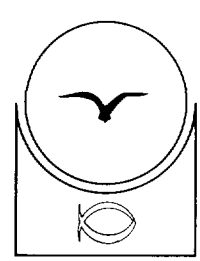
A Guide to

Protecting Coastal Waters Through Local Planning

Division of Coastal Management
North Carolina Department of Natural Resources and Community Development

A Guide to

Protecting Coastal Waters Through Local Planning



Division of Coastal Management
North Carolina Department of Natural Resources and Community Development

1986
Reprinted 1988

Contents

Introduction

The Importance of Protecting Coastal Water Quality 1

Chapter One

The History of Water Quality Protection 5

Chapter Two

The Basics of Water Quality 9

The Hydrologic Cycle 10
The River System 13
The Estuarine System 13
The Groundwater System 15
The Groundwater-Estuarine Connection 15
Coastal Water Pollutants 17
Nutrients 17
Fresh Water 17
Bacteria 17
Sediment 18
Saltwater Intrusion 18
Temperature 18
Toxic Substances 18
Water Purification 22
Soil 22
Wooded Uplands 23
Wooded Swamps 23
Tidal Wetlands 25

Chapter Three

Land Use Planning to Protect Coastal Water Quality 27

How Land Use Plans Work 29

Designing a Land Use Plan to Protect Water Quality 30

The Community's Reliance and Effects on Water Resources 30

The Water Resources 30

Water Quality Concerns Leading to the Development of Policies and Implementation Strategy 30

Government Coordination 31

Public Spending and Land Acquisition 31

Management of Development 31

Public Education 31

Implementing a Land Use Plan 33

Basic Regulations 33

Traditional Zoning 33

Subdivision Regulations 33

Regulations Related to Off-Site Facilities 34

Planned Unit Development and Cluster Zoning 34

Capital Improvement Budgets 34

Complex Regulations 34

Special or Conditional Use Permits 35

Performance Zoning 35

Local Environmental Impact Ordinances 35

For More Information 35

Appendix One

Sample Regulations 37

Appendix Two

State and Federal Laws to Protect Water Quality 49

Glossary

Coastal Water Quality and Ecology Terms 57

Bibliography

For Further Reading 61

Figures

Figure 1	The Hydrologic Cycle	11
Figure 2	Watershed System	12
Figure 3	The Food Web	14
Figure 4	Potential Groundwater Supply Problem Areas	16
Figure 5	The Groundwater-Estuarine Connection	19
Figure 6	Coastal Water Pollutants and Effects	21
Figure 7	Typical Changes in Runoff Flows Resulting from Paved Surfaces	24
Figure 8	Examples of Best Management Practices	32

Introduction

The Importance of Protecting Coastal Water Quality

A popular bumpersticker a few years ago read "No wetlands, no seafood." It could just as accurately have said, "No clean water, no seafood." Indeed, without unpolluted water, the coastal area would no longer provide the seafood, recreation activities, and lifestyles that people have increasingly come to enjoy.

Almost every aspect of life in the coastal area is related to water in some way. Fish and shellfish – the basis of much of the region's economy – are so easily affected by the water in which they live that pollution can contaminate or kill them. People depend on pure water for drinking, cooking, and cleaning, and often, their livelihoods as well. Less obvious but just as important are the ties people have to the water. In the coastal area, water is a personal point of reference, the foundation for a way of life.

Two economic activities, commercial fishing and tourism, illustrate the importance of water quality. The size and variety of the commercial fishing catch is influenced by water conditions, and 95 percent of the commercially important finfish and shellfish depend on the estuaries during some stage of their lives. The N.C. Division of Marine Fisheries estimates that the 1987 dockside value of North Carolina's commercial fishery was worth $65.6 million. Added to this figure is the value of the related industries that process, transport, and sell fisheries products to the consumer.

The tourism industry also relies on clean water. People come from all over the country to boat, swim, and fish in North Carolina's coastal waters. In fact, visitors to the coast in 1987 spent more than $1 billion. By preserving water quality coastal communities can protect the resource that brings people to the area in ever-increasing numbers.

Water provides more than an economic foundation for the coastal area, however: it has shaped the area's history and culture. The rivers, streams, and sounds have created a unique natural system that defines a way of life not found elsewhere in the state. Social traditions, individual attitudes, and personal attachments are inseparable from the waters that have influenced them.

There is no price tag for the pleasure of seeing shorebirds wade along a fringe of marsh, but that experience is valuable nonetheless, as is the sense of security people receive from their emotional connections to coastal lands and waters. Although people may not always be aware of these connections, they are essential to the overall quality of coastal life.

Although the degradation of coastal waters damages most aspects of life in the coastal area, pollution is continuing to occur. A 1984 survey of water quality trends found that water quality is declining throughout the coast. Three of the six major estuarine systems in the coastal area have more than 30 percent of their waters closed to shellfishing. Severe algae blooms indicate a worsening nutrient problem that can result in fish kills and declining fishery productivity.

Reductions in the striped bass fishery in the Albemarle Sound, for example, are thought to be the result of algae blooms that smother fish larvae and prevent the growth of other plants that would be used for food. Although point source pollution – typically discharges from factories or sewage treatment plants – has been reduced, nonpoint source pollution – the pollution that comes from more diffuse sources such as leaking septic tanks and stormwater runoff – seriously threatens the continued health of coastal waters.

What can be done to ensure that coastal water quality – and traditional coastal lifestyles – are protected as more people move to the coast and use of its resources increases?

There are several ways to address coastal water quality problems. Regulations, for instance, are used to limit some types of pollution that enter water systems from specific sources. However, a narrow regulatory approach does not encompass all the complex, interrelated

water quality problems. Dealing with the effects of nonpoint source pollution is especially complicated because the origins of the pollutants are so diverse that they cannot be easily measured or strictly regulated.

To thoroughly address water quality problems, a combination of activities such as land use planning, best management practices for farming and forestry, acquisition of natural areas for conservation, and public education must be used in addition to regulation. Of these activities, land use planning can play a unique role in resolving water quality problems. Indeed, land use controls may be the most cost effective method for reducing some types of pollution, such as urban stormwater runoff.

The objective of this guide is to provide basic information about coastal water quality problems and how local communities can deal with those problems through the land use planning process. Land use planning enables communities to protect water resources by adopting practices that will prevent problems from occurring. Planning also establishes a framework that can be used to resolve existing problems before they become severe. This saves the money that would be needed to remedy the problems and prevents the loss of fisheries, tourism, agriculture, and forestry revenue.

This handbook consists of three chapters. The first chapter describes the history of efforts to protect water quality. The second chapter explains the dynamics of water systems, how they can be polluted, and how coastal natural areas can reduce that pollution. The final chapter illustrates how land use planning can be used to prevent the degradation of coastal water quality. Major state and federal laws related to water quality and sample ordinances are described in the appendices.

Chapter One

The History of Water Quality Protection

Although water quality problems have only become the focus of public attention and intensive action since the late 1960s, water pollution has historically occurred both in North Carolina's coastal area and throughout the country. Discharging untreated sewage into waterways was a standard practice since the country was first settled, and industries have long relied on water bodies for waste disposal.

As towns and cities grew, engineers and scientists realized that the discharges were beginning to exceed the ability of water bodies to dilute untreated wastes. By the late 1800s waste treatment systems were being developed to improve the appearance and smell of urban waters, and in 1915 the first primary-secondary sewage treatment system was completed. This system filtered solid materials, allowing wastewater to flow into lakes and streams. Scientists at that time believed that wastewater could be diluted by a body of water to the point that it would be harmless.

In the 1940s, studies in highly urbanized areas such as Philadelphia found that rivers might not be able to handle the wastes that were being discharged into them. The Delaware River was so badly polluted that the waters in Philadelphia's harbor were eating the paint off ships' hulls. To protect their workers, shipping companies threatened to use other ports. In many areas people were discovering that the fish they had always caught were either dying or leaving their native waters, to be replaced by species that could tolerate the pollution.

Outbreaks of serious illness began to occur throughout the country during the 1960s. Many of the illnesses were traced to the bacteria and viruses in public drinking water supplies. In 1969 a nationwide survey found that 41 percent of the water supplies examined were delivering water that did not meet federal health standards. Ten percent of the groundwater supply systems were also found to be contaminated.

By the 1970s water pollution was more than a sewage disposal problem: toxic chemicals from manufacturing, housecleaning, agriculture, and urban streets were contaminating ground and surface waters. Public concern over the pervasive pollution of the nation's waters led Congress to enact several laws to clean up that pollution.

Congress addressed point source pollution primarily by establishing the National Pollution Discharge Elimination System and giving funds to communities (most of which went to large cities) to construct waste treatment plants. Most treatment plants still continued to rely on diluting the wastewater in surface waters, however.

Although the regulation of industrial and municipal waste discharges and improved waste treatment practices eliminated much of the bacterial contamination of water supplies, those changes did little to address the problem of toxic chemicals. Furthermore, the treatment plants in smaller towns and leaking septic tanks continued to be a problem that received little attention.

Congress recognized that stormwater runoff and other nonpoint sources of pollution were also important, and adopted regulations that require separation of stormwater from wastewater to avoid the overflowing of treatment plants during rainstorms. States were also given grants to design plans for managing nonpoint source pollution, but the management practices suggested in the plans were not mandatory, and no formal regulations for stormwater treatment have ever been adopted. The tightening of federal budgets in the 1980s decreased the funding of wastewater treatment plants and further placed the burden of dealing with stormwater on local government.

In 1978 the Nationwide Urban Runoff Program was created by the Environmental Protection Agency to determine the significance of pollution from stormwater runoff. In coastal and estuarine areas, the effects of stormwater were found to vary. In places with a particular

need for clean water, such as shellfishing areas, stormwater runoff was found to be a very serious problem.

This is especially true in large, slow-moving water bodies like the sounds along the North Carolina coast. The addition of wastewater or stormwater to those waters has been found to have serious long-term effects because certain pollutants are not readily flushed out by ocean tides. The fishing, boating, and tourism industries may thus suffer serious consequences from these pollutants.

Beyond the issues of sewage treatment and urban runoff there are many other factors adversely affecting water quality today. Problems associated with sanitary landfills, toxic waste disposal, acid rain, and leaks from underground storage containers are all pollution sources contributing to declining water conditions.

Chapter Two

The Basics of Water Quality

What does "protecting water quality" mean? What exactly requires protection? The term "water quality" refers collectively to the physical and chemical characteristics of water systems that enable those systems to support life. Therefore, what must be protected are the basic natural features of estuarine, riverine, and groundwater systems that the various forms of life in the coastal area depend upon to exist.

The estuarine system, for example, is defined by certain characteristics – salinity, temperature, tides, and the like – to which the plants and animals that live there are specially adapted. If the characteristics of the estuary that make it habitable for those creatures are changed, then the plants and animals may not be able to reproduce as successfully or they may die. These conditions – necessary for the estuarine system to support life – are what must be maintained if the estuarine system is to continue to be the basis of life in the coastal area.

Likewise, protecting groundwater quality requires that aquifers – underground reservoirs of water that provide the majority of fresh water for human consumption in the coastal area – must be able to replenish themselves and are not contaminated by chemicals, sewage, and salt water. If groundwater quality is not maintained, the lack of fresh water will severely limit a community's ability to grow and its use of water for drinking, cooking, cleaning, farming, and other routine activities.

The key to protecting water quality, then, is to understand how coastal water systems work. That understanding enables us to recognize the features of natural systems that are essential to the continued health of the coastal area and how these systems are vulnerable to damage. With this knowledge care can be taken to avoid such damage. This chapter explains the basic characteristics of coastal aquatic systems and the pollutants that can affect them.

The Hydrologic Cycle

Water is constantly in motion, whether as a gas or a liquid. Its movement may be seen easily in the form of rain or snow, or it may be invisible as it soaks into the ground or evaporates into the atmosphere. This movement of water, from the clouds to the earth and back again, is called the hydrologic cycle.

The cycle begins with the sun's energy warming the earth's exposed waters, causing evaporation. The vapor rises into the atmosphere and condenses to form clouds. The moisture in the clouds then falls to the earth as rain or snow.

When water reaches the ground, it can take three main paths: it can run off the land and collect in the creeks, streams, and rivers that eventually flow to the ocean; it can infiltrate the soil surface, recharging groundwater reservoirs; and it may be absorbed into the topsoil to be used by plants. (This water is eventually returned to the atmosphere through the process of evapotranspiration: the evaporation of water from land surfaces plus transpiration, the water given off by the roots and leaves of plants.)

Although many factors affect the course water travels on the ground, one of the most important factors – and the one directly influenced by people – is the type of surface water lands on. If water falls on undisturbed ground, half of it will seep into the ground and the rest will either run off or evaporate.

If water falls on a paved surface or on ground that has been thoroughly saturated, a portion will evaporate and the remainder will collect and flow downhill. Water runs off paved, or impervious, surfaces faster than unpaved surfaces, reducing evaporation and infiltration. As water moves across the ground or pavement it can pick up dirt, chemicals, and other pollutants and carry them into streams and sounds.

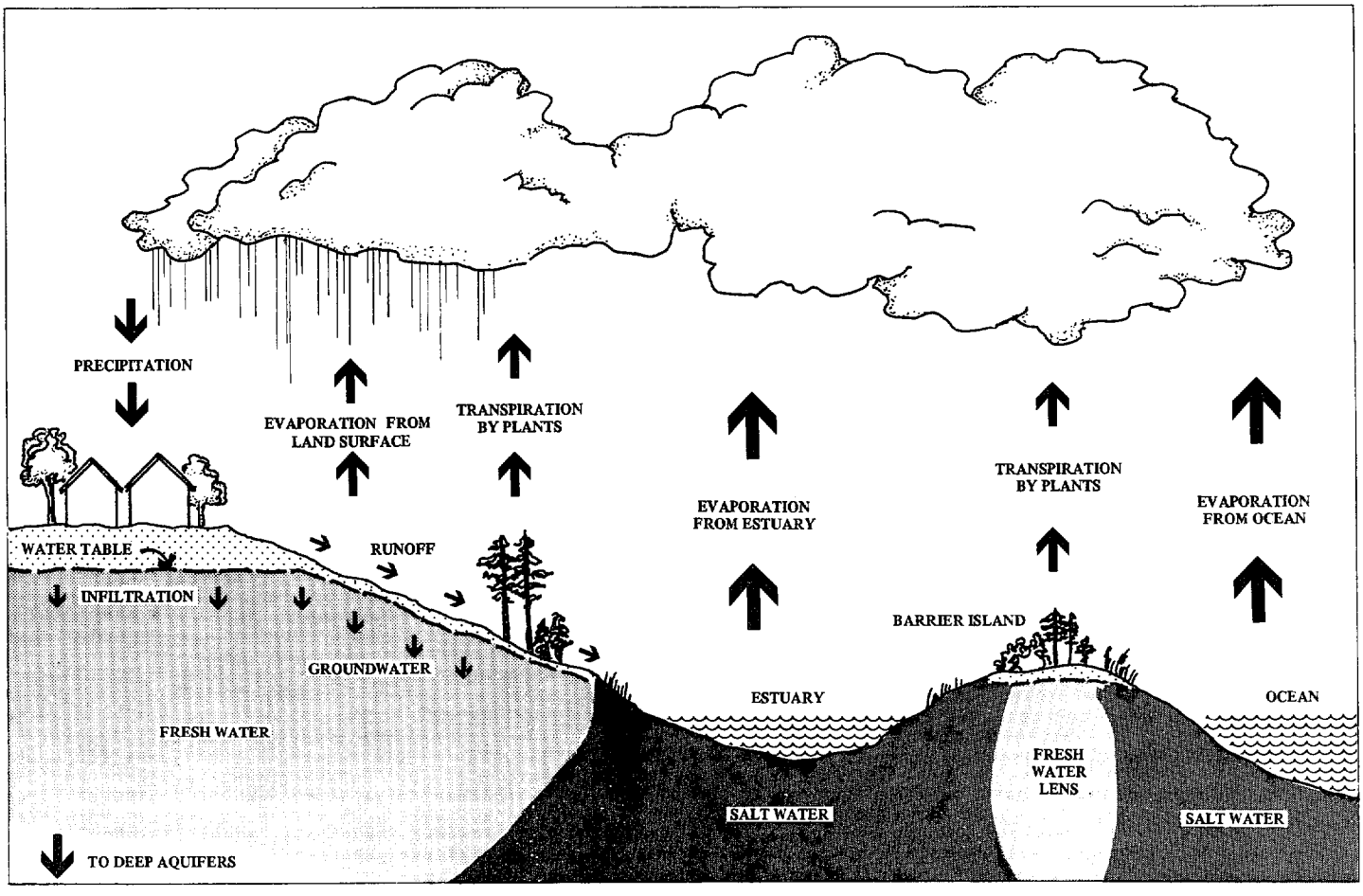


Figure 1
The Hydrologic Cycle

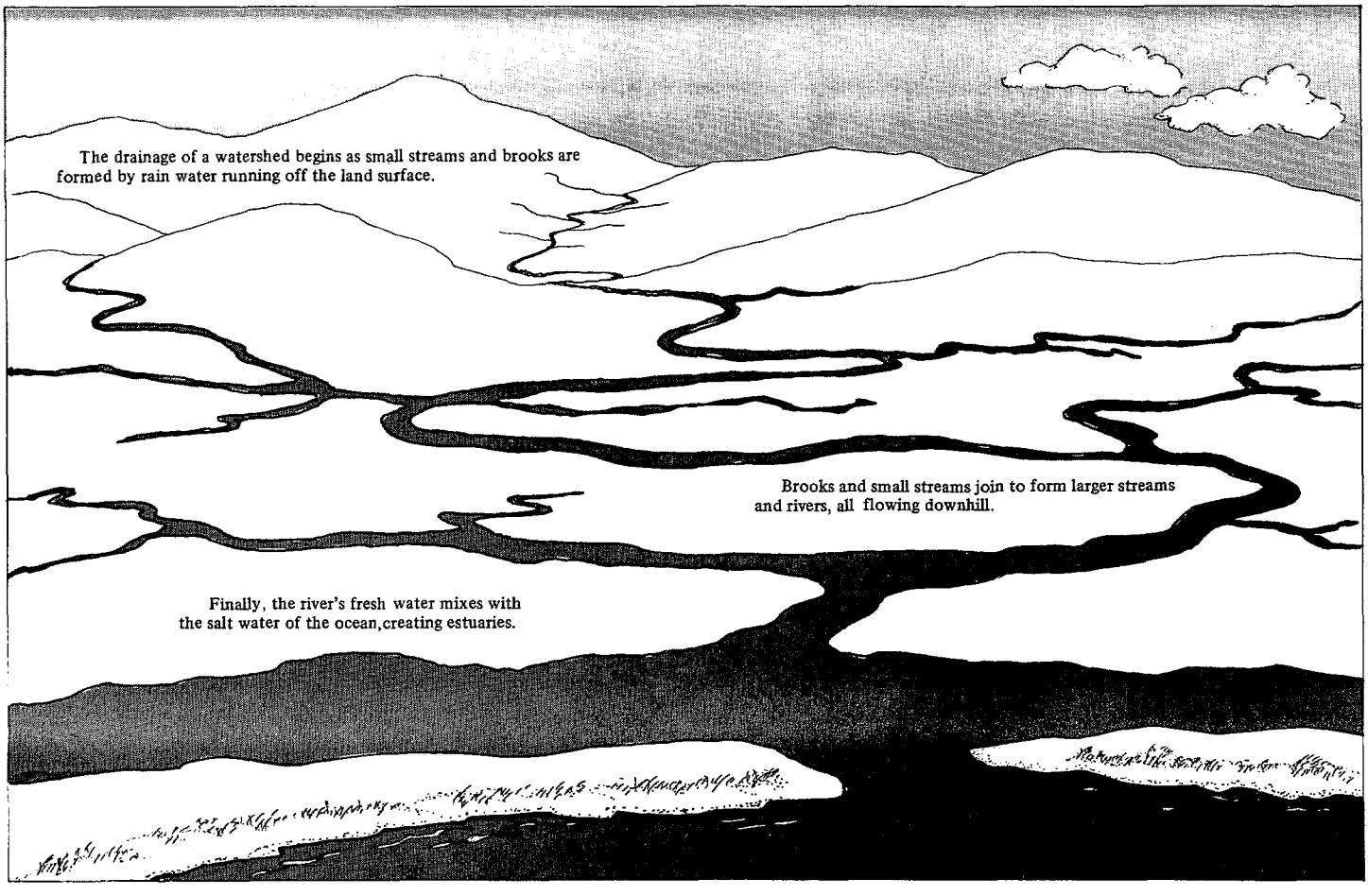


Figure 2
Watershed System

The River System

The characteristics of water and its effects on daily life can be best understood by studying the river basin where a community is located. A river basin, or watershed, is the land area drained by a river and its tributaries.

A small creek running through a neighborhood may appear to be separate from the stream that crosses another part of town, but they are connected. Creeks join to create larger streams, forming a natural drainage network that carries rainwater off backyards, fields, and streets and into rivers. Without this drainage system, land would stay wet or flooded.

Rivers are moving water systems, and so are considerably different physically, chemically, and biologically from standing water systems, such as lakes and sounds. Water currents and other physical variations in parts of the same stream or river create different habitats and communities. These physical differences can also influence the amount of oxygen in the water and what type of animals will live there.

As water circulates through a river system it can carry pollutants to other parts of the watershed. This is why coastal residents may be concerned about the activities of people living upstream in the piedmont. Although many miles apart, they all live within the same watershed, and so can affect one another through their various uses of water.

The Estuarine System

Estuaries have often been called the "cradle of life" in the coastal area, for they are the bodies of water where fresh inland and salty coastal waters mix, producing a nutrient-rich habitat for plants, fish, and other coastal creatures. North Carolina's estuarine system, the third largest in the United States, encompasses 2.3 million acres of tidal streams, rivers, and sounds.

North Carolina has a wide variety of estuaries– there are tidal rivers like the Newport and Pamlico, secluded lagoons like Rose Bay and Stumpy Point Bay, and shallow basins behind barrier islands like Bogue and Currituck sounds. All of these estuaries have different salinity patterns, tides, sediment types, and shorelines. The conditions within estuaries, especially salinity, change continually, so the organisms that live in them must be adapted to those changes.

The combination of changing salinity patterns, shallow water, and marsh grasses provides physical protection and abundant food for the juvenile finfish and shellfish that use estuaries as nursery areas. Estuaries are one of the most productive natural systems on earth, accounting for the health and profitability of most commercial fisheries.

The very functions that make estuaries productive also make them vulnerable to pollutants. Just as estuaries efficiently trap and recycle the nutrients that support the estuarine food web, they can also trap and recycle pollutants.

Pesticides and other toxic substances in runoff, for example, can be trapped, buried, and re-introduced into the water at a later time. Once in the water these substances can be taken up by marine life and passed up the food chain, sometimes to people. Comparisons of stream bottom sediments showed concentrations of lead in urban streams ten times as high as in rural streams. Similar results have been found for other pollutants. Fortunately, estuarine systems can also break down some pollutants by the same mechanisms used to degrade organic matter. Some persistent chemicals like DDT, however, will take decades to break down completely and some, such as metals, can never break down.

Pollutants can affect estuaries in a multitude of ways. Some of the effects are obvious, such as fish kills and algae blooms; other impacts are invisible. The loss of lower organisms in the

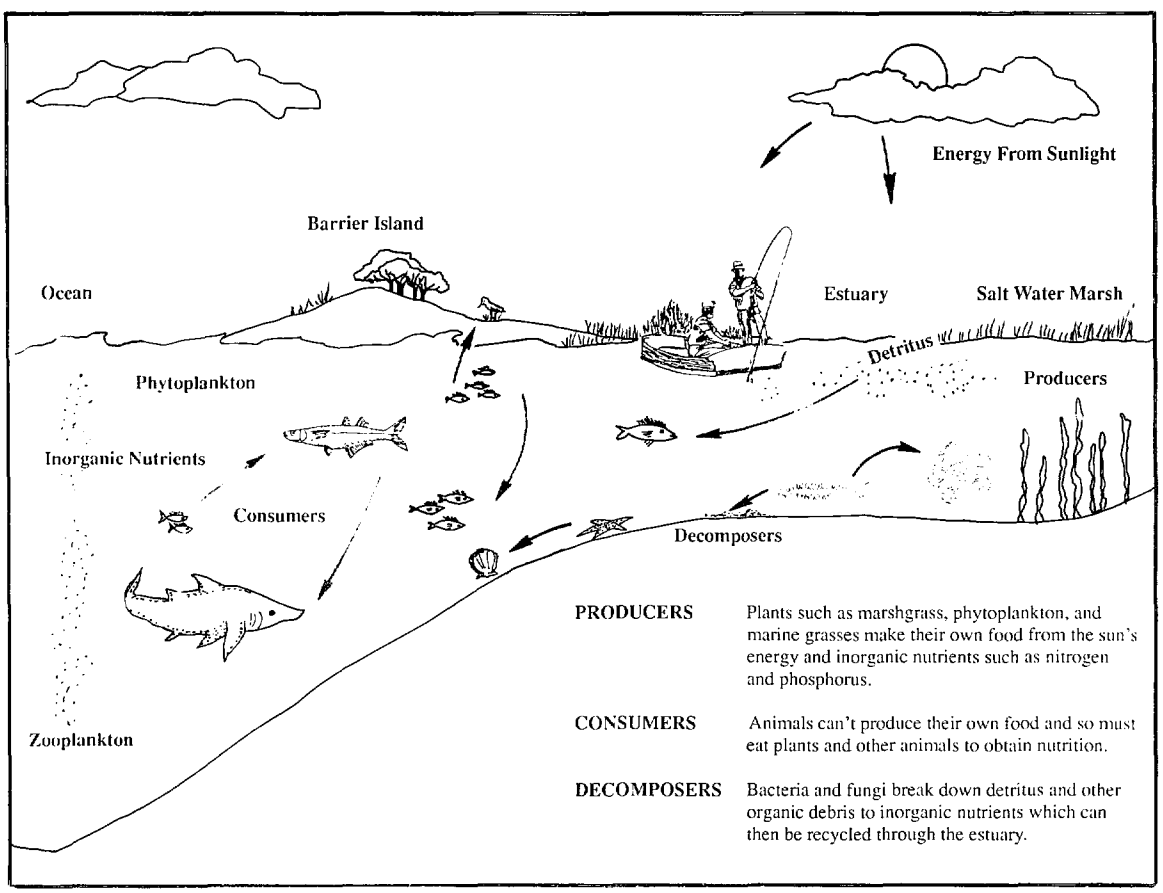


Figure 3
The Food Web

food web, slowed rates of reproduction, and disease may not immediately kill fish, but they can lead to the decline of a fishery, as well as lower its resistance to other diseases and pollutants.

The Groundwater System

When water seeps into the ground it is either absorbed by the soil or it passes through the soil to become part of the groundwater supply. The sand, gravel, and rocks that allow water to collect and move through them are called aquifers.

The water level in an unconfined or "water table" aquifer will rise and fall depending upon the amount of water stored in the ground. The recharge of this aquifer occurs through porous soils when it rains. Although this type of aquifer will recharge relatively easily, pollutants can seep into it just as easily.

The second type of aquifer is called a confined or "artesian" aquifer. This is a complex water system formed by layers of various types of rock and clay. The water in this aquifer moves through the earth under pressure rather than simply by gravity. Recharge to the confined aquifer takes place only in certain areas and depends on the difference in pressures between the water table aquifers, so it is less likely to get polluted, unless pollution sources are located in recharge areas. Artesian aquifers provide a more constant water supply in terms of volume and quality than water table aquifers.

The dynamics of groundwater movement are extremely complicated. In essence, groundwater moves downward, following the slope of the water table (not the land surface) from its highest level to its lowest. The water slowly filters between the rocks or soil that compose the aquifer, usually at a rate of a few inches a day. This slow movement keeps any pollutants from being quickly diluted. Therefore, a well located down-slope from a source of pollution could be contaminated by the groundwater flow that still contained concentrated pollutants.

The porosity of an aquifer can also affect pollution. For example, the siting of septic tanks in the coastal area where the water table lies just below the sandy soil has created problems. The porous sand does not retain the wastes as long as other soils do, and it lacks the organic material and microbes that will trap and treat pollutants. Thus the potential for bacteria to contaminate water supplies is increased.

Groundwater is difficult to clean once it has been polluted. In many cases it is technologically impossible to purify groundwater, and where it is possible it is usually prohibitively expensive.

The Groundwater-Estuarine Connection

Although the dynamics of groundwater and estuarine water systems are different, the two are interrelated. To maintain the quality of all the waters of the coastal area, it is necessary to recognize the connection between aquifers and estuaries, for there are certain practices that will protect both water systems.

Groundwater in water table aquifers eventually flows into a stream, river, lake, or sound. Although some of the contaminants in the groundwater may be dispersed as the water flows through the aquifer, some pollutants will still reach the water body. Therefore, it is possible for groundwater contamination to affect estuarine waters as well. It is also possible for pollutants in estuarine waters to flow back into the underlying aquifer. Salt water will do this, for instance, if the aquifer is not replenished.

There are also several activities in the coastal area that affect both ground and estuarine waters. For example, land clearing – whether for forestry, agriculture, or construction – exposes the ground, increasing the amount of soil, fresh water, pesticides, and fertilizer that run off into the sounds. Due to the increased runoff the disturbed land will retain less water, thus depriving the aquifer of the water it needs to recharge.

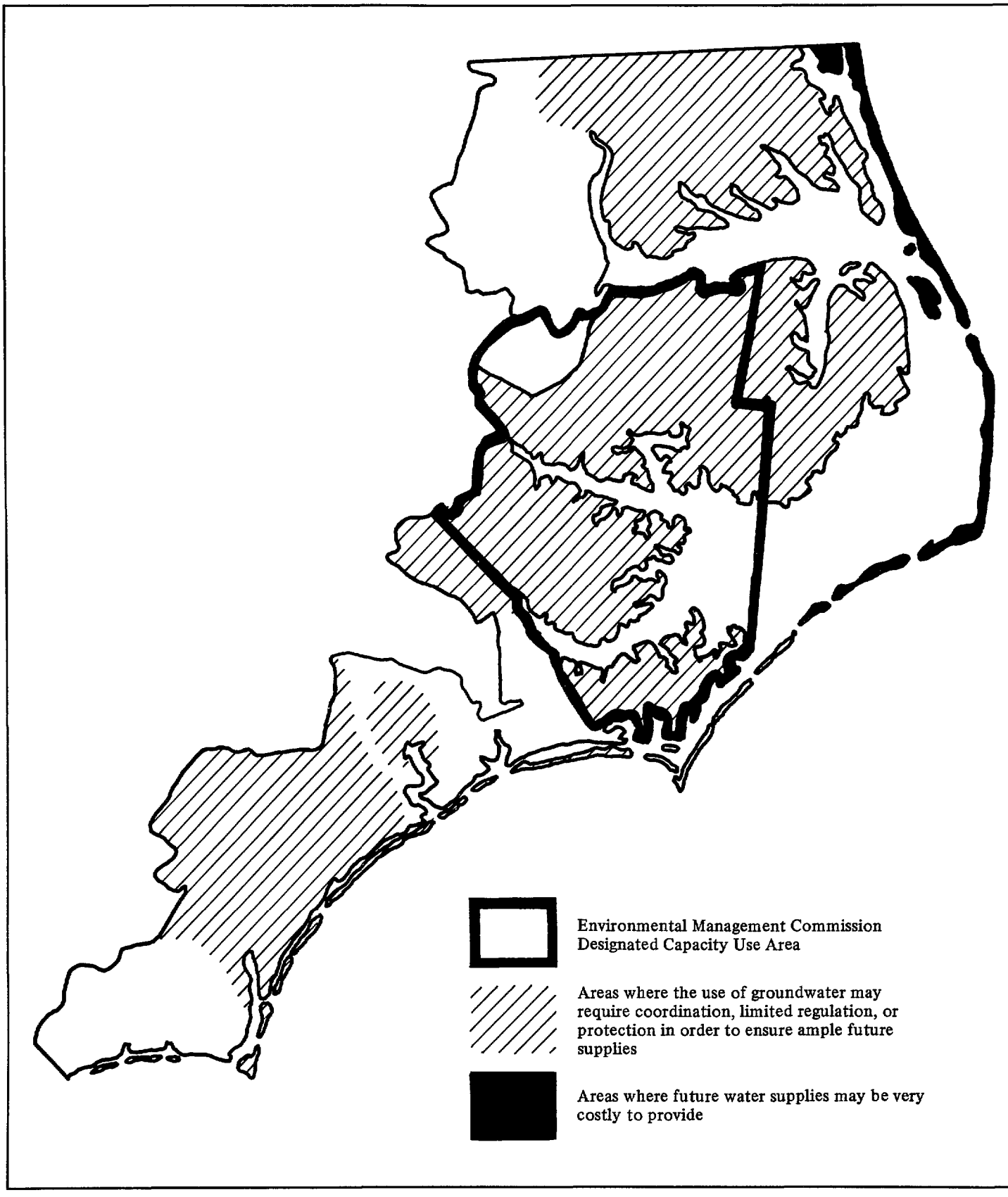


Figure 4
Potential Groundwater Supply Problem Areas

It is also more likely that pesticides and fertilizer will pollute the aquifer, because there is less groundcover and organic material to filter out pollutants. Even stormwater collection systems designed to eliminate runoff problems may pollute the aquifer. In areas where the soil is sandy and the water table is high, the pollutants, concentrated by the collection system, may enter the aquifer.

One apparently simple action – clearing a lot to build a house – when multiplied many times over along the coast can create a series of water quality problems. Therefore, the key to protecting coastal water quality is to recognize that many factors may cause water quality problems. It is important to recognize the connections between different coastal water systems to prevent problems from occurring.

Coastal Water Pollutants

In coastal North Carolina, nutrients, fresh water, and sediment are serious problems, and every year more shellfish beds are closed due to bacterial contamination. Saltwater intrusion is a major concern for barrier island communities that rely on local groundwater. The problem of temperature (or thermal pollution) and toxic substances will become a greater problem as more industry moves to the coastal area.

This section describes these major coastal pollutants and their sources, and how they can affect coastal water systems. This is only a brief overview of the primary causes of coastal water quality problems. For more information, see the bibliography at the end of the book.

Nutrients

When detergents, fertilizers, and human and animal wastes enter coastal waters, they add nutrients – principally nitrogen and phosphorous – to carefully balanced natural systems. The increased nutrients can cause certain aquatic plants to grow so extensively that they suffocate fish and other marine organisms and block out the plants on which they feed.

This problem, called eutrophication, is illustrated by the algae blooms which have been worsening in North Carolina's coastal rivers. The blooms, which have occurred on the Chowan River for several years, have recently begun to happen on the Pamlico and Neuse rivers as well.

A problem that is related to eutrophication is the reduction of dissolved oxygen in coastal waters. As organic matter (such as dead plants and algae) decays it uses dissolved oxygen, reducing the dissolved oxygen available for other aquatic life. Such a reduction in dissolved oxygen can cause fish kills. This is especially a problem in summer because warmer waters contain less oxygen.

There are a number of sources of nutrients throughout river basins: industrial and boat discharges; agricultural, forestry, and urban runoff; sewage treatment and package plants; septic tanks; and animal feedlots.

Fresh Water

Large volumes of fresh water running off cleared lands, drained wetlands, and impervious surfaces can change the salinity patterns in estuaries. These patterns are often altered suddenly and for short time periods as water runs off the land in slugs after a storm.

Salinity is one of the variables of the estuarine system to which marine organisms are specially adapted. Therefore, a change in salinity patterns can alter the estuarine habitat – and primary nursery areas in particular – causing poor reproduction, slowed growth, or death of juvenile organisms. In North Carolina, a direct link has been found between fresh water flowing into nursery areas at key stages in shrimp growth and declines in shrimp harvests.

Bacteria

Disease-carrying bacteria and viruses (or pathogens) associated with human and animal wastes can contaminate seafood, drinking water, and swimming areas, threatening both human

health and the economy of the coastal area. Eating contaminated shellfish, or even swimming in pathogen contaminated waters can result in hepatitis, a variety of gastrointestinal disorders, or infections.

For that reason the N.C. Division of Health Services recommends that contaminated shellfish beds be closed, an action which can have a significant impact on coastal economies. Currently nearly 20 percent of the shellfishing waters in North Carolina are closed and the number of acres of closed waters increases each year.

There are several sources of bacterial contamination in the coastal area. Leaking septic tanks can pollute both ground and estuarine waters, as can septic tanks that are spaced too closely, placed on porous soils, or located in high water tables. Sewage treatment plants and package plants can fail, allowing wastes to enter surface and ground waters. Discharges of human waste from boats can contaminate estuarine waters, particularly in marinas where there is a concentration of boats in a small area. Animal feedlots and stormwater runoff can also cause contamination.

Sediment

Soil washing into coastal creeks, rivers, and sounds can clog waters, covering shellfish habitats and changing the composition of estuarine bottoms. The principal causes of sedimentation are natural erosion, dredging, and loss of soil through land disturbing activities such as construction, agriculture, forestry, and peat mining.

In a 1979 study of water quality of urban streams, Richard Klein found that soil erosion in urban watersheds is generally nine times as great as erosion in rural watersheds. An acre of land under construction may lose 20,000 to 40,000 times more soil than a wooded or cultivated acre. Unfortunately, the sediment lost is usually the topsoil, the most productive part of the soil.

Saltwater Intrusion

When groundwater resources are used extensively, it is possible to use more water than the aquifer can replenish through infiltration. Without sufficient recharge of the groundwater, wells can go dry or saltwater from the estuaries can be pulled into the aquifer. Salt-contaminated water cannot be used for drinking or crop irrigation, posing a serious problem for local communities and farmers.

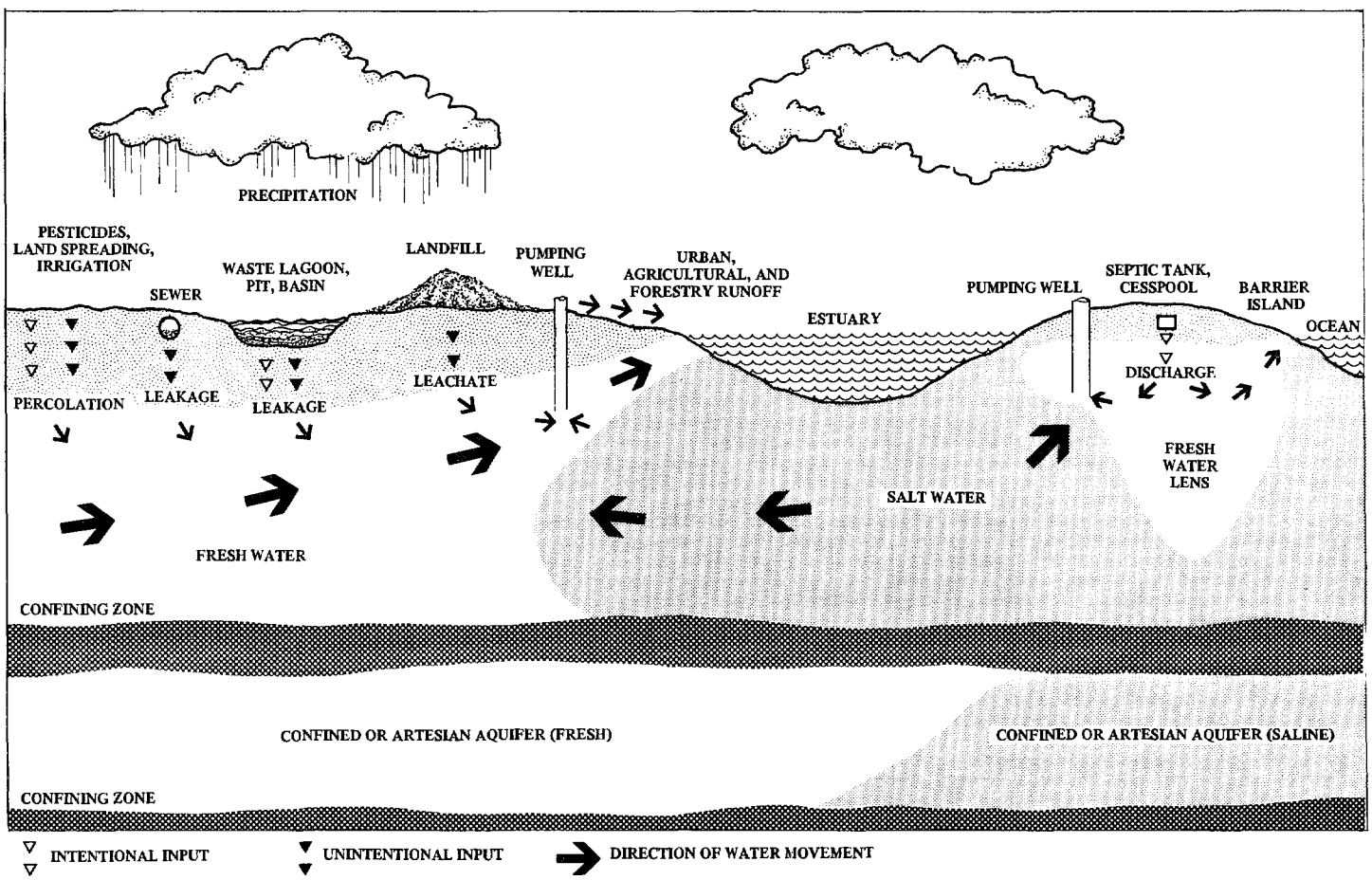
For this reason, the Environmental Management Commission has the authority to designate "capacity use areas" – aquifers where withdrawals must be regulated in order to prevent the groundwater from being overused. The one such area designated to date encompasses a large portion of the coastal area.

Temperature

Temperature is one of the physical characteristics of the estuarine system that directly affects the health of the organisms that live there. So, although temperature is not a pollutant in the strictest sense of the word, the introduction of heated discharges from manufacturing and electric generating plants into streams and rivers can affect aquatic organisms physically, biologically, and chemically. Changes in the water's temperature can alter reproduction of fish, or cause fish kills by decreasing the amount of oxygen water contains.

Toxic Substances

By far the most complex and potentially devastating threat to coastal waters is from toxic substances. Toxic pollutants of coastal interest mainly fall into four categories: heavy metals, petroleum hydrocarbons, pesticides, and other inorganic chemicals. These pollutants are found in many products in daily use and enter both estuarine and ground waters in a variety of ways. They can cause both long-term and immediate damage to human and aquatic life.


PRECIPITATION
PESTICIDES, LAND SPREADING, IRRIGATION
SEWER
WASTE LAGOON, PIT, BASIN
LANDFILL
PUMPING WELL
URBAN, AGRICULTURAL, AND FORESTRY RUNOFF
PUMPING WELL
SEPTIC TANK, CESSPOOL
BARRIER ISLAND
ESTUARY
OCEAN
DISCHARGE
PERCOLATION
LEAKAGE
LEAKAGE
LEACHATE
FRESH WATER LENS
SALT WATER
FRESH WATER
CONFINING ZONE
CONFINED OR ARTESIAN AQUIFER (FRESH)
CONFINED OR ARTESIAN AQUIFER (SALINE)
CONFINING ZONE
INTENTIONAL INPUT
UNINTENTIONAL INPUT
DIRECTION OF WATER MOVEMENT

Some forms of toxic pollution have already occured in North Carolina's coastal area – most notably oil spills, pesticide runoff, leaking landfills, and underground storage tanks. As the region grows, this type of contamination is likely to become more of a problem. Not only will industrial discharges increase, so will the potential for accidental spills and dumping. Treatment systems have not been developed to remove toxic substances from either wastewater or stormwater (many of which will not break down over time) in estuaries may cause long-term physical and economic damage.

Heavy Metals

Heavy metals, such as lead, chromium, and mercury, are inorganic elements that cannot be broken down or degraded. They are found in the fuel and exhaust of automobiles and motorboats, industrial emissions and discharges, sewage treatment plant effluent, landfill wastes, stormwater runoff, and in soil.

Groundwater supplies may be polluted by leaching from landfills or treatment lagoons, chemical spills, or from movement between ground and surface waters. Land disturbing activities such as construction, mining, forestry and agriculture can release heavy metals – many of which occur naturally in the soil – into the water. Urban stormwater runoff is a particularly significant cause of heavy metal contamination of ground and estuarine waters. A number of studies of North Carolina waters have found metals at levels high enough to affect aquatic life.

Heavy metals can affect human health and natural systems in a number of ways. Lead exposure, for instance, can cause mental retardation and brain damage in children and has been linked with miscarriages, birth defects, and infant deaths. Copper, one of the metals found in at least 90 percent of urban runoff samples, is associated with liver damage.

Some metals may accumulate in the tissue of fish, and so may be consumed by people. As organisms at low levels of the food chain are eaten by higher organisms, the level of metal present in the tissue is magnified. This is particularly a problem with some metals, such as mercury, which remain in the environment for a long time (even after the source of pollution is gone) and are readily absorbed by fish and shellfish.

Synthetic Organic Chemicals

Pesticides, paints, household cleaners, and hundreds of other products in daily use contain synthetic organic chemicals – manufactured compounds that can be extremely toxic and may remain in the environment for long periods of time. These chemicals run off cultivated fields, forest nurseries, lawns, streets, and golf courses. They also are discharged in industrial and municipal effluent and can be spilled accidentally or dumped illegally, contaminating both estuarine and ground waters.

Although the EPA estimates that there are more than 70,000 synthetic compounds in industrial use – and a thousand more introduced every year – their effects on human and aquatic life are barely known. Only a small percentage of the chemicals have been tested to determine whether or not they cause health problems. The predominant effects that are known, however, are cancer, birth defects, and chronic illness.

A particular problem in determining the effects of synthetic organics on the environment is that the EPA's water quality criteria are developed by laboratory testing of single chemicals. This does not take into account the potential of different chemicals to interact with each other in ways that magnify their toxicity.

Petroleum Hydrocarbons

Oil, gasoline, and coal release petroleum hydrocarbons into coastal waters in a variety of ways. Automobile and boat exhaust, motor oil and grease, power plant emissions, industrial discharges, accidental spills, illegal dumping, and leaking underground storage containers all bring petroleum hydrocarbons into ground and surface waters.

Pollutant	Source	Effect On Coastal Waters
Petroleum Hydrocarbons	Fuel exhausts Motor oil and grease Power plant emissions Industrial discharges Spills and dumping Leaking underground storage containers Urban runoff	Spills can kill aquatic life, damage beaches, and permanently destroy wetlands. Runoff can be toxic to marine organisms – causing death, disease, and reproductive problems.
Chlorine	Water treatment plants Swimming pool backwash	Kills aquatic life.
Nutrients	Agricultural, forestry, and urban runoff Sewage treatment and package plants Septic tanks Animal feedlots Industrial and boat discharges	Enrichment of rivers and sounds (eutrophication) resulting in algae blooms. Blooms can alter the food chain then decay, depleting oxygen and causing fish kills. Eutrophication is also suspected of causing some fish disease problems.
Fresh Water	Water running off impervious surfaces Land clearing Draining wetlands Channelization of streams	Changes salinity patterns in estuarine habitats, causing slowed growth or death of juvenile organisms, or poor reproduction.
Bacteria and Viruses	Septic tanks that are spaced too densely, placed on porous soils, located in high water tables, or that leak Sewage treatment or package plants Boat discharges Animal feedlots Urban runoff	Contaminate shellfish waters, so consumption of shellfish may cause disease. Contaminate groundwater, so using for drinking or bathing may cause disease. Contaminate surface waters, so swimming may cause disease or infections.
Sediment	Land clearing Dredging Erosion	Clogs marine waters. Covers marine habitats, smothering some organisms. Causes turbidity in water, shading out producer organisms and altering the food chain.
Temperature	Factories Electric generating plants Erosion	Alters reproduction of fish. Reduces dissolved oxygen which may then cause fish kills. Contaminates fresh water supplies used for drinking, irrigation, and the like.
Heavy Metals	Fuel and exhaust of motor-boats and automobiles Industrial emissions and effluent Landfill wastes/leachate Urban runoff Naturally in soil Hazardous waste disposal and spills Sewage treatment plant effluent	Accumulate in fish tissues and can be passed on to humans. Contaminate drinking water, causing brain damage, birth defects, miscarriages, and infant deaths.
Synthetic Organic Chemicals	Forestry, urban, and agricultural runoff Industrial and municipal effluent Spills or dumping	Cause cancer, birth defects, and chronic illness when consumed in contaminated water supplies or seafood.

Figure 6
Coastal Water Pollutants and Effects

Oil spills on land or in the water can damage coastal wetlands and kill or cause long-term damage to marine life. Such spills may also cause a loss of tourist revenue if shorelines are damaged. Although oiled sandy beaches can be cleaned (albeit at great expense), oil-contaminated marshes, mudflats, and estuarine bottoms cannot.

Chlorine

Chlorine, an inorganic chemical, poses a particular problem in the coastal area. It is commonly used in water treatment plants and swimming pools and to disinfect wastewater. It is very toxic to aquatic life and so is a serious threat to coastal water quality.

Water Purification

Some of the sediments, chemicals, and other pollutants that enter water systems may be removed by natural physical, biological, and chemical processes. Large particles may be trapped by vegetation or soil as water percolates into the ground, or the particles may filter out as sediments settle on stream beds. The biological decomposition and movement of organic matter through the life cycle will also remove some substances. Chemical interactions may also break down some toxic pollutants.

This section describes how these methods of water purification take place within natural coastal systems. An understanding of the inherent abilities and limitations of natural systems to remove pollutants is very useful for land use planning, because knowledge of those systems will enable communities to protect the areas that are exceptionally valuable in maintaining water quality.

The following outline describes how water pollutants are purified by soil, wooded uplands, wooded swamps, and tidal wetlands.

Soil

Soil physically traps many suspended particles as water filters through it. Bacteria, worms, and other soil organisms can break down biodegradable pollutants – some to usable nutrients or gases. Some substances can chemically interact with or bind to soil particles.

The ability of soil to purify water depends upon the following conditions:

- ***Whether or not water can penetrate the soil.*** If the soil consists of impervious clays or peats, or is already saturated, or if the soil surface has been paved or covered, water will not be able to enter the soil.

- ***The soil characteristics.*** The amount of organic matter in the soil, its mineral composition, and the ratio of sand, silt, and clay-sized particles affect how well water is purified. Organic matter influences the type and number of existing bacteria and other organisms which can break down pollutants as well as organic material. Organic matter can also hold certain types of pollutants such as metals.

- ***The depth from the soil surface to the water table.*** The ability of soil to remove bacterial contamination, degrade organic materials, and vaporize organic matter is greatly reduced when pollutants enter the water table. Too little space between the soil surface (or the bottom of a water treatment or detention system) and the water table enables pollutants to enter the water table more readily, thus reducing the soil's purification ability.

- ***The type and variety of organisms in the soil.*** A variety of organisms can change nutrients and toxic substances into forms that may be used by other organisms, or made harmless. However, some toxic materials can destroy these organisms, reducing the capacity of the soil to purify water.

Wooded Uplands

Trees, shrubs, and other plants along rivers and sounds decrease pollution from different types of runoff very effectively. Wooded areas are also critical for recharging groundwater and preventing its contamination.

A plant canopy catches rain and reduces the force of rainwater striking and breaking up exposed soil. Plants slow runoff flow, allowing large particles to settle out and water to seep into the soil and groundwater. Plant roots take up nutrients and physically increase the capacity of soil to absorb moisture by making it more porous, and by pulling water out of the soil. Roots also hold the soil together, making the land less vulnerable to erosion.

The ability of vegetation to moderate the effects of runoff depends on the following conditions:

- ***The density of vegetation.*** Densely wooded areas filter pollutants and absorb water more effectively than sparsely vegetated areas.

- ***The type of vegetation.*** Plants that form dense canopies and have deep roots, such as trees and shrubs, will trap more rainwater, draw more water from the soil, and protect against soil erosion better than flowers and grass.

- ***The slope of the wooded area.*** Water can move through wooded areas with steep slopes too quickly for it to be absorbed by the soil or for pollutants to settle out.

- ***The width of the wooded area.*** Increasing the amount of vegetation and the distance between development and the water decreases the amount of runoff that will flow into a river or sound, and increases the amount of water that can recharge the aquifer. Therefore, the wider the wooded buffer is, the more effective it will be in protecting water quality.

Wooded Swamps

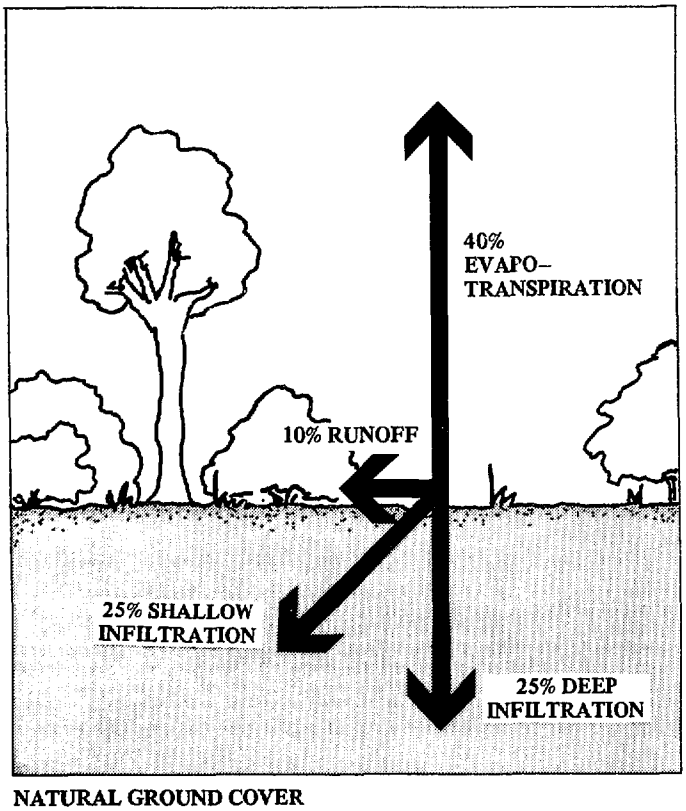
Wooded swamps maintain both water quantity and quality. They moderate water flows, reducing flooding downstream, as well as protecting nursery areas from surges of freshwater runoff. The flat terrain of swamps and the plants that grow there slow water, allowing some pollutants and sediments to settle out. Some pollutants may be buried by sediment, at least until physical or biological activity stirs up the sediments.

The ability of wooded swamps to purify water depends upon these factors:

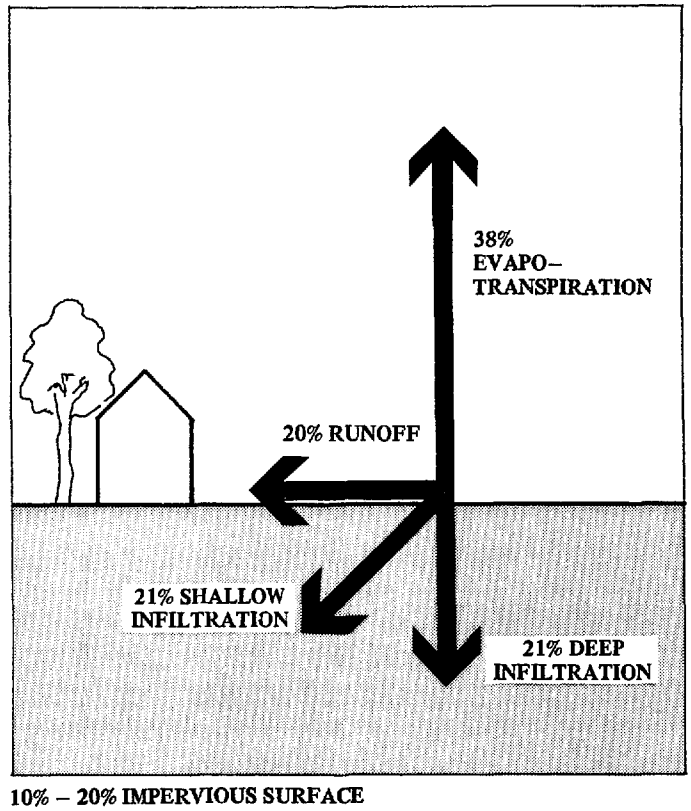
- ***The amount of time the water spends moving through a swamp.*** Water that moves slowly through a swamp is more likely to be purified through settling, evaporation, biological activity, or chemical reaction than if it moves quickly. Channelizing water through a swamp increases the rate of water movement which can cause large quantities of fresh water to move rapidly into an estuary. This rapid movement of water can change estuarine salinity patterns and adversely affect fish habitat, as well as decrease the amount of pollution that can be removed from the water.

- ***The amount of vegetation in a swamp.*** The plants in a swamp increase the rate of water evaporation, take up water and nutrients, add organic matter, and slow water so that solids can settle out. Thus, the amount of vegetation in a swamp affects the ability of a swamp to purify the water that flows through it.

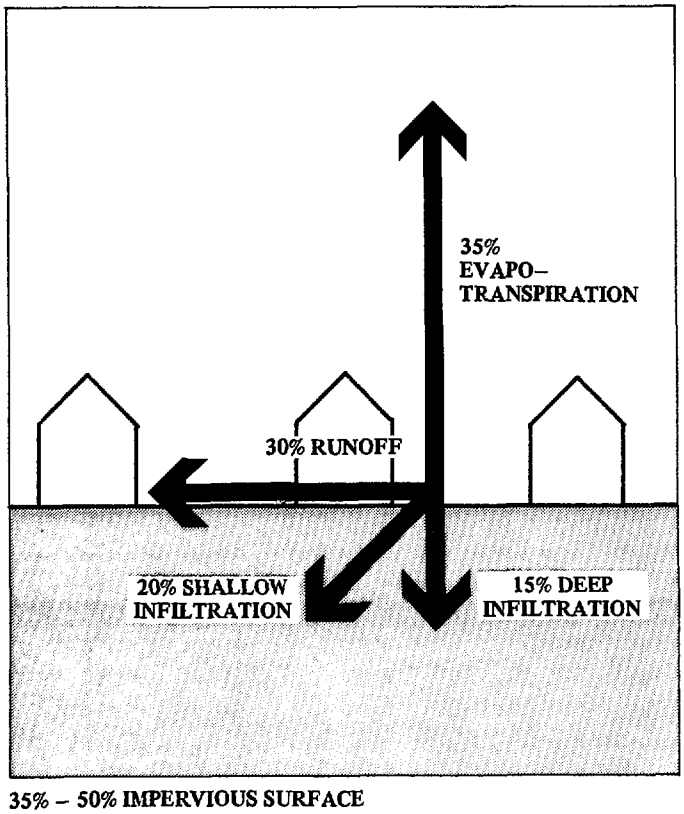
- ***The ability of water to enter the swamp.*** Road construction, berms, spoil piles, and other barriers reduce the quantity and movement of water through swamps. Water may either accumulate behind the barrier, causing flooding, or it may move around the swamp and directly into an estuary.



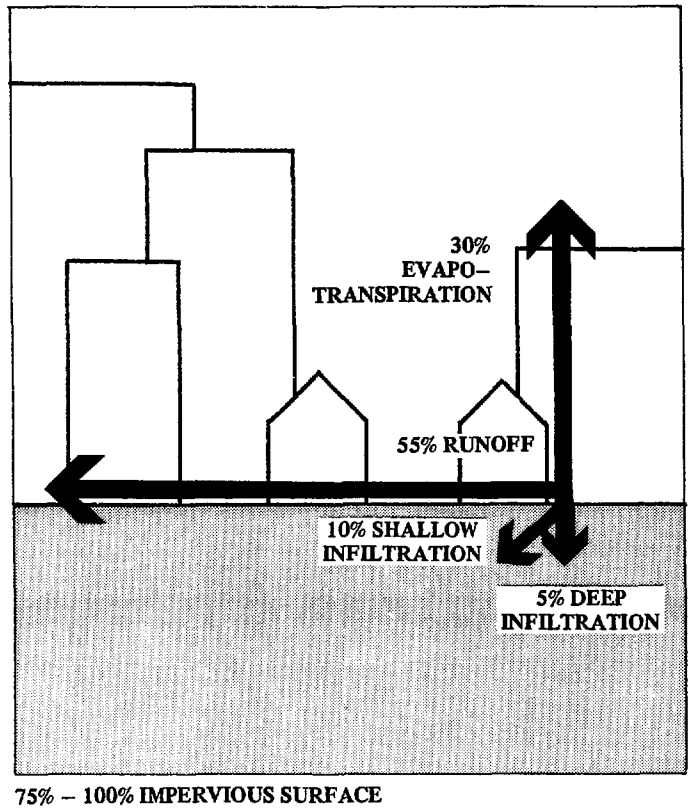
NATURAL GROUND COVER



10% – 20% IMPERVIOUS SURFACE



35% – 50% IMPERVIOUS SURFACE



75% – 100% IMPERVIOUS SURFACE

Figure 7
Typical Changes in Runoff Flows Resulting from Paved Surfaces

Tidal Wetlands

Tidal wetlands can filter pollutants in a number of ways. The wide, flat expanses of marsh grasses and the decaying matter they produce slow water, allowing solids to settle out and trapping large particles. The mucky marsh soils also have the ability to chemically break down or hold some types of pollutants.

One function of tidal marshes – and the reason they are considered to be more productive than farmland – is to break down dead plant and animal matter that provides food for estuarine organisms. During this process the organic material found in runoff may also be broken down, leaving nutrients that can be used by marsh plants.

Although tidal wetlands are considered to be very important for removing nutrients from runoff, they can only take up a limited amount of nutrients. Therefore, these wetlands should not be considered for use as a natural wastewater treatment plant. Likewise, the many beneficial functions of tidal wetlands can be lost if the wetlands are damaged or destroyed.

The ability of tidal wetlands to purify water depends upon the following variables:

- ***The ability of upland runoff to flow evenly through a wetland.*** Water runoff that is diverted into channels moves too rapidly for sediments to settle out or for a marsh to process organic matter. If water is channeled to only one section of a marsh, the marsh may not be able to assimilate the large volume of materials, or erosion may occur.

- ***The wetland's size and type.*** As the surface area of a marsh increases, so does its capacity for filtering pollutants. This capacity is also affected by how dense the vegetation is and how much peat is in its soil.

- ***The pollutant loads.*** Recent studies indicate that wetlands have a limited capacity for removing pollutants, especially nutrients, from wastewater or runoff. When that capacity is exceeded, marshes discharge the excess pollutants into the surrounding tidal waters.

Chapter Three

Land Use Planning to Protect Coastal Water Quality

As the pressures to develop the coast increase, the need to protect water resources from contamination also increases. Federal and state agencies have only limited authority to provide that protection, but local governments have the jurisdiction – through zoning and police powers – to thoroughly address the wide variety of water quality problems and their sources. Thus local governments must play a more active and aggressive role in managing development in order to sustain the health and productivity of coastal waters.

Land use planning offers local governments just such an opportunity. A land use plan expresses a community's vision of how it will develop – it is a design for locating businesses, homes, and factories within the context of the natural resources of the coast. In describing its goals for the future through the land use plan, a community can influence how water resources are used. If maintaining the quality of its waters is one of the community's objectives, then the land use plan can be written to reflect that desire.

Land use plans are the most effective way to manage coastal water resources because they establish a framework that can resolve conflicting resource needs, address potential pollution problems, provide for comprehensive water quality management, encourage use of natural areas to protect water resources, and maintain the traditional aspects of communities.

As the preceding chapter indicates, there are a multitude of needs for water in the coastal area, and sometimes those needs conflict. For example, some of the most desirable land for residential development is immediately adjacent to coastal waters, often the same waters that fishermen rely on to harvest seafood. However, water coming off the cleared and paved land and into the nursery or shellfish areas can drastically alter the basic characteristics of those areas that make them so productive. Therefore it is essential to develop ways to manage water from the land so coastal waters are not damaged. Land use plans can be used to resolve conflicting water needs, and so provide for both water quality and water use.

By developing a plan that specifies how different resources and natural areas within a community will be used, local governments can take a preventive approach to water quality problems. This approach is far less expensive and is likely to be more successful than correcting a pollution problem after it has occurred. For instance, cleaning up contaminated groundwater can cost millions of dollars – one gallon of spilled gasoline alone can cost $150 to clean up. Likewise, a study of stormwater pollution at Lake Tahoe found that planning was the least expensive method of protecting the lake from degradation.

Not only are corrective measures costly, there are no reliable estimates of the losses which could result from water pollution damage to fisheries, agriculture, or tourism before the problem could be resolved. Unfortunately, there are also some types of pollution that cannot be cleaned up.

The planning process allows the broadest possible jurisdiction for local decisionmaking so that development can be overseen at the local watershed level. This is particularly important in dealing with nonpoint source pollution which is so complex that only comprehensive management can adequately address all the associated problems simultaneously. Planning is also useful in reducing the effects of point source pollution. Proper siting of industry, for example, will protect both ground and surface waters.

Another advantage of land use planning is that communities can develop policies for growth that will ensure protection of water quality without relying on technological approaches that do not work as well in the coastal area as in other parts of the state. For instance, structural controls for runoff, such as detention ponds and recharge trenches, do not work well in the high water table and sandy or peaty soils of the coastal area.

Instead, land use plans can identify the most appropriate uses for different areas according to their soil type, drainage patterns, vegetation, and availability of utilities. Development can be targeted to areas where natural drainage patterns would be altered the least, the inherent abilities of soil, vegetation, and other natural features that protect water quality could be taken advantage of, and existing sewage and water facilities could be used fully. By working with the natural characteristics of the land – instead of ignoring them – people can continue to use, enjoy, and benefit from coastal waters.

Finally, planning can maintain the traditional cultural and aesthetic characteristics – and thus long-term property values – of a community. Natural areas have many uses (such as wildlife habitat, parks, and flood control) that make communities more attractive to residents and visitors alike. By guiding development so that it ensures the integrity of natural areas, towns and counties can preserve the water quality necessary for the diversity of coastal economic activities. This chapter explains how the land use planning process can be used to protect water quality.

How Land Use Plans Work

The planning process combines environmental principles with community management to develop a course of action that anticipates problems and guides growth. The process does not need to be complex, and, in fact, benefits from simplicity. By approaching the issues at their basic level, the resulting land use plan will be easier to implement and will gain in public understanding and support.

Protecting coastal water quality requires a coordinated effort between local, state, and federal programs that uses a mixture of technological, regulatory, and planning measures. At the heart of such a cooperative effort is the local land use plan, an important link between the various levels of government.

Perhaps the most important use of the land use plan is as a foundation for the preparation of local management tools. Zoning ordinances, subdivision regulations, and capital improvement plans gain support from a land use plan that effectively considers both the environmental and development needs of the community. Furthermore, should local ordinances be challenged in the courts, they will be much more defensible if they are consistent with the policies of the land use plan.

The ability of a local government to implement the plan must be considered as the plan is drafted. Effective implementation involves every local government agency. Local health and sanitation officials, sewer and water technicians, permit officers, engineers, inspectors, planners, and ground maintenance personnel will perform their jobs better if they understand the policies of the governing board. Policies related to water quality, then, may become a routine part of the community's activities.

Under federal law and state executive order, all federal and state plans, policies, and programs must be consistent with the North Carolina Coastal Management Program to the "maximum extent practicable." Local land use plans are incorporated into the coastal management program; therefore, government agencies must use the policies in the plans as a guide to making decisions about grant and permit applications. Local governments also use the plans for decisionmaking and, when issuing minor development permits under the Coastal Area Management Act, act in accordance with the plans.

Likewise, if an individual applies for a coastal management permit or some type of federal authorization, the proposal will be examined for consistency with the local plan. If the proposal is found to be inconsistent with the plan, the application can be conditionally approved or denied. Plans can be amended or policies clarified as the goals of the local government change.

Land use plans also help to inform property owners and developers about the goals of the local government. By knowing where and how the local government wants to develop, and where it will be providing public facilities, developers can make better decisions as they plan projects. Misunderstandings and confrontations can be reduced if the local government distributes plans to citizens who need to be aware of local policies.

Designing a Land Use Plan to Protect Water Quality

While the actual organization of a plan can vary, there are three general areas that should be included: a description of the community's reliance and effects on water resources; a description of the water resources; and a discussion of local concerns leading to the development of policies and an implementation strategy. The following examples illustrate the information that should be described in these three categories of a land use plan.

The Community's Reliance and Effects on Water Resources

- Population information indicating growth trends and seasonal fluctuations.
- Local business and industry, including an analysis of the economic impact of water-related activities.
- The area's geographic location and relationship to adjacent water bodies.
- The local water supply source and its quality, demand level, and treatment. If it is a groundwater source, include location of wells, depths to seasonal high water table, and identification of aquifers used.
- Soils that are suitable for septic tanks and soils that are unsuitable for septic tanks (i.e. loose, sandy soils that would allow pollutants to leach into the ground and surface waters or dense soils that will not allow adequate infiltration).
- Areas that currently rely on septic tanks and their distance from well sites and estuarine waters.
- Known point sources of pollution such as industrial sites, wastewater treatment plants, landfills, solid waste disposal sites, and underground storage tanks.
- Available waste treatment systems, including their state of repair and capacity, and anticipated needs for the future.
- Storm sewer drainage points and the approximate drainage area for each source.
- Other drainage systems, such as agricultural canals.
- Publicly owned lands that could provide water quality buffer zones, including parks, boat access areas, and the like.

The Water Resources

- Classifications for surface and ground waters as determined by the Environmental Management Commission, and the natural functions of these waters. This should include waters used for fisheries, swimming, and commercial activities, as well as capacity use, nutrient sensitive, and primary nursery areas.
- An inventory of wetlands of all types and discussion of their relationship to developed areas geographically and ecologically.

Water Quality Concerns Leading to the Development of Policies and Implementation Strategy

This section of a land use plan should examine the importance of water quality to the community and identify major local concerns. Policies are then written that reflect the community's water resources plan. These policies are in part illustrated by a land clas-

sification map. Land use regulations, such as zoning, planned unit development, and subdivision ordinances, can then be developed to implement the policies. The following outline describes how these policies should be addressed.

Government Coordination

- A brief description of the water quality efforts undertaken by government agencies in the area.

- An outline of water quality educational efforts which may be appropriate for the community to undertake.

Public Spending and Land Acquisition

- A schedule of priorities for repairing, rehabilitating, and constructing sewage treatment systems.

- A description of water management plans for all publicly owned lands including school yards, parks, and the like that can be used as an example for private sector development.

- An analysis of the ability of parks or other public lands to provide buffers for stormwater runoff when considering those areas for acquisition.

Management of Development

- A discussion of best management practices (such as vegetated buffers and pervious paving materials) that should be used on all lands, especially on the lands adjacent to streams, rivers, lakes, and sounds.

- Identification of conservation areas important to water quality or quantity – or other resource protection – using the CAMA Land Classification System and definition of acceptable uses.

  (Good examples of how the conservation class can be used to protect water resources are in the 1981 land use plan for Dare County and the 1986 land use plan for Tyrrell County. In addition to areas of environmental concern, these counties have used the conservation classification to designate buffers along the estuarine waters in order to maintain shoreline stability and water quality. The buffers will be determined by the soils that filter pollutants and nutrients. Development within the buffers will be managed carefully to protect both the natural resources and personal property rights. Similarly, New Hanover County has developed a conservation class along vulnerable shorelines and adopted land use ordinances specifically to protect water quality in these areas.)

- Identification of "transition" areas that are best suited for different types of anticipated development and their utility needs. For example, areas targeted for residential use with septic tanks and wells should be located in areas with good soils and adequate space between septic systems and the seasonal high water table. High density development should be provided with central sewage facilities and thus would not require high quality soils.

- Development of an effective program of regulation, monitoring, and enforcement to improve water quality conditions. This would include the proper installation and continual functioning of septic systems, water and sediment management at all construction sites, control of illegal dumping, the development and maintenance of vegetated buffers, and the reduction of impervious surfaces.

Public Education

- Encourage and sponsor educational programs on activities that affect water quality and ways to prevent water pollution. These programs could involve the Soil Conservation Service and the Division of Land Resources for sedimenta-

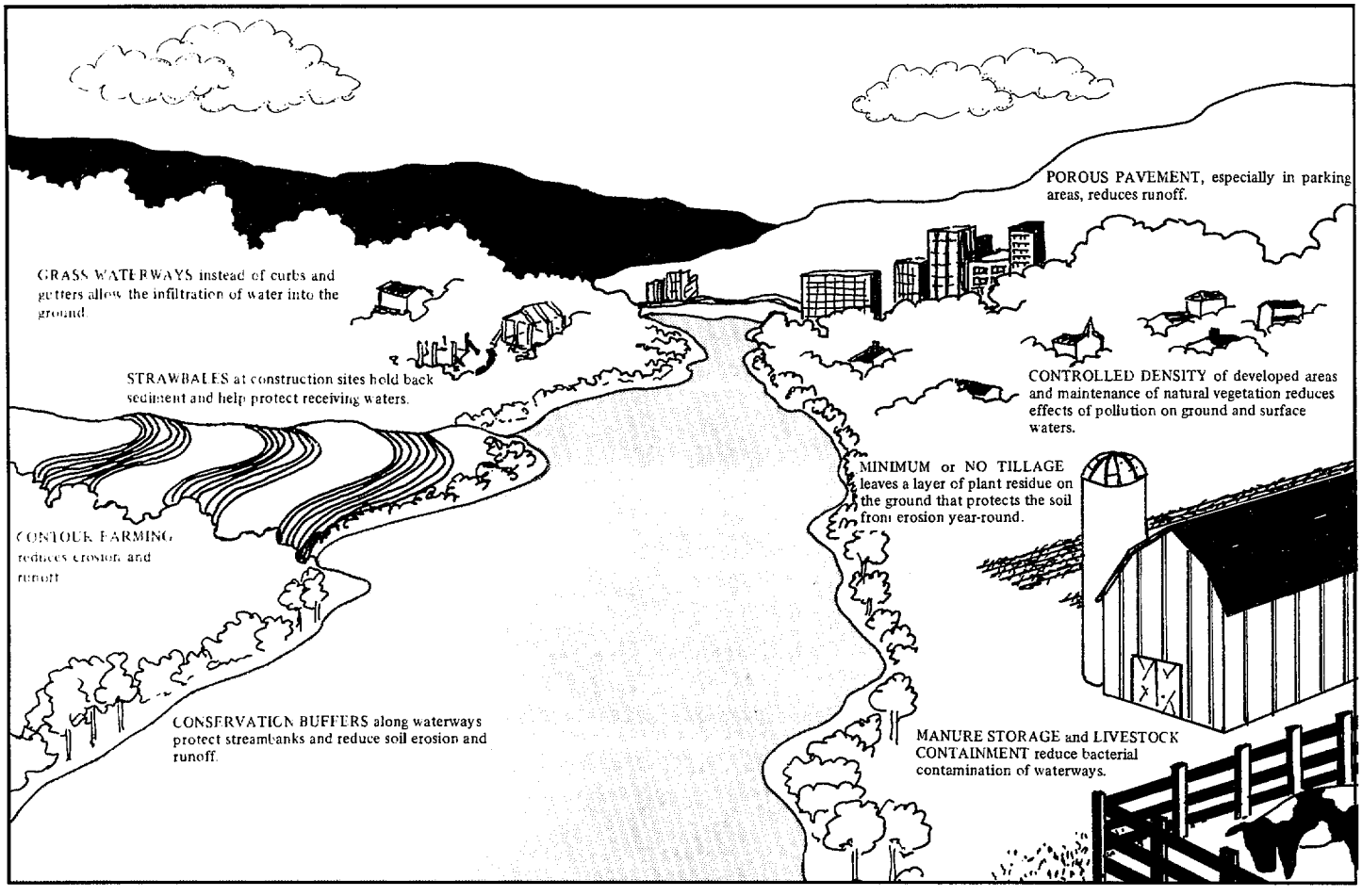


Figure 8
Examples of Best Management Practices

tion and erosion control, local agricultural extension agents for best management practices and the cost-effective use of fertilizers and pesticides, and the Division of Forestry for best forestry practices.

The divisions of Marine Fisheries and Water Resources and the Wildlife Resources Commission could provide information on water and habitat management concerns. For programs on stormwater runoff and land use planning the divisions of Environmental Management, Community Assistance, and Coastal Management and the University of North Carolina Institute of Government could be contacted.

Implementing a Land Use Plan

There are a number of tools that local communities can use to manage water resources. These tools have been divided into two groups, basic and complex.

The first group consists of traditional zoning, subdivision, and planned unit development regulations that are routinely used by local governments. The second group is made up of more complex regulatory programs such as special use permits and performance zoning that should only be used to complement an established program of more traditional regulations.

Basic Regulations

The basic regulations are designed to give local governments greater flexibility to negotiate changes in a development project's design or density, and to require the developer to provide more information about the project and its effects on the environment. This section describes these types of regulations.

Traditional Zoning

The purpose of this management tool is to require adequate standards for the development of individual properties both from a land use and construction standpoint. Zoning can control the density of development through minimum lot sizes and can determine the orientation of the structure by requiring setbacks, buffer areas, and building separation. The following are examples of zoning requirements that can be used to affect water quality:

- Set minimum lot sizes in all areas adjacent to waterways or in key watershed management areas.
- Require minimum setbacks for structures adjacent to water bodies.
- Establish conservation zones next to all waters and require some type of permanent vegetated cover. This is particularly important near primary nursery areas and waters with similar functions.
- Prohibit the direct channeling of surface water runoff into adjacent water bodies and require instead that it be managed by a method appropriate for that area and the distance from the water.
- Require that parking areas be located as far away from the water as possible.
- Require the maximum practical use of pervious materials such as open interlocking pavers for the construction of parking lots and driveways in areas located a certain distance from the water.

Subdivision Regulations

The process of converting large tracts of undeveloped land into smaller residential lots that are ready for construction is controlled by subdivision regulations. The controls focus on site design and engineering standards, and require that certain improvements, such as streets, land drainage systems, and sewers, be provided. These provisions can be enforced by a performance bond which developers are required to post before permits are issued for site improvement or construction. The following examples

can be incorporated into subdivision regulations to improve water quality:

- Require a minimum lot size for lots within a certain distance of all major surface waters.

- Require a water management plan that describes the movement of water on the site, preserves natural drainage patterns and waterways as much as possible, provides for the diversion of all stormwater into vegetated areas to allow percolation into the soil, lays out lots so that runoff volume and velocity are not greater than natural levels, and prohibits direct channeling of stormwater into surface waters.

- Require a grassed or vegetated buffer strip between high ground development and surface waters. Sufficient control should be obtained to ensure that these areas are maintained in perpetuity. This can be accomplished by requiring dedication to the community.

- Include provisions to encourage site design, construction practices, and building materials that will minimize the effects of development on water quality. These provisions can include setbacks for roads, restrictions on the use of curbs and gutters, and requirements for the use of pervious paving materials such as open interlocking pavers for driveways and parking areas.

Regulations Related to Off-Site Facilities

Subdivision regulations also can require that certain off-site facilities such as sewage treatment plants and water supply systems be provided before the proposed subdivision is approved. This type of requirement is intended to ensure that development is supported by adequate facilities.

Planned Unit Development and Cluster Zoning

Planned unit development and cluster zoning regulations combine the elements of zoning and subdivision ordinances described above. Under this approach, the local planning administrator reviews and approves in advance the complete development plans beginning with the site preparation and continuing through the final construction phases.

By reviewing a proposal in its entirety before work begins, measures to protect water quality can be added at little or no additional expense. In many cases, water management provisions actually add value to the finished project. This tool provides additional incentives for developers to add buffers and setbacks in return for greater building density. The limits and terms of this type of negotiation are usually defined through regulation and offer many benefits if properly administered.

Capital Improvement Budgets

The purpose of this management tool is to establish a firm plan for public expenditures for capital improvements. By guiding public facilities to areas where development will not damage water quality, local governments can prevent potential water quality problems from occurring. Similarly, local governments can identify areas with existing water quality problems and fund projects such as public water or sewer systems to alleviate the problems.

Complex Regulations

There are more complicated land use regulations, such as performance zoning, that can be used to accomplish specific environmental management goals. These regulations can be costly and difficult to administer, and rely on the advanced negotiating skills of local officials. This section describes these different types of regulations.

Special or Conditional Use Permits

Development permits can be conditioned to require special measures to protect the environment for projects that would create particular environmental problems. This type of permit can be used when the proposed activity normally would be permitted without question, but due to unusual circumstances additional provisions are needed to avoid environmental damage.

This is different from a zoning variance because variances address activities that are prohibited by regulation, but are allowed in unique circumstances if the regulation would present an undue hardship on the property owner. Special use permits allow projects not allowed as a use of right but which may be allowed if they meet certain standards adopted by the community.

Performance Zoning

Performance zoning identifies specific environmental standards that must be met by all development occurring in a particular zone. Developers are free to proceed in any fashion as long as they do not exceed the standards. For example, a performance standard in a zoning ordinance could provide that development may be allowed if surface runoff does not exceed a given level of flow.

While this approach can recognize the sensitivity of natural resources, it requires a highly trained administrator as well as careful monitoring and enforcement. Local governments interested in using performance zoning should be prepared to expend a great deal of administrative time and effort. In coastal North Carolina only the town of Oriental has considered a draft performance zoning ordinance.

Local Environmental Impact Ordinances

Local environmental impact ordinances require developers to provide information about, and assess the environmental impacts of, a proposed development. The local government must determine that the information and analysis is adequate before development can proceed.

The purpose of this analysis is to require developers to take into account the environmental values that may be affected by a development project and encourage them to use best management practices to avoid environmental losses. Three local governments in North Carolina have enacted local environmental impact ordinances: Chapel Hill, Pamlico County, and Holden Beach. Local governments should consult G.S. 113A before exploring the use of these ordinances.

For More Information

Although there are many ways to protect coastal water quality, each community must decide what types of planning and regulations will work best for it. It may be useful to contact other local governments that have used the management techniques described here, as well as discussing with the city or county attorney how any new tools would affect existing ordinances.

The following appendices provide background material for use in examining possible courses of action. Included are excerpts from two different types of ordinances as well as descriptions of various federal programs that may prove useful in managing water resources.

Should any additional information be needed, please contact the Division of Coastal Management at one of the following locations:

N.C. Department of Natural Resources and Community Development
P.O. Box 27687
Raleigh, N.C. 27611
919/733-2293

3411 Arendell Street
Morehead City, N.C. 28557
919/726-7021
800/682-2632

Appendix One

Sample Regulations

Proposed Extra Requirements for Protected Watershed Districts

The following regulation is the zoning ordinance used by Orange County to protect water resources. This ordinance is presented here as an example for other local governments that might wish to use this management tool.

Stream Buffers Required in Protected Watersheds

Within the Protected Watershed District, an area of land along Perennial streams shall be required to remain in its natural state, unless the area is subject to serious erosion in which case an erosion resistant vegetative cover shall be established and maintained. Perennial streams are those streams in solid blue on the USGS Quadrangle map for Orange County.

a) Width of Buffer Calculated

The stream buffer area shall start at the outer edge of the flood plain and be measured a distance of fifty (50) feet away from the flood plain plus an additional distance depending on the slope near the stream. The slope shall be calculated by measuring a distance of 250 feet from the center of the stream, determining the average rise in elevation and multiplying that value by four. This value shall be added to the minimum buffer of 50 feet to determine total width of buffer area required. The maximum buffer in any case shall not exceed 150 feet.

The flood plain is defined in the Orange County Flood Damage Prevention Ordinance, by special survey by registered engineers or surveyors, by the alluvial soil as designated in the Orange County soil survey, or through a site analysis by the Orange County Planning Staff. Slope shall bedetermined from the USGS Quadrangle map, by on-site measurements, or by special survey by registered engineers or surveyors.

b) Development Advisory Committee's Review of Stream Buffers

The Development Advisory Committee established in Article 2.4.2, can review the buffer requirements for all developments and may recommend additional buffer area where necessary.

c) Permitted Uses Within Stream Buffer Areas

The following uses are allowed as a matter of right in stream buffers. All other uses are prohibited.

1. Above ground and buried utility lines for local distribution of electricity, telephone, and cable television service, accessory, and appertant apparatus such as poles, guy wires, transformers, and switching boxes.

2. Bona fide farms except any use of farm property for non-farm purposes.

3. Neighborhood utility facilities located within a public right-of-way with the permission of the owner of the right-of-way (State, City, or Town).

4. Public and private streets, bridges, and railroad rights-of-way. Where it is necessary to construct streets, bridges, and railroad lines across buffer areas, they shall enter and exit the area as nearly perpendicular to it as possible.

d) Stream Buffers Included as Part of Minimum Lot Size Requirements

Stream buffers may be used as part of the required lot area or lot size for residential and non-residential developments.

e) Existing Vegetation in Buffer Areas

Existing forested areas or any healthy vegetation cannot be removed from a stream buffer except when replaced with vegetation resulting in comparable stormwater runoff velocity and quantity one year after planting.

f) New Vegetation in Buffer Areas Required

New vegetation shall be planted to capture non-source pollutants before they reach the perennial stream, as per applicable Orange County standards.

Model Stormwater Runoff Control Ordinance

The following runoff control ordinance is a generic national model that local governments can use for reference and discussion. This ordinance originally appeared as part of a 1980 article in *Natural Resources Journal* entitled "Stormwater Runoff Control: A Model Ordinance for Meeting Local Water Quality Management Needs" by Frank E. Maloney, Richard G. Hamann, and Bram D.E. Canter.

The model ordinance is based on sound scientific principles for water management, and was thoroughly researched and reviewed. The ordinance should not be considered for adoption in its present form, but rather should stimulate interested communities to adjust and modify the concepts presented here so that they can be applied to the characteristics and needs of a particular area.

Special consideration should be given to the suggestions in Section Six (f), Section Seven (f), and Section Nine (d) through (f) regarding a plan for sedimentation and erosion control. As applied to North Carolina, these provisions presume the plan submitted would comply with state regulations concerning land disturbing activities of one acre or more. Local governments could also adopt a separate sedimentation and control ordinance for land disturbing activities on areas smaller than one acre.

This ordinance is detailed and complex, so fairly sophisticated administrative ability would be needed to implement it. This ordinance or modifications of it should be reviewed carefully by legal counsel before it is adopted.

Section One: Short Title

This ordinance shall be known as the "Stormwater Runoff Control Ordinance."

Section Two: Findings of Fact

The (governing authority) of (local unit) finds that uncontrolled drainage and development of land has a significant adverse impact upon the health, safety, and welfare of the community. More specifically,

(a) Stormwater runoff can carry pollutants into receiving water bodies, degrading water quality and affecting finfish and shellfish production;

(b) The increase in nutrients such as phosphorus and nitrogen accelerates eutrophication of receiving waters, adversely affecting flora and fauna;

(c) Improperly channeling water increases the velocity of runoff, thereby increasing erosion and sedimentation;

(d) Construction requiring the alteration of natural topography and removal of vegetation tends to increase erosion;

(e) Siltation of water bodies resulting from increased erosion decreases their capacity to hold and transport water, interferes with navigation, and harms flora and fauna;

(f) Impervious surfaces increase the volume and rate of stormwater runoff and allow less water to percolate into the soil, thereby decreasing groundwater recharge;

(g) Improperly managed stormwater runoff can increase the incidence of flooding and the level of floods which occur, endangering property and human life;

(h) Improperly managed stormwater runoff can interfere with the maintenance of optimum salinity in estuarine areas, thereby disrupting biological productivity;

(i) Substantial economic losses result from these adverse impacts on community waters;

(j) Many future problems can be avoided if land is developed in accordance with sound stormwater runoff management practices.

Section Three: Objectives

In order to protect, maintain, and enhance both the immediate and long term health, safety, and general welfare of the citizens of (local unit), this ordinance has the following objectives:
(a) To encourage productive and enjoyable harmony between humanity and nature;

(b) To protect, restore, and maintain the chemical, physical, and biological integrity of community waters;

(c) To prevent individuals, business organizations, and governments from causing harm to the community by activities which adversely affect water resources;

(d) To encourage the construction of drainage systems which aesthetically and functionally approximate natural systems;

(e) To encourage the protection of natural systems and the use of them in ways which do not impair their beneficial functioning;

(f) To encourage the use of drainage systems which minimize the consumption of electrical energy or petroleum fuels to move water, remove pollutants, or maintain the systems;

(g) To minimize the transport of pollutants to community waters;

(h) To maintain or restore groundwater levels;

(i) To protect, maintain, or restore natural salinity levels in estuarine areas;

(j) To minimize erosion and sedimentation;

(k) To prevent damage to wetlands;

(l) To prevent damage from flooding, while recognizing that natural fluctuations in water levels are beneficial;

(m) To protect, restore, and maintain the habitat of fish and wildlife; and

(n) To ensure the attainment of these objectives by requiring the approval and implementation of water management plans for all activities which may have an adverse impact upon community waters.

Section Four: Definitions

Unless specifically defined below, words or phrases shall be interpreted so as to give them the meaning they have in common usage and to give this ordinance its most effective application. Words used in the singular shall include the plural and the plural the singular; words used in the present tense shall include the future tense. The word "shall" connotes mandatory and not discretionary; the word "may" is permissive.
(a) "Adverse Impacts" are any modifications, alterations, or effects on a feature or characteristic of community waters or wetlands, including their quality, quantity, hydrodynamics, surface area, species composition, living resources, aesthetics, or usefulness for human or natural uses which are or may potentially be harmful or injurious to human health, welfare, safety or property, to biological productivity, diversity, or stability or which unreasonably interfere with the enjoyment of life or property, including outdoor recreation. The term includes secondary and cumulative as well as direct impacts.

(b) "Clearing" means the removal of trees and brush from the land but shall not include the ordinary mowing of grass.

(c) "Detention" refers to the collection and storage of surface water for subsequent gradual discharge.

(d) "Developer" means any person who engages in development either as the owner or as the agent of an owner of property.

(e) "Development" or "Development Activity" means:

> (1) the construction, installation, alteration, demolition, or removal of a structure, impervious surface, or drainage facility; or

(2) clearing, scraping, grubbing, or otherwise removing or killing the vegetation of a site;

(3) adding, removing, exposing, excavating, leveling, grading, digging, burrowing, dumping, piling, dredging, or otherwise significantly disturbing the soil, mud, sand, or rock of a site.

(f) "Drainage Facility" means any component of the drainage system.

(g) "Drainage System" is the system through which water flows from the land. It includes all watercourses, waterbodies, and wetlands.

(h) "Erosion" is the wearing or washing away of soil by the action of wind or water.

(i) "Flood" is a temporary rise in the level of any waterbody, watercourse, or wetland which results in the inundation of areas not ordinarily covered by water.

(j) "Impervious Surface" means a surface which has been compacted or covered with a layer of material so that it is highly resistant to infiltration by water. It includes semi-impervious surfaces such as compacted clay, as well as most conventionally surfaced streets, roofs, sidewalks, parking lots, and other similar structures.

(k) "Natural Systems" means systems which predominantly consist of or use those communities of plants, animals, bacteria, and other flora and fauna which occur indigenously on the land, in the soil, or in the water.

(l) "Owner" is the person in whom is vested the fee ownership, dominion, or title of property, i.e., the proprietor. This term may also include a tenant, if chargeable under his lease for the maintenance of the property, and any agent of the owner or tenant including a developer.

(m) "Person" means any and all persons, natural or artificial and includes any individual, firm, corporation, government agency, business trust, estate, trust, partnership, association, two or more persons having a joint or common interest, or any other legal entity.

(n) "Predevelopment Conditions" are those conditions which existed before alteration, resulting from human activity, of the natural topography, vegetation and rate, volume or direction of surface or ground water flow, as indicated by the best available historical data.

(o) "Receiving Bodies of Water" shall mean any waterbodies, watercourses, or wetlands into which surface waters flow either naturally, in man-made ditches, or in a closed conduit system.

(p) "Retention" refers to the collection and storage of runoff without subsequent discharge to surface waters.

(q) "Sediment" is fine particulate material, whether mineral or organic, that is in suspension or has settled in a waterbody.

(r) "Sedimentation Facility" means any structure or area which is designed to hold runoff water until suspended sediments have settled.

(s) "Site" means any tract, lot, or parcel of land or combination of tracts, lots, or parcels of land which are in one ownership, or are contiguous and in diverse ownership where development is to be performed as part of a unit, subdivision, or project.

(t) "Structure" means that which is built or constructed, an edifice or building of any kind, or any piece of work artificially built up or composed of parts joined together in some definite manner but shall not include fences or signs.

(u) "Subdivide" means to divide the ownership of a parcel of land, whether improved or unimproved, into three or more contiguous lots or parcels of land, whether by reference to a plat, by metes and bounds or otherwise, or, if the establishment of a new street is involved, any division of a parcel of land. Subdivision includes a resubdivision and, when appropriate to the context, relates to the process of subdividing or to the subdivided.

(v) "Vegetation" means all plant growth, especially trees, shrubs, vines, ferns, mosses, and grasses.

(w) "Waters" or "Community of Waters" means any and all water on or beneath the surface of the ground. It includes the water in any watercourse, waterbody, or drainage system. It also includes diffused surface water and water percolating, standing, or flowing beneath the surface of the ground, as well as coastal waters.

(x) "Water Management Plan" refers to the detailed analysis required by Section Six for each activity described in Section Five of this ordinance.

(y) "Watercourse" means any natural or artificial stream, river creek, channel, ditch canal, conduit, culvert, drain, waterway, gully, ravine, street, roadway, swale, or wash in which water flows in a definite direction, either continuously or intermittently, and which has a definite channel, bed, or banks.

(z) "Waterbody" means any natural or artificial pond, lake, reservoir, or other area which ordinarily or intermittently contains water and which has a discernible shoreline.

(aa) "Watershed" means a drainage area or drainage basin contributing to the flow of water in a receiving body of water.

(bb) "Wetlands" means those areas where

(1) the soil is ordinarily saturated with water or;

(2) the dominant plant community is one or more of those species designated by the (Coastal Resources Commission and/or U.S. Army Corps of Engineers) as identifying wetlands or the transitional zone of wetlands.

Section Five: Applicability

(a) Unless exempted pursuant to subsection (b) or waived pursuant to subsection (c), a Water Management Plan must be submitted and approved before:

(1) a plat is recorded or land is subdivided; or

(2) an existing drainage system is altered, rerouted, deepened, widened, enlarged, or obstructed; or

(3) development is commenced.

(b) Exemptions. The following development activities are exempt from the Water Management Plan Requirement:

(1) the development of less than five single family or duplex residential dwelling units and their accessory structures (such as fences, storage sheds, and septic tanks) in an existing subdivision;

(2) the development of one single family or duplex residential structure not in an existing subdivision;

(3) agricultural activity not involving the artificial drainage of land;

(4) any maintenance, alteration, use, or improvement to an existing structure not changing or affecting quality, rate, volume, or location of surface water discharge.

(c) Waivers.

(1) A waiver of the Water Management Plan requirement may be obtained by submitting an application on forms supplied by (local agency). The application shall contain:

(i) the name, address and telephone number of the developer and owner; and

(ii) a description and a drawing of the proposed development; and

(iii) the location of the development; and

(iv) any other information requested by (local agency) that is reasonably necessary to evaluate the proposed development.

(2) The (local agency) may grant a waiver if the application demonstrates the development is not likely to:

(i) (significantly) increase or decrease the rate or volume of surface water runoff;

(ii) have a (significant) adverse impact on a wetland, watercourse, or waterbody;

(iii) (significantly) contribute to the degradation of water quality.

(3) The following types of development shall not be eligible to receive a waiver:

(i) shopping centers;

(ii) industrial or commercial facilities;

(iii) subdivisions;

(iv) roads;

(v) impervious surfaces greater than 10,000 square feet.

(d) Variances. The (local agency) may grant a written variance from any requirement of this ordinance using the following criteria:

(1) there are special circumstances applicable to the subject property or its intended use; and

(2) the granting of the variance will not:

(i) (significantly) increase or decrease the rate or volume of surface water runoff;

(ii) have a (significant) adverse impact on a wetland, watercourse, or waterbody;

(iii) (significantly) contribute to the degradation of water quality;

(iv) otherwise (significantly) impair attainment of the objectives of this ordinance.

Section Six: Contents of the Water Management Plan

(a) It is the responsibility of an applicant to include in the Water Management Plan sufficient information for the (local agency) to evaluate the environmental characteristics of the affected areas, the potential and predicted impacts of the proposed activity on community waters, and the effectiveness and acceptability of those measures proposed by the applicant for reducing adverse impacts. The Water Management Plan shall contain maps, charts, graphs, tables, photographs, narrative descriptions, and explanations and citations to supporting references, as appropriate to communicate the information required by this section.

(b) The Water Management Plan shall contain the name, address, and telephone number of the owner and the developer. In addition, the legal description of the property shall be provided, and its location with reference to such landmarks as major waterbodies, adjoining roads, railroads, subdivisions, or towns shall be clearly identified by a map.

(c) The existing environmental and hydrologic conditions of the site and of receiving waters and wetlands shall be described in detail, including the following:

(1) the direction, flow rate, and volume of stormwater runoff under existing conditions and, to the extent practicable, predevelopment conditions;

(2) the location of areas on the site where stormwater collects or percolates into the ground;

(3) a description of all watercourses, waterbodies, and wetlands on or adjacent to the site or into which stormwater flows. Information regarding their water quality and the current water quality classification, if any, given them by the (Environmental Management Commission) shall be included;

(4) groundwater levels, including seasonal fluctuations;

(5) location of flood plains;

(6) vegetation;

(7) topography;

(8) soils.

(d) Proposed alterations of the site shall be described in detail, including:

(1) changes in topography;

(2) areas where vegetation will be cleared or otherwise killed;

(3) areas that will be covered with an impervious surface and a description of the surfacing material;

(4) the size and location of any buildings or other structures.

(e) Predicted impacts of the proposed development on existing conditions shall be described in detail, including:

(1) changes in water quality;

(2) changes in groundwater levels;

(3) changes in the incidence and duration of flooding on the site and upstream and downstream from it;

(4) impacts on wetlands; and

(5) impacts on vegetation.

(f) All components of the drainage system and any measures for the detention, retention, or infiltration of water for the protection of water quality shall be described in detail, including:

(1) the channel, direction, flow rate, volume, and quality of stormwater that will be conveyed from the site, with a comparison to existing conditions and, to the extent practicable, predevelopment conditions;

(2) detention and retention areas, including plans for the discharge of contained waters, maintenance plans, and predictions of water quality in those areas;

(3) areas of the site to be used or reserved for percolation including a prediction of the impact on groundwater quality;

(4) a plan for the control of erosion and sedimentation which describes in detail the type and location of control measures, the stage of development at which they will be put into place or used, and provisions for their maintenance;

(5) any other information which the developer or the (local agency) believes is reasonably necessary for an evaluation of the development.

Section Seven: Procedures and Fees

(a) Any person planning a development as defined in this ordinance, unless exempted, shall submit a Water Management Plan or an application for waiver to the (local agency).

(b) Within ten (10) working days after submission of the completed waiver application, the (local agency) shall notify the applicant that the waiver has been approved or denied and whether or not a Water Management Plan must be submitted by the applicant.

(c) A permit fee will be collected at the time the Water Management Plan or application for waiver is submitted and will reflect the cost of administration and management of the permitting process. The (governing authority) shall establish, by resolution, a prorated fee schedule based upon the relative complexity of the project. The fee schedule may be amended from time to time by the (governing authority) by resolution. Notice of such resolution shall be published no less than fifteen (15) days prior to adoption.

(d) Within thirty (30) days after submission of the completed Water Management Plan, the (local agency) shall approve, with or without specified conditions or modifications, or reject the Plan and shall notify the applicant accordingly. If the (local agency) has not rendered a decision within thirty (30) days after Plan submission, it shall inform the applicant of the status of the review process and the anticipated completion date. If the Plan is rejected or modified, the (local agency) shall state its reasons. However, it is not the responsibility of the (local agency) to design an acceptable project.

(e) The Water Management Plan shall not be approved unless it clearly indicates the proposed development will meet the Performance Standards described in Section Eight and the Design

Standards described in Section Nine, except where a variance has been granted pursuant to Section Five, Subsection (d), or where off-site management is approved pursuant to Section Ten.

(f) Inspections. No Water Management Plan may be approved without adequate provision for inspection of the property before development activity commences. The applicant shall arrange with the (local agency) for scheduling the following inspections:

(1) Initial Inspection – prior to approval of the Water Management Plan;

(2) Bury Inspection – prior to burial of any underground drainage structure;

(3) Erosion Control Inspection – as necessary to ensure effective control of erosion and sedimentation;

(4) Finish Inspection – when all work including installation of all drainage facilities has been completed.

The (local agency) shall inspect the work and shall either approve it or notify the applicant in writing in what respects there has been a failure to comply with the requirements of the approved Water Management Plan. Any portion of the work which does not comply shall be promptly corrected by the applicant or the applicant will be subject to the penalty provisions of Section Thirteen.

(g) Appeals. Any person aggrieved by the action of any official charged with the enforcement of this Ordinance, as the result of the disapproval of a properly filed application for a permit, issuance of a written notice of violation, or an alleged failure to properly enforce the Ordinance in regard to a specific application, shall have the right to appeal the action to the (special hearing examiner). The appeal shall be filed in writing within twenty (20) days of the date of official transmittal of the final decision or determination to the applicant, shall state clearly the grounds on which the appeal is based, and shall be processed in the manner prescribed for hearing administrative appeals under (local or state code provision).

Section Eight: Performance Standards

Water Management Plans must demonstrate the proposed development or activity has been planned and designed and will be constructed and maintained to meet each of the following standards:

(a) Ensure that after development, runoff from the site approximates the rate of flow, volume, and timing of runoff that would have occurred following the same rainfall under existing conditions and, to the extent practicable, predevelopment conditions, unless runoff is discharged into an Off-site Drainage Facility as provided in Section Ten;

(b) Maintain the natural hydrodynamic characteristics of the watershed;

(c) Protect or restore the quality of ground and surface waters;

(d) Ensure that erosion during and after development is minimized;

(e) Protect groundwater levels;

(f) Protect the beneficial functioning of wetlands as areas for the natural storage of surface waters and the chemical reduction and assimilation of pollutants;

(g) Prevent increased flooding and damage that results from improper location, construction, and design of structures in areas which are presently subject to an unacceptable danger of flooding;

(h) Prevent or reverse salt water intrusion;

(i) Protect the natural fluctuating levels of salinity in estuarine areas;

(j) Minimize injury to flora and fauna and adverse impacts to fish and wildlife habitat;

(k) Otherwise further the objectives of this Ordinance.

Section Nine: Design Standards

To ensure attainment of the objectives of this Ordinance and to ensure that performance standards will be met, the design, construction, and maintenance of drainage systems shall be consistent with the following standards:

(a) Channeling runoff directly into waterbodies shall be prohibited. Instead, runoff shall be routed through swales and other systems designed to increase time of concentration, decrease velocity, increase infiltration, allow suspended solids to settle, and remove pollutants;

(b) Natural watercourses shall not be dredged, cleared of vegetation, deepened, widened, straightened, stabilized, or otherwise altered. Water shall be retained or detained before it enters any natural watercourse in order to preserve the natural hydrodynamics of the watercourse and to prevent siltation or other pollution;

(c) The area of land disturbed by development shall be as small as practicable. Those areas which are not to be disturbed shall be protected by an adequate barrier from construction activity. Whenever possible, natural vegetation shall be retained and protected;

(d) No grading, cutting, or filling shall be commenced until erosion and sedimentation control devices have been installed between the disturbed area and waterbodies, watercourses, and wetlands;

(e) Land which has been cleared for development and upon which construction has not commenced shall be protected from erosion by appropriate techniques designed to revegetate the area;

(f) Sediment shall be retained on the site of the development;

(g) Wetlands and waterbodies shall not be used as sediment traps during development;

(h) Erosion and sedimentation facilities shall receive regular maintenance to insure that they continue to function properly;

(i) Artificial watercourses shall be designed considering soil type, so that the velocity of flow is low enough to prevent erosion;

(j) Vegetated buffer strips shall be created or, where practicable, retained in their natural state along the banks of all watercourses, waterbodies, or wetlands. The width of the buffer shall be sufficient to prevent erosion, trap the sediment in overland runoff, provide access to the waterbody, and allow for periodic flooding without damage to structures;

(k) Intermittent watercourses, such as swales, should be vegetated;

(l) Retention and detention ponds shall be used to retain and detain the increased and accelerated runoff which the development generates. Water shall be released from detention ponds into watercourses or wetlands at a rate and in a manner approximating the natural flow which would have occurred before development;

(m) Although the use of wetlands for storing and purifying water is encouraged, care must be taken not to overload their capacity, thereby harming the wetlands and transitional vegetation. Wetlands should not be damaged by the construction of detention ponds;

(n) The first one inch of runoff from impervious surfaces shall be retained on the site of the development;

(o) Runoff from parking lots shall be treated to remove oil and sediment before it enters receiving waters;

(p) Detention and retention areas shall be designed so that shorelines are sinuous rather than straight and so that the length of shoreline is maximized, thus offering more space for the growth of littoral vegetation;

(q) The banks of detention and retention areas shall slope at a gentle grade into the water as a safeguard against drowning, personal injury, or other accidents, to encourage the growth of vegetation, and to allow the alternate flooding and exposure of areas along the shore as water levels periodically rise and fall.

(r) The use of drainage facilities and vegetated buffer zones as open space, recreation, and conservation areas shall be encouraged.

Section Ten: Off-Site Drainage Facilities

(a) The (local agency) may allow stormwater runoff that is otherwise of unacceptable quality or which would be discharged in volumes or at rates in excess of those otherwise allowed by this Ordinance, to be discharged into drainage facilities off the site of development if each of the following conditions is met:

(1) it is not practicable to completely manage runoff on the site in a manner that meets the Performance Standards and Design Standards;

(2) the off-site drainage facilities and channels leading to them are designed, constructed, and maintained in accordance with the requirements of this ordinance;

(3) adequate provision is made for the sharing of construction and operating costs of the facilities. The developer may be required to pay a portion of the cost of constructing the facilities as a condition of receiving approval of the drainage plan;

(4) adverse environmental impacts on the site of development will be minimized.

(b) A request to use off-site drainage facilities and all information related to the proposed off-site facilities should be made a part of the developer's Water Management Plan. Guidelines for the consideration of off-site facility use will be defined in the Manual of Surface Water Management Practices.

Section Eleven: Manual of Stormwater Management Practices

(a) The (local agency) shall compile a manual of Stormwater Management Practices for the guidance of persons preparing Water Management Plans and designing or operating drainage systems. The Manual shall be updated periodically to reflect the most current and effective practices and shall be made available to the public;

(b) The Manual shall include guidance and specifications for the preparation of Water Management Plans. Acceptable techniques for obtaining, calculating, and presenting the information required in the Water Management Plan shall be described;

(c) The Manual shall include guidance in the selection of environmentally sound practices for the management of stormwater and the control of erosion and sediment. Specific techniques and practices shall be described in detail. The development and use of techniques which emphasize the use of natural systems shall be encouraged;

(d) The Manual shall also establish minimum specifications for the construction of drainage facilities. Construction Specifications shall be established in accordance with sound engineering practices;

(e) The (local agency) shall submit the Manual and subsequent revisions of it to the (local authority) for review and approval.

Section Twelve: Maintenance

(a) Drainage facilities shall be dedicated to the (governing authority) where they are determined to be appropriately a part of the (local unit) maintained regional system or are unlikely to be adequately maintained by the developer or owner of the property.

(b) The systems maintained by the owner shall have adequate easements to permit the (local agency) to inspect and, if necessary, to take cor-

rective action should the owner fail to properly maintain the system. Before taking corrective action, the (local agency) shall give the owner written notice of the nature of the existing defects. If the owner fails within thirty (30) days from the date of notice to commence corrective action or to appeal the matter to the (special hearing examiner), the (local agency) may take necessary corrective action, the cost of which shall become a lien on the real property until paid.

Section Thirteen: Enforcement

(a) Nuisance. Any development activity that is commenced without prior approval of a Water Management Plan or is conducted contrary to an approved Water Management Plan as required by this Ordinance, shall be deemed a public nuisance and may be restrained by injunction or otherwise abated in a manner provided by law.

(b) Civil and Criminal Penalties. In addition to or as an alternative to any penalty provided herein or by law, any person who violates the provisions of this Ordinance shall be punished by a fine of not less than One Hundred Dollars ($100) nor more than One Thousand Dollars ($1,000) or by imprisonment in the county jail for a period not to exceed sixty (60) days, or by both such fine and imprisonment. Such person shall be guilty of a separate offense for each day during which the violation occurs or continues;

(c) Any violator may be required to restore land to its undisturbed condition. In the event that restoration is not undertaken within a reasonable time after notice, the (local agency) may take necessary corrective action, the cost of which shall become a lien upon the property until paid.

(d) Notice of Violation. When the (local agency) determines that development activity is not being carried out in accordance with the requirements of this Ordinance, it shall issue a written notice of violation to the owner of the property. The notice of violation shall contain:

(1) the name and address of the owner or applicant;

(2) the street address when available or a description of the building, structure, or land upon which the violation is occurring;

(3) a statement specifying the nature of the violation;

(4) a description of the remedial actions necessary to bring the development activity into compliance with this Ordinance and a time schedule for completion of such remedial action;

(5) a statement of the penalty or penalties that shall or may be assessed against the person to whom the notice of violation is directed;

(6) a statement that the (local agency) determination of violation may be appealed to the (special hearing examiner) by filing a written notice of appeal within fifteen (15) days of service of notice of violation.

The notice of violation shall be served upon the person(s) to whom it is directed either personally, in the manner provided for personal service of notices by the court of local jurisdiction, or by mailing a copy of the notice of violation by certified mail, postage pre-paid, return receipt requested to such person at his or her last known address.

A notice of violation issued pursuant to this section constitutes a determination from which an administrative appeal may be taken to the (special hearing examiner).

Section Fourteen: Severability

Each separate provision of this Ordinance is deemed independent of all other provisions herein so that if any provision or provisions of this ordinance be declared invalid, all other provisions thereof shall remain valid and enforceable.

Section Fifteen: Effective Date

This Ordinance shall become effective on _____.

Appendix Two

State and Federal Laws to Protect Water Quality

Government laws and programs related to water quality are often viewed as confusing and overly complex. They are implemented by dozens of agencies, each of which is responsible for some aspect of water resource management. Although it is beyond the scope of this handbook to detail the interactions between the various agencies, this appendix provides an overview of the state and federal laws related to water management. By and large, initiatives to address water quality have begun at the federal level of government. As problems have been identified, federal laws have been passed to establish regulatory programs and planning and management programs, or some combination of the two. The specific federal response has been influenced by the nature of the problem, the traditional jurisdiction that the problem falls within, and the political climate of the day.

Regulating activities on the nation's waterways, for example, has traditionally fallen under federal purview because of navigation and public service. Over time, the public's interest in these areas has expanded beyond simple access for navigation, and now includes water quality considerations. Because of the traditional federal involvement, the regulatory authority provided under Section 404 of the Clean Water Act was given to the U.S. Army Corps of Engineers rather than delegated to the states.

Environmental problems have often been addressed by providing federal grants and incentives to states to implement protection programs. This type of approach recognizes that high ground activities are of national interest, but that they have been traditionally state and local areas of responsibility. Sedimentation and erosion control, for example, has been addressed through state law and local ordinance and supported by limited federal grants for planning and improved management practices.

This same approach was used to encourage coastal management through the federal Coastal Zone Management Act. It provides grants to coastal states to develop resource management systems. In this case, federal, state, and local interests are reflected in the individual state's resource management program.

To a large extent, these programs have been designed to coordinate the implementation of specific environmental laws, such as erosion control, to achieve improvements in water quality. This effort has been successful, but it has also revealed gaps in the ability of government to achieve the sweeping success indicated by the programs' goals.

One of the gaps is managing high ground sources of pollution that are beyond the traditional state and federal water quality laws but which are within the local government planning, zoning, and regulatory authorities. Requiring a vegetated buffer between high ground development and a natural creek, for example, cannot be required by state and federal programs, but can be required by local ordinance.

The following list of state and federal laws indicates a wide diversity of environmental programs, but when considered as a whole the list also shows that some elements are missing from what would be considered to be a comprehensive water quality management scheme.

Major State Water Quality Legislation

The Mining Act of 1971
G.S. 74-46 et seq.

This law requires the consideration of water quality in mining activities, and that a permit be obtained for such activities. Overall, mining must not adversely affect wildlife, fresh water, estuarine or marine fisheries, violate state standards for surface or groundwater quality, or result in substantial deposits of sediments in streambeds or lakes or cause acid water pollution. The state Mining Commission is established by this act and authorized to adopt rules and regulations. Contact: Division of Land Resources-DNRCD, 919/733-3833.

The North Carolina Well Construction Act
G.S. 87-83 et seq.

This law applies to wells withdrawing at least 100,000 gallons of water per day. It requires that wells be constructed so that groundwater contamination is prevented. The Environmental Management Commission has the authority to adopt rules and regulations. Contact: Division of Environmental Management-DNRCD, 919/733-7015.

Certification of Wastewater Treatment Plant Operators
G.S. 90A-35 et seq.

The purpose of this law is to protect the quality of the state's water resources and to maintain the quality of receiving streams. The Environmental Management Commission is authorized to classify waste treatment facilities, require operator certificates, and monitor their operation. Contact: Division of Environmental Management-DNRCD, 919/733-7015.

Permits to Dredge and/or Fill in or about Estuarine Waters or State Owned Lakes
G.S. 113-229

Under this law permits are issued for dredging and filling activities. Permit applications will be denied if the proposed activity is found to have a significant adverse effect on the use of the waters by the public; the value and enjoyment of riparian property owners; the public's health, safety, and welfare; the quality of public or private water supplies; and wildlife, fresh water, estuarine or marine fisheries. The Coastal Resources Commission hears permit appeals. Contact: Division of Coastal Management-DNRCD, 919/733-2293.

State Environmental Policy Act
G.S. 113A-1 et seq.

The purpose of this law is to encourage the wise, productive, and beneficial use of the state's natural resources without damage to the environment. The act also encourages an educational program to create public awareness of environmental programs and requires state organizations to consider and report on environmental aspects and consequences of their actions involving expenditures of public money. Contact: Department of Administration, 919/733-7232.

Sedimentation Pollution Control Act of 1973
G.S. 113A-50 et seq.

This act recognizes sedimentation as a major pollutant of state waters. The act establishes the Sedimentation Control Commission and authorizes it to adopt necessary rules and regulations and implement a state program for erosion and sedimentation control. The act also requires that erosion and sedimentation control plans be submitted for activities that would disturb more than one acre of land. Contact: Division of Land Resources-DNRCD, 919/733-3833.

The Coastal Area Management Act of 1974
G.S. 113A-100 et seq.

This act establishes the Coastal Resources Commission which sets policies and standards for the North Carolina Coastal Management Program. The Division of Coastal Management issues permits for development in the four areas of environmental concern within the twenty coastal counties under the authority of the commission. The commission sets construction standards and guidelines to follow in determining whether or not a permit will be approved for development within the areas of environmental concern, including the estuarine system AEC.

Protection of water quality is one of the basic goals of the act and the commission's standards clearly state that development that would damage coastal waters will not be allowed. Although water quality can be managed to some extent through the permitting process, there are several activities that the coastal program does not have the authority to regulate, principally agriculture and forestry. Local governments, however, do have the authority to guide activities outside the designated areas of environ-

mental concern – land use planning and zoning are two of the primary methods for doing so. Contact: Division of Coastal Management-DNRCD, 919/733-2293.

Watershed Improvement Programs
G.S. 1309-16 et seq.

This law sets out procedures to be followed in connection with watershed improvements or drainage projects that involve channelization. The Environmental Management Commission is responsible for carrying out the provisions of this act. Contact: Division of Environmental Management-DNRCD, 919/733-7015.

Department of Natural Resources and Community Development, Organization and Powers Generally Related to the Control of Pollution
G.S. 143B-282 et seq.

This statute defines the powers of the Environmental Management Commission. Among other authorities, the commission can classify waters, adopt water use standards, require water use permits, and require pollution abatement and control measures. Contact: Division of Environmental Management-DNRCD, 919/733-7015.

Regulation of Use of Water Resources
G.S. 143-211 et seq.

The purpose of this statute is to conserve water resources and to maintain conditions that are conducive to the development and use of water resources. Under this act the Environmental Management Commission is authorized to designate "capacity use areas" where it is found that the use of groundwater or surface water or both requires coordination and regulation for the protection of the public interest. Contact: Division of Environmental Management-DNRCD, 919/733-7015.

Water and Air Quality Reporting Act of 1971
G.S. 143-215.63 et seq.

This statute authorizes the Environmental Management Commission to require all persons receiving a permit from the Division of Environmental Management to file reports covering the discharge of wastes in state waters and to establish and maintain approved systems for monitoring the quality and quantity of such discharges into the water. Contact: Division of Environmental Management-DNRCD, 919/733-7015.

Oil Pollution and Hazardous Substances Control Act of 1978
G.S. 143-215.75 et seq.

The purpose of this law is to protect the public's health, safety, and welfare by protecting land and water from pollution by oil, oil products, oil by-products, and other hazardous substances. This law authorizes the Environmental Management Commission to regulate oil discharges, oil terminal facilities, and oil refining facilities. Contact: Division of Environmental Management-DNRCD, 919/733-7015.

Water Use Act
G.S. 143-215 et seq.

This law charges the Environmental Management Commission with the responsibility of carrying out a program of planning and education concerning the most beneficial long-term use and conservation of the state's water resources. Contact: Division of Environmental Management-DNRCD, 919/733-7015.

North Carolina Pesticide Law of 1971
G.S. 143-Act 52 and 143-441

This law authorizes the Department of Agriculture to appoint a Pesticide Board that can adopt rules and make policies for programs to regulate the use, application, sale, disposal, and registration of pesticides. Water quality is a consideration of disposal regulations. Contact: Food and Drug Protection Division-DOA, 919/733-7366.

Toxic Substances Act of 1979
G.S. 143-476(d)

This act controls the disposal of specific toxic substances: mercury, plutonium, selenium, thallium, and uranium, PCBs, and kepone. This act makes it a felony to dump, incinerate, or otherwise dispose of these substances in water or land unless it is done in accordance with a federal or state law, regulation, or permit. The Department of Crime Control and Public Safety is responsible for coordinating state agencies' initial response to critical toxic substance incidents. Contact: Department of Crime Control and Public Safety, 919/733-2126.

Solid Waste Management Act of 1978
G.S. 130-Act 13B, 143B-142(b), 130A-294, and 130-166.30

This act establishes the Solid and Hazardous Waste Management Branch within the Department of Human Resources as the single agency responsible for implementing all state and federal legislation on solid and hazardous waste management. The department is directed to engage in research, conduct investigations and surveys, make inspections, and establish a statewide solid waste management program. Authority is given to the Commission for Health Services to develop rules for the establishment, location, operation, maintenance, use, and discontinuance of solid waste management sites and facilities. Contact: Solid and Hazardous Waste Management Branch-DHR, 919/733-2178.

Other State Laws Affecting Water Quality

Federal Water Resources Development Projects
G.S. 143-215.38 et seq.

Right of Withdrawal of Impounded Waters
G.S. 143-215.44 et seq.

Floodway Regulations
G.S. 143-215.51 et seq.

Grants for Water Resources Development Projects
G.S. 143-215.70 et seq.

Regional Water Supply Planning Act of 1971
G.S. 162A-20 et seq.

Regional Sewage Disposal Planning Act of 1971
G.S. 162A-26 et seq.

Metropolitan Sewerage Districts
G.S. 162A-64 et seq.

Waste Management Act of 1981
G.S. 130A-290 et seq.

Hazardous Waste Treatment Commission Act of 1984
G.S. 143B-470 et seq.

Major Federal Water Quality Legislation

The Clean Water Act
(formally entitled the Federal Water Pollution Control Act Amendments of 1972, PL 92-500 now PL 95-217)

The primary goal of this act was the elimination of pollution discharges into navigable waters by 1985. The five major sources of pollution considered under the act in relation to this goal are as follows:

- Municipal Pollution – To be controlled by construction of municipal sewage treatment plants (using federal grants), setting discharge requirements for the plants, and controls on other sources of municipal pollution.

- Industrial Pollution – To be controlled by discharge requirements for industrial sources of pollution, special controls for toxics, and measures aimed at preventing and cleaning up toxic spills. Municipal and industrial discharge limitations are enforced through a system of individual permits.

- Nonpoint Source Pollution – To be controlled primarily by state and local authorities by using various methods to minimize pollution from agriculture and urban runoff.

Developing means for controlling non-point source pollution is one of the major objectives of the act's planning process.

- Dredge and Fill Activities – To be controlled by a regulatory program jointly administered by the Environmental Protection Agency and the U.S. Army Corps of Engineers. This program is partially aimed at the protection of the aesthetics and ecological value of streams, lakes, estuaries, and wetlands threatened by dredging and fill activities.

- Boat Discharges – To be controlled by federal statutes and regulations that require the use of marine sanitation devices designed to meet federal criteria and which prohibit the discharge of untreated waste into waters.

The Safe Drinking Water Act of 1974, amended in 1977 (PL 93-523)

This law authorizes the Environmental Protection Agency to regulate the quality of public drinking water by setting minimum water quality standards and prescribing treatment techniques. It allows the EPA to set limits for specific contaminants that may adversely affect public health. States developing qualified programs may apply to the EPA for delegation to enforce the water quality standards within their state. North Carolina is currently administering the state's program through the Division of Health Services.

Toxic Substances Control Act of 1976 (PL 94-469)

This law authorizes the Environmental Protection Agency to regulate the manufacture, distribution, and use of chemical substances. It requires premarket testing of new chemicals, and identification and testing of all existing chemicals. If a substance should pose an unreasonable risk to human health or the environment, the EPA may modify, limit, or ban the manufacture, processing, distribution, and disposal of that substance. Pesticides, tobacco, firearms, nuclear materials, food, drugs, and additives are covered under separate laws.

Federal Insecticide, Fungicide and Rodenticide Act of 1947 (PL 75-717)

This act directs the Environmental Protection Agency to regulate the manufacture, distribution, and use of pesticides. All pesticides are registered and classified under this act. The EPA requires analysis of composition, degradability, use patterns, and chemical and physical properties before registering any pesticide. A pesticide shown to cause adverse environmental effects may be banned or given a restricted use classification.

Resource Conservation and Recovery Act of 1976 (PL 94-580) (Amended and reauthorized in 1984)

This law calls for "cradle to grave" regulation of hazardous wastes by the Environmental Protection Agency. It bans open dumping and the dumping of hazardous wastes in sanitary landfills. It requires development criteria to identify hazardous wastes and standards for companies generating, transporting, or disposing of such wastes. The state of North Carolina has received approval from the EPA to administer the provisions of this act. Contact: Solid and Hazardous Waste Management Branch-DHR, 919/733-2178.

Comprehensive Environmental Response, Compensation and Liability Act of 1980 (PL 96-510)

This act, better known as Superfund, is administered by the Environmental Protection Agency and addresses the problems of emergency response to toxic contamination, cleanup of abandoned sites, and the long-term care of closed hazardous waste sites. The act covers hazardous waste as defined in the Resource Conservation and Recovery Act and hazardous or toxic substances defined by laws such as the Clean Air Act and the Clean Water Act. This law does not cover gasoline or oil and petroleum products.

Clean Air Act of 1970 (PL 91-604 and PL 95-95)

This law, administered by the Environmental Protection Agency, establishes air quality standards and regulates the emission of air pollutants such as carbon monoxide, lead, hydrocarbons, and the like. The act is important to water quality because many of the regulated pollutants combine with atmospheric water and fall to the earth with rain.

National Environmental Policy Act

The basic goal of this act is to require federal agencies to consider the potential effects of federal projects on the environment. The act requires an environmental impact statement as part of any recommendation for major federal action that may significantly affect the environment. This assessment includes any unavoidable adverse environmental impacts the project would have; alternatives to the proposed action; the short-term uses of the human environment in comparison with the maintenance and enhancement of long term-productivity; and any irreversible and irretrievable commitments of resources that would be involved if the proposal were implemented.

Coastal Zone Management Act (PL 92-583)

This act provides funds to states to develop coastal resource management programs. The law also provides matching grants to states for acquisition of lands for estuarine or marine sanctuaries.

Rural Clean Water Program

Administered by the U.S. Soil Conservation Service, this program encourages best management practices for rural landowners.

Other Federal Laws Affecting Water Quality

The Rivers and Harbors Act of 1899

Surface Mining Control and Reclamation Act of 1977

Offshore Oil Spill Prevention Fund

Deepwater Ports Act

Federal Aid to Wildlife Restoration Act

The Endangered Species Act of 1972

Rural Development Act

Water Bank Act of 1970

Fish and Wildlife Coordination Act

Water Resources Research Act

Glossary

Coastal Water Quality and Ecology Terms

adsorption The attachment of a substance to the surface of a solid. Many pollutants can adsorb to soil particles.

algae bloom An overgrowth of algae that can float to the water's surface, shade out other aquatic plants, and use up the water's oxygen supply as the plants decompose. Algae blooms are caused by excessive nutrient pollution.

aquifer An underground rock or sand formation that holds water. Aquifers are the major source of coastal North Carolina's water supply.

Biological Oxygen Demand (BOD) A standard water quality measurement of the degradable organic waste material in water that will consume oxygen as it is broken down by microbes.

Chemical Oxygen Demand (COD) A water quality measurement similar to biological oxygen demand except that it measures the amount of chemically-reacted oxygen as well as the oxygen consumed by bacteria.

community The biotic community includes all animal and plant populations living in a given area.

detritus Disintegrated and decomposing organic matter. Detritus from salt marsh grasses is especially important as fish food in the coastal area.

discharge The release by people of any waste either directly or indirectly into waters.

Dissolved Oxygen (DO) The measure of the oxygen content of waters. This figure is used as a measure of pollution because several pollutants use up dissolved oxygen, sometimes causing fish kills.

ecosystem A system composed of living organisms and the non-living environment functioning together.

effluent The outflow of a sewer, industry pipe, or other discharge.

estuary A semi-enclosed body of water where fresh water from the land mixes with salt water from the ocean.

eutrophication The enrichment of a water system by nutrients such as phosphorus and nitrogen, characterized by algae blooms and resulting in conditions that favor plant life over animal life. The algae can choke out beneficial plant species, smother animal life, and completely destroy the once productive uses of the water system.

evapotranspiration Movement of water from the earth's surface to the atmosphere by evaporation from land surfaces and water release from plant surfaces.

fecal coliform A type of bacteria found in the digestive tracts of warm-blooded animals. Although fecal coliform bacteria do not cause disease, they indicate the possible presence of other organisms found in fecal material that may cause disease. Drinking water supplies and shellfishing waters are tested for fecal coliform for this reason.

food chain The transfer of food energy, or nutrition, from plant sources to successively higher animals. Each animal eats a lower organism and, in turn, is eaten by a higher organism.

food web The cycling of nutrients through interconnected food chains.

groundwater The water contained in the ground in aquifers.

habitat The place where an organism lives, its "address."

heavy metal Certain types of metals that are toxic, such as lead, mercury, copper, chromium, and cadmium.

hydrology The study of the movement of water.

impervious The condition of a land surface when water cannot pass through it.

infiltration The movement of water into the soil through the soil surface. This can take place only where the soil is porous, not hardened or made impervious, as by pavement.

microbes Microscopic organisms.

nonpoint source Pollution that does not come from a defined source, such as a pipe, but which is scattered – such as urban runoff, agricultural runoff, and septic tank leakage.

organic chemical Any carbon-based chemical. Man-made (or synthetic) organic chemicals can, because of their structure, mimic natural chemicals and thus be toxic to many forms of life.

organic matter Once-living material or by-products of living plants or animals.

pathogen A disease-carrying microorganism, such as a hepatitis virus.

persistent chemical A substance that will remain in the environment for a long period of time without breaking down to harmless products.

pervious The condition of having pores or spaces for water to pass through.

point source pollution Pollution that is discharged from a fixed location such as a pipe.

river basin The area of land drained by a river. All the water falling within a river basin runs into one river.

SA water Water that is classified by the Environmental Management Commission as appropriate for shellfishing and all SB and SC uses. If contaminated by bacteria SA water can be closed to the taking of shellfish.

SB water Water that is classified by the Environmental Management Commission as appropriate for contact recreation and all SC uses.

SC water Water that is classified by the Environmental Management Commission as appropriate for support of all wildlife and fishery uses and incidental contact.

salinity A measure of the amount of salt in water.

suspended solids Small solid particles that do not settle out of water, but remain suspended in it.

synergism A type of chemical interaction that can occur when certain chemicals are present together. When these chemicals interact, they become more toxic than they would be if their individual toxicities were added together.

water quality The physical and chemical characteristics of water systems that enable those systems to support life.

water quality standards Maximum levels of pollutants allowed to be discharged into, or to be present in, the state's waters. Standards correspond to the use classifications for different water bodies. For example, SA standards are designed to keep waters pure enough for the safe consumption of raw shellfish.

Bibliography

For Further Reading

A Citizen's Guide to Water Quality in North Carolina, Tread Softly/North Carolina Public Interest Research Group.

Brower, D., et al. *Managing Development in Small Towns,* Planners Press, American Planning Association, 1984.

Coastal Development and Shellfish Waters, Division of Environmental Management, Department of Natural Resources and Community Development, Raleigh 1985.

Finnemore, E. John. Stormwater Pollution Control: Best Management Practices, *American Society of Civil Engineers,* Vol. 108(EE5), p. 835.

Gordon, Wendy. *A Citizen's Handbook on Groundwater Protection,* New York: Natural Resources Defense Council, 1984.

Klein, R.D. "Urbanization and Stream Quality Impairment," *Water Resources Bulletin,* Vol. 15(4), American Water Resources Association, p. 948.

McCullough, Melissa. *North Carolina Coastal Water Quality Trends 1970-1984,* Division of Coastal Management, Department of Natural Resources and Community Development, Raleigh, 1984.

McCullough, Melissa. *Urban Runoff Impacts and Management Strategies,* Unpublished Report, Division of Coastal Management, Department of Natural Resources and Community Development, Raleigh, 1985.

McHarg, Ian. *Design with Nature,* New York: Natural History Press, 1969.

Preventive Approaches to Stormwater Management, U.S. EPA(440/9-77-001), 1977.

Segal, E., et al. *Toxic Substances Dilemma – A Plan for Citizen Action,* Washington: National Wildlife Federation.

Spitsbergen, Judith M. *Seacoast Life: An Ecological Guide to Natural Seashore Communities in North Carolina,* Chapel Hill: The University of North Carolina Press.

Stormwater and Land Management for Water Resources Protection, Environmental Protection Division, Georgia Department of Natural Resources, 1983.

U.S. EPA. *The Results of the Nationwide Urban Runoff Program, Vol. I Final Report,* Washington: Water Planning Division, EPA, 1983.

Wanielista, M.P. *Stormwater Management: Quantity and Quality,* Ann Arbor: Ann Arbor Science, 1979.

Protecting Coastal Waters Through Local Planning is published by the N.C. Department of Natural Resources and Community Development, 512 N. Salisbury Street, Raleigh, N.C. 27611-7687.

Financial support for this publication was provided in part by a grant under the federal Coastal Zone Management Act, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, Washington, D.C.

Written by Melissa McCullough, Geoffrey Willett, and Ralph Cantral. Edited by Kathryn Henderson. Illustrations by Jill Miller. Design by Jeannette Holmes.

Excerpts from "Stormwater Runoff Control: A Model Ordinance for Meeting Local Water Quality Management Needs" by Frank E. Maloney, Richard G. Hamann, and Bram D.E. Canter, are used by permission of *Natural Resources Journal.*

James G. Martin, Governor
State of North Carolina

William W. Cobey Jr., Secretary
N.C. Department of Natural Resources and Community Development

Fifteen hundred copies of this public document were printed at a cost of $3,811.00 or $2.54 per copy.