DELAWARE
ESTUARY PROGRAM

CLEAN WATER WORKS WATERSHED MANAGEMENT PLAN

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GLOUCESTER COUNTY PLANNING DEPARTMENT

In Cooperation with the U.S. Soil Conservation Service, Gloucester County Soil Conservation District, Glassboro State College, and Gloucester County College.

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EXECUTIVE SUMMARY

This is a report on a proposed water quality program for Alcyon Lake Watershed in Gloucester County, New Jersey, viewed as a possible example and prototype for other watersheds in the Delaware Estuary Region. Development of this report was supported by the U.S. Environmental Protection Agency (EPA) and by the Gloucester County Planning Board.

A program for protection of the Delaware Estuary against nonpoint source pollution is being developed as part of the National Estuaries Program by the U.S. Environmental Protection Agency and the three states of Delaware, New Jersey and Pennsylvania. The program relies primarily on land use management tools to reduce nonpoint source pollution to the Delaware Estuary, by reducing pollution from new development through improved planning and use of best management practices (BMPs), and by providing buffer strips to set back development and to filter runoff. The proposed Alcyon Lake progam exemplifies a similar approach applied to a locally important sensitive area.

The Alcyon Lake watershed situation will also be of interest in connection with the coastal nonpoint source control program, which requires the states concerned to develop programs to control significant sources of nonpoint pollution, for all coastal waters.

Alcyon Lake is polluted and eutrophic largely due to development in and around the towns of Pitman and Glassboro. Water quality modeling of the streams tributary to the Lake indicates that foreseeable future pollutant loads of the different major pollutants will increase by 22% to 52%. The monitored water quality in the streams is generally good to fair; but the number and diversity of macroinvertebrates is quite depressed, which may be indicative of long standing water quality degradation. Since the present situation is already unsatisfactory, it is apparent that measures should be taken to control NPS impacts from future development, and also to reduce NPS development from present development as far as practicable.

The deteriorating water quality conditions of Alcyon Lake and adjacent sensitive areas could be brought under control by "The Clean Water Works Management Plan", outlined in this report. Initially two main programs are described and recommended for early action: (a) the preservation of forested buffer strips, and (b) the control of water quality runoff in new developments. These programs will prevent a further deterioration in water quality due to new development. The improvement in water quality for Alcyon Lake will require controls limiting runoff from existing development. No complete program for this purpose has been outlined, although practices are identified which would contribute to this end. There is some flood damage in Alcyon Lake, and further consideration should be given to flood control, as the opportunity appears.

The plan will include measures proposed through the Delaware Estuary Program's land use management strategies plan which must be adopted by local governments and approved by the States of Delaware, Pennsylvania and New Jersey. It will comply with provisions for water quality in stormwater management adopted by the State of New Jersey. Implementation will require local ordinances for buffers (as proposed in Appendix B), local ordinances for stormwater management (in accordance with provisions of Chapter 3) and appropriate revision of site planning procedures and criteria. Public education and public participation will help to gain public acceptance of the plan, as will the outreach activities for the Delaware Estuary Program.

CLEAN WATER WORKS WATERSHED MANAGEMENT PLAN

1.0 INTRODUCTION

PURPOSE

This is a report on a proposed water quality program for the Alcyon Lake Watershed in Gloucester County, New Jersey, viewed as a possible example and prototype for other watersheds in the Delaware Estuary Region. The Final Report was prepared for the Gloucester County Planning Department by The Greeley-Polhemus Group, Inc., based upon studies by the Soil Conservation Service, the Gloucester County Soil Conservation District, Glassboro State College and the county planning board. This report was funded by the EPA and the Gloucester County Planning Department, as a demonstration project for this Delaware Estuary Program.

A program for control of nonpoint source pollution in the Delaware Estuary is being developed as part of the National Estuaries Program by the U.S. Environmental Protection Agency (EPA) and the three States of Delaware, New Jersey and Pennsylvania. The plan relies primarily on land use management tools to reduce nonpoint source pollution to the Delaware Estuary by reducing pollution from new development through improved planning and use of best management practices (BMPs), and by providing buffer strips to set back development and to filter runoff.

Runoff from the Alcyon Lake watershed contributes to the pollution of the Delaware Estuary. The local effects of the pollution in Alcyon Lake are sufficiently serious that various studies have been conducted, resulting in much more information than is available in most other estuary watersheds. The Alcyon Lake watershed situation will also be of interest in connection with the coastal nonpoint source control program, which requires the states of concern to develop programs to control significant sources of nonpoint pollution for all coastal waters. It will be of particular relevance to other parts of the region which include environmentally sensitive areas or other areas which require special protection.

The program proposed would limit nonpoint source pollution from new development. To the extent practicable, it would remediate nonpoint source pollution from existing development and consider the possible necessity of flood control. Control is proposed to be affected by buffer zones, source controls, zoning, improvement of site and subdivision planning, dual-purpose detention basins and other alternative management practices.

THE ALCYON LAKE WATERSHED

The Alcyon Lake Watershed is located in Mantua and Harrison Townships, and Glassboro and Pitman Boroughs in Gloucester County, New Jersey. Soils in the watershed include Aura loamy sand and sandy loam, Downer loamy sand, Sassafras sandy loam and Westphalia soils.

Topography of the watersheds can best be described as gentle and rolling in most areas. Steeper slopes occur adjacent to such tributaries as Cabin Run and Plank Run.

Geology of the watershed near the surface is predominantly the Kirkwood Cohansey Formation, with various layers of unconsolidated materials separated by confining clay beds.

Alcyon Lake is located approximately 2.5 miles downstream of the headwaters of Chestnut Branch, which is a major tributary to Mantua Creek. The Alcyon Lake Watershed encompasses an area of approximately 4 square miles of mixed land use including 38% productive agriculture, 53% urban/suburban, 4% water bodies, and 2% landfill and 3% miscellaneous. Lake surface area is 18.5 acres, with a maximum depth of 6.4 feet and an average depth of 3.4 feet. The lake is located approximately 5 miles upstream from the confluence of Chestnut Branch and Mantua Creek. From this point, the Mantua Creek runs approximately 6.8 miles to its confluence with the Delaware River.

Gloucester County receives an average of 44 inches of precipitation per year. Approximately 10% of the precipitation is lost as direct runoff, while evapotranspiration accounts for approximately 24 inches per year. The remainder enters the aquifer and provides base flow to streams or recharge to the deeper aquifers. In an average year, groundwater discharge accounts for approximately two-thirds of the flow of major streams.

Generally, water quality in Alcyon Lake is poor. Water quality problems occurring in the drainage area or watershed were identified as resulting from three sources namely, chemical pollution from the LiPari Landfill; sediment, organic and heavy metal pollution from urban stormwater runoff; and siltation, nutrient and pesticide intrusion from agricultural areas. Currently the lake is posted with warnings for chemical hazards and trespassing is forbidden. The LiPari Landfill and its impact on the lake sediments and water quality is presently being remediated as part of an EPA Superfund project.

ORGANIZATION OF THE REPORT

This report is organized as follows:

I. Introduction

II. Evaluation of Water Quality

III. Clean Water Works Watershed Management Plan

IV. Implementation

Appendix : Drought Resistant Landscapes

Appendix : Alcyon Lake Watershed Buffer Strip Model Ordinance

ACKNOWLEDGEMENTS

Much background material was adapted from "Protecting Water Quality in Urban Areas", State of Minnesota Pollution Control Agency, John Branch, author, October 1989.

The model selected for the hydrologic study was the Soil Conservation Service "Computer Program for Project Formulation-Hydrology", commonly known as TR-20. Use was made also of TR-55 "Urban Hydrology for Small Watersheds", and other SCS publications.

Considerable use was made of information in Thomas Schueler's "Controlling Urban Runoff: A Practical Model for Planning and Designing BMPs", Metropolitan Washington Council of Governments, 1987. This included the "simple" method of estimating pollutant export.

Buffer strips were planned based upon concepts in "Buffer Strips to Protect Water Supply Reservoirs, a Model and Recommendation", by George H. Nieswand, et al, Water Resource Bulletin, 26, 6, 959, December 1990.

2.0 EVALUATION OF WATER QUALITY AND STORMWATER CONTROL

GENERAL

The Alcyon Lake Watershed is about four (4) square miles and is divided into seven (7) subwatersheds (see Figure 1). The high level of urbanization within a small watershed has a profound influence on stream quality, because of the amount and extent of impervious surface and the quantity of nonpoint source pollution.

There are two main reasons why urbanization increases pollutant loads in runoff. First, the volume and rate of runoff are typically increased as an area is developed, providing a larger capacity to transport pollutants. Second, some polluting materials are typically made more available as the intensity of the land use increases. The following section describes these hydrologic effects and the pollutants commonly associated with urban watersheds. Although many of the effects discussed here relate to surface water quality, it is important to remember that groundwater quality can also be adversely affected by urbanization. The greatest potential for groundwater pollution comes from pollutants that are soluble in water, and are not trapped or treated by the soil during percolation.

When an undeveloped area is developed, drastic changes in the local hydrology usually result. As land is covered with roads, buildings, and parking lots, the amount of rainfall that can infiltrate into the soil is reduced. This increases the volume of runoff from the watershed. Natural drainage patterns are modified as runoff is channeled into road gutters, storm sewers, and paved channels. These modifications increase the velocity of runoff, which decreases the time required to convey it to the mouth of the watershed. This results in higher peak discharges and shorter times to reach peak discharge. The increased volume of runoff after development is significant because of the increased pollutant loading it delivers as well as potential flooding and channel erosion problems. Increased flows can cause bank-full flow to be exceeded several times each year. In addition to regular flood damage, this condition causes previously stable channels to erode and widen. Much of the material that erodes becomes bed load and can smother bottom-dwelling organisms. Sediment from streambank erosion eventually settles and silts in streams, rivers, and lakes.

Base flow in streams is also affected by changes in hydrology from urbanization because a large part of base flow is supplied by shallow infiltration. As shallow infiltration is reduced by increased impervious

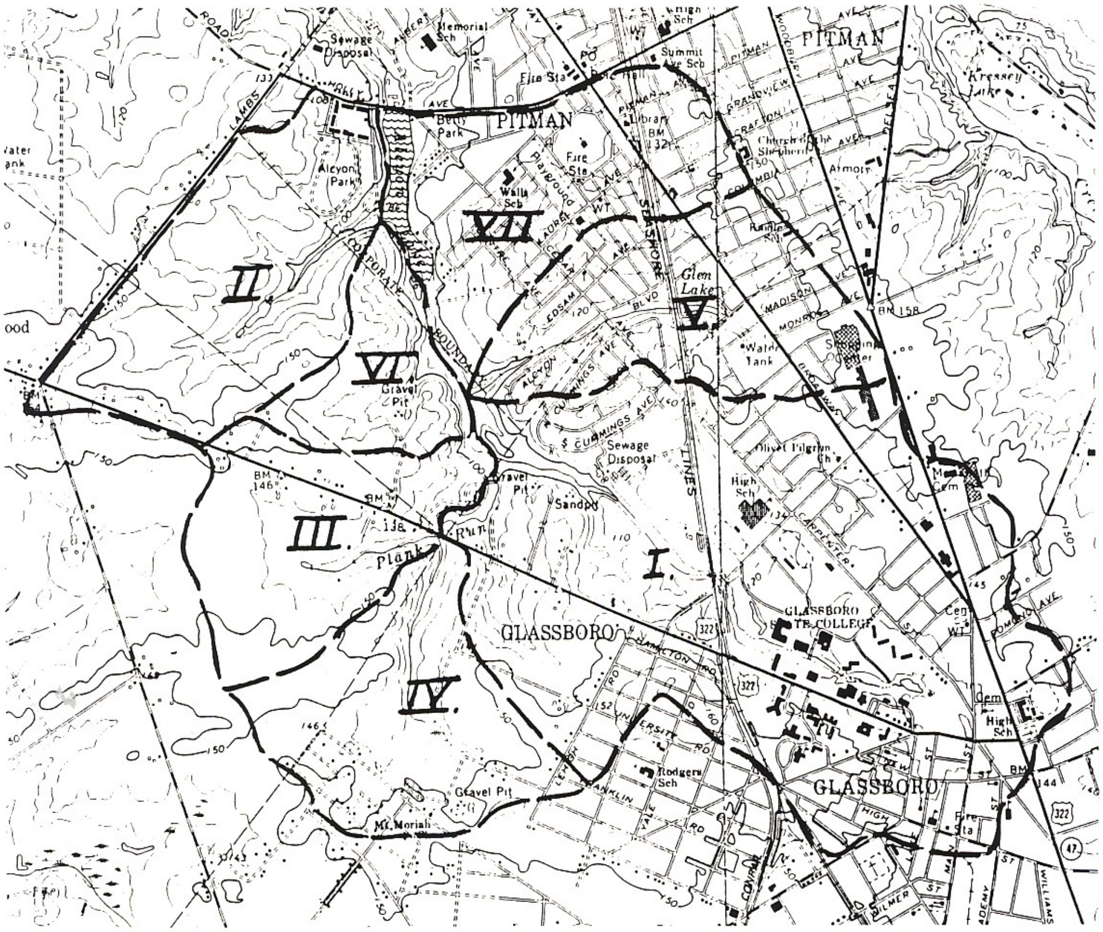
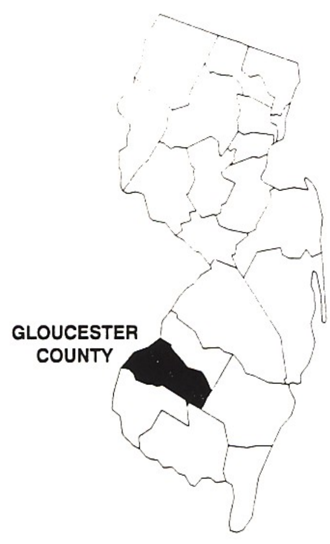


Figure 1
Alcyon Lake Watershed



cover, the volume of water available for base flow in streams is reduced. These changes in hydrology, combined with increased pollutant loadings, can have a dramatic effect on the aquatic ecosystem in streams.

For the purposes of this report it was necessary to study the hydrology of the watershed, as affected by present and anticipated future development, and the corresponding changes in water quality.

THE HYDROLOGIC MODEL

The Soil Conservation Service's Computer Program for Project Formulation - Hydrology, commonly known as the TR-20 program, was chosen for this study. The program is very versatile and can easily be manipulated to reflect major changes in the watershed as they are proposed. The model predicts downstream effects of alternative development and stormwater controls within various subareas.

Subwatershed Delineation

The Alcyon Lake Watershed was divided into seven subwatershed areas, see Figure 1. Subareas were chosen based on homogeneous land use, nearly uniform size, and not too small or too large a time of concentration. They were divided at the point where existing and potential flood storage basins are located. Future land use patterns may necessitate alternate or smaller subareas in order to analyze the effects of potential stormwater and/or water quality facilities.

Rainfall

A Type III, 24-hour rainfall distribution was used to develop the runoff hydrographs. Type III is commonly used in New Jersey as part of the Atlantic Coastal area subject to tropical storms. Storm frequencies of 2, 10 and 100 years were analyzed, the rainfall depths for each being 3.4, 5.3 and 7.4 inches respectively. Rainfall frequency implies the probability of a storm event. A two-year rainfall has a 50% chance of occurring in any one year; a ten-year storm has a 10% chance of occurring; and a 100-year storm has a 1% probability.

Soils Data

Soils data were obtained from the Soil Survey of Gloucester County published by the USDA - Soil Conservation Service. The soils within the watershed are classified into hydrologic soil groups: A, B, C, or

D. The hydrologic soil group represents the runoff potential of a soil according to infiltration and transmission rates. "A" soils have the lowest potential and "D" soils have the greatest potential for runoff.

The soil survey indicated that the hydrologic soil group B was predominant within the Alcyon Lake Watershed.

Land Use

The type of land use affects the quantity and quality of runoff from an area. The conversion from pervious cover to impervious cover reduces infiltration rates and increases the rate and total volume of runoff. Land use also determines the type of pollutants most likely to be generated.

Land use for the Alcyon Lake Watershed was obtained and compiled form several sources. Aerial photography, USGS topographic maps, the Gloucester County Land Use Maps, and soil survey maps were used as guidelines. Verification was obtained by field inspection. The Existing TR-20 model was divided into four land use categories which characterize the watershed: Woods, Orchards, Commercial, and 1/4-acre lot Residential. Future land use was estimated based on proposed projects currently being reviewed by the planning board within the basin plus several projects in the conceptual or sketch plat stage. Given the typical time frame for project completion, the interim map was assumed to represent development 5-10 years into the future.

Runoff Curve Number

The Runoff Curve Number (RCN) represents the hydrologic soil group (HSG), the land use, the antecedent moisture condition, and the hydrologic condition of the watershed. Each subarea, having a distinct RCN value, is considered homogeneous by TR-20, which has been shown to be valuable for this type of study. The single curve number represents the subarea for all times of the year and for all frequency storms. The resultant runoff volume is, therefore, an average value and should not be used for describing single storm events. The basic RCN values used in all models were taken or interpolated from TR-55, Urban Hydrology for Small Watersheds.

Time of Concentration

Time of concentration (Tc) is the time it takes for runoff to travel from the hydraulically most distant part of the subarea to the outlet or point of reference downstream. Tc varies with the hydraulic and storage conditions of the designated flow path. The longer the time for water to concentrate, the smaller will be the peak discharge from the subarea. TR-20 develops an incremental unit hydrograph for each subarea, the time to peak being a function of Tc. Runoff is computed in short time intervals which enables the program to add hydrographs together. When two hydrographs are added together, the resultant peak may not be the summation of the individual peaks, depending on their time concentration. Estimates of present Tc for each subarea was mainly based on field observations. Gullies, ditches, and drainageways were identified and observed for characteristics that affect flow. Stream channels were surveyed for detailed cross-sections, accurate slopes, and roughness characteristics. Flow path lengths were measured from the base map. Assumptions made in estimating Tc were used as consistently as possible. Velocities for sheet flow were obtained from the TR-55 program. Shallow concentrated flow velocities as a function of watercourse slope and type of channel were estimated from the TR-55 program. Channel flow velocities were calculated using Manning's Equation for open channel flow. Individual travel times for the three flow regimes are added together to determine the Tc for the subarea.

Future Time of Concentration

Increases in peak discharges due to development are generally attributed to the construction of impervious areas and stormwater systems which are more efficient hydraulically than the rural state. Typical development increases flow velocities so that more discharge reaches points of concentration concurrently. Where runoff once flowed over rough terrain, through field gullies and natural streams, urbanization provides smooth gutters, streets, storm drains and open channels that convey runoff rapidly downstream. To reflect the development occurring in the watershed for the full build-out condition, Tc was modified.

TR-20 develops a mass curve of runoff for each watershed. The hydrograph is determined by the rainfall distribution, rainfall depth, and runoff curve number. Each subarea peaks at a time determined by its time of concentration. As the runoff from an upper subarea travels downstream, the program routes the hydrograph through valley reaches using the Modified Attenuation Kinematic method. Reach routing requires either a rating curve, discharge versus cross-sectional area data, or routing coefficients. As runoffs enter reservoirs, TR-20 uses the storage indication method of routing. For an existing or a proposed reservoir, the routing requires stage-discharge-storage data. The purpose of routing the hydrographs is to determine the downstream effects of various stormwater management alternatives.

The future condition with ultimate development according to current zoning ordinances would increase the stage in Alcyon Lake by approximately 0.6 foot for each of the storms. While this is not a major impact, it may be significant, since there are several houses within close proximity of the lake.

A stormwater retention basin at the site of the Rough Acres Reservoir (drainage area = 1.0 square mile) was evaluated to determine its impact on Alcyon Lake. Although the water quality requirements were not incorporated in this basin, it still lowered the elevation of Alcyon Lake to within 0.2 foot of the present condition for the 2-year storm, 0.1 foot for the 10-year storm. It reduced the 100-year storm elevation by 0.1 foot. This shows that a stormwater retention basin can be useful in minimizing future flood conditions in Alcyon Lake.

It should be noted that this basin would flood U.S. Route 322 for all the storms evaluated. Thus, to avoid this effect, either road would need to be raised, or the basin would have to be relocated upstream of the road.

A stormwater retention basin on Cabin Run (drainage area = 0.31 square miles) was also evaluated without addressing the water quality regulations. The resultant elevations of Alcyon Lake were 0.4 foot higher than present condition for the 2- and 10-year storms and 0.3 foot for the 100-year storm. The difference in effectiveness of the two basins appears to be because of the difference in drainage area controlled.

Inclusion of storage to meet water quality regulations would further reduce peak discharges into Alcyon Lake by a small amount.

If the 0.6-foot increase in stage in Alcyon Lake causes problems with surrounding properties, stormwater retention basins could be designed using site specific data. It may be possible to provide all the control needed at the Rough Acres site. Detailed field surveys to determine stage storage information and extent of wetlands would be required for this design. The impact on the wetlands and the highway would need to be carefully considered. If the higher stages do not cause problems, only water quality, erosion, and sediment control regulations would need to be addressed.

Alternatives to Consider

Based on the hydrologic modeling results, the following are possible alternatives for stormwater management:

1. Grass Berm - Since ultimate development showed a 0.6 foot increase in the stage of Alcyon Lake which could have a significant impact on several buildings, an alternative is to build up the tops of banks of Alcyon Lake in order to keep the water within the lake and not out of bank.

2. Flood Proofing - Flood proofing consists of those adjustments to structure and building contents which are designed or adopted primarily to reduce flood damages (e.g., flood retarding wall around perimeter of building).

3. Dual Purpose Basin - Utilizing Rough Acres Lake as a stormwater retention basin is another alternative, however, flooding of US Route 322 would require raising the road elevation or relocating the basin upstream of the road. The dual purpose basin would not only control the increase from post development runoff but improve water quality.

It is apparent that the problems of stormwater management in this area will require careful planning on a watershed basis.

NONPOINT SOURCE POLLUTANT DEVELOPMENT

The major nonpoint source pollutants from developments include sediment, nutrients, trace metals, oxygen-demanding substances, bacteria, and hydrocarbons. Each of these pollutants is discussed below.

Fine Sediment

Fine sediment is made up of tiny soil particles that are washed or blown into lakes and streams is the major pollutant by volume in state surface waters. Sediment fills in streams, lakes, rivers, wetlands, and road ditches, and can affect aquatic life by smothering fish larvae and eggs. Suspended soil particles can cause water to look cloudy or turbid. Excessive turbidity reduces light penetration in water, decreases primary productivity, impairs sight feeding fish, clogs fish gills, and increases drinking water treatment costs. Fine sediment also acts as a vehicle to transport other pollutants including nutrients, trace metals, and hydrocarbons to (nearby) surface waters. Runoff from construction sites is a large source of sediment in areas under development.

Nutrients

Nutrients are a major concern for surface water quality because of the effect they can have on lakes. Phosphorus and nitrogen can cause algal blooms and excessive aquatic plant growth in lakes. Of the two, phosphorus is usually the limiting nutrient that controls the growth of algae in lakes. As phosphorus loadings rise, the potential for algal blooms and accelerated lake eutrophication also increases. The ammonium form of nitrogen can also have severe effects on water quality. The ammonium is converted to nitrate and nitrite forms of nitrogen in a process called nitrification. This process consumes large amounts of oxygen and can kill fish. In developing areas, major sources of nutrients are organic matters such as lawn clippings and leaves and improper or excessive use of fertilizers. Malfunctioning septic systems or leaking sanitary sewers can be a significant source.

Trace Metals

Trace metals are a water quality concern because of the toxic effects they can have on aquatic life and on human life. The most common trace metals found in urban runoff are lead, zinc, and copper.

The toxicity of trace metals in runoff varies with the hardness of the receiving water. As total hardness of the water increases, the threshold concentration levels for adverse biological effects increases. Many of these metals are in particulate form, and are carried with the flow until the sediment settles out. When these metals settle out, they can accumulate over a period of time to levels that are harmful to aquatic life.

Oxygen-Demanding Substances

While land animals extract oxygen from the air, aquatic life depends on oxygen dissolved in water. When organic matter is consumed by microorganisms, dissolved oxygen is consumed in the process. After rainfall, urban runoff can deposit large quantities of oxygen-demanding substances in lakes or streams. The biochemical oxygen demand (BOD) and chemical oxygen demand (COD) of typical urban runoff is of the same order of magnitude as the effluent from an efficiently run secondary wastewater treatment plant. This can create a pulse of high oxygen demand during storm runoff that can totally deplete oxygen supplies in shallow, slow moving, or poorly flushed waters. Oxygen depletion is a common cause of fish kills. In urban areas, pet wastes, street litter, and organic waste are common sources of oxygen-demanding substances.

Bacteria

Bacteria levels are most severe in the summer when temperatures are most favorable for their reproduction. The 1983 EPA NURP study found that total fecal coliform counts exceeded EPA water quality criteria at almost every site and almost every time it rained. The coliform bacteria that are detected may not be a health risk in themselves, but are often associated with other pathogens. Pet, other animal wastes, and malfunctioning or inadequate septic systems are common sources of bacteria in developing areas.

Hydrocarbons

Among the most common constituents in runoff from developed land are hydrocarbons. Sometimes they come from industrial facilities, but most frequently from gasoline filling stations and from vehicles on highways and in parking spaces. Some hydrocarbons are carcinogens, and others are harmful to biota, especially filter feeding macroinvertebrates. Hydrocarbons from spills occur as floating masses; but most of the hydrocarbons in urban runoff occur absorbed on to particulates (sediment), with a small proportion dissolved in the water.

THE POLLUTANT DELIVERY PROCESS

Understanding the pollutant delivery process is fundamental to nonpoint source pollution control. There are three steps to the delivery process -- availability, detachment, and transport. Most substances must go through this chain before they can become pollutants. Breaking this chain at any step will prevent a substance from being delivered to receiving waters. Some pollutants are more readily controlled at a particular step in the delivery process. A basic understanding of this process and the characteristics of the pollutants in question helps to target Best Management Practices (BMPs) so that they prevent delivery most effectively.

Availability

Obviously, a material must be available before it can become a potential pollutant. The quantity of a material in the environment and its characteristics determine the degree of availability. In an urban environment, the quantity of certain pollutants in the environment is a function of the intensity of the land use.

For example, the availability of a material such as fertilizer is a function of the quantity and the manner in which it is applied. Applying fertilizer in quantities that exceed plant needs leaves the excess nutrients available for loss to surface or ground water. Reducing the availability of fertilizers through reduced use and proper application is the best way to control nonpoint source pollution from these materials.

Detachment

Detachment is the process in which materials are dislodged from their original location and become mobile. The detachment process can either by physical or chemical. Most physical detachment is the result of raindrop impact or overland flow. Chemical detachment involves dissolving soluble materials or ion exchange processes. Control of pollutant delivery in the detachment phase is most practical for materials such as sediment, when erosion control practices are used to prevent the detachment of soil particles.

Transport

Transport is the final phase of the delivery process. Transport involves moving a material from its point of detachment to receiving waters. In urban areas, a large part of the runoff is transported to receiving waters over impermeable surfaces such as streets or in storm sewers. This results in very efficient transport of pollutants to receiving waters, once they are detached. For many urban nonpoint source pollutants, especially those associated with sediment, interrupting transport is the most practical way to prevent their delivery to receiving waters. Detention or infiltration practices can be effective for interrupting transport of many pollutants.

EXISTING WATER QUALITY CONDITIONS: VISUAL INDICATORS

In June, 1992, a streamwalk of sections of each of the tributaries feeding Alcyon Lake was performed. The objective of the streamwalk was to use visual biological indicators to determine stream water quality and to evaluate the watershed and the inherent pollution potential.

The first stage of the visual indicator approach was a tour of the watershed to establish existing land use variation and extent, management practices in use, and potential pollutant sources. The land use is not overly diverse in the watershed: the watershed is highly urbanized, with residential and commercial development represented by the towns of Pitman and Glassboro. The remainder of the watershed is in agriculture and a small portion of woodland. The agriculture is almost totally devoted to fruit production in the form of peach orchards. These orchards appear to be in good shape as regards potential erosion, because most of them have herbaceous cover between the trees. The farm lanes through the orchards have some soil erosion in several locations and could use some farmer maintenance. If farm traffic allowed, lanes maintained in grass would reduce this problem. Most of the orchards were not planted on the contour, but instead in blocks. Any new orchards should be established on the contour if possible. The few agricultural acreages that are annually tilled pose the potential for offsite sedimentation and pollution. Soil conservation practices like cover crop, contour or cross-slope farming, buffer strips, terraces, and grass waterways should be considered if the cropping system poses the potential for erosion.

All in all, agricultural-woodland undeveloped portion of the watershed appeared to be under acceptable management from a soil conservation viewpoint. No specific severe problems were encountered in the streamwalk. Although access was not gained to every field, aerial photography along with representative access points was used to provide an overview of the watershed conditions.

The streamwalk itself started at Alcyon Lake and moved up the various tributaries where access could be obtained. The procedure cited in the Soil Conservation Service publication, Water Quality Indicators Guide: Surface Waters was followed in a conceptual fashion. Each tributary of Alcyon Lake was assessed using the sediment, nutrient, and pesticide field sheets of the Indicators Guide. Numerical rankings were assigned to each stream in order to provide a ranking of excellent, good, fair, or poor as relating to the three pollutants. Although some subjective judgement is necessary to complete the sheets, this visual approach is useful, especially when done in conjunction with some sampling of macroinvertebrates. Generally, macroinvertebrate sampling can provide a fairly reliable insight into the overall water quality regime in a water body. Bottom-dwelling macroinvertebrates can be broken into three groups: intolerant of pollution, moderately tolerant, and tolerant. Examples would be stoneflies and caddisflies for intolerants, dragonflies and blackflies for moderates, and segmented worms and midges for tolerants. By using Beck's Biotic Index, a ranking can be given based on the results of a stream bottom sample using a sampling net. Beck's index assigns numerical values to the number of macroinvertebrate species found in each of the three tolerance groups. The numerical results were as follows:

1.	Cabin Run: (97 points)	A. Sediment	Good: 32 points
		B. Nutrients	Good: 28 points
		C. Pesticides	Good: 37 points
2.	Rough Acres Run: (106 points)	A. Sediment	Good: 35 points
		B. Nutrients	Good: 29 points
		C. Pesticides	Excellent: 42 points
3.	Spruce Run: (93 points)	A. Sediment	Fair: 28 points
		B. Nutrients	Good: 28 points
		C. Pesticides	Good: 37 points
4.	Chestnut Branch: (90 points)	A. Sediment	Fair: 25 points
		B. Nutrients	Good: 32 points
		C. Pesticides	Good: 33 points
5.	Long Run: (75 points)	A. Sediment	Fair: 17 points
		B. Nutrients	Good: 32 points
		C. Pesticides	Fair: 26 points

To summarize, the stream with the highest overall water quality appeared to be Rough Acres Run. This can be attributed to the fact that this watershed is predominantly comprised of peach orchards that mostly are kept in good cover. There is not much annually-tilled ground. Septic and paved areas are minimal. The lowest overall water quality appeared to be found in Long Run, which is the most urbanized watershed. It flows through Pitman and is subject to accelerated stormflows, lawn fertilizers and pesticides, road salts and sands, septics, and other pollutants from urban development. The other three streams fell in between, with insignificant differences between them. The one common factor noted in all of the streams, was that numbers and diversity of macroinvertebrates was quite depressed, which may be indicative of long-standing water quality degradation.

WATER QUALITY MODEL

The pollutant export model used by SCS in the Alcyon Lake Watershed study is known as the "Simple Method" as developed by the Metropolitan Washington Council of Governments in its 1987 book, Controlling

Urban Runoff: A Practical Manual for Planning and Designing Urban BMP's, by Thomas Schueler. This method is a straightforward way to estimate selected pollutant runoff loading from developing areas.

Pollutant loadings were estimated for total phosphorous, total nitrogen, biochemical oxygen demand (BOD), zinc, and lead. Loading estimates were done on a subwatershed basis for greater accuracy. Estimates were developed for two conditions - the existing and the foreseeable future, with land-use data mirroring that which was used in the TR-20 stormwater hydrology model. In this way, the water-quality modeling is matched with the hydrology.

It should be clearly understood that this model is a general planning tool that provides insight into pollutant export trends linked to land use changes. The numbers generated by the model should not be interpreted quantitatively. Instead, the trends that the numbers illustrate should be considered, and land-use planning should be done accordingly.

The results generated by the model can be found in Table 1 for the entire Alcyon Lake Watershed. Model results by subwatershed can be found in Tables 2-8. To summarize, the model results clearly show that all of the pollutants estimated would increase markedly under the conditions of the foreseeable future.

Pollutant	Future Increase
Total phosphorous	27%
Total nitrogen	52%
BOD	51%
Zinc	36%
Lead	22%

There are several premises that are responsible for the pollutant increases. First, increased impervious surfaces mean increased runoff. This runoff is not only being delivered to the bottom of the watershed more quickly, but also in greater volumes and is transporting more pollutants related to people - oils and greases, automobile exhaust emissions, road salts, and sands. Second, more people in the watershed mean more septic systems and pets. This is another source of nutrients that will be delivered to the lake. Third, the construction-related disturbances of the landscape that take place during development deliver sediment (as suspended solids) and nutrients downstream. Fourth, the established development contributes lawn-related nutrients in runoff following high-intensity storm events.

TABLE 1

Alcyon Lake Watershed: Pollutant Loadings
Comparison of Existing vs Future Conditions*

Pollutant	Amount, Pounds Per Year: Existing	Future	% Increase
Total P	4,653	5,902	27
Total N	19,145	29,077	52
BOD	53,161	80,268	51
Zn	547	745	36
Pb	433	529	22

*Future conditions were calculated for subwatersheds 2, 3, 4, and 6 only. The other watersheds are already in a developed condition for the purposes of modeling.

TABLE 2

Subwatershed 1: Pollutant Loadings

Pollutant	Amount, Pounds Per Year (Existing and Future)
Total P	193
Total N	1,484
BOD	3,784
Zn	27
Pb	13

TABLE 3

Subwatershed 2: Pollutant Loadings

Pollutant	Amount, Pounds Per Year: Existing	Future
Total P	28	204
Total N	144	1,568
BOD	0	3,998
Zn	0	29
Pb	0	14

TABLE 4

Subwatershed 3: Pollutant Loadings

Pollutant	Amount, Pounds Per Year: Existing	Future
Total P	40	447
Total N	210	3,436
BOD	0	8,762
Zn	0	64
Pb	0	31

TABLE 5

Subwatershed 4: Pollutant Loadings

Pollutant	Amount, Pounds Per Year: Existing	Future
Total P	43	475
Total N	223	3,650
BOD	0	9,308
Zn	0	68
Pb	0	33

TABLE 6

Subwatershed 5: Pollutant Loadings

Pollutant	Amount, Pounds Per Year
Total P	842
Total N	4,570
BOD	14,603
Zn	184
Pb	170

TABLE 7

Subwatershed 6: Pollutant Loadings

Pollutant	Amount, Pounds Per Year	
	Existing	Future
Total P	23	257
Total N	121	1,976
BOD	0	5,039
Zn	0	37
Pb	0	18

TABLE 8

Subwatershed 7: Pollutant Loadings

Pollutant	Amount, Pounds Per Year
Total P	2,512
Total N	4,913
BOD	15,700
Zn	198
Pb	183

It should also be noted that the model expresses pollutants in terms of pounds per year, not the usual concentration expression of milligrams per liter. Consequently, it cannot be ascertained what the actual concentrations of pollutants would be entering the waters of the lake. This would best be achieved through a water quality sampling/monitoring program.

What do the model results mean? The assumption made by the model is that no BMP's are being installed and that land development is taking place in a relatively haphazard fashion with no regard to buffers, wetland filter areas or protection of sensitive drainageways or steep slopes. If the land planning concepts and BMPs discussed in Chapter 3 are implemented, pollutant loads to the lake should be reduced accordingly.

SUMMARY, WATER QUALITY AND STORMWATER CONTROL

Analysis of hydrologic model results indicated that future development may result in damaging stages in Alcyon Lake during storms, and that, for best results, stormwater management should consider planning a watershed basin.

Nonpoint source pollution from developments already has had undesirable effects locally (as well as contributing to pollution of the Delaware Estuary). The water quality of the tributary streams is mostly good to fair; but the depressed condition of macroinvertebrates already mentioned, indicated long standing degradation. The lake itself is impacted and eutrophic. Modeling indicated that under anticipated future growth conditions, key pollutants will increase from 22% to 52%. Since the present situation is already unsatisfactory, it is apparent that measures should be taken to control NPS impacts from future development, and also to reduce NPS pollution from present development as far as practicable.

3.0 CLEAN WATER WORKS WATERSHED MANAGEMENT PLAN

GENERAL

Gloucester County is mainly concerned with protection of Alcyon Lake and nearby sensitive areas; but the plan will also fulfill the needs of the Delaware Estuary program. The plan consists of initial controls related to buffer strips and water quality controls of runoff for new development. These programs are specifically outlined and recommended. In addition a desirable future control of runoff pollution from initial development is considered desirable, but not specifically outlined, and the planning of flood control improvements is suggested for future consideration.

Almost without exception, changing an open or agricultural land use to an urban land use will affect water quality. The actual concentration of pollutants may increase, and the total loading of pollutants can increase even more. This is because the volume of runoff must be considered in addition to the concentration of pollutants.

Prior to development, planners can incorporate features that minimize nonpoint source pollution by reducing the volume of runoff and increasing the chance that pollutants will be intercepted before they reach a water resource. These considerations generally fall in three categories: zoning, site planning and best management practices, with provisions for water quality.

Zoning may include buffer strips and other provisions for controlling the location of development which might affect water quality. Site planning refers to the detailed layout of individual sites. The best management practices include measures to reduce runoff pollution by site controls or by stormwater management. BMPs are necessary for all new development, but it is also desirable to reduce NPS pollution from existing development, to the extent practicable.

WATERSHED MANAGEMENT PLAN

The Watershed Management Plan (Figure 2) illustrates the Alcyon Lake Watershed based upon the adopted municipal land use element of the master plan and adopted zoning ordinance. The watershed design indicating potential site development has been predicated upon three land planning parameters: the existing tax map boundary for each parcel; the percentage of maximum allowable impervious surface set forth in a

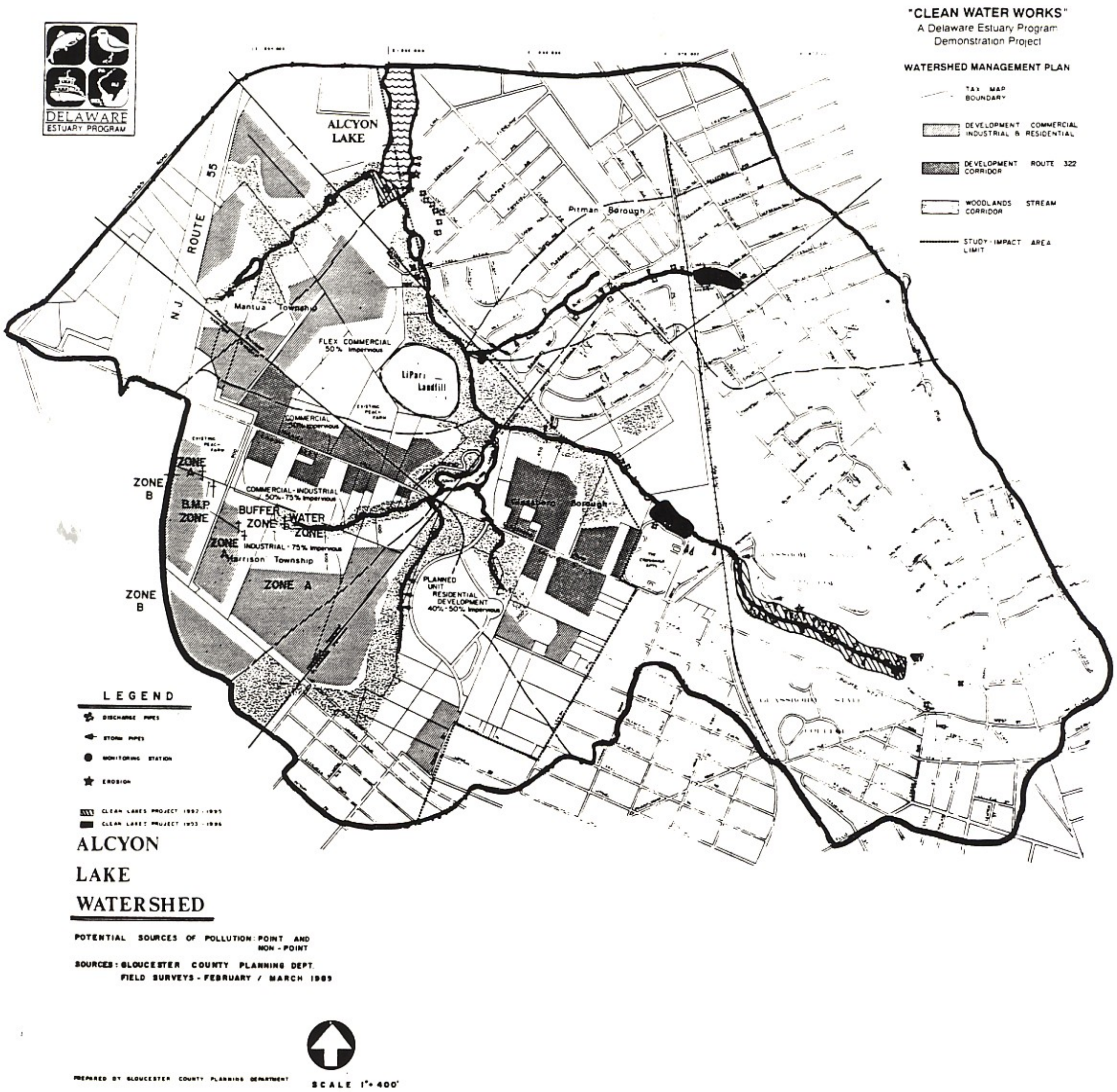


Figure 2
Watershed Management Plan

municipality's land development ordinance; and a buffer strip model based upon the function of ground slope and buffer width. These parameters determine the footprints of potential commercial, residential or industrial location within the undeveloped areas of the Alcyon Lake Watershed. This plan shows a high proportion of development adjacent to the waterways; but considerable open space that might also be developed. The "Clean Water Works" program must deal with large areas of contiguous impervious surface. Here, surface runoff picks-up all pollutant particulates from sheet flow and conveys the water into the principal waterways.

The plan will improve water quality by steering development away from tributaries. This will increase the removal of sediments and dissolved pollutants reaching the stream, reduce overland flow velocities which will abate streambank erosion and displace from the water's edge activities which generate nonpoint source pollution. The watershed design model permits surface water runoff to be cleansed by the filtering capability of natural vegetation. This natural action of physical and chemical breakdown in pollutant particulates permits surface water of a higher quality to enter stream tributaries. This method of land development may be achieved through proper environmental planning with increased quality of our water resources.

The planimetric delineations in Figure 2 were projected from two features: the proposed development site outline and the existing topographic relief from the U.S.G.S. Quad Maps. These two delineations were superimposed upon a base map. This working base provides both horizontal and vertical control for a preliminary sketch plan. The foundation for this plan centers upon on-site impervious slope percentages and Best Management Practices (BMPs). The staging of runoff control from development is: limit on impervious surface (site); stormwater management practices (BMPs); natural vegetated buffer (overland flow); and flowing waters (tributaries). This stage of approach gives the benefit of time to improved water quality by natural and controlled action. By this, it allows for both the settling of pollutant particulates by way of proper BMPs and pollutant removal through overland flow by physical, chemical and biological processes. Depending on site specific conditions, this can be a very effective way of eliminating both nitrogen and trace metals.

This manner of development is also cost effective. If located near the road systems, transport costs may be reduced; and off-site drainage is remote from streams because of location on high ground. The cost of pipes and inlets for stormwater collection is reduced, and grading on-site promotes balanced development.

This, accompanied with a very low- or no-maintenance buffer, creates a wildlife habitat that increases biological activity with little cost to the owner. It demonstrates that development can occur less expensively, while environmental quality is improved through effective measures.

In order for this plan to have its intended effect, basic limits and restrictions on development must be incorporated into zoning plans and ordinances.

SITE PLANNING

In new development, good site planning can do a great deal to limit increases in runoff and reduce the potential for erosion and sedimentation problems. A good starting point for site plans is to identify goals that would help direct the choice of practices and strategies toward those which would reduce the root causes of adverse impact on hydrology and water quality. The following goals provide such direction.

1. **Approximate the pre-development hydrologic conditions.** This is a goal that can only be addressed comprehensively at the level of site planning.

   The issues of runoff volume, infiltration recharge and water quality revolve around the amount of pavement allowed in development standards and its configuration in terms of its relationship to drainage paths and vegetative cover.

2. **Confine development and construction activities to the least sensitive areas.** The best way to limit the adverse impact of development on runoff and water quality is to develop comprehensive site plans that avoid creating construction activity in the most sensitive areas. Zoning is required to accomplish this. Following are means of protecting sensitive areas.

* **Natural drainageways** - Construction in natural drainageways destroys the natural vegetation protecting the soil from erosion (and with it the filtering capacity of the vegetation). This type of vegetation is among the most difficult to reestablish.

* **Steep slopes** - For given types of soil, the steeper the slope, the greater the erosion hazard. This is because the effects of gravity and reduced friction between soil particles on steep slopes means it takes less energy for the water to dislodge and transport soil particles.

* **Dense vegetation** - After slopes, good vegetative cover is the most important factor in preventing erosion. Disturbance of areas with a well established dense vegetative cover will yield the greatest change or impact in terms of erosion risk. Wooded areas with understory cover are the most runoff-absorbent types of cover in the landscape. Destruction of such vegetation adds significant expense to the construction budget for clearing and destroys an inherently valuable attribute of the site.

* **Porous soils** - Infiltration into the soil provides the most effective type of storm water storage volume available on a site. Infiltration reduces both the volume of

runoff and the peak discharge for a given rainfall event, as well as providing treatment of water by filtration through the soil strata and recharge of ground water resources. However, precautions must be taken not to degrade ground water quality.

* **Erodible soils** - When denuded of vegetation during construction, areas with easily eroded soils yield greater volumes of transported soil than those with erosion-resistant soils. To the extent that site planning can avoid disturbing erodible soils in the land development process, large erosion and sedimentation problems will also be avoided.

3. **Fit development to the terrain.** Choose road patterns to provide access schemes which match landforms.

4. **Preserve and utilize the natural drainage system.** Keep pavement and other impervious surfaces out of low areas, swales and valleys. This means working for site plans that keep the roads and parking areas high in the landscape and along ridges wherever possible.

   If natural vegetated drainageways are preserved in the site planning process, flood volumes, peak discharges, and base flows will be held closer to their pre-development levels. Trace metals, hydrocarbons and other pollutants will have a much greater opportunity to become bound to the underlying soil. The infiltration, which would occur along the entire drainageway, would not only contribute to the reduction of runoff volumes, but would also allow nutrients to be taken up by the vegetation lining the drainageway.

BEST MANAGEMENT PRACTICES FOR STORMWATER RUNOFF

General

Stormwater runoff is the surface and ground water that results from precipitation. In developed areas, urban stormwater is the major component of sewer and stream flows. As an area becomes more developed, the maximum rate and volume of runoff rise; and the amounts of pollutants carried in the water increase to a greater extent. This is caused in part by changes to surface drainage patterns, growing numbers of impervious areas (e.g., streets, roof, parking lots), and more human and vehicle traffic. Human activities add pesticides, fertilizers, animal waste, oil, grease, heavy metals and other potential pollutants to stormwaters. The end results may be flooding, erosion, and water quality deterioration.

Stormwater management refers to the development of effective programs and practices designed to:

* reduce the potential of erosion and flooding; and
* preserve the quality of stormwater runoff; and
* increase water availability.

The major focus of this section is to provide information on Best Management Practices (BMPs) that can be utilized by design engineers and municipal officials to control stormwater runoff and improve water quality. When standards of BMPs are specified, this does not necessarily require that the specific BMPs mentioned are required, but rather any combination of BMPs which will have the same degree of effectiveness. (The selection of BMPs is covered in more detail in Chapter 4: Implementation.)

For most BMPs which are really good housekeeping techniques, large appropriations of funds may not be required. However, as with most good housekeeping practices, significant amounts of manpower and time will need to be allocated for BMPs success.

BMPs have been divided into three categories; existing developments (residential and commercial), proposed developments (residential and commercial) and agriculture.

Existing Developments:

1. Septic tank maintenance.
2. Lawn and garden Integrated Pest Management.
3. Home composting of all organic wastes.
4. Label all storm sewers: i.e., "This inlet flows to Alcyon Lake".
5. Retrofit risers on stormwater basins with floatable skimmers to prevent oil and debris from leaving basin.
6. Retrofit existing stormwater basins for extended detention or the addition of a wetland/biological treatment component.
7. Street and parking lot cleaning (litter control).
8. Municipal leaf/grass clipping composting site.

Proposed Developments:

1. Reduce impervious areas - porous pavement, grid or modular pavements, shorter driveways, sidewalks on one side of the street, narrower streets, gravel driveways.
2. No curbs, and limited storm sewers if feasible - use grass waterways wherever possible.
3. Storm sewers with settling/clean-out chambers for sediment.
4. Streamside buffer strips.
5. Vegetative buffer strips.

6. Extended detention basins or wet basins.

7. Less lawn - use natural vegetation and wildflowers in common areas.

Agricultural:

1. Maintenance or establishment of grass-legume cover in orchard areas.
2. Conservation tillage.
3. Integrated Pest Management.
4. Crop rotation.
5. Terraces.
6. Contour farming.
7. Contour stripcropping.
8. Streamside buffer strips.
9. Grass waterways.

Existing Developments

Septic Tank Maintenance - Failure to properly maintain a septic tank can result in serious ground and surface water contamination. Septic tank cleaning depends on the size of the tank and the number of people it services. As a general rule, septic tanks should be inspected at intervals of no more than every two years to determine the rate of scum and sludge accumulation.

Lawn and Garden Integrated Pest Management - In an urban setting, pesticides and fertilizers are in use on almost every street. Unfortunately many homeowners are using more pesticides and fertilizers on their lawns and gardens than required. The over application of pesticides and fertilizers combined with stormwater runoff can cause severe nutrient loading and pollution in our local streams, ponds and lakes. Integrated Pest Management can control pests, reduce the use of pesticides and save time and money for the homeowner.

Home Composting of Organic Yard Waste - Leaves, grass clippings, and twigs are excellent materials to use for composting. Compost prevents moisture loss from soil, provides a good fertilizer and soil conditioner, controls weed growth, reduces erosion and soil compaction, and keeps soil cool under intense sunlight.

Label Catch Basins - This technique involves stenciling catch basins to let people know where inlets drain. This could be as simple as stenciling "This inlet drains to Alcyon Lake". This is an excellent tool to educate the public about stormwater runoff and its discharge points. Many people are under the impression that inlets are tied directly to municipal sewer systems. If people are aware of the discharge points of inlets, then they would be less likely to pour oil, grease, antifreeze or organic waste into catch basins.

Extended Detention Basins - Detention basins are impoundments that collect stormwater runoff. The objective of the basins is to detain the release of stormwater so that it is released at a slower rate than the incoming flows. When the detention time of the runoff is extended in the basin, sediment, pollutants and suspended particles are allowed to settle to the basin bottom. However, detention basins cannot usually be added to existing developments.

Street and Parking Lot Cleaning - This involves sweeping, vacuuming, flushing or otherwise cleaning access roads, rail lines, parking lots and other paved vehicular traffic areas. The objective is to remove dry weather accumulations of pollutants, especially fine particulate matter and fallen leaves, before washoff can occur.

Municipal Leaf/Grass Clipping Compost Site - Municipalities should be encouraged to establish composting sites for leaves, grass clippings and other organic yard wastes with access for local residents. Residents can drop off their organic yard wastes for composting and in turn pick up compost mulch for use in home gardens and flower beds.

Special landscaping may reduce runoff pollution. A special type of "drought resistant garden" has been developed in Washington Township, see Appendix A. The conservation of water is a necessary objective of this area because of the precarious long-term situation of the groundwater supplies. These supplies are jeopardized by danger of saline intrusion of deep-lying salt water, caused by overuse of groundwater throughout what has been designated by the State of New Jersey as "Water Supply Critical Area No. 2".

The drought resistant garden technique would reduce the demand for water in areas where it was applied. More directly relevant to Nonpoint Source Pollution is Xeriscape land use [also known as minimum disturbance-minimum maintenance], which is very effective in preventing the washing of nutrients into vulnerable waters.

Proposed Developments

Wet detention ponds are impoundments that have a permanent pool of water and also have the capacity to temporarily store stormwater runoff until it is released from the structure. This capability to hold runoff and release it at lower rates than incoming flows has made the detention pond a popular practice for flood control and stormwater management. Although detention ponds were originally required for flood peak restoration, they can also be effective in reducing particulate pollution, with suitable design provisions.

Wet detention ponds are one of the most effective BMPs available for treatment of urban runoff. During a storm, polluted runoff enters the detention pond basin and displaces "clean" water until polluted runoff reaches the outlet of the structure. When the polluted runoff does reach the outlet, it will have been diluted by the water previously held in the basin. This reduces the pollutant concentration of the outflow.

After the storm, fine suspended solids in the wet pond will have a relatively long period of time to settle out until the next storm occurs. In addition to efficient settling, this long detention time also allows some removal of dissolved nutrients through biological uptake. These nutrients are mainly removed by algae and aquatic plants. After the algae die, the nutrients can settle to the bottom of the pond and become part of the sediments. "Dry" detention ponds not including design provisions for extended storage remove relatively little of the particulates.

Extended detention basins are storm water detention basins that are designed to temporarily hold stormwater for an extended period of time, usually 18-36 hours. Extended detention ponds rely upon this detention time to allow physical settling of pollutants, in the interest of water quality. They are different than traditional type detention ponds because of the removal of particulate pollutants. Extended detention basins can be normally dry, have a shallow marsh, or have a permanent pool. In many instances, dry ponds designed as flood control structures can be modified to meet the criteria of an extended detention pond for a relatively low cost.

Extended detention basins can be fairly effective for removing particulate pollutants from urban runoff. The efficiency of an extended detention basin depends largely upon the detention time that runoff is held in the basin. Lab studies have shown that the majority of urban sediments settle out within the first six hours while the remaining fine sediments may take several days to settle. This study was based upon a settling depth of four feet. Longer detention times are desirable, because ideal settling conditions for the finer pollutants usually do not develop in the basin for several hours.

Wetland treatment involves passing runoff through a natural wetland or a constructed wetland to remove or treat pollutants. Wetlands provide favorable conditions for removal of pollutants from urban runoff through sedimentation and also provide a pool of biological activity to use nutrients during the growing season. They also favor groundwater recharge and help to minimize flood flows. Although wetlands are effective for removing pollutants, certain drawbacks limit their use as a BMP. The major problems with wetland treatment are the environmental damage that may be done to natural wetlands, and the large land area required for constructed wetlands.

The effectiveness of wetland treatment systems for the removal of urban pollutants will depend upon the physical characteristics of the system, such as wetland size to watershed size ratio, runoff residence time in the wetland, and water budget. In general, as the wetland to watershed ratio increases, and the effectiveness of the wetlands for pollutant removal also increases. A wetland in Wayzata, Minnesota, with a drainage area of 72 acres and wetlands of 7.5 acres, retained 78 percent of all phosphorus and 94 percent of all suspended solids entering it during the evaluation period. The effectiveness of wetlands for removing nutrients depends heavily upon the season. During the summer, when biological activity is maximized, nutrient uptake will be the greatest.

Floatable skimmers on outlet risers are devices used to retain floating debris and oil in detention basins. The floating debris and oil eventually sinks to the bottom of the detention area and becomes part of the sediments or is removed from the surface through regular maintenance.

The effect of floatable skimmers on water quality will depend upon the amount and type of floating material transported by runoff. Typically, a well-designed floatable skimmer can trap virtually all floating debris that reaches it. In an area with large loading of floating trash, this can provide significant water quality benefit. However, in most urban storm sewers (except in the event of spills), the hydrocarbons adhere to fine particles, which are not removed by skimmers.

Vegetated waterways are broad shallow channels with a dense stand of vegetation established in them that are designed to control erosion from concentrated water flows, promote infiltration and trap pollutants. The combination of low velocities and vegetative cover provides an opportunity for pollutants to settle out or be treated by infiltration.

Several studies have been conducted to determine the effectiveness of vegetated waterways for improving water quality. One study concluded that they are somewhat effective for removing certain pollutants form stormwater runoff. Trace metals were the pollutants with the highest rates of removal by the waterway. The rates ranged from 42 percent removal for dissolved cadmium to 65 percent removal for total lead. Other removal rates were 25 percent for COD, 33 percent for total residue, 51 percent for ammonia, and 32 percent for nitrate-nitrite nitrogen. Decreases in BOD, turbidity, organic nitrogen, and total phosphorus were not significant. Bacteria levels in the waterway actually increased, but were attributed to biologic activity in the waterway.

Low gradient grass waterways are best suited to providing water quality benefits.

Reduction of impervious areas are areas that have an impervious cover (streets, roads, parking lots, roofs, etc.) prevent percolation of stormwater runoff into the soil. If the soil is unable to soak up the runoff, the stormwater runoff volume increases significantly. To reduce the amount of impervious cover, the use of porous pavement, grid or modular pavement, shorter driveways, gravel driveways, and sidewalks on only one side of the street should be seriously investigated.

Storm sewers with clean-out chambers are designed to capture the contaminants that accumulate on impervious surfaces between storm events. Thus, these structures provide stormwater treatment by controlling the stormwater runoff, which allows the contaminants to settle before the stormwater is released to receiving streams. They are usually most effective in controlling the coarser sediments.

Streamside buffer strips and vegetated filter strips located adjacent to water bodies and around the perimeter of construction sites function to preserve water quality. In addition to preserving wildlife habitat, buffer and vegetated filter strips allow stormwater runoff to flow through the vegetated strips prior to leaving the area. The vegetation in the buffer strips reduces the velocity of the runoff, filters out sediments, pollutants and other forms of contaminants, and enhances groundwater recharge.

The effectiveness of filter strips for pollutant removal is a function of the length and slope of the filter strip, soil permeability, the size of the drainage area, and the type and density of vegetative cover. Also critical to the performance of filter strips is the distribution of water flowing over them. If water is allowed to concentrate because of poor grading or uneven runoff distribution, the filter will be short-circuited and have only minimal benefit. When properly designed and operated, filter strips can trap 30 to 50 percent of sediment.

More native vegetation in common areas can be useful. Traditionally, common areas are seeded with a typical grass mixture which requires the use of pesticides, fertilizers, and irrigation. By using a seed mixture of native wildflowers, you can maintain these common areas with less pesticides, fertilizers and water. In addition, using native wildflowers brings a unique natural beauty to an area.

Agriculture

Listed below are conservation practices that are recommended on agricultural lands. These are time honored practices that are voluntarily being used by farmers on a daily basis. If additional information is required concerning the practices listed below, the USDA, Soil Conservation Service, District Conservationist should be contacted.

Maintenance of establishment of grass cover in orchard areas reduces the velocity of the runoff, filters out sediments, pesticides, fertilizers and other pollutants. In addition, this practice reduces the potential for erosion and enhances groundwater recharge.

Conservation tillage and no till practices leave crop residue on the surface of the land to reduce erosion, increase infiltration, reduce evaporation, and reduce the amount of sediment reaching surface water.

Integrated pest management utilizes cultural, biological, chemical, and combinations of the above to control pest infestations. Integrated pest management can control pests, reduce the amounts of pesticides used and save both time and money for the farmer.

Crop rotation helps to maintain or improve the physical condition of the soil and to control weeds, insects, and disease. This practice reduces the amount of insecticides, pesticides, fertilizers and herbicides that would normally be applied to a field.

Terraces are low earth embankments constructed across a slope. Terraces are used to control erosion, conserve water, and improve water quality by filtering out pollutants from stormwater runoff.

Contour farming is where water is channeled across a slope instead of down the slope. In addition, the soil is able to absorb more water. The practice of farming the contour of the land is very effective in reducing erosion.

In contour stripcropping contoured strips of close grown crops are alternated with strips of row crops. This practice also reduces the potential for erosion.

Streamside buffer strips are located adjacent to streams, ponds and lakes can significantly improve or maintain water quality. Buffer strips help to reduce the levels of sediment, crop nutrients, pesticides and other chemicals introduced into surface water. In addition, buffer strips are excellent sources for wildlife cover and habitat. They are discussed in the following section.

Grass waterways were previously discussed above.

EXISTING STORMWATER MANAGEMENT PRACTICES

The stormwater management practices that have been utilized in the Alcyon Lake Watershed reflect those practices which were acceptable fifteen or twenty years ago. It was during this time that the watershed experienced heavy development and urbanization pressure. The stormwater management practices that were encouraged during that time entailed piping the stormwater runoff directly off site to the nearest stream as quickly as possible. This common approach of the past has adversely affected the watershed of the present.

An inventory conducted to locate existing stormwater management practices in the watershed resulted in the following findings. Numerous outfall structures are outletting directly into various stream, ponds and lakes. These practices were found almost exclusively in well established areas. The newer developed areas have utilized practices which include a detention/infiltration basin at the Peach Tree Ford and Tractor dealership and grass waterways and riprap conduit outlet protection (stone placed at the outlet to prevent erosion) at the Hidden Creek development. Both projects are located on Route 322 in Glassboro.

In addition, the Alcyon Lake Watershed also includes small irrigation ponds or small lakes which act as natural detention/water quality basins within the subwatersheds of Alcyon Lake.

Glen Lake which is located in the Borough of Pitman and is situated on Long Run (a major tributary of Alcyon Lake) is one of these small lakes. Glen Lake receives direct urban runoff from both the Boroughs of Pitman and Glassboro. Since Glen Lake is an impoundment, it has functioned in the past as a water quality basin and sediment basin. Glen Lake, however is in a severe state of eutrophication. A visual inspection of the lake in July 1991 denoted large quantities of aquatic vegetation, and bar formations, shallow depth, and a strong odor emitting from the lake. Due to the severe eutrophication of Glen Lake, its ability to continue to act as a water quality/sediment basin has been greatly reduced. Since Glen Lake received direct urban runoff and is situated on a major tributary of Alcyon Lake, every means should be pursued to restore Glen Lake to its original design depth. This will allow Glen Lake to properly function as a water quality/sediment basin.

BUFFER STRIPS

Strategies to lessen nonpoint source pollution by buffer strips can be illustrated by way of a watershed management concept. This concept depicts zones of land use areas which promote active and non-active practices: the Water Zone, the Nondevelopment Buffer Zone; the Special Restrictions Zone; and the State Standard Zone B.

The Water Zone is defined as the tributary or feeder stream into Alcyon Lake. Here, activity should be only passive recreation with no direct contribution to the pollution load.

The Nondevelopment Buffer Zone (buffer strip) is a naturally vegetated area lying between the water's edge and areas of more intensive land use. The buffer should comply with minimum land disturbance restraints of wooded, non-wooded and mixed use. A basic width of 150' is recommended. The extent of the buffers will be as shown in map Figure 2.

The Special Restriction Zone is an area upslope of the buffer zone which addresses stormwater runoff from development. The "best-management practice" for permitted land use should be required within this zone. Since Alcyon Lake watershed is relatively small, the entire watershed upstream of the buffers should be so regulated.

The State Standard Zone B consists of land areas lying outside of the watershed, but within the areas of atmospheric draft impact. This recognizes the potential for atmospheric deposition of pollutants.

The provision of buffer strips to protect reservoirs has been covered by research at Rutgers University. (Nieswand G.H., et al, Buffer Strips to Protect Water Supply Reservoirs: A Model and Recommendations", Water Resource Bulletin, 26, 6, 959, December 1990.) In accordance with reference cited, greater widths may be appropriate for greater slope, or different conditions of cover. The questions how far up the tributaries such buffers should be extended is further discussed in Chapter 4: Implementation. In the chapter is also discussed the relationships between buffer strips desirable to protect the Alcyon Lake watershed, and the minimum requirements for buffers recommended in the Delaware Estuary plan.

SUMMARY OF CLEAN WATER WORKS MANAGEMENT PLAN

The plan outlines various consideration which should govern land use management of Alcyon Lake Watershed, including a designation of areas on a base map to be reserved in open space or scheduled for specific land use. It includes a buffer zone concept, based upon buffers of base width 150', with greater width where there are steep slopes or impervious cover. The recommended types of land use, in order to be effective, should be included in county plans and municipal zoning ordinances, since voluntary compliance with such restrictions is unlikely to be sufficient.

Best Management Practices for new development are described which would be sufficient to make a major reduction in runoff pollution for future development. However, it is necessary to make a decision in the case of each development as to the type and degree of control which is to be required.

The BMPs suggested for existing facilities, especially phosphorous control and agricultural runoff controls will require techniques of public education and participation and the attention of Conservation Districts.

How to merge these desirable practices into an implementable plan within the context of the Delaware Estuary Program is covered in Chapter 4: Implementation.

4.0 IMPLEMENTATION

GENERAL

The implementation of the Clean Water Works Watershed Management Plan will require land use planning, to be implemented by buffer strips, zoning and site plan review, and BMPs for new development, and later there will be consideration of adding control for existing development, and flood control. The plan will include provisions established through the Delaware Estuary Program's management plan, and approved by the states of Delaware, Pennsylvania and New Jersey. Regulations requiring water quality in stormwater management planning for new development must be adopted by the states. These water quality controls will be reflected in land use planning and management, which must conform to the requirements of the Delaware Estuary Program, when established by regulations of the State of New Jersey.

BUFFER STRIPS

The intent and purpose of the required natural buffers shall be to:

1. Enhance the quality of water entering surface water tributaries in the Alcyon Lake Watershed;
2. Prevent the degradation of property by enhancing the environmental character and water quality of streams within the Alcyon Lake Watershed;
3. Reduce pollutant loading to Alcyon Lake from point and nonpoint sources of pollution;
4. Prevent degradation of stream quality due to impairment of streams' biological system within the Alcyon Lake Watershed;
5. Preserve and maintain naturally wooded stream corridors; and
6. Keep the water cool in the lake and its tributaries

A buffer strip is a site plan set-back within which development which might cause pollution is generally precluded, and natural forest growth is encouraged. For any development which is allowed in buffer strips, there is usually a requirement for an unfertilized vegetative filter strip, but this requirement may be fulfilled in this case by the requirements for natural vegetation. The buffers described in this ordinance exceed the minimum requirements expected to be established for the Delaware Estuary. These requirements of buffers are 50 foot width for minor tributaries and for freshwater wetlands, within the zone of influence. In view of the sensitive nature of the Alcyon Lake Watershed, buffers recommended are 150 foot width, plus an extra allowance for very steep slopes. A proposed buffer strip ordinance is given as Appendix B. The buffer strips are intended to be established around Alcyon Lake and other lesser lakes, and throughout the length of tributaries to the lake as shown on map Figure 1, but not on other minor tributaries and channels.

It is desirable to allow some relaxation of buffer restrictions where small lots are involved. For waterfront lots, formally established prior to 1 July 1992, with a depth of less than 150 feet, the buffer restrictions would apply only to the 40% of the lot, nearest the water, leaving 60% upon which improvements could be placed.

SITE PLANNING AND ZONING

The objectives of land use planning in this area are described in Chapter 2. A delineation of probable future development is shown in Figure 2, on the basis of which projections of land use and of future runoff pollution have been made. In order to be effective, the Clean Water Works plan must be adopted formally and incorporated in zoning ordinances. Also the system of buffer strips must be formally adopted as a limitation on site planning. The other planning considerations are dependent upon continuing attention by county and municipal planning boards, and public education.

BMPs ON NEW DEVELOPMENT

The runoff water quality controls for new development are BMPs imposed by municipal ordinance, in accordance with state law and regulations. The object is removal of particulate pollutants. Although maintenance of water quality is the objective, the controls themselves are technology-based. That is, the desired goal is defined based upon specific BMPs.

Either these specific BMPs or other BMP alternatives determined to have equivalent effect may be used. Two levels of BMPs are established: standard BMPs, which are for general use, and special BMPs, which are used when a greater degree of control is required.

The final definition of BMPs will be by the state, after formal recommendation by the Delaware Estuary Program. However, after extensive work and consultation with all concerned, the following tentative

Delaware Estuary BMPs have been developed for control of particulate pollution from any new development which will result in creation of over half an acre of additional impervious surface.

The standard BMP is defined by the extended detention of the runoff either from 1-1/4 inches of rainfall occurring in two hours, or of a one year frequency 24-hour rainfall. The water is to be released by fixed outlets over 18 hours, if in a residential neighborhood, or 36-hours otherwise. The minimum site outlet is two inches. Various other BMPs or combinations of BMPs are accepted as standard if determined to be equally effective, including provisions at site.

The special BMP is defined by any one of three alternatives. The first is extended detention of the one year frequency 24-hour rainfall, with release over a 48-hour period. The second is extended detention of the one year 24-hour rainfall in a wet basin of adequate capability. The third is retention of the one year 24-hour rainfall in an infiltration basin, with pre-settlement of sediment. (The third alternative is only acceptable where groundwater quality is not at risk.)

It is clear that BMPs for runoff control should not be applied across-the-board, but that the degree of control required depends on both the inherent harmfulness of the facility in question, and any special sensitivity of the area affected by the runoff. A harmfulness index of stormwater runoff, classified by origin, may be summarized as follows.

CLASS OF HARMFULNESS	
1	From industrial and waste management sources, multiple-family housing, commercial facilities such as gas stations, and shopping centers, highways, urban areas, and single-family housing with lot sizes smaller than one-third acre per housing unit.
2	From single-family housing developments, with lot size one-third acre or larger per housing unit, and runoff from lesser roads.
3	Undeveloped land or unfertilized vegetation.

Unless demonstrated to be otherwise in specific situations, classifications 1-3 are in descending order of pollutant loading, the most intense being first. Of course, in cluster housing, the pollutant loading per acre for dense development may be compensated for by reduced acreage developed.

In addition, there are other categories of NPS pollution which are highly variable in their pollutant loading, including agriculture and road salts. Within the category of agricultural use, certain land uses such as fertilizer storage and cattle feed lots probably deserve to be treated as Class 1, whereas normal pasture or wood lots are probably Class 3. These classes of harmfulness provide a basis for utilizing proposed standard and special BMPs in a cost-effective manner.

The classification of industries and waste management sources depends upon the circumstances. Some sources have such polluted runoff that even a classification of "1" is not adequate. In such cases, standard or even special BMPs for urban runoff will be insufficient. Source controls and/or treatment may also be required, under provisions of other programs.

For general classification purposes, the harmfulness index provides a useful guide to the environmental effects of any proposed land use, when considered with respect to environmental sensitivity of the area affected downstream. Most sensitive areas, such as wetlands and wildlife refuges, have building restrictions imposed by law. When exceptions may be allowed, special BMPs would be required (for example, if facilities are allowed to be built along the shores of the lake or within a buffer strip. All new facilities of Class 1 harmfulness throughout the Lake Alcyon Watershed, would be required to have Special BMPs.

PUBLIC EDUCATION

It is essential for the success of this project that there be public understanding and public support within the municipalities concerned, as well as by county and state agencies. For this reason programs of public education and public participation are necessary.

The public education program was developed by the Gloucester County College, in cooperation with the County Planning Department and the County Soil Conservation District. As a preliminary, three environmental awareness workshops were held in the fall of 1991 and again in spring 1992.

The overall plan is to make available water-related activities to teachers in grades K-12 so that they may be used to supplement an existing curriculum. In curricula that are already squeezed into a year of school, the teachers felt that to take a series of days or weeks to use the activities would not enhance its usage in schools. Thus the preference of the teachers was to use the activities as supplemental activities.

The Clean Water Works curriculum is divided into a series of relevant questions which relate to the water environment. These questions are termed Interest Inquiries. They are defined as questions posed to the class to help initiate thinking and verbal responses and later to be followed by an activity. The questions serve in place of stated concepts that are often seen in activity workbooks. Further, each activity is referred to as a Learning Module which consists of a number of standard subsections--to be discussed later.

The Interest Inquiries of the curriculum are then subdivided into Primary Interest Inquiries (questions that are broad in scope and yet conform to the aims of the original proposal developed by the Gloucester County Planning Department) and Subsequent Inquiries which are more specific questions that require an answer and eventually lead to one of the water-related activities. Each Subsequent Inquiry is subdivided into four classes of module Primary, Elementary, Junior High-Middle School and High School-level activities.

The Learning Modules are the water-related activities which require students to become active participants in the learning process. An attempt was made by the author to use materials in the activities that were readily accessible and generally inexpensive, thus making the activities more teacher-friendly and non-threatening. Each Learning Module contains a list of objectives, a section called background information, materials, a procedure, supplemental activities, references and a list of audio-visual aids.

The background information includes the relatedness of the activity to the Subsequent Inquiry, a short summary of the activity, and hints and precautions for the teacher using the activity.

A videotape presentation has been designed to run thirty minutes or less, with vocabulary and presentation style geared to attract the younger high school student level. The presentation covers three main areas. First, description and information about the implementation of the Alcyon Lake Cleanup project which has been funded through superfund monies. (How this came about and why it was deemed necessary as a showcase project for the EPA, etc.). Secondly, information about eutrophication of lakes and the relationship between aquatic environment ecology, nonpoint source pollution and Gloucester County's present water conservation status. Future community needs are explored and repeated once before and once after the information segments. Lastly, the presentation offers the viewers several ways in which they may change their own habits to accommodate more community needs with regard to water conservation and the understanding of water resources limitations imposed by local and Federal regulatory agencies.

The purpose of the presentation is mainly to inform and alert both students and community members to alternatives for personal water use within conservation guidelines. Information regarding current water resource limitations at state and local levels is stressed as well as ecological concerns about long term effects of nonpoint source pollution.

The main object of the public education program will be two-fold: (a) to increase public acceptance of the necessity of mandatory BMPs and site planning restrictions, and (b) to provide public support of activities which are of a non-regulatory nature, particularly source control of pollutants from existing developments, whether private, commercial or agricultural.

PUBLIC PARTICIPATION

An effective public participation program will inform citizens about water quality and its impact upon the environment. This public participation program seeks to increase public awareness of potential problems and possible solutions. Involvement is the key, with participation being the motivation resolution. Through a volunteer program of participants, interest will be created in not only the residents but also in local businesses and public officials throughout the county. The program recommended herein was developed by Glassboro State College.

Formation of a watershed association, will help to keep water quality issues in focus; and will improve environmental understanding. The principal approach is to recruit members by way of existing environmental organizations. After an initial membership list is formed, participation by the general public will be sought. Once the watershed association begins to function, members will take an active role in monitoring water quality, educating children about water pollution and keeping in line with current environmental concerns.

Interest will be heightened by way of the Delaware Estuary Program through the public outreach activities. This is an outreach program geared to advertise and promote the Delaware Estuary Programs goals and objectives. Individual members of the watershed association would subscribe to the "Estuary News" Newsletter and the "Rising Tide" Newsletter. This would act as a communique between the Delaware Estuary

Program and the watershed association keeping members abreast of ongoing estuary strategies. Representatives of the watershed association could voice their interest by attending meetings with the Citizens Advisory Committee, the Local Government Committee or the Scientific and Technical Advisory Committee. These resources could act as an avenue to association activity. These committees, along with the Policy and Management Committee, will offer a forum for public comment and the opportunity for input toward beneficial action in preserving our water resources.

The public participation will serve to publicly air any problems related to specific interests, particularly business interests, which may be impacted by measures designed to improve water quality and the environment. Adjustments and refinements may be made, which will facilitate acceptance and implementation of the final plan.

WATERSHED MONITORING

The Gloucester County Planning Department has been awarded an USEPA/NJDEPE Clean Lakes Grant to implement a Phase II project within the Alcyon Lake Watershed. This four year program is intended to control point and nonpoint sources of pollution from the Glassboro State College campus and from municipally owned properties in Pitman Boro.

As part of this Project, the Planning Department will implement a surface water monitoring program at five water quality stations located on principal tributaries within the watershed to evaluate the effectiveness of watershed management programs, and to determine nutrient and sediment loadings to Alcyon Lake. In cooperation with the Gloucester County Health Department, samples will be analyzed for nutrients, bacteria, pH, phosphorus and dissolved oxygen. On the Cabin Run tributary, a pesticide scan will also be performed. At a later stage in development of the project, there may also be requirements to monitor other pollutants related to water quality and NPS control. Information of this type will be available to the outreach group.

Included within the scope of services will be the development of an automated Geographic Information System (GIS) designed to store, manipulate and display special and descriptive land use data. The creation of a structured geographic database will provide the capability to depict areas of site specific land planning, perform and analyze current and projected land development scenarios, and determine "best" site design to achieve improved water quality. Empirical water quality data obtained from developed sites will provide the opportunity to assess environmental conditions with regard to water resources.

GEOGRAPHIC INFORMATION SYSTEM

Geographic Information System (GIS) technology is providing many opportunities to integrate and analyze different combinations of data which formerly were not practical. The ability to associate spatial data layers with tabular data bases ia an unique ability of the GIS. With this new ability more sophisticated models and results are possible.

Within the Alcyon Lake Watershed, GIS technology (GRASS) was incorporated. However it was not utilized to its potential because of technical difficulties associated in digitizing data and the need to complete the project on schedule. Therefore, for the most part, the model results were obtained by using GIS as an auxiliary tool instead of being the primary tool.

The intent was to develop several GIS layers of data including soils, existing land cover/land use, future land cover/land use and subwatersheds. In association with appropriate tabular data, runoff curve numbers could be generated for each subwatershed based upon each soil and land cover/land use combination. This information would then be input into the TR-20 hydrologic model. Various GIS outputs of spatial data would then be available.

5.0 CONCLUSIONS

Alcyon Lake in Gloucester County, New Jersey is damaged by pollution and is eutrophic. The deteriorated water quality conditions of the Lake and adjacent sensitive areas can be brought under control by "The Clean Water Works Management Plan", outlined in this report. Initially two programs, are specifically described and recommended for early action: (a) the preservation of forested buffer strips, and (b) the control of water quality of runoff from new developments. These programs will prevent a further deterioration in water quality due to new development. Three major discoveries were found based upon water quality and water quantity analyses. First, hydrologic modeling revealed that future development will require storm water management planning within the watershed basin for flood control. Second, water quality indicators show that the number and diversity of macroinvertebrates were depressed in the stream studies. And third, development from anticipated future growth will result in the increase of key pollutants by 22% to 52%. These results are indicative of the need for "Best Management Practices" in proper watershed planning.

The improvement in present standards of water quality for Alcyon Lake will require controls limiting polluted runoff from existing development. No complete program for this purpose has been outlined, although practices are identified which would contribute to this end.

The plan will include measures proposed through the Delaware Estuary Program's land use management strategies plan which must be adopted by local governments and approved by the States of Delaware, Pennsylvania and New Jersey. It will comply with provisions for water quality in stormwater management adopted by the State of New Jersey. Implementation will require local ordinances for buffers (as proposed in Appendix B), local ordinances for stormwater management (in accordance with provisions of Chapter 3) and appropriate revision of site planning procedures and criteria. Public education and public participation will help to gain public acceptance of the plan, as will the outreach activities for the Delaware Estuary Program. In addition to its relevance to the Delaware Estuary Program, this demonstration project will be of interest to the coastal nonpoint source control program, which requires states to develop programs to control significant sources of nonpoint source pollution for all coastal waters.

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APPENDIX A

DROUGHT RESISTANT LANDSCAPES

The "Clean Water Works" Drought Resistant Garden was a cooperative effort between the Delaware Estuary Program, Gloucester County, Washington Township, Rutgers University and various landscape nurseries and services. The Garden, located at Washington Lake Municipal Park in Washington Township, is within pristine cedar wetlands.

The project, initially begun by the Delaware Estuary Program Personnel and Rutgers Cooperative Extension, was offered as a vehicle to conserve water. With the purpose and intent of the project in place, the next objectives became finding a suitable display area and generating a preliminary site plan. Bill Coughlin of the Washington Township Environmental Commission secured the most suitable area for the garden. Alan Koch, landscape architect for Gloucester County Parks and Recreation Department, generated the site plan, contacted potential contributors for plant material donations and implemented the plan of action for completion.

Construction of the garden areas began once the plan was approved by Washington Township. The municipality's Public Works Department constructed a retaining wall for soil erosion control and aesthetic purposes. Upon completion, clean fill was brought onto the site, and final grading was performed by the Gloucester County Highway Department.

Upon the completion of site preparation tasks, the logistics of receiving and planting landscape material began to take shape. Roger's Nursery Service installed all plantings within individual garden plots. The project was completed for the adult workshop seminar on water conservation. Dr. Bruce Hamilton of the Department of Landscape Architecture at Rutger's University, demonstrated how and what plants would be most advantageous for water conservation and methods to landscape an individual private residential lot.

A somewhat different landscaping method, designated by the New Jersey Department of Environmental Protection and Energy as "minimum disturbance minimum maintenance", is designed to provide alternative landscaping without the necessity of using fertilizers. It is especially useful for lakes, such as Alcyon Lake, which suffer from eutrophication.

APPENDIX B

BUFFER STRIP MODEL ORDINANCE

100. Title.

This ordinance shall be known and may be cited as the "Alcyon Lake Watershed Buffer Strip Ordinance".

200. Intent and Purpose.

The intent and purpose of this ordinance to require natural buffer shall be to:

1. Enhance the quality of water entering surface water tributaries in the Alcyon Lake Watershed;

2. Prevent the degradation of property by enhancing the environmental character and water quality of streams within the Alcyon Lake Watershed;

3. Reduce pollutant loading to Alcyon Lake from point and nonpoint sources of pollution;

4. Prevent degradation of stream quality due to impairment of streams' biological system within the Alcyon Lake Watershed;

5. Preserve and maintain naturally wooded stream corridors.

For the purpose of this ordinance, unless the context clearly indicates a different meaning, the term "shall" indicate a mandatory requirement, and the term "may" indicates a permissive action.

300. Establishment of Buffer Strips

Buffer strips are hereby established along the shores of Alcyon Lake, and along its tributaries and along the shore of minor lakes as shown on map Figure 2. The minimum width of buffer strips shall be 150 feet from the waters edge, at low water, or 50 feet from the edge of any wetland, if greater. If, prior to 1 July 1992, building lots were approved which would be affected by such buffers, the buffers shall extend no more than 40% into such lots, leaving 60% in which building can take place. Buffer widths may be increased in the event of steep slopes, as indicated hereinafter.

The buffers shall be maintained in a fully wooded condition, in order to minimize runoff pollution, encourage wildlife and keep the waters cool.

400. General Standards.

In the preparation of a development application, the following standards shall be applied which restrict the use of three types of vegetative buffers:

1. Wooded area buffers:

   A. No disturbance is allowed with wooded areas of buffers which:

(i). Have had no harvest of wood products for at least ten (10) years;
(ii). Lie within 150' of a stream or tributary;
(iii). Exceed a slope of 20%;

B. All existing undergrowth, forest floor, duff layer and leaf litter must remain undisturbed and intact.

C. Limited disturbance within wooded buffers shall be restrained to areas where:

(i). There will be no cleared openings and an evenly distributed stand of trees;

(ii). Activity within the buffer shall be conducted so as to minimize disturbance of vegetation less than 4' in height;

(iii). Removal of vegetation less than 4' is limited to that necessary to create a winding footpath no wider than 3'; and

(iv). The pruning of live trees that do not exceed 12' in height above the ground is permitted, provided that at least the top two-thirds (2/3) of the tree canopy is maintained.

2. Non-wooded buffers shall be maintained to:

A. Be allowed to revert or be planted to forest;

B. Keep a dense, complete and vigorous cover of non-lawn vegetation which can be mowed no more than once a year; and

C. Minimal activity within the area so as to prevent damage to the vegetation and exposure of soil.

500. Design Standards.

The following buffer design standards have been established to enhance water quality with regard to surface water runoff.

1. Only buffer slopes less than 30% shall be included in the measurement of buffer width.

2. Areas with slopes greater than 30% are too steep to be effective as a treatment buffer, but should be left undisturbed.

3. Buffer effectiveness depends upon the width of 150' plus a percentage of slope indicated in 2 above.

600. Maintenance Agreement.

Buffer maintenance and use restrictions shall be based upon a "no disturbance" or "risk free" enforcement standard.

1. Yearly inspection of the buffer by the municipality will result in visual inventory of buffer area for soil erosion or storm damage vegetation.

2. All eroded areas must be seeded and mulched.

3. Buffers shall not be used for any motorized vehicles.

4. Burning of vegetation within the buffer shall be prohibited.

5. Activity within the buffer shall be conducted so as to prevent damage to vegetation and exposure of soil.

700. Applicability.

The provisions of this ordinance shall be applicable to residential development applications, non-residential development applications and road construction projects.

800. Variances.

Variances from the buffer strip requirements shall be allowed only after a determination by the Planning Board that the development proposed is required for necessary water related purposes or some other public purpose, and that the deviation from buffer strip requirements had been held to a minimum.

900. Severability of Provisions.

If the provisions of any section, subsection, paragraph, subdivision or clause of this ordinance shall be judged invalid by a court of competent jurisdiction, such order or judgement shall not affect or invalidate the remainder of any section, subsection, paragraph, subdivision or clause of this ordinance to be severable.

1000. Interpretation.

This ordinance being necessary to promote the general welfare and environmental quality shall be interpreted liberally to effect the purposes thereof.

1100. Effective Date.

This ordinance shall take effect immediately.