilities that would
meet the effluent limitations and water quality based standards to
achieve at a minimum, secondary treatment. "With each successive
statute, federal assistance to municipal treatment agencies increased"
(Ibid.). The Water Quality Act of 1965 established water quality based
standards and effluent limitations based on collected data of known
discharges to be used in terms of assessing pollution of interstate
waters (Ibid., p. 6). However, despite the great undertaking of financing
and building adequate treatment facilities, there still were no real
provisions that governed regulatory compliance with the FWPCA
and its amendments in 1965.
The author has made the assumption that a limited amount of regulatory compliance and enforcement occurred at this point in time since the Federal government was struggling to write, interpret and enforce the provisions of the Act. The federal government also recognized this short-fall and set down to revamp the 1965 Water Quality Act and to replace it with an Act that would set statutory precedence for water quality controls. The Clean Water Act of 1972 did exactly that.

"On October 18, 1972, Congress overrode a presidential veto to enact the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) (CWA of 1987, 1993, p. 9). This piece of legislation proved to be the anticipated milestone provision that strengthened the Act. "The Federal Government, through EPA, assumed the dominant role in directing and defining water pollution control programs across the country (Ibid). "Section 101, "Declaration of Goals and Policy," (1972 Act) stated, "The objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Ibid). The Clean Water Act of 1972 (1993) also explains that.

"the same section set down two "national goals": (1) eliminating the discharge of pollutants into navigational waters by 1985, and (2) achieving an interim water quality level that would protect fish, shellfish, and wildlife, while providing for recreation in and on the water wherever attainable" (CWA of 1987, 1993, p. 9, 10).

"Section 101 of the 1972 Clean Water Act, specifically Sections 101(a)3 through Sections 101(a)(7) set up national policy regulations as follows:

101(a)(3): it is the national policy that the discharge of toxic pollutants in toxic concentrations be prohibited;

101(a)(4): it is national policy that Federal financial assistance be provided to construct publicly owned
treatment works;

101(a)(5): it is the national policy that areawide waste
treatment management planning processes be
developed and implemented to assure adequate
control of sources of pollutants in each state;

101(a)(6): it is the national policy that a major research and
demonstration method be made to develop technology
necessary to eliminate the discharge of pollutants
into the navigational waters, waters of the
contiguous zone, and the oceans;

101(a)(7): it is the national policy that programs for the
controls of nonpoint sources of pollution be
developed and implemented in an expeditious manners
as to enable the goals of this Act to be met
through the control of both point and nonpoint
sources of pollution" (CMA of 1987, p. 63, 64).

Holmes (1979, p. 2) argued that the Clean Water Act of 1972, Public
Law 92-500 placed "its major emphasis on point source controls" and
little or no emphasis on nonpoint source pollution. Holmes (1979, p. 1)
further stated that "until the Federal Water Pollution Control Act
(FWPCA) was completely revised by Public Law 92-500 (the FWPCA
amendments of 1972), EPA's program for dealing with nonpoint source
pollution was limited to research" (Holmes, 1979, p. 1). Instead, the
Department of Agriculture took the lead in establishing programs through
"the Soil Conservation Service's agricultural conservation program
(ACS), the Federal-State extension service's conservation education
program, and the pesticide registration and labeling program,
administered until 1971, by the Agricultural Research Service, and since
then, the EPA" (Ibid.).
Holmes (1979, p. 2) was convinced that the 1972 Clean Water Act did not mention nonpoint source pollution in its definition. On the contrary, the federal statute required regulation of nonpoint source pollution in its definition by exclusion. This 1972 Clean Water Act was still open for interpretation and as such, Section 208 was amended in 1981 to include nonpoint sources. Section 208 of the 1972 Clean Water Act was amended in 1981 to include:

"(1) guidelines for identifying and evaluating the nature and extent of nonpoint sources of pollutants, and (2) processes, procedures, and methods to control pollution from:

a. agricultural and silviculture activities, including runoff from fields and crops and forest lands;

b. mining activities, including runoff and siltation from new, currently operating, and abandoned surface and underground mines;

c. all construction activity, including runoff from the facilities resulting from such construction;

d. the disposal of pollutants in wells or in subsurface excavations;

e. salt water intrusion resulting from reductions of fresh water flow from any cause, including extraction of ground water, irrigation, obstruction and diversion; and

f. changes in the movement, flow or circulation of any navigational waters or ground waters"

The Water Quality Act of 1987 was amended to include specific guidelines for nonpoint sources. "Section 315 and Section 402(p) specifically deal with NPS pollution" (EPA, 1999, p.2.4). "Section 315 of this Act requires that each state must assess nonpoint sources of pollution within its boundaries. State investigations must identify nonpoint sources of pollution that contribute to water quality problems, as well as waters or stream segments unlikely to meet water quality standards without additional nonpoint source controls "(CWA of 1987, 1993, p.41). "The EPA NPS agenda for (1989-1993) under Section
319:..."To protect and restore designated uses of the Nation's waters by providing strong leadership for the National nonpoint source program and by helping states and local governments overcome barriers to successful implementation of NPS measures" (EPA, 1989, p.2.5).

"New Jersey passed its version of the federal WPCA on July 26, 1977" (Klaudi, 1995, p.16, cited in New Jersey Water Pollution Control Act, Title 58:10-1, 1977, p.371). And, in 1990, New Jersey passed the Clean Water Enforcement Act, P.L. 1990, c.28, which modified the Water Pollution Control Act (Klaudi, 1995, p.16). The NJPDES regulations were incorporated into the Water Pollution Control Act (Chapter 14) and were amended by the Clean Water Enforcement Act (Effective April 1991). Incorporated into the NPDES, New Jersey copied the federal statutes of NPDES and renamed it the New Jersey Pollutant Discharge Elimination System (NJPDES) regulations, whereas it included the individual, industrial and general stormwater dischargers in the State of New Jersey. The Federal Clean Water Act also takes into account municipal stormwater dischargers within the State of New Jersey. A great need of concern arose within the New Jersey (NJ) Legislature which prompted this Act, stating:

"the Enactment of the Clean Water Enforcement Act was prompted by a rising concern with the Legislature that the NJPDES permit program was not being taken seriously enough, either by the department or permittees, coupled with a more general frustration over lagging progress in improving surface water quality throughout the State. Proponents of the CWEA cited data collected for the Environmental Protection Agency by the department and local wastewater treatment entities showing a high incidence of non-compliance by both municipal and industrial permittees, including instances of significant single exceedances of specific discharge limits, as well as chronic exceedances over time."

Clean Water Enforcement and the Water Quality Acts

The "NPDES and NJPDSS Permitting Programs" (Klaudi, 1993, p.18) are the "key to enforcing the effluent limitations and water quality standards of the Act" (CWA of 1957, p.48). NJPDES regulations are covered in 40 Code of Federal Regulations (40 CFR) Parts 122.1-122.64 (40 CFR, 1994). 40 CFR Part 122.1, subpart A, contains definitions and general program requirements (Part 122.1-122.4, p.118-127). Provided as part of this literature review as Appendix A was a list of the relative definition of terms for NJPDES permits. Additionally, 40 CFR Part 122.26 contains the rules and regulations governing "stormwater discharges (applicable to State NPDES programs, see 123.25)" (40 CFR, 1944, p.144-161). The regulations cited above are for the point source discharges of stormwater. These sources include:

"(iii) discharge from a large municipal separate storm sewer system; and (iv) a discharge from a medium municipal separate storm sewer, and, (v) a discharge which the Director, or in States with an approved NPDES programs, either the Director or the EPA Regional Administrator, determines to contribute to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States. This designation may include a discharge from any conveyance or system of conveyances used for collecting and conveying stormwater runoff or a system of discharges from municipal separate storm sewers, except for those discharges from conveyances which do not require a permit under paragraph (a)(2) of this section or agricultural stormwater runoff which is exempted from the definition of point source at 122.2" (40 CFR, Part 122.26, p.144).

As previously discussed, 40 CFR Part 122.26(D)(3)Large and medium municipal separate sewer systems" (40 CFR, 1994, p.144) require NPDES permits, as do combined sewer systems (Ibid., p.146). The definition of a "large municipal separate storm sewer system" means all municipal separate storm sewers " (Ibid.) that have a population greater than or equal to 250,000 (40 CFR Part 122.26 (4)(i)-(iii)) or part of a "major municipal separate storm sewer outfall...as described in Part
122.26(5) (40CFR.1594.p.146). The definition of a "municipal separate storm sewer system" was that of an "incorporated place with a population of 100,000 or more but less than 250,000" (Ibid.). These definitions are needed to show how point source discharges of stormwater, whether municipal or industrial in nature are defined and the rules governing the regulated activity are published in the federal register. Relative definition of terms for stormwater discharges are also listed in Appendix A.

NPDES and NJPDES Programs

Rules and regulations that govern nonpoint source (NPS) discharges have not yet been published in the New Jersey register although the NPDES permitting program has published rules in the federal register. To date, the State of New Jersey has not adopted in total those rules, and are far behind in the actual implementation of those rules (Cohen, personal communication. NJDEP Bureau of Stormwater Permitting, acknowledgement). The USEPA has recognized that individual States have not yet met compliance dates, even with extensions to those dates, and at this point in time, are not requiring the NJDEP to permit all NPS discharges within their boundaries, although it will occur as mandated by USEPA. EPA (1989) stated that "the recent interest in NPS pollution stems from the Water Quality Act of 1987 (P.L. 100-4), which represents a congressional shift from 15 years of NPS pollution planning and problem identification to a new National NPS program (p.2.1). Currently, the USEPA is sponsoring training programs to individual States on the National NPS program in conjunction with providing guidelines for watershed permitting on a statewide basis as a five year pilot program anticipated to facilitate compliance with existing NPDES and NJPDES permits (USEPA, 1995).
Guidance Document Literature Review

Urban Runoff Pollution Prevention and Control Planning Handbook, written by the USEPA (1993), was prepared for municipal officials to provide a practical, easy approach to develop and implement stormwater pollution prevention strategies in accordance with existing and upcoming guidelines that are acceptable to the NJDEP as best management practices and their implementation of these controls. Similarly, the guidance document that this author prepared provided a step-by-step guidance approach to help municipal officials to calculate, design and implement stormwater programs comparable to the State of New Jersey municipal stormwater permit. The targeted audience in both of these guidance documents are the same. The Urban Runoff Pollution Prevention and Control Planning guidance manual provides information and research capabilities as well as guidance on how to implement these controls.

"The handbook is both an information source for urban runoff pollution issues and a guide to the planning and implementation of effective pollution prevention and control plans" (USEPA, 1993, p.1). The handbook was divided into nine clear, concise chapters which outlined a step-by-step approach "that municipal officials can use to develop technically feasible, targeted, affordable and comprehensive pollution prevention and control plans" (Ibid). In contrast, the Cook College Continuing Professional Education Center, Rutgers University affiliate, had offered a training seminar titled, Environmental Law and Regulation, where a step-by-step, cookbook approach was not offered. Instead, the training seminar on "pollution prevention" outlined what the State requirements were and what was expected for compliance with this plan. It briefly discussed how the NJDEP had changed its focus on pollution control strategies and offered the benefits of a pollution prevention approach. This training was projected to the targeted audience as discernible.
The N.J. Pollution Prevention Act of 1991 represented a change in focus from "treatment to prevention" and from "end of pipe to production process" (Milacofsky, 1994, in Environmental Law and Regulation). It seemed imperative to alter our ways of thinking of production in order to produce no product, and from an enforcement standpoint, no mandatory goals. The material presented at the training seminar was limited and vague.

The New Jersey Department of Environmental Protection & Energy, specifically the Bureau of Stormwater Permitting (NJDEP, BSWP), in accordance with USEPA mandate to permit stormwater industrial and municipal separate storm sewer systems, conducted several public education outreach training courses for all those involved with the process. This bureau prepared a guidance document titled: NJDEP & E Industrial Stormwater Pollution Prevention Plan Guidance, NJDEP's Permit No. NJ0088316, signed November 1993 by former Governor Jim Florio and former Acting Commissioner NJDEP.

"This guidance document provides industrial facilities with summary guidance on the development of Stormwater Pollution Prevention Plan (SPPP) and identification of Best Management Practices (BMPs)." (NJDEP, BSWP, 1993, Foreword). The purpose of this manual was to streamline "simple, cost effective BMPs... that over time can save money for the facility in terms of reduced materials loss, longer equipment life, and a better working environment." (Ibid). The table of contents listed the following chapters, divided into guiding principles:

Contained within this guidance document is a forward detailing why the manual was produced and a table of content providing the relevant information. In most instances, the style and format of USRPA and NJDEP guidance documents are the same. This format was recommended so that the reader can easily ascertain how to use the manual with relative ease. The manuals are designed to instruct the users in accordance with the standards specified by the authority agency and to facilitate compliance with the various programs. All of the guidance documents reviewed were intended as an education outreach for the user whether the user is a local health official, municipal planner, NJDEP personnel, or private consultant.

The Stormwater Pollution Prevention Plan for Wheelabrator Gloucester Company, L.P., prepared for Wheelabrator Gloucester Co., L.P., 600 US RT. 130, P.O.Box 129, Westville, New Jersey, 08093 (prepared by Rust Environment & Infrastructure, Inc., 3220 Tillman Drive, Suite 300, Bensalem, Pennsylvania 19020) represented a strikingly similarity to that of the NJDEP & SPPP and BMP guidance manual. It contained a Table of Contents labeled as "1.0 Introduction, 2.0 Certification and Authentication, 3.0 Storm water Pollution Prevention Team, 4.0 Existing Environmental Management Plans, 5.0 Site Assessment, 6.0 Best Management Practices and Plan Design, and 7.0 Implementation Schedule." (SPPP for Wheelabrator, 1995). The Introduction also included a purpose and contained all the necessary information to prepare the plan. The manual was prepared in accordance with the NJDEP Industrial Stormwater permitting program and is acceptable for use at Wheelabrator.

The Statewide Watershed Management Course, sponsored by USRPA, shall also serve as a guidance manual for all intending purposes. Unlike the poor presentation of the pollution prevention presentation that was provided by the NJDEP in cooperation with Cook College, Rutgers
University, the watershed permitting guidance provided was exemplary. The course content was presented in the same manner as all other USEPA guidance documents. The underlying goal was presented with course content material. The format was orderly and consistent with those guidance documents prepared for the NJDEP and USEPA. It presented "Background on Watershed Management (Modules 1 and 2), Establishing Statewide Coordination Elements (Module 4), Defining Core Activity Element-Part 1 (Module 5), Defining Core Activity Elements, Part 2 (Module 5), Getting Started (Module 3), Making the Transition, Part 1 (module 6), Making the Transition-Part 2 (module 6), and Putting a Statewide approach to practice (Module 7)" (USEPA, 1995). Also, this guidance format allowed for questions and answers. It is through these types of hands-on, active participation in work groups and group activities that enabled the participants to utilize this information.

A Risk Communication Manual for Government: Improving Dialogue With Communities, submitted to the NJDEP & E. Division of Science and Research, by Billie Jo Hance (Research Associate), Caron Chess (Associate Director) and Peter M. Sandman (Director) of the Environmental Communication Research program, NJ Agricultural Experiment Station, Cook College, was an exact replication of the format afforded to guidance documents recommended for the USEPA and NJDEP for distribution to various organizations. These guidance documents stand alone and were provided for facilitating compliance with and working cooperatively with the regulatory agencies, whether it be USEPA, NJDEP, or any other appointing authority. Former Commissioner of NJDEP, Scott Weiner (1991) expressed his gratitude toward the acceptance of this guidance manual by vehemently saying that "Communication is the cornerstone of effective environmental management."

Improving Dialogue With Communities (NJDEP, 1991, p.1) was made
possible by the Division of Science and Research as part of the Spill Research Fund. This project "also contributed significant substantive input and cooperated in setting up an advisory committee with members of NJDEP and the NJDOH (Ibid.).

Curriculum Development and Objective Based Goals

A training manual written in 1995, "A Training Program for NPDDES and Safe Drinking Water Compliance Evaluation Inspectors, by Lewis G. Klaudi, furnished the NJDEP, Division of Enforcement Field Operators, Southern Bureau of Water and Hazardous Waste Enforcement element, with an unabridged edition of an compliance evaluation inspection manual. The comprehensive training manual was provided to the southern field office to compliment the daily job performance reviews of its employees. The manual utilized curriculum development through a "unit plan format" developed at Rowan College of New Jersey" (Klaudi, 1995).

This author reviewed the curriculum that was developed by Lewis G. Klaudi, "A Training Program for NPDDES and Safe Drinking Water Compliance Evaluation Inspectors", 1995, for objective based goals and the instruction "unit plan format commonly utilized to design curricula. The unit plan chosen was "NPDDES" and it was targeted for those with college degrees. Since this was an internal training manual prepared for those who currently work for NJDEP, EFO, SBWHE. this author will state that a bias has been established and that preferably a college degree such as a Bachelor of Science in environmental studies or another related field of study is required. This bias was confirmed in the subject discipline chapter (Klaudi, 1995, p.52). This author agreed with the specified time limits required for teaching the lessons. This was particularly important for those receiving the training, since the participants already possess some working knowledge needed to complete the lessons without difficulty in the specified time frames.
It was evident that this curriculum design had contained a rationale for teaching the lessons, employed instructional strategies, and established objectives based goals. Objectives were presented as those being cognitive, affective, and psychomotor skills. The unit plan format also provided chapter outlines on how to achieve these objective based goals. The format utilized activities and instruction materials as a means of evaluation. Overall, the curriculum design of the unit plan format was consistent with meeting program design criteria.

Conclusion

The related literature review was necessary to provide legislative history of the Federal Water Pollution Control Act and its various forms of the Act as it pertains to establishing protocols for compliance with permitting. All the guidance documents reviewed presented information on and contained the necessary guidance to educate the public on the environment. The guidance documents provided by the NJDEP and USEPA are sterling resources for completing plans and making recommendations for assisting the State of New Jersey in water protection.
Definition of Terms

Average storm. A storm event that is typical for a geographical area or yearly season, on the basis of amount, intensity, and duration of rainfall. (Trush&Detection)

Base flow. The flow concentration to a creek by groundwater. During dry periods the base flow constitutes the majority of stream flow. (Ibid.).

Best Management Practices (BMPs). Means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce pollution of "waters of the United States." BMPs also include treatment requirements, operating procedures and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. (40 CFR, Parts 100-149).

Characterization plan. A study of the natural and abiotic infrastructures associated within a specific region or watershed.


Combined sewer overflow. Conveyances that discharge stormwater runoff combined with municipal sewage. (40 CFR, Part 122.26)

Co-Permittee. A permittee to a NPDES permit that is only responsible for permit conditions relating to the discharge for which it is operator.

Data analysis. Outlines how the characterization data plan will be assessed (Ibid.).

Data Management. Organizing field notes, raw data sheets, other materials into a usable format, such as a database (Ibid.).

Discharge. When used without qualification means the discharge of a pollutant (40 CFR, Parts 100-149).

Discharge Characterization. Monthly mean rain and snowfall estimates and the monthly average of storm events (Ibid.).

Discharge Rating Curve. A plot of the quantity of water flowing versus the depth of water in a natural watercourse. (Ibid.).

Estimated runoff. The approximate amount of stormwater that runs off the ground surface and enters a drainage system for a particular storm event. (Ibid.).

Environmental Protection Agency (EPA). Means the United States Environmental Protection Agency.
First Flush. Either the first part of a storm event or the first storm of the season. The greatest concentration of pollution is typically found in the first flush discharge. (Ibid.).

Flow quantity interval. The quantity of water that flows by a monitoring site between collections of individual samples. (Ibid.).

Grab sample. A sample that is an instantaneous measure for a pollutant loading as a representative sample.

Illicit discharge. Any discharge to a municipal separate storm sewer that is not composed entirely of stormwater except discharges pursuant to a NPDES permit (other than the NPDES permit for dischargers from the municipal separate storm sewer) and discharges resulting from fire fighting activities.

Infiltration. Water that enters into the system through cracks.

Inflow. Extraneous water, other than infiltration, that enters the sewer system unnecessarily. (Ibid.).

Municipality. Means a city, town, borough, county, parish, district, association, or other public body created under State law and having jurisdiction over disposal of sewage, industrial wastes, or an Indian tribal organization, or a designated and approved management agency under Section 208 of CWA (40 CFR, Parts 100-149).

Municipal separate storm sewer. A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels or storm drains).

Nonpoint source pollution. Urban water run-off that is collected from non-identified sources which contribute to pollutant loadings discharging into streams.

NPDES. National Pollutant Discharge Elimination System. Means the National program for issuing, modifying, revoking and reissuing, terminating monitoring and enforcing permits, imposing and enforcing pretreatment standards, under sections 307, 318, and 405 of the CWA (40 CFR, Parts 100-149).

Outfall. Means a point source as defined by 40 CFR 122.2 at the point where a municipal separate storm sewer discharges to waters of the United States. (40 CFR, Part 122.26).

Permit. Means an authorization, license, or equivalent control document to implement the requirements of this part and parts 123 and 124.

Pollutant loading. The total amount of pollutants entering a source.

Qa/Qc. Quality Assurance/Quality Control.

Rainfall volume. Amount of precipitation, rain or snow, ice melt that falls during an event.

Representative Sample. A sample that meets specific criteria identified in the characterization plan. (Ibid.).
Runoff Coefficient. A dimensionless number associated with the rationale for estimating run-off (Ibid).

Standard Industrial Classification Code (SIC). A code that is given to all registered businesses in the state of NJ for the industrial activity that the facility engages in.

State Authorities. Nothing in part 122, 123, or 124 precludes more stringent State regulation of any activity covered by those regulations, whether or not under an approved State program.

(a) Coverage:


(2) These regulations cover basic EPA permitting requirements (part 122) what a State must do to obtain approval to operate its program in lieu of a Federal program and minimal requirements for administering the approved State program (part 123) and procedures for permit processing of permit applications and appeals (part 124). Part 124 is also applicable to other EPA permitting programs, as detailed in that part.

(b) Scope of the NPDES permit requirement. (Code of Federal Regulations, Protection of Environment, 40 CFR, Parts 100-143, July 1, 1994 revised).

Stormwater. Stormwater run-off, snowmelt run-off, and surface run-off and drainage.

Total Dissolved Solids. Means the total dissolved (filterable) solids as determined by use of the method specified in 40 CFR part 136.

Valid Storm event. Storm event which causes a discharge of run-off that is measurable.

Waters of the United States or waters of the U.S. Means: (a) all waters which are currently used, were used in the past, or may be susceptible to use in intrastate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; (b) all intrastate waters, including intrastate state wetlands; (c) all other waters such as intrastate lakes, rivers, and streams, mudflats, sandflats, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect our could affect interstate or foreign commerce including any such waters; (d) all impoundments of waters otherwise defined as waters of the United States under this definition; (e) tributaries of waters identified in paragraphs (a) through (d) of this definition; (f) the territorial sea; and (f) wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) through (f) of this definition (40 CFR, Parts 100-149).
Water Pollution Control Act., Ch. 14. Federal Act which was amended by the Clean Water Enforcement Act.

Watershed. The geographic region from which water drains into a particular water body. (Ibid).
Bibliography


NJDEP. (Summer 1995). Office of Environmental Planning. Watershed Focus.


Nonpoint Source Control Guidance Construction Activities. (December 1993). USEPA, Office of Water Planning and Standards, Washington, D.C., 0.1, 0.3, 0.4, A-1.


Stormwater Management in Gloucester County. Gloucester County Planning Department. Still Run Watershed Stormwater Monitoring Plan. Final Report. (February 1994). 1-1, 1-2, 1-6, 2-3, 2-5, 2-8, 2-9, 2-10, 2-12, 2-13, 2-14, 2-15, 3-1, 3-3, 3-4, 3-5, 4-15, 4-17, 5-3, 5-15, 6-1, 6-2, 6-3, and 6-5.


Chapter 3 "Procedures and Methodologies"

The purpose of this study was to produce a written guidance document, to be used by municipal officials located throughout Gloucester County, that would provide compliance assistance for the preparation of a stormwater management plan. Additionally, the author thoroughly researched and selected actual construction permits that were issued to commercial and industrial contractors and builders for the design and implementation of retention, detention ponds and stormwater orifices currently on file at the New Jersey Department of Agriculture, Gloucester County Soil Conservation Service ("SCS").

A stormwater characterization plan was prepared by the author for Gloucester County. The purpose was to create background data that was reliably and consistently recorded as measurable rainfall and to alter or redesign the database to include parameter identification of pollutants discharged during a storm event. Raw data was contributed to this effort by Gloucester County Solid Waste Complex (facility owned by the Gloucester County Improvement Authority, see Bibliography) and by Wheelabrator Gloucester Company, L.P. (see Bibliography). Approximately 6 months of rainfall data from each facility were contributed to the production of this study. The data was checked by the author for reliability with the Philadelphia International Airport's records. This information combined with that of the permitted constructed stormwater orifices located in Gloucester County were entered into the SCS's computer models.
The information was then statistically manipulated using the SCS's computer models (TR-55 and TR-20) to calculate runoff rates and create hydrographs commonly associated with the current infrastructures located within most municipalities. The author further assumed that this data will help municipalities to calculate, design and implement stormwater programs within their municipalities and to apply to the State of New Jersey for a municipal stormwater permit, which there is not currently such a program in place within the NJDEP.

Furthermore, this written guidance document will explain in laymen terms at the local officials' level:

1. how to begin gathering research on stormwater management plans; and
2. where to gather information on existing plans; and
3. how to utilize this knowledge; and
4. how to create an environmental awareness and sensitivity towards "watershed permitting" as an avenue for solving pollution prevention problems.

Attitudes and sensitivity are a result of creating an awareness of ecological problems by reviewing this content matter.

The New Jersey Department of Environmental Protection in cooperation with the New Jersey Department of Agriculture have joined forces to bring about public education on non-point source pollution and stormwater management (NJDEP and NJDOA, December 1994). It has been envisioned that the best way to deal with promoting pollution prevention strategies was to use a "watershed approach"; whereas, municipal boundaries, whether political or natural such as streams, are crossed and a multitude of people within and across those boundaries are...
integrated toward an action. That action was toward pollution prevention by developing stormwater management plans.

METHODOLOGY

Methods of gathering background information included attendance at the Statewide Watershed Management Course (see bibliography) held by the OSEPA, the Environmental Regulation Training Course (Ibid., Milecofsky), and various interdepartmental seminars. This author consulted the Gloucester County SCS personnel, its library and received personal instruction and assistance in using the computer models and graphs. Additional materials needed to complete the guidance document were obtained at the Rowan College of New Jersey Library, government document section, and also the Gloucester County Library.

The NJDEP’s Office of Water Planning and Watershed Permitting staff were interviewed and recognized by this author to be an compelling asset by providing both oral communication and written documentation on this study. The Department also has available to the public a "Public Access" information room for obtaining published materials. Several sources were obtained by the author in this manner. The Gloucester County Health Department has also played a crucial role in gathering materials for this study.

Specific Procedures Used To Gather Research

The written guidance document for municipalities for storm water permitting in Gloucester County was prepared by the author to provide guidance in compliance assistance with the NJDEP and to prepare local
officials and planners on how to develop a storm water pollution prevention plan ("SFPP"). This objective was achieved by gathering all the information available in print to present a literature review (see Chapter 2) and to be able to prepare the guidance document as a "working" document rather than a reference.

Gathering information proved to be a difficult task. A bias existed in that there was ample printed material on the Clean Water Act, but there is relatively little information available on non-point source pollution, also covered by this Act. The first references that the author referred to were the Code of Federal Regulations ("40 CFR") Statutory Laws and the Rules and Regulations governing the New Jersey Pollutant Discharge Elimination System ("NJPDES") permits. Stormwater permitting and non-point source pollution are covered by the above rules and regulations.

Next, the author consulted "The Water Environment Federation" ("WEF"), a national organization that had published several reference texts on these issues. As a member of the WEF, the author purchased several references which proved advantageous to the study. Subsequently, the author has sufficient knowledge of the permitting process and best management practices geared toward pollution prevention strategies given her professional experience within the NJDEP. As an employee of NJDEP, it was helpful that internal communication and public documents were readily available. The Department provided status updates on the changes proposed in the Federal Register and assisted the author in providing relevant public education materials needed to produce this written guidance document. Concurrently, the author...
studied the draft characterization study of the Whippany Watershed, prepared by NJDEP and others and designed a guidance document similar to this resource. The gathered data was meaningful and useful for this study.

The SCS assisted the author in staking out the watersheds on large topographical maps at the SCS's office and by providing information and data points relevant to constructed stormwater infrastructures located in Gloucester County. Also, several industrial facilities have contributed raw data to assist the author in using the SCS's TR-20 and TR-55 computer models. These models allowed the author to present data relevant to preparing these SPPP plans. All of this information was statistically manipulated to derive hydrographs of the watersheds and to predict curves and other variables contained within these models. The author then prepared charts, graphs, and education guidance sheets to be incorporated into the final product. This written guidance document served as a preliminary document that compiled existing data and presented it in a format which was used by municipalities for designing storm water management practices.

Criteria For Toxic Selection

There currently is no formal written guidance document that assists municipalities in Gloucester County in achieving compliance assistance with NJDEP's NJPDES rules for storm water permitting. The NJDEP is now deregulating environmental regulations and moving toward pollution prevention strategies. The Clean Water Enforcement Act does not consider non-point source pollution ("NPS") in its entirety, and has not formalized specific rules. The NPS program for municipalities is volunteer at best. The NJDEP and the NJDOA SCS programs are
clearinghouses of information. This information was made available by public education and the technological advances marked by computer modeling.

**Format**

The format selected for presentation of the written guidance document was based on the standard format that USEPA and NJDEP consistently use for preparing guidance manuals for use by the public as technical reports. All fundamental research and final data will be presented by use of tables, organization charts and by using narrative form. Computer modeling and raw data databases were incorporated into the text as Appendices for easy reference. This material was presented in a narrative form so that the target audience can comprehend how to utilize this valuable resource. Information of how to gather the data was also included within the text. Other recommendations and authors of similar work are referenced in Chapter Five, the summarization of the study.

**Background Of the Researcher**

The author was a graduate of Richard Stockton State College with a Bachelor of Science in Environmental Science. Prior to the 1989 graduation from Richard Stockton State College, the author was recruited on campus to perform the duties of an Environmental Specialist, within the New Jersey Department of Environmental Protection. The author has NJDEP regulation experience in the grant funding for publicly owned treatment works, experience in writing permits under NJDEP and, primary experience as an enforcement officer in the Southern region of the State.
of New Jersey for compliance with environmental regulated pollutant dischargers.

The author was also a matriculated graduate student at Rowan College of New Jersey, and specialized in Environmental Education and Conservation. The author has participated in two six-hour educational programs which are nationally recognized. Project Wild was presented at Montclair State University's School of Conservation during the fall of 1995. The author also participated in Project Wet, the newest curriculum designed for educators, during the spring of 1996.
Chapter 4
INTRODUCTION

The Stormwater Management Regulations, N.J.A.C. 7:8 provided for the implementation of the Municipal Stormwater Management Program for the preparation of a stormwater management plan and the adoption of stormwater ordinances to be adopted by municipalities. As previously stated throughout this document, the program was voluntary at best. The written guidance document contained herein, as a result of the author's work, provided the necessary tools that municipal officials at all levels of planning, design, and decision-making will need to ensure proper ownership, operation, and maintenance of stormwater management facilities and provided the basis for stormwater permitting within Gloucester County.

Nonpoint source pollution (NPS) and urban runoff "are formidable obstacles to achieving water quality resource goals in many municipalities" (USEPA, September 1993, p.1). The USEPA and the NJDEP in cooperation with the NJ Department of Agriculture (NJDEP and NJDOA, December 1994) have joined forces in their attempt to educate the public on NPS pollution by making available to local officials, planning documents that describe best management practices for developing "technically feasible, targeted, affordable and comprehensive urban runoff pollution and prevention and control plans" (ibid.). This written guidance document compliments those guidelines.

Section One of this written guidance document provided an overview of what is considered to be NPS pollution. Section Two of this written guidance document defined the geographical area of concern as Gloucester
County, New Jersey and described the affected areas. Section Three of this written guidance document defined best management practices outlined in putting together a "Stormwater Pollution Prevention Plan" (SPPP) designed for municipal officials located in Gloucester County. As an extension to the SPPP, Section Four described the projected "Statewide Watershed Permitting Process" as presented by USEPA. It was concluded through this effort that the NJDEP enforcement elements certainly support permitting through a watershed approach based on science and consistency. Ultimately, the program initiated by the "Whippany River Watershed Characterization Report" (NJDEP, Office of Environmental Planning, September 1995) provided the basis for watershed permitting in New Jersey. Finally, Section Four presented a detailed discussion of soil erosion by water by small urban hydrology and its impact on assessing watershed characteristics as a result of simulation and computer modeling. The examination of data for each watershed was necessary to prioritize NJDEP and NJDOA permitting efforts aimed at non-point source pollution problems that were the limiting factors to achieving water quality standards. Soil Conservation Service ("SCS") Technical Release-55 (TR-55) Method was employed to determine run-off rates, volumes and to create a hydrograph for both pre- and post-development conditions as a summary to this guidance document to illustrate the effects of NPS pollution.
Section 1

Land Use Development Practices and Stormwater Runoff Contaminants

The effects of land use are a direct result of stormwater runoff and nonpoint source pollution. The 1972 Clean Water Act, Section 208, was amended in 1981 to include nonpoint sources. Nonpoint sources of pollution stem from agricultural and mining activities, residential and commercial construction activities, urbanization, combined sewer overflows and from stormwater regulation and nonregulation discharges. The USEPA has defined stormwater to mean stormwater runoff, snow melt, surface runoff, street debris that comes in contact with surface runoff, and infiltration of runoff into the groundwater. Similarly, nonpoint source pollution was defined as runoff that originates from diffuse land areas which transports and contributes pollutants to the surface and groundwaters.

1.1. Effects of Land Use Activities on Water Resources

Land use activities have had a detrimental effect on the quality and quantity of water being delivered through specific drainage regions. Since stormwater runoff is a continuous combined discharge of receiving streams that transport contaminants emanating from upstream, it is almost impossible to assess its quality. The pollutant load that discharges to the watershed is often unknown. Therefore, it is necessary to implement best management practices ("BMP's") at its origin and to initially determine whether structural or non-structural stormwater management facilities ("SWMP") are necessary prior to any regulated land use activity. Proper implementation of best management practices ("BMP's") and the design of a stormwater pollution prevention
plans ("SPPF") will enable municipalities to play a significant role in the preservation and protection of water resources.

1.2 Pollutant Loads Associated With Land Use Development

A. Construction Activities

Commercial and residential construction for large developmental housing projects and shopping centers were a major contributor to sediment loading downstream from construction activities. The Soil Erosion and Sediment Control Act (Chapter 251, P.L. 1975) requires that projects greater than 5000 square feet obtain the approval of the SCS and implement an soil erosion and sediment control plan. A contractor must adhere to the standards for construction and submit to the local SCS district a soil erosion and sediment control plan with appropriate preconstruction measures and maintenance procedures to prevent soil erosion during construction activities.

Areas that were previously disturbed and altered through human activity for construction purposes contributed substantially more particulate and sediment matter with greater erosional mobility than that of agriculture or urbanization.

B. Agricultural Sources

Agriculture and farming practices have contributed to water quality problems through mobility and sedimentation by removing vegetative cover and affecting soil stability. Past agricultural practices indicated that undesirables such as phosphorus, nitrogen, pesticides, fungicides, herbicides, and other organic compounds were intentionally introduced to farming to increase crop yields. Unfortunately, these pollutants are highly soluble in stormwater runoff as nonpoint source pollution.
C. Urbanization

Nonpoint source pollution has been referred to as people pollution. This type of pollution comes from our everyday activities that result in increased litter, wastes from failed septic systems at our homes, pet feces that are left in areas that may enter a storm drain, motor oil, gasoline by-products non-soluble in water, fertilizers applied to our lawns and gardens for aesthetics, landscaping activities, and the common household hazardous products used for cleaning. All of these items will eventually make it to our waterways and exceed surface water and ground water quality standards. These standards were developed based on best available technology as maximum contaminant levels with numeric standards of pollutant loads allowable in concentration.

1.3 Common Nonpoint Source Pollutants

A. Sediments

It is at the receiving stream that the effects of sedimentation were realized. Increased turbidity occurred in streams as increased levels of suspended solids entered a slow moving waterbody. The high levels of turbidity resulted in the decrease of available sunlight proving detrimental to species specific aquatic organisms, both plant and animal. And, most importantly, alteration that occurred as a result of sediment deposition in a waterbody significantly altered the hydrology and drainage patterns of stream beds by changing its slope, contours, and velocity of transport mechanisms.

B. Nutrients

Nutrients were found to have nondeleterious effects on water quality under normal conditions. However, the increase of nitrogen in a receiving stream due to increased pollutant loading through nonpoint
source pollution causes nitrogen to break down chemically into more harmful contaminants as it comes in contact with oxygen in the stream. Nitrogen broken down into NH3 or NH4 ammonia or NO2 nitrite and NO3 nitrate were highly soluble in water and were responsible for causing chemical displacements within the biological community of the stream. These compounds were oxygen depleting in nature and caused choking of the stream by the reduction of reproductive capabilities of higher plants. This NPS pollution was responsible for stagnant waters inundated with algal blooms.

Phosphorus, manifested itself as phosphates, and also caused eutrophication or over-enrichment of nutrients in the waterbody as a result of runoff from a variety of sources and diffuse land areas. Phosphates were responsible for the over stimulation of algal growth by the consumption of dissolved oxygen in the waterbody. Phosphates naturally occur in soils in normal amounts suitable for nutrient uptake and were of vital importance to benthic plants for photosynthesis.

C. Pesticides

Pesticides from agricultural land use activities, industrial activities, construction activities and human urbanization were transported by stormwater and increased in loadings as NPS pollution. Its ultimate fate of transport or deposition became unknown to the organisms dependent on the stream. Pesticides and other organics alter the chemical makeup of an organism and were responsible for genetic failures and reduced reproduction in aquatic communities.

D. Pathogens and Water-Borne Diseases

Pathogens are pollutants that enter a stream directly by runoff. Geographical areas designated in Gloucester County as agricultural areas

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for cattle, horses, pigs, and other livestock have had a detrimental effect on the degradation of water quality. Similarly, there remain portions of Gloucester County that were not served and have exhibited hydraulic failure of septic systems by discharging pollutants onto the ground surface which might flow or drain into surface waters. Additionally, Gloucester County was home to several municipal and industrial landfills. As such, it was projected that pathogens and water-borne diseases would exceed surface and ground water quality standards at an alarming rate as a direct result of land use activities. It was also concluded that humans were highly susceptible to parasites, bacteria, viruses, and protozoa type diseases borne by water.

There were other pollutants that were commonly associated with nonpoint source pollution that were not discussed within this document. It was not within this document's scope to include all pollutants that comprise NPS but to merely highlight the pollutants that were of greatest concern for the targeted areas.

Section 2

Water Quality Problems of Gloucester County Watersheds

This written guidance document for stormwater permitting for municipalities in Gloucester County targeted only three of the major watersheds located in Gloucester County. The three watersheds that were chosen as areas of concentration were selected based on similar land use activities. Land use consisted of 25-50% urban/suburban, 35% agricultural and about 40% forested area. It was concluded that the pollutant parameters found in each of these three areas were total phosphorous, Ammonia-Nitrogen and fecal coliform; all stemming from landfill activities, septic systems, and agricultural runoff.
selected watersheds were the Big Timber Creek and Woodbury Watersheds, the Mantua Creek Watershed and the Raccoon-Oldmans Creek watershed. The Big Timber Creek watershed was included in this document as a reference only since virtually all of the water that falls into this watershed drains into Camden County and was not included within the scope of this document.

2.1 Big Timber Creek and Woodbury Creek Watersheds

The 208 Water Quality Management Report on Alternatives, Burlington, Camden and Gloucester Counties, New Jersey (September 1977, p. 22-26), geographically located the Big Timber Creek as the boundary line centrally located between Camden and Gloucester Counties as shown on map #1. Most of the rainfall that occurred within this 63 square mile area flowed northward and drained into Camden County.

The remaining rainfall that occurred in the Big Timber Creek watershed flowed southward and drained to the Woodbury Creek Drainage basin. The Woodbury Creek drainage area was comprised of municipalities that were situated entirely in Gloucester County. "This small drainage basin has a drainage area of 12.6 miles and is bordered on the north by the Big Timber Creek basin, on the southeast by the Mantua Creek basin, and on the west by the little Mantua Creek Basin and empties into the Delaware estuary" (Ibid.).

The Woodbury Creek Watershed consisted of three known tributaries. These tributaries were the Woodbury Creek (drainage area 5.5 miles), Matthews Branch (drainage area 2.0 miles), and the Ressia Run (drainage area 1.5 miles).
2.2 Mantua Creek Watershed

The Mantua Creek watershed was located entirely in Gloucester County and adjacent to three different watersheds as shown on map #2. North of the Mantua Creek watershed was the Woodbury Creek basin described above. Southward of the Mantua Creek watershed was the Raccoon Creek basin, and on the westward side of this basin was the Big Timber Creek watershed. There were eight known tributaries covering approximately 60 square miles that contributed flow to this drainage basin. Unique to the Mantua Creek watershed was that the lower portion of the basin was marked by tidal influence. The soil characteristics of this basin were well drained sandy soils typical of the Atlantic Coastal Plains areas.

2.3 Raccoon-Oldmans Creek Watershed

The Raccoon Creek and Oldmans Creek drainage basins occupy a total of 65 square miles as shown on map #3. This area was the most southern watershed contained within the Gloucester County 208 study area. The municipalities that lay in this southern most basin were Logan Township, Woolwich Township, Swedesboro, Harrison and South Harrison Township. All of these municipalities discharge to the Delaware estuary.

Similar to the Big Timber Creek watershed, the Oldmans Creek watershed forms the boundary between Gloucester and Salem Counties.

Agricultural land use within the Raccoon-Oldmans Creek watershed was almost twice as concentrated as that of the other two watersheds described above. Swedesboro, located at the bottom of the Raccoon Creek basin was considered to be the only area greatly affected by urbanization. The remaining areas of this watershed were ecologically sensitive areas protected as forest land.
The Raccoon-Oldmans Creek watershed was under tidal influence. The soils were typical of the Atlantic Coastal Plains. However, clay deposits were usually found in tidal areas. These clay deposits often impeded runoff water from percolation into the predominant sandy soils and subjected the area to frequent flood conditions. Flood conditions were responsible for the increased rate of runoff and for the gouged steep stream banks that resulted in accelerating erosional capabilities.

Section 3

SPPP and EMP Guidance Document For Stormwater Permitting

This written guidance document provided municipalities located in Gloucester County with a narrative example of the development of Stormwater Pollution Prevention Plans (SPPP) and the identification of Best Management Practices (BMP's) needed at the local government level to control nonpoint source pollution (NPS) and urban runoff problems associated with pollutant transport mechanisms. The Stormwater Regulations of 1991, which were promulgated under the NPDES program as a response to the Clean Water Act initiative and the 1990 Pollution Prevention Act, were incorporated into this summary guidance document.

The New Jersey Department of Environmental Protection (NJDEP) and the New Jersey Department of Agriculture (NJDA) strongly encouraged municipalities to develop and implement stormwater controls and ordinances to prevent NPS and soil erosion pollution problems as a result of urbanization.

The Pollution Prevention Act of 1990 had four basic objectives:

1. pollution should be prevented or reduced at the source; and

2. if pollution can not be prevented or reduced at the source, then it should be recycled in an environmentally friendly manner; and
3. If pollution can be recycled in an environmentally friendly manner, then it should be treated in an environmentally friendly manner; and

4. If none of the above apply, disposal must be the last alternative.

The stormwater regulations were implemented to accentuate pollution prevention strategies listed above based on source reduction and BMP's to lessen NPS pollution. Municipalities had an edge on the planning and implementation of such controls as a legitimate stakeholder due to ownership, accountability, legal authority, management practices, maintenance practices, funding capabilities and public education responsibilities as formidable entities. Municipalities were preferable in receiving regulatory oversight from both the State and Federal Governments for technical assistance and for the appropriation of grants or long term borrowing to comply with these pollution control strategies.

The State of New Jersey was comprised of 567 incorporated municipalities that provided local stability to champion all municipalities to eventually adopt plans and ordinances for stormwater runoff. It was envisioned that the planning, design and implementation of SPPPs and BMPs by municipalities would be consistent with political ideologies and public awareness and sensitivities toward ecological preservation of natural resources.

The NJDEP and Energy (joint public entities in 1993 that consisted of NJDEP and Board of Public Utilities, within the Department of Energy, under Governor Jim Florio and Acting Commissioner Jeanne Fox), "hereinafter the NJDEP", were responsible for the production of an "Industrial Stormwater Pollution Prevention Plan Guidance" summary to be
used by industrial facilities associated with stormwater activities.

The NJDEP Bureau of Stormwater Permitting issued a NJPDES General Permit No. NJ0068315 for Industrial stormwater facilities that were not currently permitted under the NJPDES permit program for point source discharges of pollutants to surface waters of the State. This guidance was to be used by industrial facilities that had no non-stormwater discharges and who could eliminate, remove, or cover all "source" materials from exposure to stormwater runoff.

Simultaneously, the NJDEP issued a Request For Authorization "RFA" under the stormwater general permit to facilities that were either regulated or non-regulated as industrial facilities that discharged stormwater only and which had no potential to come in contact with process waters, boiler and condensate process water, noncontact cooling water or sanitary systems. In certain scenarios, a facility may have an industrial stormwater general permit and by eliminating either the source, materials, or treatment process, may be eligible to petition the NJDEP to revoke this general permit (NJ0068315) and reissue as a general RFA to discharge stormwater to either a stormwater municipal conveyance system or to a surface water body.

The monitoring and reporting requirements of these two permits differ. The monitoring requirements of the industrial stormwater general require the monitoring and reporting of numeric effluent based water quality standards, which were based on best available technology and surface water quality standards as allowable pollutant discharges that were within allowable concentrations to the receiving stream and below the maximum contaminant levels established by the USEPA. In contrast, the general stormwater permit contained no numeric effluent.
limitations and had only self-monitoring as reporting requirements. Notwithstanding these differences in approach to stormwater permitting efforts, both permits require the implementation of BMPs and the design of an SPPP to be maintained and operated at the facility for the facility's use. This written guidance document for stormwater permitting for municipalities located in Gloucester County will parallel the stormwater general MPA for all intensive purposes.

The monitoring and reporting requirements for pollutant parameters are based on the receiving stream(s) characteristics as a surface water. Ultimately, all watersheds in Gloucester County discharge to a designated zone of the Delaware River. As such, the monitoring and reporting requirements must be consistent with those of the Delaware River Basin Commission (DRBC) parameter pollutant loadings as effluent based water quality standards.

The NJDEP Bureau of Stormwater Permitting established the organizational chart below to be used for "Developing Your Stormwater Pollution Prevention Plan" referenced in the Industrial Stormwater Pollution Prevention Plan Guidance (NJDEP, BSWP, 1993, p.iii) that the author retrofitted for similar purposes as the SPPP was developed at the municipal level for a general stormwater permit.

Additionally, the author critiqued other BMP manuals that were disseminated by USEPA (Urban Runoff Pollution Prevention Control Planning, USEPA, September 1993), NJDEP and NJDCA (December 1994), and the State of New Jersey (Ocean County Demonstration Study, June 1989) relative to NPS and stormwater facilities. The author selected appropriate BMPs that were suitable for incorporation into the SPPP general permit developed for stormwater permitting for municipalities.
located within Gloucester County.

Lastly, the author used a "Stormwater Pollution Prevention Plan Evaluation" form developed by the author and peers at the NJDEP Southern Bureau of Water Compliance and Enforcement section commonly used for compliance evaluation inspections for NJPDES permits to ascertain that the objectives of this written guidance document were clearly defined and achieved. The author did not alter this evaluation form to reflect only municipal dischargers because, more often than not, the municipality may actually own the area where industrial activity occurs, provide oversight, allocate money or resources to a private industrial operator, or a combination of these scenarios. The evaluation form has been placed at the end of the SUPP with its narrative description.
"Developing Your StormWater Pollution Prevention Plan"

GETTING STARTED

Form a pollution prevention team
Describe any existing environmental plans

SITE ASSESSMENT

Inventory of source materials
Mapping requirements
Narrative description of existing conditions

BMP SELECTION AND PLAN DESIGN

Remove or cover Good housekeeping.
Visual Inspections Preventative maintenance
Diversion Non-stormwater discharges

IMPLEMENTATION STRATEGY

Appropriate controls
Employee training

EVALUATION PROCESS

Record keeping & Internal Reporting
Inspection schedule
Maintenance schedule

GENERAL PLAN REQUIREMENTS

Certification of SEPP
Required Signatures
Plan Location and Public Access

Industrial Stormwater Pollution Prevention Plan Guidance (NJDEP, BSWP, 1993, p.iii)
3.1.A. Forming A Pollution Prevention Team

Municipal entities were the elite choice for the implementation, designation and construction of SPPPs and EMPs since the responsibilities of carrying out stormwater management activities were accomplished by a variety of existing public departments.

In Gloucester County, the public employees charged with the responsibilities and enforcement of the Municipal Land Use Law (MLUL) were responsible for the designation of appropriate land use activities for categorical areas found within the county. Also, the Gloucester County Planning Board members had to approve by a majority vote to pass a resolution needed to approve any activity governed by the MLUL. Together, these two managerial authorities were responsible for any approval of land use restricted to Gloucester County. Analogously, all municipalities located within the State of New Jersey were incorporated in its entirety, and as such, all municipalities were governed by the MLUL and subject to authority approval at the municipal or county level for land use planning purposes.

Therefore, the author recommended that an initial starting point to the selection process of forming a pollution prevention team was to select persons from this public group. Presented below in narrative form were summary guidance of some of the regulated activities that these public employees would contribute to the team:

(1) The MLUL and persons responsible for its enforcement set up municipal charters that designated areas of environmental sensitivity which needed to be protected and preserved; and

(2) It set up control ordinances for minimum area building lots.
to maintain pervious areas necessary to prevent erosional activity and NPS pollution from occurring; and

(3) It approved where and what types of constructional activities would occur; and

(4) It enforced soil erosion and sediment control plans; and

(5) It set up specific types of areas to build homes; and

(6) Provided developmental considerations for alternative housing for the preservation of open areas; and

(7) Had the ability to purchase Green Areas property; and

(8) Set up zoning and subdivision title rights; and

(9) Built buffer areas to prevent degradation of existing natural resources; and

(10) Mapped out areas of existing industrial, commercial, residential and undesignated land use activities on planning maps; and

(11) Mapped out all areas that have sanitary sewerage facilities, cross-connections due to urbanization, wet/dry weather surcharges; and

(12) Developed demographic maps; and

(13) Located all existing paved roads that represented impervious areas; and

(14) Designated areas for parks and recreation; and

(15) Designated human services areas needed by the local government.

The author further recommended that the pollution prevention team include a spectrum of municipal engineers, project planners, persons familiar with grant writing skills necessary for obtaining and securing grants and bonds to finance the project, designers, preconstruction engineers, public works personnel, soil and water specialists, improvement authorities, public elected officials, tax payers, and education and health specialists. The general public must be included as part of this team since the public would most likely be paying for
3.1.B. Objectives of the Pollution Prevention Team

The first objective of the pollution prevention team was to decide what role each of the members play in the development, implementation, maintenance, ownership and operation of the SPPP and structural BMPs for stormwater facilities, if any. A list must be posted for all to view and confirm who was responsible for what part of the SPPP and include all pertinent levels of command (authority control, reporting non-compliance activities, safety), telephone numbers and coverage at all times to ensure human safety and control.

An objective based goal was to revise the plan as necessary. Regularly scheduled inspections and daily logs should be maintained by the personnel responsible for the maintenance and operation of the plan. At the municipal level, this would be done by the Department of Public Works, Department of Transportation, local water and sewer utilities, and any other group charged with its maintenance activities. Simple maintenance methods included mowing the lawn, removal of trash, debris and large solids, etc. This goal was needed to correct any non-compliance with the SPPP and to be updated to include new construction activities. A chain of command for reporting was required to establish clear, concise communication and education about the SPPP.

The preparation and implementation of a SPPP is dependent on an evaluation of existing environmental plans. Examples of existing environmental plans targeted at a municipal level would include plans for recycling, lawn and leaf litter collection policies and procedures, a household hazardous waste program and an amnesty program regularly scheduled to encourage removal of harmful substances without an
investigation of its source.

Land use plans were developed for municipalities using aerial photography and land surveys to determine what percentages of the total land area were available for designated uses. Streams, estuaries, and environmentally sensitive areas including forests and agricultural resources were shown on the map. These maps also contained areas of degradation of our natural resources. Landfills, open dumping areas, municipal separate storm outfalls and existing sanitary sewer infrastructures mapping inclusive of regulated industrial and commercial facilities that discharged pollutants as point sources and NPS pollution areas and activities were contained within mapping boundaries.

3.1.3 Site Assessment

A detailed review of "source materials" (NJDEP, RSPF, Industrial Stormwater Pollution Prevention Guidance, 1993) means "any materials or machinery related to process or other industrial activities which should be a source of pollutants in stormwater discharge" (Ibid.).

1. Source Materials

At a municipal level, source materials would most likely be found at public works' garages, municipal owned water and/or wastewater treatment plants, or similar owned properties. Publicly owned transportation facilities were identified as potential contributors to NPS pollution since materials were stored outside and subject to stormwater runoff. These types of facilities store sand and salt piles for deicing activities, stockpiled soil and construction debris, and had gasoline, diesel and oil fueling stations. A larger site assessment, the municipality as a whole, must be inventoried to identify all non-storm water discharges. A narrative description was also provided.
2. Map the area

A municipal land use map would include all existing and permanent structures that represented all impervious paved areas and would contain all surface water bodies as recipients of storm water. Permanent maps located existing structural control BMP measures used to control or divert stormwater and showed locations of all stormwater discharge outfalls. Any revision mapping for NPS pollution was performed here.

3.1.C. BMP Selection and Plan Design

The USEPA handbook titled "Urban Runoff Pollution Prevention and Control Planning" [USEPA, September 1983, p.19] provided a schematic for BMP selection and plan design. This schematic was found on the preceding page and was cited above for cross-referencing. The schematic represented a cursory review of the handbook and outlined chapter by chapter within that reference what program and technical activities were required to successfully design and implement an SPFP.

The "SPFP need only to be as specific as necessary to meet the minimum requirements of the General permit" (NJDEP, November 1993, p.2). BMP selection and plan design for a general stormwater permit at a municipal level was retrofitted to utilize the six specific BMPs recommended by the Department. As recommended by the NJDEP, Bureau of Stormwater Permitting, and contained within the Department's 1983 guidance, the following BMPs were selected as non-structural (with the exception of #5) BMPs required by the general permit:

1. Remove or cover.
2. Good Housekeeping.
4. Visual Inspections.
5. Diversion of Stormwater.
Urban runoff pollution prevention and control planning process.
Remove and cover (BMPI1) was the simplest, and most cost-effective BMP. Removal activities included building pole barns, housing or constructing roofs over source materials that would prevent precipitation from coming into contact with source materials mixing with stormwater runoff comprised of unknown pollutant loadings that adversely affected surface water quality. Cover materials included tarps and the placement of air tight, non-leaking drums on wooden pallets to prevent material runoff.

Good housekeeping activities (BMPI2) and Preventative maintenance (BMPI #3) and Visual inspections (BMPI #4) at a municipal level would include practices such as regularly scheduled repair and maintenance of work trucks, industrialized vehicles (backs, dumptrucks, cranes, etc.) parking and truck washing activities, clean-up around heavily-used equipment, careful cleansing of paved surfaces that contain petroleum products as washwater, prompt clean-up of any spills, safely piled material storage areas, street sweeping activities, street washing activities, minimum use of sand and salt during deicing to protect the safety of the public, minimum use of pesticides and fertilizers for maintaining grassed areas for flood protection and stormwater conveyance facilities (swales, filter strips, constructed wetlands), daily inspection of sewage pump stations, sanitary sewers, and storm drains to prevent failures or clogs, removing cluttered debris that enters storm drains as NPS, etc.

On a municipal level, these activities were accomplished via communication and shared ownership and responsibilities at staff meetings, in-service training, community Right-To-Know practices, safety seminars for educational purposes and retraining of qualified and
diversified staff were critical components of the SPPP and BMP. The economic and ecological benefits realized by a municipal approach to stormwater practices were too extensive to list.

Diversion activities (BMP #5) and removing/permitting unauthorized discharges (EMP #6) were associated with contaminated stormwater runoff to a wastewater treatment facility required an Significant Indirect User's (SIU) NJDEP permit approved by the NJDEP or delegated approval from a publicly owned treatment works as part of the Industrial Pretreatment Program (IPP).

The actual planning and design guidelines for diversion activities associated with stormwater runoff by use of structural BMPs such as detention basins, wetponds, constructed wetlands, infiltration facilities, and vegetative practices were beyond the scope of this written guidance document and the author's professional expertise for designing structural BMPs. However, general stormwater permitting within Gloucester County required that some if not all of the BMPs contained within be incorporated into the SPPP. Therefore, the author has reproduced these plans and designs as a reference recommended by the NJDEP and as an integral attachment to compliment this document.

As such, the author incorporated into Appendix A in its entirety an original version (Chapter 2 only) of the NJDEP's Stormwater Management Facilities Maintenance Manual for use by municipal governments located throughout the State of New Jersey, the "State of New Jersey Department of Environmental Protection, Division of Water Resources, Ocean County Demonstration Study, Stormwater Management Facilities Maintenance Manual" (June 1989) Chapter 2 in its entirety.
3.1.D. Implementation Schedule

The implementation times of an SPPP and BMPs were variable. Some basic BMPs were implemented immediately, such as remove and cover. Limited money, time, people and resources were needed to accomplish this BMP. Good housekeeping practices were implemented following training and education provided by management. All persons involved in the planning, design, implementation, maintenance, and operation of the SPPP were instructed and received on the job training about the SPPP.

Preventative maintenance activities of the SPPP were phased in as resources were allocated, work orders changed and daily operational controls and man power were available to effectively carry out the SPPP. Visual inspections as an effective BMP were incorporated into the evaluation process. This was necessary so that daily inspections, maintenance and operation logs and reporting requirements would ascertain whether or not the SPPP and BMPs were adequate controls.

Structural BMPs obviously required extensive phasing in. Municipalities had to use the inventory source mapping and land use planning activities to determine what areas needed immediate attention. Environmentally sensitive areas were priority for the placement of structural BMPs. The less expensive and simplest BMPs were completed next. Municipalities were capable of completing most of the projects without the assistance of the public as normal operating procedures. However, as the scope of the project intensified and the cost as well, local governments held public hearings and passed bonds associated with
longterm borrowing to cover the initial planning, design, and implementation of structural BMPs.

3.1.5. Evaluation Process

The evaluation process was the key to determining whether your SPPP and BMPs worked. If the SPPP failed, then you must reevaluate its purpose and add corrective measures to the plan. An effective SPPP ascertained whether or not the SPPP and BMPs were adequate controls based on the result of daily inspections noting conditions (usual and extraordinary), maintenance schedules and operation logs, work orders (priority and routine), time coding for cost-effective analysis and administrative purposes combined with appropriate reporting requirements.

Provided below as Appendix G was a copy of the SPPP evaluation form used by the NJDEP, Southern Bureau of Water Compliance and Enforcement Section (March 1996), for use as a checklist to ascertain compliance with the stormwater regulations. Note that some items on this form were not required by this SPPP since stormwater permitting for municipalities had not yet occurred in the State of New Jersey as the USEPA had originally intended.
4.1 Watershed Permitting Efforts

A watershed was defined as an area of land that emptied water to a specific point. For instance, small watersheds flow into larger watershed areas. In Gloucester County, small watersheds drain water from a few areas of land and empty into small streams. These small streams flow transversely to larger streams. All of the land drained by these areas make up the larger stream's watershed. For Gloucester County, all water within the largest watershed drains to the Delaware estuary.

The Whippany River Watershed Characterization Report (NJDEP, September 1995) was recognized by the USEPA as a pioneer effort toward a statewide management approach to watershed permitting (Statewide Watershed Management Course, September 1995, USEPA). This written guidance document for stormwater permitting for municipalities in Gloucester County conferred that the statewide approach toward NPS and watershed permitting could be used at the local level based on local landuse activities and growth projections.

"It is widely accepted that changes in land use, resulting from development increases stormwater and associated NPS from various activities. Development often results in increases of impervious cover surfaces which significantly alter the amount and drainage patterns of stormwater runoff leaving a site. Runoff from construction activities, stormwater discharges, urban surfaces, and the loss of riparian vegetation are suspected of contributing to increased levels of siltation in the river" (Whippany River Watershed Characterization Report, NJDEP, September 1995, Executive Summary).
The effects of urbanization typically results in land use modifications (USACE. Hydrologic Engineering in Planning. April 1981, Ch. 7) that had a detrimental effect on the natural environment. As urbanization continued, larger areas of land were altered for human use. This resulted in the loss of pervious land areas. Land use activities such as the construction of homes and roadways were directly responsible for decreasing the rate of infiltration of precipitation into the ground and for increasing both the volume and rate of urban runoff. This response has had a negative effect on erosion. Erosion caused by wind and water transport usually resulted in siltation deposits at the bottom of streams and altered previous drainage systems by cutting channels and increasing streambank depth. Erosion and NPS pollution were responsible for the decreased amount of natural storage normally found within the basin. To truly gain an awareness and sensitivity to the concerns of soil erosion and NPS, the author has prepared for use visual maps and hydrographs which have been manipulated to characterize the storm event as it occurs and its effect on erosion.

The Statewide Watershed Management Approach designed by the USEPA (USEPA, September 1995) strongly recommended that a statewide approach proceed as a management practice with stakeholder involvement to "facilitate nonpoint source program implementation on a watershed basis" (Ibid, p. 5.15). This approach involved the review of existing NPS programs and investigating funding mechanisms under the Clean Water Act (CWA) to finance NPS projects that correspond with watershed permitting management goals. "Putting a Statewide Approach Into Practice" was presented as a basin management cycle by the USEPA and was presented below.
Exhibit 7-2. Basin Management Cycle

<table>
<thead>
<tr>
<th>PUBLIC PARTICIPATION</th>
<th>ACTIVITY STEP</th>
<th>TIMING</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAKEHOLDER INVOLVEMENT</td>
<td>1. Conduct Initial Outreach and Organize Basin and Watershed Task Committee</td>
<td>MONTHS 1-3</td>
</tr>
<tr>
<td></td>
<td>2. Collect Relevant Basin Information</td>
<td>MONTHS 3-18</td>
</tr>
<tr>
<td></td>
<td>3. Analyze and Evaluate Information</td>
<td>MONTHS 19-24</td>
</tr>
<tr>
<td>STAKEHOLDER INVOLVEMENT</td>
<td>4. Prioritize Concerns and Issues</td>
<td>MONTHS 25-27</td>
</tr>
<tr>
<td></td>
<td>5. Perform Detailed Assessments of Priority Issues</td>
<td>MONTHS 28-36</td>
</tr>
<tr>
<td>STAKEHOLDER INVOLVEMENT</td>
<td>6. Develop Management Strategies</td>
<td>MONTHS 37-45</td>
</tr>
<tr>
<td></td>
<td>8. Finalize and Distribute Basin and Watershed Plans</td>
<td>MONTHS 49-54</td>
</tr>
<tr>
<td>STAKEHOLDER INVOLVEMENT</td>
<td>9. Implement Basin and Watershed Plans</td>
<td>MONTHS 55-60 AND BEYOND</td>
</tr>
</tbody>
</table>

10. Repeat Cycle
In summary of the watershed management approach, the USEPA has listed the "Top Ten" Lessons Learned (Ibid., p.2-30 to 2-33) from this approach as:

(1) "Stakeholders should recognize from the beginning that not all activities, programs or resources should be included in the statewide framework".

(2) "Building a consensus vision for statewide watershed management begins with educational forums that allow stakeholders to work together in developing partnerships and fostering an understanding of how the approach can serve as a coordinating framework for water and other resource programs". (Ibid.)

(3) "A state-wide approach provides a long-term mechanism for continuing support of ongoing and priority watershed initiatives." 

(4) "Documentation describing the consensus approach to statewide watershed management is essential".

(5) "A methodical, well-conceived, comprehensive approach to the development process lays the foundation for the teamwork and coordination that collectively represent the hallmark of statewide watershed management".

(6) "Investment of time and effort during development and transition to statewide watershed management is essential".

(7) "Phased implementation of statewide watershed management allows time for the approach to mature".

(8) "Operations under statewide watershed management do not necessarily require additional resources".

(9) "Proper means and timing of outreach is critical for successful public participation in statewide watershed management".

(10) "Statewide watershed management has a positive impact on teamwork, morale, and program relationships".

Public educational approaches to a basin management system and to NPS pollution prevention controls must play a crucial part of planning at any level. Some of the educational teaching strategies employed to instill environmental awareness and sensitivity to watershed problems included being knowledgeable about the community and its management structures, being informed about regulatory requirements, advocating
that it was cost-effective, staging public meetings, creating activities
for fun and real purpose (adopt-a-watershed, stenciling storm
drains, litter walks), using the media or radio to show public support,
targeting activities for school-aged children for reinforcement,
designing environmental education curricula, sponsoring community
events, forming citizen advisory groups, grassroots organizations, and
all others to gain broad-based community support for long-term planning.

4.2 Computer Model

Computer models were exemplary tools needed to assess erosional
capabilities as a response to urban nonpoint source pollution (NPS) and
runoff associated with land use activities. This was accomplished by
using the SCS's computer model to develop hydrographs. A flow chart
explaining the steps necessary to run the model was provided for you
use as Appendix B. "A hydrograph is a graph showing stage, discharge,
velocity or other properties of water flow with respect to time."
(USDA, SCS, September 1989, p.1).

A discharge hydrograph was depicted as the runoff rate (ordinate
axis or Y-coordinate of a graph) against time (plotted as the abscissa
axis or X-coordinate). Hydrographic manipulation of the time of
concentration T(c) or X, and the distribution or amount of runoff
(quantity or Y) at the point of computation, showed the estimated single
curve characteristic of watershed activities. "One characteristic, the
duration of time or flow, is nearly a constant for a particular
watershed, regardless of the value of the peak flow from a specific
storm, assuming a constant storm duration." (Ibid.) Another criteria
needed for hydrograph manipulation was to use a design storm event.
Rarely does such an event naturally occur. The SCS's TR-20 model used the two-year, the ten-year, and the twenty-five year storm events (2, 10, and 25), respectively. The SCS's methodology refers to controlling erosion based on "Bankfull" (2 year) and "Out of Bank" (10 year storm) (personal communication with Hunter Birkhead, NJDA, Soil Erosion Engineer). The Urban Hydrology For Small Watersheds (USDA, SCS, June 1986) manual complimented the TR-55 model and provided instruction for estimating runoff and peak discharges in small watersheds. Graphic illustrations of discharge hydrographs (Appendices C through F) showed the highest points of runoff and erosion. The author computed the following graphs (Appendices C through F) by plotting the coordinates of the Time of concentration T(c) against the runoff (Quantity) for pre-and post-development of the Hill Branch Watershed, subarea 1 as depicted on the U.S.G.S map and the aerial photograph contained herein. The purpose of the hydrograph(s) was to match the peak(s) of the pre-development of the watershed with that of post-development for the same watershed using criteria two as the 2 and 10 year storm events.

The "Graphical features of a hydrograph include:

A. Point of Rise
B. Rising Point of Inflection
C. Peak
D. Recession point of inflection
E. End point of Recession.

and Delineate the following segments:

A-C Rising Limb—Generally reflects storm characteristics
B-D Crest Segment—highest concentration of runoff
C-E Recession Limb—Withdrawal of stored Water
A-E Base time of the hydrograph—Duration of Runoff"

Source:
USDA, SCS, September 1989, p.5. "Engineering Hydrology Training Series".
CHAPTER 5

Restatement of the Problem

To date, no such general permit has been issued to an individual municipality for stormwater dischargers. This thesis focused on the design of a stormwater characterization plan that was acceptable to the New Jersey Department of Environmental Protection and provided the basis for municipal stormwater permitting by municipalities within Gloucester County.

Procedures Used For The Study

The author has rigorously worked with the NJDEP Bureau of Stormwater Permitting and Watershed Permitting groups to advance permitting efforts aimed at municipalities for stormwater ordinances and controls for nonpoint source pollution on a watershed basis. The author has cooperated with the SCS, Gloucester County district, to perform in-stream monitoring of rainfall by using rain gauges to measure the height of water discharging to the basin and to hydrograph the erosional capabilities associated with the Hill Branch Watershed, subarea 1, located in Mullica Hill Township, Gloucester County.

Simultaneously, the author requested actual rainfall data from the Gloucester County Solid Waste Complex, South Harrison Township weather station, equipped with a tipping scale and from the Bethel Mill Park, Hurfville tipping scale. Together, this data was combined and computated using the SCS’s TR-20 computer model to delineate the Hill Branch watershed (Appendix H). Actual field data was critical to verify the data used in the model. Otherwise, the model would of been hypothetical. The Hill Branch watershed model was factored into the records and database contained at the SCS’s office for soil erosion and
sediment control plans for permitting on a watershed basis. This data was integrated into the SFPF and BMP written guidance document to signify the importance of collecting field data and to gain an understanding and appreciation of the watershed.

Conclusions of the Study

The author has produced a written guidance document for stormwater permitting by municipalities located within Gloucester County. This document may be expanded or modified by any municipality to fit the design of BMP’s and a SFPF which would curb NPS pollution and erosion. The author participated in the actual in-stream monitoring necessary for characterizing a watershed and has made best professional judgments as to how BMP’s should be planned and designed in accordance with a SFPF acceptable to the NJDEP.

Recommendations for Further Study

The USEPA and the NJDEP need to enact and enforce the stormwater regulations for small municipalities since it will not happen in itself. These two regulatory agencies need to work together to promote NPS pollution control and prevention strategies on a watershed basis. As recommended in the "Statewide Watershed Management Approach", the author agreed that a statewide approach to stormwater permitting and basin management with equal stakeholder involvement by the state and municipality was needed. It was envisioned that this document will assist municipalities in moving forward to design and implement on their own, plans that eliminate NPS pollution.
Combination Staff Gauge/ Crest Gauge

Materials needed:
- 4 ft fence post or other
- PVC pipe, 1" diam. (or wider), 4 or 5 ft long
- 2 end caps for the PVC pipe
- 2 or 3 metal clamps or U-bolts
- Section of 2" x 4" wood, (sawdust same length as PVC pipe)
- Wooden dowel, 1/4" to 3/4" diam. to fit inside the PVC pipe
- Granulated cork

Assembly:

This combination gauge serves as both a staff gauge to measure the water level of a stream at the time of inspection, and a crest gauge to measure the highest level reached by the stream between the last inspection and the current inspection. A staff gauge can't tell you the high water level for a rain event unless you read the gauge at the actual time when the stream crested, whereas a crest gauge preserves a record of crest height that can be read at a later time.

The crest gauge shown here is based on the "beach ball" principle. It consists of a PVC pipe containing a wooden dowel and a supply of granulated cork. As the water rises, so does the powdered cork. When water comes down, the cork granules remain stuck to the wooden dowel at the level of highest water.

By taking successive staff and crest gauge readings and plotting them on a time graph, you can obtain a general picture of how a stream behaves in response to rain. For instance, a rapid rise and fall in stream levels would be diagnostic of the land's inability to slowly release water. Long-term trends can also show a correspondence between stream levels and land use changes. For example, the data might show that a new shopping center has caused the stream to crest several inches higher for the same amount of precipitation.

Calibration: Calibrate the gauge by measuring the difference between the lowest point on the stream bed and the zero point on the scale marked on the 2" x 2". (Note that the lowest point on the stream bed wasn't necessarily the point where the gauge is located, but it must be along the same cross section.) This "depth-of-stream factor" must always be added to the gauge readings. Facilitate the gauge yearly, and after severe episodes of erosion or deposition.

To read the crest gauge, remove the top end cap and lower the dowel. Use the scale on the 2" x 2" to measure the level of the cork powder "ring." Don't forget to add the depth-of-stream factor (see calibration above). After taking the reading, wipe off the cork powder and replace the dowel. Occasionally you may need to add more cork powder.

For more information, contact Ken Pritchard, Special Projects Coordinator, Adopt a Beach, P.O. Box 2148, Seattle, WA 98111; 206-624-6013.

If you establish a flow curve that correlates stream height to flow rate for your stream, then in the future you will be able to estimate stream flow based on readings from the staff or crest gauge alone. Without the need for a flow meter, (stream flow rate is expressed in cubic feet of water per second, e.g.) To establish the flow curve, you will need to use a flow meter. Volunteers who do not wish to invest in a flow meter (which may cost upward of $3,500) may be able to borrow one from the utility that controls streamwater. Flow readings at time of four different stream flow stages provide enough data to establish the curve.
APPENDIX A
NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
STORMWATER MANAGEMENT FACILITIES
MAINTENANCE MANUAL

CHAPTER TWO
PLANNING AND DESIGN GUIDELINES
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A. OBJECTIVES

This Chapter of the STORMWATER MANAGEMENT FACILITIES MAINTENANCE MANUAL presents both general recommendations and specific guidelines to be used in the planning, design, and review of detention, retention, and infiltration facilities. The Chapter has been prepared with several purposes in mind:

* To describe the character, magnitude, and extent of stormwater management facility maintenance problems actually observed in the field and the type and degree of maintenance efforts required to address them.

* To demonstrate the direct correlation between unwise, uninformed, or otherwise incorrect planning and design decisions and subsequent facility maintenance problems.

* To emphasize the ability of sound planning and design decisions and thorough and enlightened review procedures to eliminate, reduce, or facilitate maintenance efforts at stormwater management facilities.

* To illustrate the cost-effectiveness of eliminating maintenance problems and/or reducing required maintenance efforts during a facility’s planning, design, and review stages.

* To encourage planners, designers, and reviewers to consider maintenance to be as important as the hydrologic, hydraulic, structural, and aesthetic aspects of a proposed stormwater management facility.

* To present planning and design guidelines that will promote stormwater management facilities that are as safe, easy, and economical to maintain as possible.

B. INTENDED READERS

In light of the objectives listed above, those who will benefit most from this Chapter are:

* Project Planners and Designers responsible for the preconstruction development of stormwater management facilities.

* Engineering Department, Planning Board, and other government agency personnel responsible for the review of proposed facility designs.

In addition, the information contained in this Chapter can alert:
Retention Facility: A SWMF which, similar to a detention facility, temporarily impounds runoff and discharges its outflow through a hydraulic structure to a downstream conveyance system. Unlike a detention facility, however, a retention facility also includes a permanent impoundment and, therefore, is normally wet, even during non-rainfall periods. Storm runoff inflows are temporarily stored above this permanent impoundment.

Finally, to further organize our presentation and provide thorough coverage of all pertinent aspects of SWMF’s, let’s break each facility type into its various major components. These are:

A. Bottoms and Permanent Pools  F. Emergency Outlets
B. Dams, Embankments, and G. Low Flow Measures
    Side Slopes       H. Vegetative Cover
C. Principal Outlets        I. Trash Racks
D. Outflow Systems          J. Access
E. Inlets                  K. Perimeters

While most of the component names listed above are self-explanatory, complete descriptions of each are presented in Table 2-1 on Page Plan-10. Feel free to refer to them whenever necessary.

D. WHY WORRY ABOUT MAINTENANCE NOW?

We’re glad you asked that question. And now is a perfect time to answer it, before we get into specific planning and design guidelines.

Prior to the development of this manual, the Department of Environmental Protection conducted an extensive field investigation of more than 50 SWMFs located throughout the State. This investigation was conducted, in part, to identify the nature, severity, and extent of maintenance problems at actual SWMFs and determine the role that planning and design played in the creation or worsening of those problems. Among other results, the field investigations revealed that most of the observed SWMF maintenance problems, including some which were virtually unsolvable without massive infusions of time, money, and hard work, could be traced to shortcomings in the planning and design process. These shortcomings may have been the result of a lack of effective planning and design standards, inadequate or inaccurate design and review procedures, or simply the failure to realize that, someday, someone would have to maintain the SWMF that, at the time, existed only on paper.

Regardless of the culprit, it can be seen that the elimination of these breakdowns in the planning, design, and review process will greatly reduce the incidence of SWMF mainten-
This simplistic example does not include changes in interest rates and maintenance costs, disposal problems, or other variables, but it clearly demonstrates how efforts to reduce SWMF maintenance during the planning and design stage can have a decidedly positive benefit/cost ratio. It is also important to recognize that, while having a great impact on reducing long-term maintenance costs, the use of the guidelines and recommendations presented in this Chapter should have a minimal impact on increasing actual planning, design, review, and even construction costs. In addition, as these guidelines become more a part of our regular planning, design, and review procedures, the extra cost to implement them will become less and less.

It is difficult to put an exact dollar value on all of the benefits to be gained from the planning and design of a "minimum maintenance" SWMF. Too often, as field inspections have shown, a poorly designed SWMF can become a serious safety hazard, despite considerable maintenance efforts to prevent it. These hazards range from unsafe structural conditions or inadequate hydraulic capacity, which may threaten downstream lives and property, to unintended standing water, which poses a drowning threat to children and adults alike.

One safety hazard of particular significance is the creation of mosquito breeding habitats. Due to their ability to transmit viruses and other diseases, mosquitoes must be controlled, particularly in developed areas where contact with humans and domestic animals is the greatest. Unfortunately, as can be seen, these are the very same areas where most SWMFs are constructed. All mosquitoes have four stages of development - egg, larva, pupa, and adult. The adult female lays her eggs on still bodies of water or, in some species, on moist surfaces such as mud or fallen leaves. The water bodies need only be mere inches in depth and can be found in surface depressions, scour holes, tire ruts, and even in the voids of riprap linings. Each batch may contain from 100 to 300 eggs and, depending upon the weather and her stamina, the female may repeat the process several times without mating again. Suspended by the water, the eggs quickly hatch into larvae, which then grow rapidly into pupae and then emerge as flying adult mosquitoes. It is possible for mosquitoes to complete their life cycle in 7 to 10 days, with approximately half being spent in the aquatic stage. Therefore, it can be seen that, wherever water remains still or stagnant for only 4 to 5 days, at least one generation of mosquitoes numbering upwards of several hundred can be bred. The longer the water remains stagnant, the greater the potential for mosquito breeding.
1. Maintainability

It’s a complicated word, but the concept it represents is simple: As you plan or design your stormwater management facility, always attempt to (1) eliminate as much required maintenance as possible; (2) facilitate the performance of those required maintenance tasks which still remain; and (3) prevent the need for emergency or extraordinary maintenance efforts. Project reviewers should use these three goals as criteria in deciding the suitability of proposed SWMFs.

2. Accessibility

In order for proper maintenance to be performed, the various components of the SWMF and, indeed, the facility itself must be accessible by maintenance personnel and equipment. Physical barriers such as fences and legal barriers such as easement restrictions can negate even the best maintenance programs. Keep in mind such things as depressed curbs, fence gates, access roads, manhole steps, handrails, and other access features when you’re planning, designing, or reviewing your next SWMF. A complete list of access guidelines is presented in the following sections regarding Detention, Retention, and Infiltration facilities.

3. Durability

The use of strong, durable, and noncorrodible materials, components, and fasteners can greatly reduce required maintenance efforts. These include: lightweight, noncorrodible metals such as aluminum for trash racks, orifice plates, and access hatches; hardy, disease-resistant grasses for bottoms and side slopes; reinforced concrete for outlet structures and inlet headwalls; and gabions for channel and outlet linings. If you want your project to last, here’s how to do it, and save maintenance dollars as well. The initial investment in high quality materials will pay off in the long run.

4. Constructability

The road to maintenance headaches is paved with good planning and design intentions that somehow went awry. Before the construction plans and specifications are completed and approved, make sure they are complete, clear, concise, and

PLANNING AND DESIGN GUIDELINES

like some of those hydrologic, hydraulic, and structural aspects you’ve mastered. Compared to them, the recommended maintenance considerations should be easy to assimilate and even expand upon. Let’s briefly review them:
Now that we've asked our Four W's, you may have a question for us; namely, HOW? The following pages present technical planning and design guidelines regarding each of the major components of detention, retention, and infiltration facilities. They are presented by facility type for simple reference and include descriptive drawings and diagrams. They're intended to assist planners, designers, and reviewers in developing SWMFs that require minimum levels of simple maintenance.

It is important to note that the guidelines presented on the following pages should be used in conjunction with all other hydrologic, hydraulic, structural, aesthetic, and legal requirements pertinent to the proposed facility and are not intended to replace them in any way. Remember also that each project and facility site is unique and may require additional or stricter measures. Therefore, the guidelines should be combined with ingenuity and creativity each time they're used.

Finally, the guidelines should serve to stimulate the development of additional planning ideas and design approaches to SWMF maintenance. To assist in this process, typical maintenance problems actually observed in the field are also presented for each facility type and component, just prior to the technical guidelines themselves. Keep these problems in mind as you review and implement the guidelines.
<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>DESCRIPTION</th>
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</thead>
<tbody>
<tr>
<td>INLETS</td>
<td>Upstream surface and subsurface conveyance measures which discharge inflow into facility.</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>OUTFLOW SYSTEMS</td>
<td>Downstream surface and subsurface conveyance systems which receive outflows from principal outlets.</td>
</tr>
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<tr>
<td>ACCESS</td>
<td>Accessibility of various components by maintenance personnel and equipment.</td>
</tr>
<tr>
<td></td>
<td>[All Facility Types]</td>
</tr>
<tr>
<td>VEGETATIVE COVER</td>
<td>Self-explanatory.</td>
</tr>
<tr>
<td></td>
<td>[All Facility Types]</td>
</tr>
</tbody>
</table>

NOTE: The component descriptions presented above have been developed for this SWMF Maintenance Manual. Other and/or additional descriptions may be employed in other publications and by other jurisdictions and agencies.
A. BOTTOMS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Standing water
* Soggy Surfaces
* Poor Grass Growth
* Excessive Sedimentation
* Limited Access

1. To promote complete emptying and prevent standing water or soggy surfaces, vegetated bottoms should have a minimum slope of 2 per cent and be graded to the outlet structure or low flow channel.

2. To promote complete emptying and prevent standing water or soggy surfaces, the lowest point in the bottom should be at least 4 feet above the seasonally high groundwater level or bedrock unless adequate subsurface drains are provided.

3. To provide adequate drying time, to avoid delaying scheduled maintenance efforts, and to prevent mosquito breeding, the maximum storage or ponding duration should not exceed 48 hours.

4. To avoid delaying scheduled maintenance efforts, topsoils and subsurface soils should be sufficiently permeable to allow both rapid infiltration and evaporation.

5. Subsurface drains connected to the principal outlet structure, low flow channel, or other discharge point are encouraged to promote quick and thorough drying of the facility bottom. In doing so, care should be taken to prevent stormwater inflow from inadvertently bypassing the basin’s outlet controls. (See G. LOW FLOW MEASURES for additional details.)

6. To minimize routine grass maintenance such as mowing and fertilizing, the use of grass varieties that are relatively slow growing and tolerant of poor soil conditions are encouraged. Information on grass varieties and mixtures are available from such agencies as the local Soil Conservation Districts. (See H. VEGETATIVE COVER for additional details.)

7. To promote lasting growth, grasses and other vegetative covers should be compatible with the prevailing weather and soil conditions and tolerant of periodic inundation and runoff pollutants. (See H. VEGETATIVE COVER for additional details.)

8. To facilitate removal efforts, sedimentation should be promoted at localized, readily accessible areas. The use of sediment traps at inflow and outflow points is encouraged.
face and subsurface soil stabilization measures or non-vegetated linings should be utilized as necessary. In doing so, avoid the use of loose stones, riprap, and other irregular lining materials which require hand removal of weeds and debris and may be a safety hazard to maintenance personnel.

5. All nonvegetative linings which are bordered by grass should be designed to permit complete mowing along all edges.

6. The effects of rapid pool drawdown should be checked to prevent sloughing.

7. For safe movement of personnel and safe operation of equipment, fences should not be constructed within 3 feet of either the top or toe of any side slope that exceeds 5 horizontal to 1 vertical.

C. PRINCIPAL OUTLETS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Structural Deterioration  
* Limited Access  
* Corroded Appurtenances  
* Vandalism  
* Excessive Debris Accumulation

1. For durability, principal outlet structures should be constructed of reinforced concrete containing Type II cement and having a specified 28-day compressive strength of 3,000 psi. Concrete shall be designed in accordance with all applicable codes and requirements, including the current edition of Building Code Requirements for Building Construction (ACI 318) of the American Concrete Institute.

2. For durability, all appurtenances, including access hatches, trash racks, gratings, railings, orifice and weir plates, and fasteners should be constructed of lightweight, noncorrodible materials. Material strengths should be sufficient to withstand design loads without damage or failure.

3. Outlet orifice and weir plates should be constructed from aluminum or other lightweight, noncorrodible material. The plates should be fastened to the structure with noncorrodible, removable fasteners. A gasket of neoprene or similar material should be placed between the plate and the structure wall. The opening in the structure wall over which the plate is bolted should have at least twice the area of the outlet orifice or weir to facilitate future expansion. (See PLATE 2-A for additional information.)
PLANNING AND DESIGN GUIDELINES
DETENTION FACILITIES

4. To facilitate access and movement by maintenance personnel, principal outlet structures should have a minimum horizontal interior dimension of 4 feet. (See J. ACCESS for additional details.)

5. Vital parts of the principal outlet structure should be readily and safely accessible to maintenance personnel during both normal and emergency conditions. Temporary measures such as ladders are only acceptable for emergency conditions as part of an approved emergency action plan. (See J. ACCESS for additional details.)

6. To minimize both required maintenance and the consequences of inadequate maintenance, principal outlets should avoid utilizing moving parts for outflow control whenever possible.

7. To facilitate cleaning, outlet pipes should have a minimum diameter of 18 inches. The pipes should be constructed of durable materials, such as reinforced concrete.

8. Grading and landscaping around principal outlet structures should be designed to facilitate mowing, trimming, debris removal, and other general maintenance tasks. Grassed slopes which require mowing should not exceed 3 horizontal to 1 vertical. Vegetated cover which does not require mowing or nonvegetated linings should be used where steeper slopes are necessary.

9. Stable areas which provide maintenance personnel with firm footing should be provided at the upstream face of principal outlet structures. Linings such as reinforced concrete, gabions, and grouted riprap should be considered.

10. All nonvegetative linings which are bordered by grass should be designed to permit complete mowing along all edges.

11. Dry weather flow through a principal outlet structure should not interfere with routine interior maintenance tasks. Benching, low flow pipes and channels, drop structures, or similar measures should be utilized to convey low flow into and through the structure.

12. Principal outlet structures should be designed to discourage vandalism and graffiti.
significantly reduce the frequency of required sediment removal operations.

5. To facilitate cleaning, inflow pipes should have a minimum diameter of 18 inches. For durability, the pipes should be constructed of reinforced concrete.

6. Grading and landscaping around facility inlets should be designed to facilitate moving, trimming, debris removal, and other general maintenance tasks. Grassed slopes which require mowing should not exceed 3 horizontal to 1 vertical. Vegetated cover which does not require mowing or non-vegetated linings should be used where steeper slopes are necessary.

7. Stable areas which provide maintenance personnel with firm footing should be provided at facility inlets. Linings such as reinforced concrete, gabions, and grouted riprap should be considered.

8. All nonvegetative linings which are bordered by grass should be designed to permit complete mowing along all edges.

9. Dry weather flow from a facility inlet should not interfere with routine maintenance tasks. Benching, low flow pipes and channels, drop structures, or similar measures should be utilized to convey low flow from the inlet to the principal outlet.

F. EMERGENCY OUTLETS

 typical problems that impede or unnecessarily increase proper maintenance include:

* Difficult to Clean
* Erosion and Scour
* Excessive Sedimentation
* Displaced Lining

1. Grass and other vegetative cover is encouraged whenever flow velocities and other design constraints permit. Surface and subsurface soil stabilization measures should be utilized to increase allowable flow velocities and to reduce erosion and scour. [Note: Safe passage of emergency overflows must receive first priority and must not be compromised by selection of emergency outlet lining.]

2. Where nonvegetative linings are required (see 1 above), loose stone, riprap, and other irregular linings which require hand removal of weeds and debris should be avoided.
NOTES:

1. PROVIDE 4" WEEP HOLES IN CONCRETE CHANNEL 12' O.C. (MAX.) OR EVERY 100 S.F. OF LINING (WHICHEVER IS LESS). WEEP HOLES MUST NOT BE DIRECTLY CONNECTED TO ANY LOW FLOW CHANNEL UNDERDRAIN PIPE. PLACE GEOTEXTILE FILTER FABRIC UNDER WEEP HOLES.

2. PROVIDE CONSTRUCTION AND EXPANSION JOINTS IN CONCRETE AT REQUIRED INTERVALS.

3. PROVIDE CUTOFF WALLS AS REQUIRED

4. FOR GABION LINED LOW FLOW CHANNELS, PROVIDE WEEP HOLES IN UPSTREAM FACE OF OUTLET STRUCTURE AT DOWNSTREAM END OF GABION LINING. GABION LINED CHANNEL CAN THEN SERVE AS ITS OWN UNDERDRAIN.

5. WHERE THE RATE OF FLOW THROUGH THE UNDERDRAIN SYSTEM IS A CONCERN RELATIVE TO THE STORM WATER QUALITY CONTROL, THE UNDERDRAIN SYSTEM SHOULD BE DAYLIGHTED UPSTREAM OF THE CONTROL STRUCTURE.

SEE TEXT FOR ADDITIONAL INFORMATION

NJDEP
SWMF MAINTENANCE MANUAL
LOW FLOW CHANNELS AND UNDERDRAINS
TYPICAL DETAILS
PLATE 2-B
2. Where disturbance of existing vegetation cannot be avoided, replacement with low maintenance vegetation with strong resistance to disease and allelopathic (self-weeding) characteristics is encouraged. In general, grass will be easier to establish and will provide better erosion protection than other types of ground cover vegetation. The use of grass varieties that are relatively slow growing and tolerant of poor soil conditions will minimize routine maintenance tasks such as mowing and fertilizing.

The need for supplemental fertilizing can be substantially reduced when the vegetative cover includes a percentage of nitrogen fixing species, such as white clover and other legumes. In addition to minimizing maintenance costs, a reduction in required fertilization will also minimize the potential pollution effects of nitrogen and nitrate runoff.

3. To promote lasting growth, grasses and other vegetative covers should be compatible with the prevailing weather and soil conditions and tolerant of periodic inundation and runoff pollutants.

4. To promote lasting growth, an adequate depth of suitable topsoil should be provided below all vegetative covers. A minimum thickness of 6 inches is recommended.

5. Construction plans and specifications should include requirements for establishing and maintaining all vegetative covers.

6. The effects of sediment removal from vegetated surfaces should be considered in the selection of appropriate cover.

7. Additional information on vegetative covers is available from such agencies as the USDA Soil Conservation Service, local Soil Conservation Districts, the South Jersey Resource Conservation and Development Council, the N.J. Cooperative Extension Service of Rutgers University, and County Cooperative Extension Service offices. Consultation with these agencies during facility planning, design, and review is encouraged.

I. TRASH RACKS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Difficult to Clean
* Difficult to Remove
* Structural Failure
* Excessive Debris
NJDEP
SWMF MAINTENANCE MANUAL
DETENTION BASIN
TRASH RACKS
TYPICAL DETAILS
PLATE 2-C
9. A suitable number of gates should be provided in all fences. The gates should be wide enough to allow passage of necessary equipment and personnel. They should be appropriately located so that they can be fully opened without interference by trees, parked cars, existing or proposed grades, or other obstructions. If it is necessary to lock a gate, it should be done with a noncorroding chain and padlock. This will permit the installation of additional padlocks on the chain (each padlock becomes a link in the chain), thereby allowing authorized access through the gate by more than one person without the need for multiple keys.

10. Safe, suitable access for maintenance personnel and equipment should be provided to the exterior of each facility component. In doing so, avoid remote component locations, steep slopes, unstable surfaces and linings, and narrow walkways.

11. Suitable access should be provided along both sides of a fence for mowing, trimming, and fence repair.

12. Safe, suitable access for maintenance personnel and equipment should be provided to the interior of the principal outlet. In doing so, avoid heavy hatches, gratings, and other covers. Railings, grab rails, slip-resistant steps, low flow channels, benchings, and hinged, lightweight access covers greatly facilitate interior maintenance. Sufficient interior space should also be provided. A minimum horizontal dimension of 4 feet is recommended.

13. At subsurface detention facilities, suitable access, observation points, and monitoring wells should be provided to allow inspection and cleaning. Access should be provided to all major facility components, particularly at inlets and the principal and emergency outlets, and wherever sediment deposits are expected. This will permit sediment and debris removal through high pressure water spray and vacuum (e.g., Jet-Vac). All access points should be at safe locations on the surface which can be readily accessed, safely barricaded, and clearly identified.

K. PERIMETERS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Difficult to Mow or Clean  * Inadequate Size
  * Too Close to Adjacent Structures

1. Field evaluations conducted during the development of this Manual indicate that readily visible detention facil-
The following Planning and Design Guidelines are intended to assist in the creation of stormwater infiltration facilities that require the least practical level of maintenance. To accomplish this, they have been developed to (1) eliminate avoidable maintenance tasks, (2) minimize the long term amount of regular maintenance, (3) facilitate the performance of required maintenance tasks, and (4) reduce the potential for extensive, difficult, and costly remedial or emergency maintenance efforts.

As such, the guidelines presented herein are intended to supplement all other applicable infiltration facility standards, including those pertaining to hydrologic, hydraulic, structural, environmental, legal, and aesthetic aspects. They should also be used creatively in conjunction with all other applicable standards to create stormwater infiltration facilities that require minimum levels of maintenance performed with the least possible effort, time, and cost.

To assist in their use, the Planning and Design Standards are presented by infiltration facility component in the following order:

A. Bottoms  
B. Dams, Embankments, and Side Slopes  
C. Inlets  
D. Emergency Outlets  
E. Vegetative Cover  
F. Access  
G. Perimeters

Detailed descriptions of each facility component listed above are presented in Table 2-1 on Page Plan-10.

At the beginning of each component section presented below is a list of common maintenance problems that the guidelines which follow have been developed to prevent. These problems, which have been identified through surveys, interviews, and site inspections, are intended to enhance the effectiveness of the guidelines by illustrating the guidelines' origins and purpose. They should also serve to stimulate the development of additional guidelines by infiltration facility planners, designers, and reviewers. More detailed information regarding infiltration facility maintenance problems and their causes can be found in the NJDEP's Ocean County Demonstration Study Report. Additional information regarding infiltration facility planning and design is published in the NJDEP's A Guide to Stormwater Management Practices in New Jersey.
INFILTRATION BASIN
GABION TRENCH ALONG BASIN BOTTOM. EXTEND TO ALL BASIN INFLOW POINTS.

GABION BASKETS ARE RECOMMENDED OVER LOOSE STONE TO PROVIDE SMOOTH TOP SURFACE WHICH WILL FACILITATE MOWING OF BASIN BOTTOM AND TO PREVENT UNAUTHORIZED REMOVAL AND OTHER VANDALISM.

NOTE: FILTER FABRIC (GEOTEXTILE)

NG. SCALE

NJDEP
SWMF MAINTENANCE MANUAL
INfiltrATION BASIN
UNDERDRAINS
TYPICAL DETAILS
PLATE 2-D

SEE PARAGRAPH 4 ON PAGE PLAN-30 FOR ADDITIONAL INFORMATION
NO SCALE

BASIN SIDE SLOPE

12" MINIMUM

COARSE SAND BOTTOM LINING TO PROMOTE COMPLETE INFILTRATION AND FACILITATE DESILTING

4'-0" MINIMUM

BEDROCK

SEASONAL HIGH GROUNDWATER LEVEL

SEE PARAGRAPH 9 ON PAGE PLAN-32 FOR ADDITIONAL INFORMATION

NJDEP
SWMF MAINTENANCE MANUAL
NONVEGETATED INFILTRATION BASIN BOTTOMS TYPICAL DETAILS
PLATE 2-E
5. All nonvegetative linings which are bordered by grass should be designed to permit complete mowing along all edges.

6. The effects of rapid pool drawdown should be checked to prevent sloughing.

7. For safe movement of personnel and safe operation of equipment, fences should not be constructed within 3 feet of either the top or toe of any side slope that exceeds 5 horizontal to 1 vertical.

C. INLETS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Difficult to Clean
* Erosion and Scour
* Excessive Sedimentation
* Displaced Lining

1. All inflow pipes and culverts should terminate at a headwall or flared end section with adequate cutoff walls.

2. Linings placed downstream of facility inlets should accommodate design flows without erosion or scour. They should also facilitate removal of sediment and debris. Avoid loose stone, riprap, and other irregularly shaped linings which require hand removal of weeds, sediment, and debris. (See A. BOTTOMS for additional details.)

3. Consideration should be given to placing localized sediment and debris traps immediately downstream of facility inlets. (See A. BOTTOMS for additional details.)

4. Provisions to minimize sediment from entering the facility should be considered. Street sweeping, upstream sedimentation basins and offsite soil stabilization measures can significantly reduce the frequency of required sediment removal operations.

5. To facilitate cleaning, inflow pipes should have a minimum diameter of 18 inches. The pipes should be constructed of durable materials, such as reinforced concrete.

6. Grading and landscaping around facility inlets should be designed to facilitate mowing, trimming, debris removal, and other general maintenance tasks. Grassed slopes which require mowing should not exceed 3 horizontal to 1 vertical. Vegetated cover which does not require mowing or non-
1. To minimize maintenance efforts, the use of existing, undisturbed site vegetation is encouraged. To do so, the existing site topography must provide adequate storage volume.

2. Where disturbance of existing vegetation cannot be avoided, replacement with low maintenance vegetation with strong resistance to disease and allelopathic (self-weeding) characteristics is encouraged. In general, grass will be easier to establish and will provide better erosion protection than other types of ground cover vegetation. The use of grass varieties that are relatively slow growing and tolerant of poor soil conditions will minimize routine maintenance tasks such as mowing and fertilizing.

The need for supplemental fertilizing can be substantially reduced when the vegetative cover includes a percentage of nitrogen fixing species, such as white clover and other legumes. In addition to minimizing maintenance costs, a reduction in required fertilization will also minimize the potential pollution effects of nitrogen and nitrate runoff.

3. To promote lasting growth, grasses and other vegetative covers should be compatible with the prevailing weather and soil conditions and tolerant of periodic inundation and runoff pollutants.

4. To promote lasting growth, an adequate depth of suitable topsoil should be provided below all vegetative covers. A minimum thickness of 6 inches is recommended. The effects of this topsoil on the basin's ability to infiltrate stormwater runoff must be considered in the basin's design.

5. Construction plans and specifications should include requirements for establishing and maintaining all vegetative covers.

6. The effects of sediment removal from vegetated surfaces should be considered in the selection of appropriate cover.

7. Additional information on vegetative covers is available from the USDA Soil Conservation Service, local Soil Conservation Districts, the South Jersey Resource Conservation and Development Council, the N.J. Cooperative Extension Service of Rutgers University, and County Cooperative Extension Service offices. Consultation with these agencies during facility planning, design, and review is encouraged.
appropriately located so that they can be fully opened without interference by trees, parked cars, existing or proposed grades, or other obstructions. If it is necessary to lock a gate, it should be done with a non-corrodible chain and padlock. This will permit the installation of additional padlocks on the chain (each padlock becomes a link in the chain), thereby allowing authorized access through the gate by more than one person without the need for multiple keys.

10. Safe, suitable access for maintenance personnel and equipment should be provided to the exterior of each facility component. In doing so, avoid remote component locations, steep slopes, unstable surfaces and linings, and narrow walkways.

11. Suitable access should be provided along both sides of a fence for mowing, trimming, and fence repair.

12. At subsurface infiltration facilities, suitable access, observation points, and/or monitoring wells should be provided to allow inspection and cleaning. These access points should be provided at opposite ends of the facility to permit sediment removal by high pressure water spray and vacuum (e.g., Jet-Vac). All access points should be at safe locations on the surface which can be readily accessed, safely barricaded, and clearly identified.

G. PERIMETERS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Difficult to Mow or Clean
* Inadequate Size
* Too Close to Adjacent Structures

1. Field evaluations conducted during the development of this Manual indicate that readily visible facilities receive more and better maintenance than those in less visible, more remote locations. This finding should be kept in mind during overall site layout. Readily visible facilities can also be inspected faster and more easily by maintenance and mosquito control personnel.

2. Fences, when required for safety or other purposes, should be located to minimize interference with grass mowing and trimming. Suitable access should be provided along both sides.
B. DAMS, EMBANKMENTS, AND SIDE SLOPES

Typical problems that impede or unnecessarily increase proper maintenance include:

* Steep Slopes
* Long Slopes
* Poor Grass Growth
* Sloughing and Erosion
* Shoreline Deterioration

1. For shoreline protection and to facilitate grass mowing, a suitable non-erosive lining such as gabions should be placed along the edge of the permanent pool. The lining should extend sufficiently above and below the permanent pool elevation to account for wave heights and run-up. (See PLATE 2-F for additional information.)

2. Below the permanent pool level, a 4' to 6' wide level area should be provided to prevent people or objects from sliding into deeper water. The side slope from this level area to the bottom of the pool should be at a slope that will remain stable, usually no steeper than 2 horizontal to 1 vertical. (See PLATE 2-F for additional information.)

3. Side slopes greater than 5 feet in height should not be steeper than 4 horizontal to 1 vertical, for safe movement of personnel and safe operation of equipment. Side slopes less than 5 feet high should not exceed 3 horizontal to 1 vertical. Flatter side slopes are recommended wherever possible.

4. For safe movement of personnel and safe operation of equipment, side slopes steeper than 5 to 1 and higher than 15 feet should be terraced at their midpoints. The terrace should have a minimum width of 3 feet and should be graded at 2 per cent towards the lower half of the slope.

5. Suitable access to and along side slopes should be provided for maintenance personnel and equipment. (See I. ACCESS for details.)

6. Topsoil and vegetative covers must be protected from erosion caused by local runoff and the slope's steepness. Surface and subsurface soil stabilization measures or non-vegetated linings should be utilized as necessary. In doing so, avoid the use of loose stones, riprap, and other irregular lining materials which require hand removal of weeds and debris and may be a safety hazard to maintenance personnel.

7. All nonvegetative linings which are bordered by grass should be designed to permit complete mowing along all edges.
8. To provide adequate drying time, to avoid delaying scheduled maintenance efforts, and to prevent mosquito breeding, the maximum storage or pending duration above the permanent pool should not exceed 48 hours.

9. The effects of rapid pool drawdown should be checked to prevent sloughing of the side slopes.

10. For safe movement of personnel and safe operation of equipment, fences should not be constructed within 3 feet of either the top or toe of any side slope that exceeds 5 horizontal to 1 vertical.

C. PRINCIPAL OUTLETS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Structural Deterioration  * Limited Access
* Corroded Appurtenances  * Vandalism
* Excessive Debris Accumulation

1. For durability, principal outlet structures should be constructed of reinforced concrete containing Type II cement and having a specified 28-day compressive strength of 3,000 PSI. Concrete shall be designed in accordance with all applicable codes and requirements, including the current edition of Building Code Requirements for Building Construction (ACI 318) of the American Concrete Institute.

2. For durability, all appurtenances, including access hatches, trash racks, gratings, railings, orifice and weir plates, and fasteners should be constructed of lightweight, noncorrodible materials. Material strengths should be sufficient to withstand design loads without damage or failure.

3. Outlet orifice and weir plates should be constructed from aluminum or other lightweight, noncorrodible material. The plates should be fastened to the structure with noncorrodible, removable fasteners. A gasket of neoprene or similar material should be placed between the plate and the structure wall. The opening in the structure wall over which the plate is bolted should have at least twice the area of the outlet orifice or weir to facilitate future expansion. (See PLATE 2-G for additional information.)

4. To facilitate access and movement by maintenance personnel, principal outlet structures should have a minimum horizontal interior dimension of 4 feet. (See I. ACCESS for additional details.)
5. Vital parts of the principal outlet structure should be readily and safely accessible to maintenance personnel during both normal and emergency conditions. Temporary measures such as ladders are only acceptable for emergency conditions as part of an approved emergency action plan. (See I. ACCESS for additional details.)

6. To minimize both required maintenance and the consequences of inadequate maintenance, principal outlets should avoid utilizing moving parts for outflow control above the permanent pool elevation whenever possible.

7. To facilitate cleaning, outlet pipes should have a minimum diameter of 18 inches. The pipes should be constructed of durable materials, such as reinforced concrete.

8. Grading and landscaping around principal outlet structures should be designed to facilitate mowing, trimming, debris removal, and other general maintenance tasks. Grassed slopes which require mowing should not exceed 3 horizontal to 1 vertical. Vegetated cover which does not require mowing or nonvegetated linings should be used where steeper slopes are necessary.

9. All nonvegetative linings which are bordered by grass should be designed to permit complete mowing along all edges.

10. Dry weather flow through a principal outlet structure should not interfere with routine interior maintenance tasks. Benching, low flow pipes and channels, drop structures, or similar measures should be utilized to convey low flow into and through the structure.

11. Principal outlet structures should be designed to discourage vandalism and graffiti.

D. OUTFLOW SYSTEMS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Difficult to Clean  * Erosion and Scour
* Excessive Sedimentation  * Displaced Lining

1. The outflow conveyance system downstream of a retention facility should have adequate capacity to accommodate facility outflows. This will not only allow design outflows and water surfaces to be attained, but will also help achieve required drawdown times.
7. All nonvegetative linings which are bordered by grass should be designed to permit complete mowing along all edges.

8. Dry weather flow through a facility inlet should not interfere with routine maintenance tasks. Benching, low flow pipes and channels, drop structures, or similar measures should be utilized to convey low flow from the inlet into the permanent pool.

F. EMERGENCY OUTLETS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Difficult to Clean  * Erosion and Scour
* Excessive Sedimentation  * Displaced Lining

1. Grass and other vegetative cover is encouraged whenever flow velocities and other design constraints permit. Surface and subsurface soil stabilization measures should be utilized to increase allowable flow velocities and to reduce erosion and scour. [Note: Safe passage of emergency overflows must receive first priority and must not be compromised by selection of emergency outlet lining.]

2. Where nonvegetative linings are required (see 1 above), loose stone, riprap, and other irregular linings which require hand removal of weeds and debris should be avoided.

3. All nonvegetative linings which are bordered by grass should be designed to permit complete mowing along all edges.

4. See B. DAMS, EMBANKMENTS, AND SIDE SLOPES for information regarding emergency outlet side slopes.

G. VEGETATIVE COVER

Typical problems that impede or unnecessarily increase proper maintenance include:

* Erosion and Scour  * Poor Growth
* Difficult to Mow

1. To minimize maintenance efforts, the use of existing, undisturbed site vegetation is encouraged. To do so, the existing site topography must provide adequate storage volume.
PLANNING AND DESIGN GUIDELINES
RETENTION FACILITIES

ings and the anticipated debris as well as the consequences of outlet or drain clogging.

2. For durability, all trash rack components, including bars, hinges, fasteners, and clamps, should be constructed of lightweight, noncorrodible material such as aluminum. The components should have sufficient design strength to withstand anticipated loads caused by facility outflows, debris, and, where necessary, maintenance personnel.

3. To facilitate cleaning, trash racks should be comprised primarily of sloping bars aligned longitudinally (in the direction of flow). Perpendicular bars, aligned transverse to the direction of flow, should be added for strength and rigidity. These transverse bars should be located below the top face of the longitudinal bars and, if possible, should be round in section. (See PLATE 2-H for additional information.)

4. To minimize the frequency of cleaning, trash rack bars should be spaced close enough to collect debris which may block the outlet orifice or weir but allow passage of smaller debris which will not. In general, longitudinal bars should be spaced a distance equal to 1/3 the diameter of the outlet orifice or 1/3 the width of the outlet weir. Minimum and maximum spacings of 1 inch and 6 inches on center, respectively, are recommended. Transverse bars should be spaced as necessary for strength and rigidity. (See PLATE 2-H for additional information.)

5. Trash racks should be hinged or attached with non-corrodible, removable fasteners to allow access to the outlet orifice or weir by maintenance personnel. Lightweight trash racks are easier to lift, repair, and clean behind. (See PLATE 2-H for additional information.)

6. Trash racks at principal outlets should be accessible for cleaning with the water level at the normal pool elevation and, if necessary, at the facility's maximum design water surface elevation. Gratings, walkways, or other stable areas of adequate size should be provided at all principal outlet trash racks to provide firm footing for maintenance personnel and equipment.

7. Stable areas of adequate size should be provided at all trash racks which protect permanent pool drains. Concrete pads or other firm surface is recommended.
I. ACCESS

Typical problems that impede or unnecessarily increase proper maintenance include:

* Inadequate or Unsafe Access to Facility Components
* Heavy Gratings and Hatches
* Corroded Locks
* Lack of Fence Gates

1. The facility must be readily accessible from a street or other public right-of-way. Inspection and maintenance easements, connected to the street or right-of-way, should be provided around the entire facility. The exact limits of the easements and rights-of-way should be specified on the project plans and other appropriate documents.

2. Field evaluations conducted during the development of this Manual indicate that readily visible retention facilities receive more and better maintenance than those in less visible, more remote locations. This finding should be kept in mind during overall site layout. Readily visible facilities can also be inspected faster and more easily by maintenance and mosquito control personnel.

3. Access roads and gates should be wide enough to allow passage of necessary maintenance vehicles and equipment, including trucks, backhoes, grass mowers, and mosquito control equipment. In general, a minimum right-of-way width of 15 feet and a minimum roadway width of 12 feet is recommended.

4. To facilitate entry, a curb cut should be provided where an access road meets a curbed roadway.

5. To allow safe movement of maintenance vehicles, access ramps should be provided to the shoreline of all retention facilities with side slopes greater than 5 feet in height. All access ramps should not exceed 10 per cent in grade.

6. Access roads and ramps should be stable and suitably lined to prevent rutting and other damage by maintenance vehicles and equipment.

7. When backing-up is difficult or dangerous, turnaround areas should be provided at the end of all access roads.

8. To expedite overall maintenance efforts, vehicle and equipment staging areas should be provided at or near each facility site.
3. To allow safe movement of maintenance personnel and equipment, fences should be located at least 3 feet beyond the top or toe of any slope steeper than 5 horizontal to 1 vertical.

4. Fences should be constructed of durable, vandal-resistant materials. Fences must meet all local code requirements.

5. To minimize the amount of required trimming, fences in grassed areas should be installed, whenever practical, with a bottom rail set high enough above finished grade to allow mowing beneath it.

6. Grassed areas beyond the tops of retention facilities should have a minimum slope of 2 per cent to promote effective surface drainage and thorough drying.

7. Perimeters should be planned and designed to discourage vandalism and dumping of trash and debris.

8. Facility perimeters should be large enough to allow movement and operation of maintenance and mosquito control equipment. A minimum perimeter width of 25 feet between the facility and adjacent structures is recommended along at least one side of the facility. This portion of the perimeter should be readily accessible from a street or other public right-of-way.
Figure 1-1.—Flow chart for selecting the appropriate procedures in TR-55.

Limitations

To save time, the procedures in TR-55 are simplified by assumptions about some parameters. These simplifications, however, limit the use of the procedures and can provide results that are less accurate than more detailed methods. The user should examine the sensitivity of the analysis being conducted to a variation of the peak discharge or hydrograph. To ensure that the degree of error is tolerable, specific limitations are given in chapters 2 through 6. Additional general constraints to the use of TR-55 are as follows:

- The methods in this TR are based on open and unconfined flow over land or in channels. For large events during which flow is divided between sewer and overland flow, more information about hydraulics than is presented here is needed to determine $T_c$. After flow enters a closed system, the discharge can be assumed constant until another flow is encountered at a junction or another inlet.

- Both the Graphical Peak Discharge and Tabular Hydrograph methods are derived from TR-20 (SCS 1983) output. Their accuracy is comparable; they differ only in their products. The use of $T_r$ permits them to be used for any size watershed within the scope of the curves or tables. The Graphical method (chapter 4) is used only for hydrologically homogeneous watersheds because the procedure is limited to a single watershed subarea. The Tabular method (chapter 5) can be used for a heterogeneous watershed that is divided into a number of homogeneous subwatersheds. Hydrographs for the subwatersheds can be routed and added.

- The approximate storage-routing curves (chapter 6) should not be used if the adjustment for ponding (chapter 4) is used. These storage-routing curves, like the peak discharge and hydrograph procedures, are generalizations derived from TR-20 routings.
APPENDIX D
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TWO YEAR

Time T(C)
Post 9  Pre 3
HILLBRANCH
TEN YEAR

TIME T(C)

Quantity

0.00  2.00  4.00  6.00  8.00  10.00  12.00  14.00  16.00

POST F         PRE F

HILLBRANCH
TEN YEAR

TIME T(C)

Y = (T-2)

0.00  2.00  4.00  6.00  8.00  10.00  12.00  14.00  16.00

POST F         PRE F
HILLBRANCH
TEN YEAR

TIME T(C)

Post 1
Pre 1

HILLBRANCH
TEN YEAR

TIME T(C)

Post 1
Pre 1
HILLBRANCH
TEN YEAR

TIME T(°C)

O 1.00
O 0.80
O 0.60
O 0.40
O 0.20
O 0.00

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APPENDIX F
HILLBRANCH
TWENTY FIVE YEAR

TIME T(C)

POST 6 PRE 5

HILLBRANCH
TWENTY FIVE YEAR

TIME T(C)

POST 6 PRE 5
HILLBRANCH
TWENTY FIVE YEAR

TIME T(C)

QUANTITY

0.00  0.20  0.40  0.60  0.80  1.00

26.5  26.7  26.9  27  27.1  27.2
# CERTIFICATIONS

1. Date of Authorization

2. SPPP Preparation Cert. (Attachment C) Due Date (6 mo. from Authorization)

3. Date Attachment C was submitted to the Department

4. SPPP Implementation Cert. (Attachment D) Due Date (18 mo. from Auth.)

5. Date Attachment D was submitted to the Department

# ANNUAL INSPECTION & RECERTIFICATION

26. Annual Inspection Date(s)

27. Annual Inspection Findings:

(A) Incidents of Non-Compliance w/SPPP

(B) Remedial Action(s)

28. Did the facility submit their Annual Recertification (Attachment D) to the Dept? YES NO

29. Date(s) Annual Recertification was submitted to the Department

30. Are incidents of non-compliance & remedies identified in the certification? YES NO

# SPPP REVIEW

31. Does the SPPP contain the following?:

(A) Pollution Prevention Team Roster (w/ emergency phone numbers) YES NO

(B) Coordination of SPPP w/ Other Existing Environmental Management Plans YES NO

(C) An Inventory of ALL "Source Materials" YES NO

(D) An Inventory of ALL Non-Stormwater Discharges YES NO

(E) Facility Site Map as per Attachment B, Part II YES NO

(F) Narrative Description of Existing Conditions as per Attachment B, Part C YES NO

(G) Description of Best Management Practices as per Attachment B, Part D YES NO

(H) Best Management Practices Implementation Schedule YES NO

1. Are the BMPs implementation dates within 18 months of the Authorization Date YES NO

(I) Inspection Schedule as per Attachment B, Part C YES NO

(J) Maintenance Schedule as per Attachment B, Part F YES NO

(K) Reports summarizing each annual inspection performed YES NO
### GENERAL INFORMATION

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### 13. Violations/Deficiencies or Comments

- Did the facility meet the terms and conditions set forth in N.J.A.C. 7:34A-3, Appendix A (SPPP preparation/implementation and certifications)? Was the SPPP properly prepared and implemented by the facility and does the SPPP adequately eliminate exposure of source materials (industrial materials, machinery, waste products) to stormwater?

### 14. RATING

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### 15. Evaluator

16. Title

### 17. Information Furnished By (Name)

18. Title

### 19. Organization

20. Date of Inspection
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