Planning to Protect Water and Natural Areas

Worldwide, there is a growing recognition for the need to balance development with watershed protection and water basin management. Any sustainable effort must recognize the interdependence of land use, spatial development, natural areas and water resources. The Chesapeake Bay Program provides an example of comprehensive, integrated and innovative water basin management. Although not flawless, it can serve as a model for the development of other regional watershed protection and management programs in the United States and around the world.

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INTRODUCTION

Overview of water and natural area management

Urban sprawl, fragmented natural areas, and polluted air, soil, and water challenge urban and regional planners throughout the world. Water and nature management is exceedingly difficult because these resources have multiple uses, are impacted by numerous pollution sources, and intersect jurisdictional boundaries. The traditional environmental planning approach to these problems is based on the separation of urban, rural, and environmental functions and tends to primarily focus on the protection of natural areas. However, this is not a sustainable method of planning because "islands of nature will not survive in a sea of destructive practices in agriculture and urban development" (Tjallingii, 1996, p. 18). Therefore, planning must seek to achieve a better balance between ecosystem and watershed integrity and the provision of human, social, and economic services. In order to accomplish this, planning must recognize that problems with water and natural areas (e.g., pollution, the abundance or shortage of water, water quality, impacts of sprawl and poor habitat quality and quantity) are interrelated.

Therefore, in order to balance the need for growth while promoting watershed protection, water basin management must recognize the interdependence of land use, spatial development, natural areas and water resources. For this reason, a holistic approach to planning is needed that integrates ecological, spatial, environmental, economic and water management principles into planning in order to minimize the adverse impacts of development and land use. There are numerous strategies for non-point source abatement, mitigation of water quality impacts, and the protection of natural areas (Lundqvist, Lohm, and M. Falkenmark, 1985):

- *Regulatory approaches*—nutrient caps, pollution permits, cross compliance, and river basin organizations.
- *Economic instruments*—land evaluation, taxes, fees, subsidies, cost recovery, economic incentives, investment policies, and permit trading.
- *Analytical tools*—research, predictive modeling, monitoring, and project evaluation.
- *Management plans*—that assess the social, educational, legal, administrative, technical, and financial factors to create a realistic plan for the optimal integrated management of land and water

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resources (e.g., river basin planning and tributary strategies).

- *Spatial and land management techniques*—critical area programs, transfer of development rights (TDRs) from sensitive areas to areas identified for growth, riparian stream buffer restoration programs, transportation planning to decrease emissions and atmospheric deposition, land acquisition programs, urban growth boundaries, and subdivision and zoning regulations.
- *Best management practices (BMPs)*—to decrease runoff from agriculture (e.g., nutrient balance, low-input farming, economic incentives, cost share programs, and education), urban areas (e.g., separated sewage and storm water collection systems and designs that decrease permeable services and filter pollutants), and construction areas (e.g., erosion control techniques).
- *Education and training*—to achieve coordination of land and water management and conservation.

Combinations of these strategies are utilized in programs throughout the world to promote integrated land, water, and environmental conservation and management. Cases illustrating the complexity of watershed management and the use of innovative management strategies are evident in Europe and the United States, both of which face growing watershed management challenges. This article examines the interstate watershed management framework of the *Chesapeake Bay Program*, which consists of federal, regional, state, and local initiatives.

The following section provides an overview of the Chesapeake Bay Program and identifies the three main common threats to water resources and natural areas: 1) excess nutrients; 2) poor habitat quality and quantity; and 3) development pressures. Next, the paper identifies the three main environmental planning themes that guide planning and management efforts in the Chesapeake Bay: 1) pollution reduction; 2) natural area protection and restoration; and 3) sustainable development. For each of these themes, the strategies used to promote these themes are described and, when permissible, the effectiveness of the strategies is also described. The final section evaluates the Chesapeake Bay Program and identifies strengths and weaknesses of its strategies, as well as the strategies that may be transferable to other watersheds in the United States and around the world.

This examination of water basin management programs implementing comprehensive (i.e., encompassing various pollutant sources), integrated (i.e., across jurisdictional boundaries and policy fields), and innovative management strategies is important for the future advancement in water management. The analysis presented here does not provide a comprehensive blue print for watershed management; conditions vary too much from watershed to watershed for this to be possible, and therefore policies and programs must be tailored to the specific environmental, geographic, hydrologic, economic, and political circumstances of an area. This analysis only attempts to provide an overview of available tools and a general framework for effective water basin management.

Overview of the Chesapeake Bay

The Chesapeake Bay exemplifies a large scale, innovative, high profile program with multi-jurisdictional commitment. The Chesapeake Bay is located along the central east coast of the United States and is the U.S.'s largest estuary with a watershed that covers more than 64,000 square miles and extends over six states—Maryland, Virginia, Pennsylvania, New York, West Virginia, and Delaware—and the District of Columbia. The main body of the bay is roughly 200 miles long, with an irregular shoreline approximately 4,400 miles in length and a surface area exceeding 23,000 square miles (Moreau, 1997). Land use within the Chesapeake basin is characterized as 10 percent developed, 60 percent woodland and nature, and 30 percent agriculture. Furthermore, the bay has

approximately 50 major tributaries; the main tributary basins include the Susquehanna, Potomac, James, Rappahonnock, and York Rivers (NASDA, 1997). In addition, it includes 1,650 local communities consisting of approximately 15.1 million people (CBP, 1999).

In reaction to emerging environmental problems, the Chesapeake Bay Program was formed in 1983 to promote interstate cooperation between Maryland, Pennsylvania, Virginia, and the District of Columbia. The Chesapeake Bay Program has evolved into a nationally renowned regional program that works in conjunction with federal regulations, the Chesapeake Bay Agreement, state programs, and individual local governments.

Threats to water resources and natural areas

The Chesapeake Bay faces a number of threats to water resources and natural areas that present challenges to spatial, environmental and water planning. The three main threats to water resources and nature areas are pollution and eutrophication, poor habitat quality and quantity, and development pressures.

Excess nutrients

The excess of phosphorus and nitrogen nutrients are a critical pollution problem for both the Chesapeake Bay region. Excess nutrients contribute to eutrophication, which is the increase in algae growth, followed by reduced oxygenation, lower water column transparency, and decreased water quality that result in adverse ecological consequences. Excess nutrients often result from the overflow of combined sewage systems, urban runoff, industry, slurry and silage seepage, and runoff from agricultural areas.

Studies of the bay demonstrate that atmospheric deposition and diffuse land discharges are the largest sources of nutrient pollutants affecting water quality (CBP, 1999b; Correll, Jordan, and Weller, 1992). For example, in 1996 diffuse sources contributed 66 percent of the phosphorus load and 57 percent of the nitrogen load to the bay. Whereas, atmospheric deposition contributes to approximately 9 percent of phosphorus and 21 percent of nitrogen entering the bay (CBP, 1999). Important nonpoint sources include runoff from agriculture, construction sites, and urban areas. Therefore, effective land use and environmental planning controls are required to reduce nutrient losses to the environment.

Poor habitat quality and quantity

Poor habitat quality and quantity present another important challenge to planners in the Chesapeake Bay basin. The Chesapeake Bay is facing the loss of important woodlands and wetlands which function as critical habitat and also prevent pollutants and sediment from entering tributaries and reaching the bay. Approximately 59 percent of the bay basin is forested; however, forests are lost at a rate of about 100 acres per day due to suburban development and population growth (Chesapeake Bay, 1998). In addition, the Chesapeake Bay region has more than 1.5 million acres of wetlands; however, population growth and development pressures threaten these wetlands. For example, between 1982 and 1989, 5 acres per year of estuarine wetlands and 3,000 acres per year of freshwater wetlands were lost. Therefore, future protection and restoration of existing and degraded wetlands and forests are essential.

Development pressures

Population growth and development pressure are significant threats to the Chesapeake Bay. Population growth triggers the demand for development which results in the loss of wetlands, forests, and agricultural lands. Unmanaged development also results in increased impervious surfaces and runoff, sprawling development patterns, and inefficient traffic patterns that increase vehicle miles traveled and air pollution (USGS, 1999). The Chesapeake Bay region will experience significant population growth within the next two decades and therefore officials must conscientiously plan for the sustainable development of the area.

The Chesapeake Bay is experiencing rapid population growth that threatens natural areas and water resources. For example, between 1970 and 1997 population within the bay's

watershed grew by 28 percent to 15.1 million and is expected to grow to 18 million by 2020 (CBP, 1988). This population increase is expected to spur the construction of 1.7 million new homes in the region, which under current development patterns will consume more than 636,000 acres of forest and farmland and thus significantly impact the bay's natural resources (CBP, 1999b). Furthermore, vehicle miles traveled has increased 117 percent between 1970 and 1997 and is expected to further increase with intensified development (CBP, 1999b). Therefore, the region must strive to promote efficient growth patterns and transportation systems to reduce land consumption, vehicle miles traveled, and pollution.

Finally, the loss of wetlands, forests, and agricultural lands to sprawl impacts the health of ecosystems (USGS, 1999). Because each land use change generates numerous environmental repercussions, the choices of development type, location, density, construction methods, design and way of conducting day-to-day activities are fundamental in achieving sustainable development (Rogers, 1992). Although incremental land use decisions, like draining a small wetland, encroaching on a stream, and clearing a forest appear to have limited impacts, the cumulative impact of these changes can pose severe environmental consequences on a larger scale. Moreover, since the economy of the Chesapeake Bay region relies heavily upon the health and vitality of the environment, it is very important to plan for sustainable development in order to protect, preserve and restore the water resources and natural areas.

THE CHESAPEAKE BAY PROGRAM

Overview of the management program

Between 1950 and 1970, downward trends in water quality and fisheries attracted national attention to the Chesapeake Bay. In 1965, the U.S. Army Corp of Engineers began a comprehensive study of the bay that focused on navigation, fisheries, flood control, noxious weeds, water pollution, water quality, beach erosion, and recreation (Moreau, 1999). Subsequently, the Chesapeake Bay Program (CBP) was authorized in 1975. Under the CBP, the U.S. Environmental Protection Agency was given the authority to administer a five-year, $27 million study of the bay to examine water quality problems and then recommend a management plan for restoration.

In 1980, the legislatures of Maryland, Pennsylvania, Virginia, and the District of Columbia established the Chesapeake Bay Commission (CBC) to promote interstate cooperation. The CBC established the Chesapeake Executive Council to assess and manage the implementation of coordinated plans, established an implementation committee to coordinate technical matters and plan preparation, and created a liaison office for Bay activities. Responsibilities of the CBC include: 1) identifying concerns requiring interstate action; 2) recommending legislative and administrative actions needed to respond to those concerns; 3) keeping the legislatures properly informed about the region and its resources; 4) representing the common interest of the states in activities involving the federal government; and 5) providing a forum for the resolution of interstate conflicts (Moreau, 1999).

The first Chesapeake Bay Agreement was signed in 1983, initiating a regional partnership to restore the bay (Chesapeake Bay Implementation Committee, 1988). The major participants in the program include the states of Maryland, Pennsylvania and Virginia; the District of Columbia; the Chesapeake Bay Commission (a tri-state governing body); the U.S. Environmental Protection Agency (EPA) (representing the federal government); and citizen participation. In addition, a second Chesapeake Bay Agreement was adopted in 1987 and amended in 1992. This agreement established an overall vision for protecting and restoring the bay, including the main goal of reducing nitrogen and phosphorus loadings by 40 percent by the year 2000. Finally, in June of 2000 the Chesapeake Bay Program signed the new *Chesapeake 2000 Agreement* to guide restoration efforts throughout the next decade.

The Chesapeake Bay Program is considered a national and international model for estuarine restoration and watershed protection. State,

county, and local governments within the Chesapeake Bay watershed have initiated efforts to protect the bay. One of the important aspects of the program is the increased effort by local governments and watershed organizations to reduce pollution, monitor neighborhood water quality, and restore habitat to improve the bay. Local governments also play a vital role in addressing the effects of land use and poor spatial development patterns (e.g., congested roads, costly public services, the decline of open space, destructive land uses and the deterioration of the local environment). Local governments contribute to the success of restoration, and therefore the program continues to focus on their participation as the key to the management of land use in the watershed.

Since its commencement, the Chesapeake Bay Program has created numerous environmental and land use policies to encourage sustainable development and bay restoration. For example, in 1995 the *Local Government Partnership Initiative* was established to coordinate the restoration efforts of 1,650 local governments within the Bay watershed. Also, in 1996 the *Local Government Participation Action Plan* and the *Priorities for Action for Land, Growth and Stewardship in the Chesapeake Bay Region* were adopted to address land use management, growth and development, stream corridor protection, and infrastructure improvements. These programs have identified three basic management themes that local governments can use to protect the bay (Allen and Hall, 1999):

1. *Land management and stewardship* involves reducing resource consumption and costly sprawl development patterns by encouraging the revitalization of existing communities, the protection of agricultural and forested lands, and sustainable development patterns in order to protect important environmental areas and water quality.
2. *Stream corridor protection and restoration* involves coordinating and supporting efforts to protect, enhance, and restore wetland and forest buffers important for filtering sediment and nutrients before reaching the bay.
3. *Infrastructure improvements* involve upgrading, maintaining and inspecting sewage treatment plant facilities, stormwater management infrastructure and septic systems.

The CBP is constantly seeking ways to improve existing programs and deal with emerging challenges. The CBP continues to monitor the effectiveness of policies, research and develop new policies as well as improve existing policies, and convey the program's goals, policies, and restoration status to the citizens of the region.

Strategies for water resource and natural area protection

The following section highlights several important strategies utilized by the Chesapeake Bay Program to promote three main environmental planning themes: 1) nutrient reduction; 2) natural area protection and restoration; and 3) sustainable development.

Nutrient Reduction

To achieve the 40 percent nutrient reduction goal, the Chesapeake Bay Program's overall strategy is to design and implement a comprehensive system of controls and Best Management Practices (BMPs) with consideration of the type of pollutants, their sources, and other environmental, physical, and social conditions that affect water quality. This broad strategy balances regulations with incentive-based programs and delegates implementation to the states to allow flexibility to tailor programs to meet state-specific needs and conditions. Under this framework, the Bay Program focuses on reducing nutrients from both agriculture and urban areas.

Agriculture

Agriculture covers approximately 30 percent of the total surface area of the Chesapeake Bay region and contributes to a significant portion of

the nutrients entering the bay. The nutrients are a result of excess chemical fertilizers, animal manure, sewage sludge used on fields, and animal wastes that run off feedlots and pastures. Some of the main strategies used to reduce nutrients from agriculture sources include the promotion of sustainable farming practices, nutrient management programs, incentive programs, and tributary strategies.

Sustainable farming practices: There are various programs promoting *best management practices* (BMPs) and *best management systems* (BMSs) to resolve water quality problems in the bay watershed and promote sustainable agriculture. BMPs are a wide variety of techniques designed to more efficiently and effectively practice agriculture and to reduce runoff (NASDA, 1997). For example, BMPs include vegetated buffer strips, conservation tillage, streambank fencing, strip cropping, alternative livestock watering systems, and animal waste handling, storage, transportation, and use as fertilizer. Additionally, resource specialists advocate the combination of various BMPs and nutrient management plans for a best management systems approach to more effectively reduce nutrients and improve production. For example, this may include combining conservation tillage practices with grass waterways, strip-cropping, diversions, stream side buffers and a nutrient management plan.

Examples of state programs promoting sustainable agriculture are seen in Maryland and Virginia. Maryland encourages the adoption and implementation of BMPs by offering a range of financial and technical resources to farmers through the Maryland Agricultural Water Quality Cost-Share Program (MACS) (NASDA, 1997). MACS provides farmers with education and up to 87.5 percent of the cost to install a range of eligible BMPs to protect water quality, such as animal waste storage facilities, grade stabilization structures and grassed waterways. In addition, there are more than 850,000 acres managed under certified nutrient management plans and more than 400 individuals certified to provide management services to farmers.

Virginia's Agricultural Stewardship Act (ASA) created a program in which the Department of Agricultural and Consumer Services (DACS) works with farmers and local Soil and Water Conservation Districts (SWCDs) to resolve water quality problems caused by sediment, nutrients, and pesticides from agricultural operations (NASDA, 1997). Under the program, the DAC receives complaints alleging specific agricultural activities are causing water pollution and then investigates and oversees mitigation. The program provides a wide variety of means and BMPs for farmers to correct water quality problems before enforcement action is deemed necessary. For example, a farmer must create a plan with "stewardship measures" and an implementation schedule to prevent water pollution. The plan must include a tract map, affected water feature designation, soil maps, and a statement of pollution problems. This program allows the opportunity for citizens to identify water quality problems and then provides technical, financial, and legal support to farmers to resolve the problems.

Nutrient Management Programs: Because of the high levels of nutrients from agricultural lands, CBP and states have placed significant emphasis on nutrient management programs. The purpose of nutrient management programs is to balance nutrient inputs and outputs by determining the amount of fertilizer required based on factors such as soil condition, crop rotation, and BMPs in use. This maximizes the benefits of fertilizers and minimizes the impacts on water quality. With a goal of placing 3 million acres of farmland under nutrient management programs by 2000, the CBP's nutrient management strategy has been regarded as one of the most successful in the nation (CBP, 1997).

Different states within the Chesapeake Bay region have developed their own nutrient management programs. For example, Pennsylvania created the Nutrient Management Law in 1993 to strengthen manure management standards in order to reduce loads from livestock. Also, in 1998 Maryland passed the Water Quality Improvement Act, which is regarded as the most comprehensive nutrient management law in the country (CBP, October

1997). The Act requires landowners with nutrient application greater than 10 acres, farm operations grossing $2,500 or more annually, or livestock operations with more than eight animal units[1] to prepare nutrient management plans. Maryland provides financial assistance, technical assistance and software packages to aid farmers (MD Department of Agriculture, undated). In addition, Virginia offers state tax credits as incentives to farmers to develop nutrient management plans and to purchase nutrient application equipment (CBP, October 1997).

The number of acres under nutrient management plans is an indicator of the progress of nutrient management programs. Figure 1 illustrates that since program inception in 1986, more than 3 million acres are projected to be under nutrient management by 2000.

Incentive Programs: Sustainable agriculture practices and nutrient management programs often present high upfront costs to farmers. Therefore, there are numerous incentive-based strategies, in particular cost-share programs for agricultural BMPs, to encourage farmers to implement better agricultural practices. Funding for cost-share programs comes from federal agencies as well as state appropriations. State and federal cost-share programs assist farmers with the costs of installation as an incentive for participation, usually in ratios ranging from 80:20, 75:25, or in some cases such as Pennsylvania's streambank fencing program, 100 percent (CBP, October 1997). Figure 2 illustrates the cost share ratios and funding allocations for state cost share programs.

Tributary Strategies: Many strategies were too general to effectively meet the 40 percent reduction goals. Therefore, in 1992 the Chesapeake Executive Council created the framework for tributary strategies in order to address the need for a more area and source specific approach. Tributary strategies are basin-specific nutrient reduction plans designed for each of the ten major tributaries in the bay. They are designed to take into account the watershed's unique physiographic features (e.g., hydrology, soil, and land use), political climate and institutional structures. The strategies were specifically created to deal with the variation in loadings by jurisdiction, and they allow each jurisdiction to establish tailored, comprehensive nutrient reduction strategies that balance regulatory controls with incentive-based programs. Tributary strategies address three primary areas for nutrient reduction: 1) wastewater treatment plants upgrades to incorporate the BNR

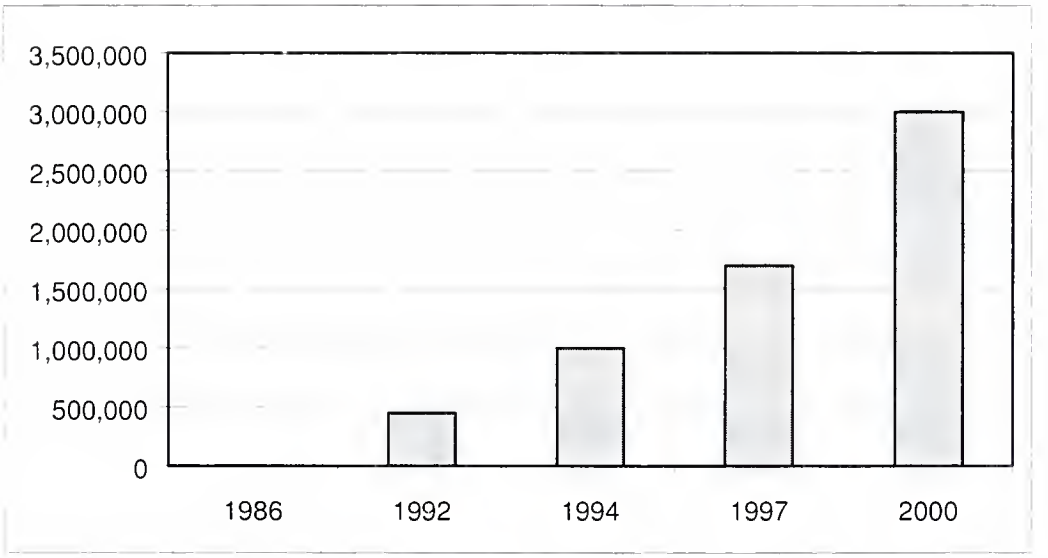

Figure 1. *Acres in Nutrient Management Programs*

State	Cost-Share Ratio	State Funding
Maryland	– 50-87% cost-share ratio – $10,000 cap/practice – $50,000 cap/practice for animal waste storage	– $29.9 million (1983-95)
Pennsylvania	– 80% cost-share ratio – $30,000 cap	– $3 million/year
Virginia	– 75% cost-share ratio – (cap unknown)	– $1 million/year

Figure 2: *Cost-Share Program Allocations (Source: CBP, October 1997b).*

process; 2) agricultural BMPs; and 3) urban storm water BMPs (CBP, 1994).

Another key component of all tributary strategies is public involvement to increase local commitment to the bay's restoration. In particular, there is emphasis on consensus building among major stakeholders, such as farmers and the larger agricultural community, as a way to increase ownership of the plan among constituencies and encourage participation during implementation stages. However, lack of authority and resources and unclear roles and missions present some weaknesses of this approach (CBP, October 1997). Nevertheless, the states continue to support this framework with the belief that local support, locally tailored strategies, and collaboration will significantly enhance the long-term effectiveness and sustainability of watershed based nutrient reductions (CBP, October 1997).

Another important aspect of the tributary strategies program is the introduction of nutrient trading in order to address differences in the cost-effectiveness of nutrient reduction strategies among various tributaries. Because some tributaries, like the Susquehanna Tributary Strategy, fall short of meeting the required 40 percent nutrient reductions, nutrient trading was introduced to compensate for this shortfall by recognizing the increased reductions in other tributaries (CBP, October 1994). Therefore, a 1992 Agreement allows for reallocations of the 40 percent goal to other tributaries outside of the Susquehanna basin (CBP, 1994). All states are considering effluent trading programs but have not yet formally institutionalized the necessary framework.

Urban water

Nutrients from urban areas originate from municipal wastewater treatment plants, sewer overflows and runoff from urban areas (e.g., lawns, roadways, and other developed areas) (NASDA, 1997). Urban best management practices and wastewater treatment plant upgrades are strategies used to decrease nutrients from urban areas. Urban best management practices include erosion and sediment controls on areas under development and stormwater controls in developed areas. These practices are applied by industrial, commercial, and residential facilities to manage lawns, open spaces, and construction sites. Examples include erosion and sediment control,

stormwater management, and septic system maintenance.

Wastewater treatment plant upgrades are another primary control strategy to reduce nutrients. For example, Biological Nutrient Removal (BNR) technology, an advanced nutrient removal system, has been installed in 43 major wastewater treatment plants in the Chesapeake Bay basin. Currently, 48 percent of the flow is treated by BNR and 64 percent of the flow will be treated using BNR after the full implementation of Tributary Strategies. This will lead to a considerable decrease in nutrient loads from municipal wastewater treatment plants.

Effectiveness of nutrient reduction strategies

In 1997, the CBP completed a comprehensive water quality assessment to evaluate progress toward the 40 percent reduction goal. Figure 3 illustrates the reductions in nitrogen and phosphorus between 1985 and 2000. Phosphorus loads declined by 6 million lbs./yr between 1985 and 1998 (mostly due to a ban on phosphates in detergents) and the 40 percent reduction goal was satisfied. However, nitrogen loads declined by 42 million lbs./yr and the 40 percent reduction goal was *not* satisfied. Therefore greater emphasis must be placed on reducing nitrogen loads.

Natural area protection and restoration

The Chesapeake Bay relies on coordinated public and private actions to protect forests and wetlands in the bay's watershed. Strategies used to protect and restore natural areas are the Riparian Forest Buffer Initiative, preservation programs, and the Wetlands Initiative.

Riparian Forest Buffers Initiative

Protecting riparian forest buffers through acquisition, easements, and development regulations is important for water resource and natural area protection. Nearly 50 percent of the bay's riparian[2] forests have been converted to other land uses or degraded. It is important to protect and restore riparian forest buffers because they filter pollutants such as nutrients, sediment, and pesticides in surface and groundwater, and reduce downstream impacts for floods (CBP, March 1999). Nutrient and sediment reductions of 30 to 90 percent can occur when runoff and groundwater pass through riparian forest buffers. In addition, riparian buffers are recognized as an effective control measure to maintain streambank stability, enhance and restore stream habitat, provide corridors for wildlife, and provide cooler water temperatures, leaf litter, and cover for aquatic species.

With over 111,000 miles of perennial and intermittent streams in the Chesapeake Bay watershed, protecting riparian forest buffers is a challenge. In 1996, a Riparian Forest Buffers Initiative was adopted to increase riparian buffers[3] on 2,010 miles of stream and shoreline in the watershed by the year 2010 (CBP, 1999a). In order to reach this goal, Maryland and Pennsylvania will restore 600 miles, Virginia will restore 610 miles, and D.C. and federal lands

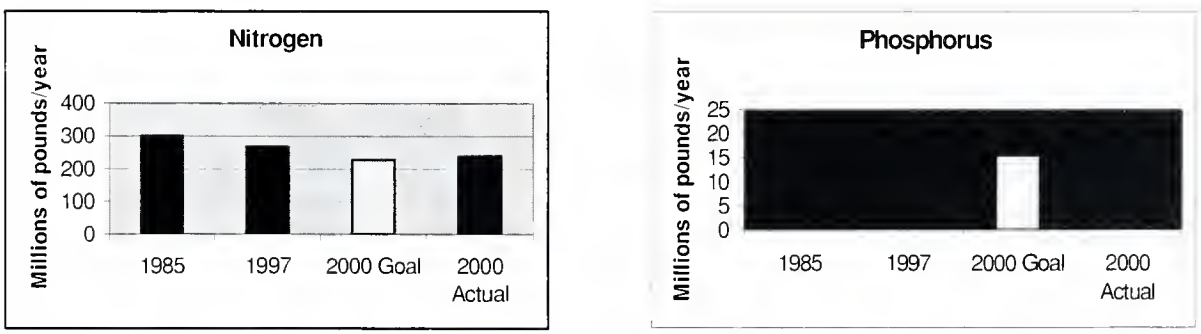

Figure 3: *Effectiveness of Nutrient Reduction Strategies (Source: Chesapeake Bay Program, 1999).*

will restore 200 miles of riparian forest buffers. As part of this initiative, the Chesapeake Bay Program and signatory jurisdictions revise or adopt local zoning and subdivision ordinances, comprehensive land use plans, and regional or watershed stormwater management plans to restore riparian buffers. Additional restoration efforts involve small grant programs, federal-state partnerships supporting Conservation Reserve Enhancement Programs, cost-share programs, tax breaks, easements, and acquisition. The results of restoration efforts are promising. Between 1996 and 2000, approximately 711 miles of riparian forest buffers were restored, which is 35 percent of the 2010 restoration goal.

Preservation programs

The Chesapeake Bay Program seeks to permanently preserve critical environmental areas and relies on public-private partnerships to achieve this goal. The 2000 Chesapeake Bay Agreement guides the next decade of restoration in the Chesapeake Bay watershed. This new agreement has committed members to "...permanently preserve from development 20 percent of the land area in the watershed by 2010" (CBP, December 2000). This goal translates into permanently preserving 7,783,856 acres from development. The CBP plans to permanently protect this land through perpetual conservation or open space easement or fee ownership, held by a federal, state, or local government or non-profit organization.

It is estimated that 6,688,757 acres are currently preserved by all signatory jurisdictions. Of this total amount, approximately 2,116,305 acres are owned by the federal government, 4,209,227 acres are owned or eased by the state governments, 282,291 acres are owned by the local government, and 80,934 acres are owned or eased by nonprofit or other private sources. Subtracting from the acres of land already preserved, there are an additional 1,095,099 acres remaining to preserve in order to meet the 2010 goal.

The Wetlands Initiative

Nearly 1.5 million acres of wetlands occupy the Chesapeake Bay watershed, but increasing population and development pressures are degrading and destroying both tidal and nontidal wetlands in all of the Chesapeake Bay states (CBP, undated a). The Chesapeake Bay Program has recognized the important role that wetlands play in the overall health of the bay and its living resources and has committed itself to protecting and restoring wetlands. In 1988, the Chesapeake Bay Program developed the Wetlands Policy Implementation Plan which established a "no net loss" goal for the watershed. The plan called for fostering the protection of wetlands through four strategies: 1) the inventory and mapping of wetlands; 2) the protection of existing wetlands; 3) the rehabilitation and restoration of degraded wetlands; and 4) education and research. In addition, in 1997 the CBP developed strategies to identify and track wetlands in the Chesapeake Bay watershed to achieve a net gain in wetlands acreage and to assist local governments and watershed groups in wetland management.

Maryland, Virginia, and Pennsylvania have tidal and nontidal wetlands programs to help develop policies and regulations toward wetland protection. In addition, the states have taken steps to protect wetlands beyond the regulatory programs. For example, in 1996 Maryland established a 60,000-acre wetlands net-gain goal, and Pennsylvania has stricter mitigation requirements under their regulatory wetlands program. In order to assist the states with wetlands protection, the 1997 Chesapeake Executive Council adopted an additional wetlands policy designed to speed the restoration and protection of wetlands in the Chesapeake Bay basin. Under Directive 97-2, Wetlands Protection and Restoration Goals, the CBP focuses efforts for achieving no-net-loss of wetlands and to move toward a net gain in the Chesapeake Bay watershed. Under Directive 97-2, the CBP and its partners are committed to complete and publish wetlands status-and-trends reports every five years, to develop state strategies for achieving net gains, to publish a community-based approach to wetlands

preservation and restoration, and to develop quantifiable wetland restoration goals. Despite these efforts to protect and restore wetlands, however, wetland loss still continues.

Effectiveness of natural area protection and restoration

With more than 90,000 acres (150 square miles) of open land consumed annually by growth in the Chesapeake Bay States, the protection and restoration of natural areas is increasingly important as well as challenging. Public and private institutions have united to protect and restore riparian forest buffers, preserve important environmental areas, and stop wetland degradation. The results of current efforts are promising, but continued future support is required. In order to meet its goals, the program must restore 1,299 acres of riparian forests, preserve over 1 million more acres of land, and continue to strive for a net gain in wetlands. This will require significant cooperation and commitment from national, state, and local governments and nonprofits.

Sustainable Development

To promote sustainable development, the Chesapeake Bay primarily relies on voluntary county and local governmental actions, like development management tools, to control land-use planning, water and sewer planning, construction, and other growth-related management processes (Allen and Hall, 1999). Bay restoration and protection programs concentrate on coordinating local initiatives involving land use management, stream corridor protection, and infrastructure improvements. The following highlights some of the important development and land use management strategies utilized by state, county, and local governments within the Chesapeake Bay watershed. Tools described and assessed include critical area regulations, urban growth boundaries, infill/community redevelopment, transfer of development rights, subdivision requirements and cluster zoning, and potential funding strategies for water resource and natural area protection.

State critical area regulations

Both Virginia and Maryland utilize critical area regulations to protect important lands adjacent to the bay. Critical areas are typically identified on a state and regional basis because natural areas cross political jurisdictions and therefore require the cooperation of multiple jurisdictions. Critical area regulations provide multi-jurisdictional commitment and long range planning for significant natural resources. Programs require a broad range of skills and resources for planning, legal justification, and financing, in addition to incorporating various development management tools to balance development and conservation.

For example, Maryland adopted the Chesapeake Bay Critical Area Protection Law in 1984, declaring that the state has a critical and substantial interest in fostering more sensitive development activity along the Chesapeake Bay shoreline in order to minimize damage to water quality and natural habitats (Malone, 1990; Godschalk, 1987). The Act defines the critical area as "lands beneath the Bay and all uplands within 1,000 feet of tidal water or tidal wetlands" and classifies existing development within the critical areas as:

1. *intensely developed areas*—existing developed areas where new growth should occur and improvements to water quality and water conservation are stressed;
2. *limited developed areas*—development is allowed as long as it does not change the established density and prevailing land use and it must improve water quality and conserve existing natural habitat; and
3. *resource conservation areas*—development cannot exceed an overall density of one development unit (du)/acre.

In addition, local governments are required to develop local zoning and development plans that include limiting commercial and industrial development, reducing impervious surfaces,

protecting shore erosion, and describing landscaping requirements.

Maryland's Critical Area Protection Law has been considered to be one of the most extensive and innovative coastal area protection programs in the country; however, there are some criticisms of the regulation. For example, some criticize that the standard, uniform specifications are over-simplistic in that they disregard the differences between shore locations and fail to recognize the potential use of performance standards to mitigate environmental impacts. In addition, the restrictions limiting residential development on land abutting the bay has affected housing prices. Critical area restrictions increase housing prices because they limit the supply of land available for housing construction and increase the value of the shoreline development as an amenity, which is capitalized into the value of land and housing prices (Parsons, 1992). A study of housing price increases resulting from Maryland's critical area restrictions estimated that housing prices for areas with water frontage increased between 46 and 62 percent, prices for housing without frontage increased between 14 and 27 percent, and prices for housing near but not in the critical area increased between 13 and 21 percent (Parsons, 1992).

Urban growth boundaries

An urban growth boundary is a planning tool that guides future development by delineating an arbitrary line around a geo-political region in order to distinguish areas appropriate for urban expansion from areas appropriate for agriculture, rural, and resource protection (Frankel, 2000). The boundary should also coordinate with a strategy that provides the necessary urban services to ensure efficient and timely development. Urban growth boundaries not only serve the local community by encouraging more cost-efficient development, they also can improve the health of the bay by promoting compact urban development and preserving important natural areas from development (CBP, 1997a). For example, urban growth boundaries can limit the number of vehicle miles traveled, protect important environmental areas, and reduce impervious surfaces.

An example of a community using urban growth boundaries as a development management tool within the Chesapeake Bay watershed is the Isle of Wight County, VA. The Isle of Wight County created Development Service Districts that coincide with major transportation corridors and future sewer service expansion plans in order to protect important rural lands from development (CBP, 1997a). Within the districts, the county assumes the responsibility of providing infrastructure, therefore decreasing development costs and encouraging development within the districts. In addition, the county revised land use management ordinances to establish performance standards for landscaping, control of access, lot coverage, and buffering in order to better manage development and protect sensitive environmental and agricultural areas.

Infill/community redevelopment

Promoting infill development allows a community to revitalize existing urban areas, provide adequate and affordable housing, utilize existing infrastructure and reduce the consumption of rural and environmentally sensitive lands. Infill development benefits the region by reducing the number of vehicle miles traveled, reducing the need for septic systems in rural areas which contribute to excess nutrients within the bay, and encouraging the clean up of contaminated sites for future use which reduce the amount of toxic pollutants entering the bay.

An example of a community within the Chesapeake Bay that actively promotes infill development is Lititz Borough, PA (CBP, 1997a). Lititz Borough is located in Lancaster County and has policies to sustain a vibrant downtown center, preserve the town's historic district, and preserve rural lands. In order to promote infill development in downtown, Lititz Borough has a seven-year tax abatement program for commercial and industrial businesses that locate within the downtown. In addition, the town also utilizes an urban growth boundary to promote growth in designated areas and to discourage sprawl outside of the town's limits. Lititz Borough is an example of how a community

coordinates different development management techniques to encourage economic development, compact urban form, and environmental sustainability. The utilization of different development management techniques to promote infill and prevent pollution contributed to Lititz Borough's designation as a Gold Chesapeake Bay Partner Community for efforts to protect its land, rivers, and the bay.

Transfer of development rights (TDR)

The Transfer of Development Rights (TDR) is a tool that allows for the transfer of development rights of one parcel in exchange for the right to develop another parcel more intensely (Smith, 2000). TDR serves as a market-driven, incentive-based development management tool that provides compensation to a landowner without the need for expensive public acquisition (CBP, 1997a). Benefits to the bay include permanently preserving environmentally sensitive areas, forests, and agricultural lands that serve as natural pollution buffers and filtration areas for water quality. In addition, it minimizes the number of septic systems, amount of impervious surface, and the number of vehicle miles traveled.

Montgomery County, MD maintains a careful land management program with more acres preserved under legal protection than any other urban county in the nation. In 1997, over 93,000 acres, nearly one-third of the county, was preserved under legal protection (Allen and Hall, 1999). The County designated 90,000 acres within the sending areas, and has downzoned the area from 1 du/ 5 acres to 1 du/ 25 acres and has allowed one credit per five acres to sending area owners (Smith, 2000). In addition, the county has designated receiving areas where public facilities and public services can support higher density development. The program has been relatively successful; approximately 6,629 development rights from over 400 properties have been severed by easements for a land area of 43,993 acres. Of these, only 5,123 have been transferred to receiving zones. The success of Montgomery County's program is attributed to a land market that promotes TDR sales from the sending areas to the receiving areas, the appropriate determination of the value of TDR's to buyers and sellers, and a clear program that has been properly marketed to landowners, developers, realtors, bankers and attorneys (CBP, 1997a). However, one drawback of the TDR program is that from a regional prospective, Montgomery County cannot prevent development from areas outside its borders.

Subdivision requirements and zoning

Subdivision regulations can play an important role in the protection of important natural areas. For example, cluster zoning allows for the protection of rural character and minimizes the impacts on resource lands by focusing growth into smaller areas of a parcel and preserving the remainder as open space or farmland. Clustering can improve stormwater management by allowing stormwater to be channeled and detained in detention ponds located within the open space. In addition, specified vegetated buffer requirements within subdivision regulations are important to filter sediments and pollutants, reduce flooding, and protect water quality within the watershed.

Howard County, MD, located between Washington D.C. and Baltimore MD, has adopted subdivision controls and cluster zoning to mitigate the effects of rapid growth that threaten rural areas. For example, Howard County's Subdivision and Land Development Regulations require wetlands to be placed in open space when it is created, a buffer of 25 feet around nontidal wetlands, a buffer of 75 feet along perennial streams in residential zoning districts, and a buffer of 50 feet along intermittent streams and along perennial streams in nonresidential zoning districts (Howard County, 1999). Furthermore, because the county's three acre lot minimum was not adequate to handle growth pressure, in 1992 the county adopted three rural cluster districts with specific guidelines to aid developers in subdivision design (CBP, 1996):

1. *Rural Conservation* (RC) allocates priority to agricultural uses and permits residential use at a density of 1 dwelling unit per 4.25 acres with mandatory clustering on parcels greater than 20

acres:

2. *Rural Residential* (RR) applies to areas where the most extensive subdivision has already taken place and is intended to accommodate most of the demand for rural residential development as infill: and

3. *Density Exchange Option* (DEO) is an overlay district that covers all lands within the RC and RR districts. Density may be exchanged between qualified sending and receiving areas. The intent is to give farmers considerable flexibility in transferring density away from the best farms to those locations that have the least long-term viability for agriculture.

Howard County's subdivision regulations and cluster zoning has been relatively successful, and there has been a strong demand for clustered lot subdivisions. In addition, an assessment of Howard County's General Plan cites rural clustering and density exchange as devices to help achieve its goal of 30,000 acres under protection from future development (Howard County, 1999). However, the county did not achieve greater use of shared septic systems to create tighter rural clusters because costs and the agency approval process discouraged implementation.

Potential funding strategies for protecting water resources and natural areas

There are various funding strategies used in the Chesapeake Bay region to support sustainable development. First, a special assessment district can be used to protect or improve a special geographic feature. A special assessment district is an independent government entity formed to finance governmental services for a specific geographic area, such as a stream, small watershed district, or natural resource management district. Residents of the special district pay taxes to finance specific improvements that will benefit them or resolve a community problem, like excessive runoff in the district. For example, residents interested in reclaiming a wetland or improving a waterway can use a special assessment district to manage and finance the project.

Second, a stormwater management utility is an enterprise that can charge landowners a fee based on parcel size and the degree of development. The revenue from this fee can be dedicated to stormwater management activities, such as retrofitting existing systems or providing sediment and erosion control. Third, wetland or forest banking can be used to replace a wetland or forest destroyed by development. Mitigation banks facilitate the administration of a system where appropriate areas for wetlands or forests are matched with developers in need of satisfying off-site mitigation requirements.

Fourth, local governments can utilize a State Revolving Fund where the state provides funds to finance both public and private sector projects that enhance or protect water quality. Projects may include septic system repair or replacement, erosion control, upgrading wastewater treatment facilities, or the construction of animal waste storage facilities. Finally, an endowment fund from a public or private organization can be used for a variety of projects, such as wetlands and habitat creation/restoration, tree planting and streambank stabilization.

Effectiveness of development strategies

The effects of development management are difficult to determine empirically; however, recent modeling efforts indicate the potential effects of different development scenarios. An analysis presented in *Integrating Build-Out Analysis and Water Quality Modeling to Predict the Environmental Impacts of Alternative Development Scenarios* (1998) indicates the potential results from different buildouts within Maryland's Patuxent River watershed. The Maryland Office of Planning (MDOP) modeled land and water resource impacts of three different development alternatives (CBP, March 1998):

1. *2010 Base Zoning* ("worst case scenario"), portraying new development according to current zoning but without the influence of other existing county

subdivision and environmental ordinances and without BMPs for nutrient management;

2. *2010 Current Programs*, portraying new development under current zoning, subdivision, and environmental regulations, as well as implementation of agricultural nonpoint source pollution control; and

3. *2010 Directed Growth*, portraying enhanced levels of growth management, land conservation, and pollution control practices included in Maryland's Tributary Strategies, such as forest conservation, stream buffer protection, rural clustering, increased development potential in growth areas, transfer of development rights, extending sewer service in designated growth areas, protective agricultural zoning, and the purchase of development rights.

The results of modeling the three scenarios suggest that implementation of both growth management and pollution control options are essential in maintaining nutrient load caps beyond the year 2000. In the year 2010, modeling results suggest that pollution levels will be much lower if growth and new development is well directed. In addition, growth management applied in conjunction with other management tools, such as BMPs, will be one of the most important factors determining future pollution levels. For example, MDOP estimates that in the year 2010, nitrogen pollutant loads to the Patuxent River watershed could be about 1,141,000 pounds lower if "Directed Growth," "Resource Protection," and BMP options were used to manage growth. In addition, by the year 2010, stream quality would degrade in nearly half of the Patuxent watershed under the *Current Programs*, while under the *Directed Growth* scenario stream quality would limit degradation to about one quarter of the watershed. The modeling results suggest the importance for state, county, and local governments to continue to pursue sustainable development strategies.

EVALUATION OF THE CHESAPEAKE BAY PROGRAM

The water resource and natural area management approach of the Chesapeake Bay exemplifies a comprehensive, integrated, and innovative management program that can serve as a model for the development of future programs. The following section evaluates the program to protect water resources and natural areas. It identifies the strengths and weaknesses of the Chesapeake Bay Program and some of the strategies that can be applied more broadly in this country and abroad.

Although millions of dollars have been spent on bay restoration programs since the Program originated in 1983, measuring the effectiveness of any program is difficult because of the indistinct link between programs and improvements to water quality and natural areas. However, a general assessment of the strategies utilized by the Chesapeake Bay Program demonstrates a number of significant strengths. Overall, the Chesapeake Bay Program displays good interstate and intrastate cooperation and community involvement. The program goes to great lengths to promote community outreach and provides many opportunities for citizen involvement. In addition, the program is improving its monitoring systems and includes an integrated goals and indicators system that clearly illustrates the status of restoration efforts.

The Chesapeake Bay Program has also created innovative nutrient reduction strategies. For instance, Tributaries Strategies are a flexible and area-specific approach to nutrient reduction. In addition, the Chesapeake Bay has advanced cost-share programs that encourage farmers to implement BMPs. In addition, governments and non-profits within the Bay have successfully collaborated to protect millions of acres of natural areas and hundreds of miles of riparian forest buffers. Furthermore, the Chesapeake Bay Program is proactively coordinating the support of the 1,650 communities within the Bay for a bottom-up approach to development management.

However, the Chesapeake Bay still faces several issues that will require the additional attention from policy makers, local governments, and community members. For example, the nutrient reduction strategies have not effectively reduced nitrogen loads. More innovative strategies must be developed (such as market-oriented nutrient trading programs) and more money should be allocated to cost share programs to help farmers implement BMPs. Moreover, additional efforts are needed to halt wetland degradation in order to achieve the goal of a no net loss of wetlands. The Chesapeake Bay could learn from more effective natural area protection programs and nutrient reduction strategies already implemented in places like the Netherlands. Finally, since many of the sustainable development strategies are dependent on market and private developers, there is great uncertainty to whether development management techniques will effectively influence private developers.

CONCLUSION

Lastly, an examination of water basin management programs that implement a holistic approach that encompass comprehensive, integrated, and innovative management strategies is important for promoting sustainable development. The Chesapeake Bay case study illustrates the complexity of water and nature management and the creation of innovative management strategies. It displays various approaches to promote nutrient reduction, natural area protection and restoration, and sustainable development. For example, noteworthy strategies that may serve as models for future management plans include the Chesapeake Bay's Tributary Strategies, cost-share programs that alleviate costs for farmers implementing best management practices, the Riparian Forest Buffers Initiative, and various development management techniques designed to promote efficient development. This analysis does not serve as a comprehensive blueprint for management; policies and programs must be tailored to the specific environmental, geographic, hydrologic, economic, and political circumstances of an area. However, many of these strategies may be applied to management systems in other regions and countries to improve water resources and natural area protection.

[1] 1,000 pounds live weight = one animal unit.

[2] Riparian areas are lands adjacent to a body of water, such as streams, rivers, marsh, and shoreline.

[3] According to the Initiative, a riparian forest buffer is defined as "a conservation width of at least 100 feet on each side" (CBP, March 1999).

References

Allen, G. & S. Hall. 1999. Local Reins on a Sprawling Land. *The Journal of the George Wright Society*. Vol. 16, No. 1., pp. 45-55.

Caruso, B. 2000. Comparative Analysis of New Zealand and US Approaches for Agricultural Nonpoint Source Pollution Management. *Environmental Management*. Vol. 25, No. 1, pp. 9-22.

Chesapeake Bay Implementation Committee. 1988. *The Chesapeake Bay Program: A Commitment Renewed: Restoration Progress and the Course Ahead under the 1987 Agreement.*

Chesapeake Bay Program. 1988 (December). *Population Growth and Development in the Chesapeake Bay Watershed to the Year 2020.* Available online: http://www.chesapeakebay.net/pubs/522.pdf.

Chesapeake Bay Program. 1993 (February). *Chesapeake Bay Program Nutrient Reduction Strategy Reevaluation.* Report #8. CBP/TRS 84/93.

Chesapeake Bay Program. 1994 (October). *Achieving the Chesapeake Bay Nutrient Goals: A Synthesis of Tributary Strategies for the Bay's Ten Watersheds.*

Chesapeake Bay Program. 1996 (April). *Chesapeake Bay Communities: Making the Connection. A Catalog of Local Initiatives to Protect and Restore the Chesapeake Bay Watershed.* EPA 903-R-95-018.

Chesapeake Bay Program. 1997a (October). *Beyond Sprawl: Land Management Techniques to Protect the Chesapeake Bay. A Handbook for Local Governments.* EPA 903-B-97-005.

Chesapeake Bay Program. 1997b (October). *Analyzing Nonpoint Source Water Pollution Problems: Nutrient Control Policies in the Chesapeake Bay States.* EPA: 903-R-97-028.

Chesapeake Bay Program. 1998 (April). *Who pays for Sprawl? The Economic, Social, and Environmental Impacts of Sprawl Development. A Literature Review.* EPA 903-R-98-011.

Chesapeake Bay Program. 1998 (August). *Chesapeake Bay Watershed Model Applications & Calculation of Nutrient & Sediment Loadings, Appendix H: Tracking Best Management Practice Nutrient Reductions in the Chesapeake Bay Program.* EPA 903-R-98-009.

Chesapeake Bay Program. 1998 (March). *Integrating Build-out Analysis and Water Quality Modeling to Predict the Environmental Impacts of Alternative Development Scenarios.* EPA 903-R-97-018.

Chesapeake Bay Program. 1999 (March). *Riparian Forest Buffers, Linking Land and Water.* EPA 903-R-99-002.

Chesapeake Bay Program. 1999 (October). *The State of the Chesapeake Bay: A Report to the Citizens of the Bay Region.* EPA 903-R99-013.

Chesapeake Bay Program. 2000 (December). *Summary of Preserved Land in the Chesapeake Bay Watershed - A Baseline of Existing Lands (Draft).* EPA 903-D-00-001.

Chesapeake Bay Program. 2000 (March). *Small Watershed Grants Program, FY 1998 Final Report.* EPA 903-D-00-001.

Chesapeake Bay Program. 2000a. *Summary of Preserved Lands in the Chesapeake Bay Watershed- A Baseline of Existing Land.* December.

Chesapeake Bay Program. 2000b. *Forests in the Chesapeake Bay Region in 2000.*

Chesapeake Bay Program. 2000c. *Nutrient Trading and the Chesapeake Bay Program.*

Chesapeake Bay Program. undated a. Wetlands restoration and preservation. [Online]. Available: http://www.chesapeakebay.net/habrest.htm [2000, November 10].

Chesapeake Bay Program. undated b. Chesapeake Bay Indicators. [Online]. Available: http://www.chesapeakebay.net/indicators.htm [2000, November 10].

Committee on Watershed Management, Water Science and Technology Board, Commission on Geosciences, Environment, and Resources, and National Research Council. 1999. *New Strategies for America's Watersheds.* Washington, D.C.: National Academy Press.

Correll, D., T. Jordan, & D. Weller. 1992. Cross Media Inputs to Eastern US Watershed and their Significance to Estuarine Water Quality. *Water Science and Technology*. Vol. 26, No. 12, pp. 2675-2683.

DGVI Commission. 1998. *Evaluation of Agri-Environmental Programmes.* VI/7655/98.

Environmental Law Institute. 1997. *Enforceable State Mechanisms for the Control of Nonpoint Source Water Pollution.*

Environmental Law Institute. 2000. *Putting the Pieces Together: State Nonpoint Source Enforceable Mechanisms in Context.*

Frankel, A. 2000. Urban Growth Boundaries, Development Management Presentation.

Gardiner, J, K. Thomson, & M. Newson. 1994. Integrated Watershed/River Catchment Planning and Management: A Comparison of Selected Canadian and United Kingdom Experiences. *Journal of Environmental Planning and Management*, Vol. 37, No. 1, pp. 53-67.

Godschalk, D. 1987. Balancing Growth with Critical Area Programs: the Florida and Chesapeake Bay Cases. *Urban Land.* March.

Heijligers, M. 2000. The ecological network as a cultural challenge: theoretical framework and some practical case-studies.

Hidding, M. B. Needham, & J. Wisserhof. 2000. Discourses of town and country. *Landscape and Urban Planning*. Vol. 48, pp. 121-130.

Hoffman, R. and K. Fletcher. 1984. *America's Rivers: An Assessment of State River Conservation Programs*. Washington, D.C.: River Conservation Fund.

Horton, T. & W. Eichbaum. 1991. *Turning the Tide: Saving the Chesapeake Bay*. Washington, D.C.: Island Press.

Howard County Department of Planning and Zoning. 1999. Achievements of the 1990 General Plan. [Online]. Available: http:// www.co.ho.md.us [2000, November 10].

Malone, L. 1990. Critical area regulation. *Environmental regulation of land use*. pp. 13-1-13-8, 13-31-13-37.

Marx. P. 1999. Rhinos and Tigers and Bays (Oh My!), and Other Congressional Tales. *The Journal of the George Wright Society*. Vol. 16, No. 1, pp. 39-55.

Maryland Department of Agriculture. undated. Nutrient Management. [Online]. Available: ww.mda.state.md.us/nutrient/default.htm.

Maryland Department of Natural Resources. Undated. Chapter Three- Watershed Management Programs and Initiatives. [Online]. Available: http://www.dnr.state.md.us/bay/czm/nps/nps_plan/chapter_3.html [2000, November 10].

Ministry of Transport, Public Works & Water Management. 1997. Fourth National Policy Document on Water Management Government Proposals Summary. Available online: http:// www.un.org/esa/agenda21/natinfo/naiu/neder-fw.htm

Moreau. D. 1997. *The Chesapeake Bay Program: A Case Study of Programs to Cleanup an Important National Resource- Draft*.

National Association of State Departments of Agriculture (NASDA) Research Foundation, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), and the U.S. Environmental Protection Agency (EPA). 1997. Innovative Approaches to Natural Resource Protection: A Summary of Successful State Comprehensive Resource Management Planning Initiatives. [Online]. Available: http:// www.nasda.org/nasda/nasda/Foundation/protect/summary.html [2000, June 26].

Norton, M. & T. Figher. 2000. The effects of forest on stream water quality in two coastal plain watersheds of the Chesapeake Bay. *Ecological Engineering*. Vol. 14, No. 4, pp. 337-361.

Olem, H. & A. Duda. 1995. International Watercourses: The World Bank looks toward a more comprehensive approach to management. *Water Science and Technology*. Vol. 31, No. 8, pp. 345-352.

Parker, D. 2000. Controlling agricultural nonpoint water pollution: costs of implementing the Maryland Water Quality Improvement Act of 1998. *Agricultural Economics*. Vol. 24, No. 1. pp. 23-31.

Parsons, G. 1992. The Effect of Coastal Land Use Restrictions on Housing Prices: A Repeat Sale Analysis. *Journal of Environmental Economics and Management*. Vol. 22, p. 25-37.

Pionke, H., W. Gburek, & A. Sharpley. 2000. Critical source area controls on water quality in an agricultural watershed located in the Chesapeake Basin. *Ecological Engineering*. Vol. 14, No. 4, pp. 325-335.

Rogers, J. 1992. Sustainable Development Patterns: The Chesapeake Bay Region. *Water Science and Technology*. Vol. 26, No. 12, pp. 2711-2721.

Schultink, G. & R. van Vliet. 1997. Wetland Identification and Protection: North American and European Policy Perspectives.

Shuyler, L., L. Linker, & C. Walters. 1995. The Chesapeake Bay Story: The Science Behind the Program. *Water Science and Technology*. Vol. 31, No. 8, pp. 133-139.

Smith, P. 2000. Transfer of Development Rights, Development Management Lecture.

Tjallingii, S. 1996. Ecological Conditions: strategies and structures in environmental planning. DLO Institute for Forestry and Nature Research, Wageningen: The Netherlands.

Tjallingii, S. 2000. Ecology on the edge: Landscape and ecology between town and country. *Landscape and Urban Planning*. Vol. 48, No. 3-4, pp. 103-119.

U.S. Census Bureau. Undated. US Census Bureau, IDB summary demographic data for the Netherlands. Available online: http://www.census.gov/cgi-bin/ipc/idbsum?cty=NL [30 March, 2001].

US Environmental Protection Agency (USEPA). 1988 (January). *Chesapeake Bay Nonpoint Source Programs*.

US Geological Service (USGS). 1999. Monitoring Nutrients in the Major Rivers Draining to Chesapeake Bay. Water-Resources Investigations Report 99-4238. Available Online: http://va.water.usgs.gov/online_pubs/WRIR/99-4238/99-4238.html.

Van Engen, H., D. Kampe, & S. Tjallingii. 1995. Hydropolis: The role of water in urban planning. Proceedings of the International UNESCO-IHP Workshop. Backhuys Publishers, Leiden: The Netherlands.

Verbeek, M., H. Post, & H. Wind. 1996. Policy analysis for strategic choices in integrated water management. *Water Science and Technology*. Vol. 34, No. 12, pp. 17-24.

Wiedeman, A. 2000. *Nutrient Trading for the Chesapeake Bay*. August.

Wisserhof, J. 1995. Enhancing Research Utilization for Integrated Water Management. *Water Science and Technology*. Vol. 31, No. 8, pp. 311-319.