Population Growth and Development in the Chesapeake Bay Watershed to the Year 2020

The Report of the Year 2020 Panel
to the Chesapeake Executive Council

December 1988

Acknowledgements

The 2020 Panel's meetings were open to all interested parties. The insights and comments provided by the public and by members of agencies and interest groups during these meetings were extremely useful. They provided many different perspectives, which both enlightened and helped guide the Panel's work.

Members of the Population Growth and Developement Commitment Team and their staff were active participants throughout the year. Their enthusiasm, data, comments, and attention to detail allowed the Panel to stay focused on the issues before it. Among the Team members and staff who were involved, we gratefully acknowledge the assistance of: Keith Buttleman, Anne DeWitt Brooks, and Sharon Anderson, Virginia Council on the Environment; Edwin Thomas, Maryland Department of State Planning; David Carroll and Cecily Majerus, Maryland Governor's Office; Roy Newsome and Pat Buckley, Pennsylvania Governor's Office of Policy Development; Ann Pesiri Swanson, Chesapeake Bay Commission; Nancy Menning, U.S. Environmental Protection Agency; and Gerald McCarthy, Virginia Environmental Endowment.

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The Honorable Gerald L. Baliles, Governor of Virginia
The Honorable William Donald Schaefer, Governor of Maryland
The Honorable Robert P. Casey, Governor of Pennsylvania
The Honorable Marion Barry, Jr., Mayor of the District of Columbia
The Honorable Lee M. Thomas, Administrator, U.S. Environmental Protection Agency
The Honorable W. Tayloe Murphy, Jr., Chairman, Chesapeake Bay Commission

At your request, we studied the consequences of population growth and development for the Chesapeake Bay watershed to the year 2020. We examined a broad range of options for preventing or ameliorating adverse environmental impacts that come from growth.

Although we were challenged by the complexity of our task, a far greater challenge now rests with you: to make the visions that are framed in this report reality. You must convey a strong sense of leadership; an overriding sense of stewardship for the Bay and its watershed must emanate from your offices. Judging, from the comments received at the Panel's four public meetings, it is clear that strong and widespread support exists for the kinds of actions we are suggesting.

The actions advocated in this report will do much more than improve the Bay. They are universal in scope. They work to ensure the economic and environmental vitality of the entire region. Success in these actions will result in local and regional successes elsewhere as well.

Our report calls for bold actions. It will require the development of new policies and programs. We recognize that they are not without cost. Funding must be found to implement the actions recommended, or the millions of dollars of investment already made in the Bay will dwindle away as growth overwhelms current successes. Likewise, it will become more costly the longer you wait, and at some point no amount of money could reverse the disastrous effects of unmanaged growth.

We recognize that reports such as ours are legion. Decade after decade, committees, panels, commissions, and vocal individuals have catalogued problems and offered prescriptions for their resolution. The recommendations made here could easily be side-tracked "for more study". It is our sense however, that this moment in the history of the region demands immediate action. We sense an important difference in the political climate from past decades. Indeed, by signing the Chesapeake Bay Agreement you set in motion the drive for new policies to protect the Bay.

Behind us, providing momentum, lie a decade of Bay studies, five years of initiatives, and two decades of growing environmental concern. The recommendations in this report are a logical extension of the Bay programs. Public officials, politicians, developers, and private citizens who worked on this Panel, who attended and participated in the Panel's meetings, and who came to the public meetings that were held in each jurisdiction, are all strongly behind effective land use management that will restore and protect the Bay. All are now awaiting the leadership that will produce effective, timely actions.

The time is ripe for these actions. With uncommon unity, people are prepared to act on their sense of joint responsibility for the Bay, its rivers, and the surrounding land.

The ability of your jurisdictions and agencies to work together for the common good and the future of the Bay has attracted international attention. You have created a unique compact, and made far reaching commitments that will serve people throughout the watershed well in the years ahead.

We unanimously report to you our findings and recommendations. We are pleased to have served you in this effort, and look forward to working with you in our private, professional, and public capacities to begin implementing this regional agenda.

The Year 2020 Panel

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Summary

The 1987 Chesapeake Bay Agreement challenges the region's leaders to create a future that is different from what today's trends will otherwise bring. Dealing with growth effectively while improving Bay water quality and creating a better life for all people is key to this challenge.

The future provides opportunities and holds bright promises: a better quality of life, a cleaner Bay, a robust economy, and a sense of place and social well being.

Environmental quality fosters economic vitality. This vitality, in turn, provides the financial resources with which to address other problems and issues. The two serve one another. A prosperous society can afford a sound environment; a sound environment enhances prosperity. But this future may be in jeopardy. Even the most casual review of the state of the Chesapeake Bay region reveals disturbing trends that will slowly overtake the gains being made in improving environmental quality. Unmanaged growth has created pollution and congestion and has degraded the quality of life. These trends are not destiny. As it studied the problems of growth and development to the year 2020, the Panel found that means are available to change these trends if prompt and forceful action is taken.

Conclusions

The Panel was impressed with projections showing 2.6 million new residents in the region by the year 2020. This 20% growth in population could change extensive areas to developed uses.

"...procedures currently being used throughout the Bay region for managing and providing for growth and development are inadequate..."

As a result of its work, the Panel's major conclusion is that procedures currently being used throughout the Bay region for managing and providing for growth and development are inadequate, and must quickly be changed if current trends are to be reversed. While many local jurisdictions are making valiant efforts to deal with growth issues head-on, overall there is a drastic need for change. The use of land is a great environmental, social, and economic challenge. Society must create rational growth patterns, supported by adequate infrastructure and public transportation. Scattered unplanned development is wasteful and expensive, and generates greater net pollution than more rational patterns of development.

American society is extremely consumptive and wasteful of resources. It must focus on waste reduction, recycling of materials, and conservation of resources. Harbingers of where current trends lead are the degraded quality of the Bay, water shortages, the trash crisis, suburban sprawl, hop-scotch patterns of development, congestion, air and water pollution, and inefficient use of resources. Adding increased numbers of roads, septic systems, parking lots, and disturbed land surfaces creates more pathways for pollutants to reach the Bay at an increasing rate. Water quality is inextricably linked to population growth.

Growth requires effective land use planning and education of the public in proper land management and stewardship. The longer solutions are put off, the greater the problems become. Better stewardship and management of the land and better direction and incentives for appropriate growth are needed. It is much easier (and cheaper) to prevent a problem than to correct one, which is why action is needed soon.

New highways, sewers, and other infrastructure have a powerful effect on the location and pace of development. The best planning allows for such infrastructure to guide and manage growth. Unfortunately, the opposite often happens. Patterns of low density residential sprawl occur and then require improved linkages. Open areas eventually fill with new homes and congestion occurs along the new roads. Densities are too low to support mass transit and no readily available rights-of-way can be found for additional roads.

A major force in establishing the present land use pattern has been the desire of people to locate primary residences in low density settings and second homes near the water. Unfortunately, development in agricultural, forest, and shorefront areas chews up valuable farmland, woodland, and shore access areas and destroys existing local economies. As resource-oriented businesses die or are forced out, the support businesses for farming and seafood harvesting die as well. The diversity of the local economy is dramatically changed as well as the heritage, social conditions, sense of place, and visual character of the area.

Visions of Success

The Panel is dismayed by the lack of growth management and planning, particularily on a state and regional level. It became readily apparent that the lack of comprehensive state and regional planning, uncoordinated public investment strategies, and undirected problem solving contribute greatly to the current problems of the watershed. Unless changed, this lack of clear policy and direction will compound future problems.

To provide a framework for making useful recommendations, the Panel conceived six linked visions of what should come to pass in the region by the year 2020. All segments of society will benefit from achievement of these visions. Likewise, all must share in the in the cost of their implementation. The visions are clearly and simply stated. They are presented in the present tense to em-

phasize this is what will have happened if appropriate actions are undertaken today. Accomplishing the visions will produce a watershed with the following characteristics:

Well before the year 2020, state Comprehensive Development and Infrastructure Plans have been developed and implemented. State and federal agencies, counties, and municipalities encourage diverse and efficient land development patterns -- ones that concentrate growth and development in urban, suburban, and already developed rural centers. All growing areas have existing or planned facilities. Densities in most of these areas support mass transportation, van pooling, or other forms of ride sharing to reduce traffic.

These thriving urban centers and suburban areas are supported with funding adequate to maintain or enhance existing services. Cities and towns are vitalized by prudent public and private investment. Developers are offered incentives to provide greater community services and mitigate environmental impacts.

New mixed use growth centers are planned to take advantage of existing or projected infrastructure. Large open space areas are located within walking, bicycling, or short-drive distances of most people. Open space amenities are given the same priority as infrastructure.

Sensitive areas are protected from encroachment and damage. These areas have been defined and mapped by state and local authorities, and effective programs are in place to protect these natural assets. Very sensitive areas are in public ownership or under easement. Wetlands and lakes, rivers, and other waterbodies are protected from upland impacts by undisturbed vegetated buffers. In both urban and rural areas the shoreline of the Bay and its tributaries forms a series of vegetated corridors. These connect to large forested areas and allow for enhanced water quality, ecological balance, and biological diversity. Water supply has become a statewide issue, and safe and adequate supplies are available from protected groundwater and surface water sources.

Areas with resource-based industries such as agriculture, forestry, mining, and seafood harvesting are protected from encroachment of incompatible land uses. These industries remain important parts of the local and state economy. They have brought their environmental problems under control. Protection of these areas through effective land use controls, reasonable incentives, and innovative funding mechanisms insures a lasting, diverse economy and resource use options for the future.

Transfer of development rights from one land parcel to another better suited for development is commonplace and is proving to be an effective growth and resource management tool.

Growth in rural areas takes place in existing centers. Rural towns and highway intersections are defined by service boundaries and development space is provided for an appropriate mix of uses. These centers, with the assistance of state and federal governments, provide adequate sewer and water utilities. Use of on-site waste water treatment is limited so as to protect effectively surface and groundwater from pollution.

Outside these rural centers, residential development is limited so as to retain the economic, ecological, and scenic values of the countryside. Large woodlots and forests are retained and are selectively used for managed forestry, if they are not in preserves or parks. Quarries and other mining activities occur but are screened from neighboring uses by well developed wooded buffers. Municipal, County, and State roads are planned to allow for adequate capacity for rural traffic.

The volumes of waste produced in the region have been greatly reduced and are being effective-

ly handled. Energy and water use per capita has been reduced as conservation programs have been put in place.

The public and government agencies are sensitive to their responsibilities not to damage the environment and to conserve resources.

"...states must take a much more active and central role in the planning process . . . a Comprehensive Development and Infrastructure Plan must be put in place..."

Stewardship of the land and Bay is practiced by ordinary citizens who have been made aware of how they affect the land and water. The quality of the Bay is improved, tourism is strong, resource-based industry, manufacturing, and service businesses desire to locate in the basin because of its resource base, amenities, diverse economy, and the quality of life it provides residents.

Those programs that require funds are supported by Development and Conservation Trust Funds that fund infrastructure and purchase land, easements, and development rights in support of the goals of the Comprehensive Development and Infrastructure Plan.

Realizing the Visions - Recommended Actions

Success in realizing these visions hinges on two things: the states must take a much more active and central role in the planning process for both land use and infrastructure, and a Comprehensive Development and Infrastructure Plan must be put in place in each state to guide state investments and policy and to create coordination among local land use plans. Only then can the visions and recommended actions listed below be implemented to change the course of the Chesapeake region.

Vision I: Development is concentrated in suitable areas.

Action 1. States must each develop and keep current a Comprehensive Development and Infrastructure Plan. All planning, funding, and development must be consistent with this Plan.

- The Chief Executive of each jurisdiction should establish a broad-based Task Force or Commission to promote the preparation and implementation of a state-level plan.
- Legislatively create (or designate) and fund a lead state planning agency with responsibility for preparing the state plan, coordinating planning and development activities, and achieving consistency among and with local and other state plans.
- By legislation, require that all agencies conform to the state plan.
- Develop criteria for the content of state and local plans and for determining consistency of local plans with the state plan.
  - require local zoning and planning.
  - require regular updates of state and local plans.

- establish an interagency task force to report to the Governor or Mayor annually on the plan and its progress and success.

Action 2. States must take the lead to establish and implement policies and programs that result in compact and efficient growth patterns.

- Create incentives
  - for reuse and redevelopment of areas already served by infrastructure (e.g., enterprise zones, creative zoning, density bonuses, and land assembly).
  - for locating housing and employment in designated growth areas served by public transportation.
  - to encourage use of mass transportation, car pools, and van pools.
- Invest in public transportation to support state and local growth policies.
- Develop programs to reduce private automobile use:
  - provide adequate and attractively priced parking at public transportation stations.
  - decrease availability of free or subsidized parking.
  - develop more high occupancy vehicle lanes and bus lanes on highways.

Action 3. States and localities must maximize use of existing infrastructure.

- Adopt programs and policies that concentrate growth at appropriate densities in designated growth areas with existing infrastructure.

Action 4. States should allow local communities maximum flexibility in innovating and adopting procedures for creating public open space and obtaining easements that are of public benefit.

Vision II. Sensitive areas are protected

Action 1. States must define sensitive areas and have appropriate state and local agencies designate such areas on a series of maps that comply with a standard map specification. These are to be used in planning, management, and project review.

- Include wetlands, floodplains, aquifer recharge areas, wellhead protection zones, water supply watersheds, important habitat areas, unique and scenic areas, large forest tracts, and other areas in need of special protection.
- Coordinate all mapping through a single agency that establishes statewide standards.

Action 2. States must make sensitive area protection mandatory.

- Require that the Comprehensive Development and Infrastructure Plan contain criteria for sensitive resource protection, management, and enforcement.

- Provide training for local officials in land use planning, resource management, and development review
- Furnish state or county level technical assistance for sensitive area protection planning and development proposal review.
- Adopt and enforce minimum standards for site development, construction, and maintenance to minimize impacts to the environment.

Action 3. States should coordinate acquisition and protection programs directed at sensitive resources.

- Coordinate public and private land and easement purchases by creating a coordinating group that keeps participating groups and agencies informed of needs, priorities, and progress.
- Provide state funds for purchase of very sensitive areas either in fee simple or through conservation easements.
- Review incentives available to encourage conservation easement donations and provide better incentives.

Action 4. Establish federal, state and local buffer zone programs that require adequate deep-rooted vegetated buffers be left undeveloped around sensitive resources and along all watercourses and water bodies.

- Set criteria for buffer zone widths according to the resource being protected and adjacent conditions. Clearly define the uses permitted within a buffer that will not compromise its effectiveness.
- Reestablish buffers in developed areas.

Vision III. Growth is directed to existing population centers in rural areas and resource areas are protected.

Action 1. Require state and local plans to define and map growth and resource protection areas.

- Indicate all areas where growth is inconsistent with resource protection.
- Provide adequate funding to improve and develop infrastructure in designated growth areas.
- Limit public investment in sewer and water systems to designated service areas. Require any expansion of the service areas to conform with local and state plans.

Action 2. Protect important agricultural and forest lands.

Action 3. State and local governments must protect water supply watersheds from development.

- Protect and where necessary purchase areas within watersheds where development would degrade the water supply. Encourage creation of easements that protect the watershed.
- Develop a specific management plan for each of these watersheds.

- Provide state leadership in planning and developing water supplies to meet the needs of rural areas.

Action 4. In Maryland and Virginia, stop condemnation of shellfish areas for marina and sewage treatment plant development.

Action 5. Each state should expand public park and recreation systems.

- Provide funding for the development of green belts around urbanized areas.
- Expand recreation opportunities near developed and designated growth areas.
- Emphasize low intensity recreational areas in undeveloped areas.
- Provide more public access to waterbodies.

Action 6. States should develop strategies to discourage development in areas devoted to resource-based industries and to reduce the need for localities to compete for property tax revenues.

- Institute a transfer of development rights system to allow local officials to designate areas of high and low growth, and to transfer the development rights from a designated resource protection area to a designated growth area. This will compensate the affected landowner and keep designated land in its current use.
- Offer incentives and other inducements to industrial development when this development is inside designated growth areas.

Vision IV. Stewardship of the Bay and the land is a universal ethic.

Action 1. State agencies should establish written environmental stewardship policies to guide their actions and should review their programs to ensure conformance within these policies.

Action 2. States should develop a required school curriculum unit focused on environmental and growth issues.

Action 3. Each state and the federal government should prohibit dumping of sewage from vessels into the Bay.

Action 4. Develop a broader-based public awareness of stewardship and proper environmental management.

Vision V. Conservation of resources, including a reduction in resource consumption, is practiced throughout the region.

Action 1. Reduce waste generation.

- Impose disincentives on excessive waste generation, including excessive use of consumer packaging that will become waste.
- Promote hazardous waste minimization.
- Create local recycling programs for all materials that are capable of being recycled.
- Require recycling of used motor oil, including do-it-yourself oil changes.

- Establish hazardous household products collection programs at the local level.

Action 2. States should develop programs to reduce automobile use and fuel consumption.

Action 3. States should develop programs to reduce water and power usage.

- Impose a sliding scale levy on water and power use to discourage excessive consumption.
- Set standards and require all new construction and remodeling to be energy and water use efficient.

Action 4. States should make best environmental management practices mandatory for development, agriculture, and forestry.

Action 5. Foster innovative technology and programs that reduce resource consumption and environmental impacts.

- Fund approaches that are practical and can be widely used.

Vision VI. Funding mechanisms are in place to achieve all other visions.

Action 1. Establish state Development and Conservation Trust Funds to provide for infrastructure, development incentives, and the purchase of land, permanent easements, or other rights in the land.

- Potential sources of funds to capitalize the Funds include:
  - higher fuel taxes
  - tax on profits from land sales
  - utility surcharges
  - user fees
  - property transfer tax
  - voluntary income tax check-off

Action 2. Develop revenue sharing or pooling arrangements among municipalities or counties affected by growth.

Action 3. States should encourage development of local taxing districts to allow local governments to recover the operating costs of public facilities unique to that district.

State and Federal Actions

Each jurisdiction has a unique set of concerns and needs, and programs that address the impacts of growth are at various stages of definition and development. Different approaches and priorities to reach the Visions and achieve the Actions will be used by each jurisdiction. In some cases legislative changes will be needed and in others fiscal appropriations will be required. Many actions can be initiated immediately, while others will require longer to implement. In addition to the general recommendations, each State's delegation to the Panel has prepared an agenda for action tailored to its state. The Panel prepared a Federal agenda.

Pennsylvania Action Agenda

Pennsylvania should consider the following actions.

Convene a task force charged with reviewing this report, and present within 90 days a Pennsylvania Action Agenda. The Action Agenda should take the report's respective recommendations and apply them, as appropriate, to the Commonwealth.

Legislation should be prepared and enacted to establish a State Planning Office in the Office of the Governor. The Planning Office should be directly responsible to the Governor, and should be broadly charged with the planning and overview responsibilities set forth in the 2020 Report. The legislation should also provide for a State Planning Board, advisory to the Governor and to the State Planning Office, with membership representative of the interests, economy, and cultural composition of the Commonwealth.

Legislation should be prepared and enacted dealing with regional planning in the Commonwealth, a function whose area-wide perspective warrants statutory expression.

The Municipalities Planning Code should be reviewed in light of the findings in the 2020 Report, and amendments to the Code should be drafted to accomplish the Report's recommendations.

A mechanism should be established for providing technical assistance and funding support to municipalities as they seek to deal with their responsibilities in implementing the recommendations of the 2020 Report.

Convene a panel to review the management policies that apply to all lands owned by the Commonwealth, and to suggest ways in which the various policies can be better coordinated, consistent with the mission of each land-managing agency, to further the aims of the 2020 Report.

Funding should be provided for the development of a model environmental education curriculum for Pennsylvania school districts.

Maryland Action Agenda

Maryland should consider the following actions.

Release the 2020 Report with strong support for the Visions to local governments, and environmental, development, economic, and community interests. Conduct a series of informational meetings and workshops to explain the background and purposes for the Visions and Actions and obtain ideas for how the Visions and Actions can be accomplished .

Request that state agencies indicate how the Visions and Actions can be accomplished with current or new resources and authorities. Each agency should state what issues it must address and what it will have to do differently to help realize the Visions and Actions. State agencies should respond by March 1, 1989.

Charge the Department of State Planning with preparation of the initial Comprehensive

Development and Infrastructure Plan by September 1, 1989, including criteria for determining consistency of State and local Plans. Capital improvements including major facilities; transportation; open space, recreation, and park areas; schools, etc. will be included.

Direct the Governor's Council on the Chesapeake Bay to report to the Governor on July 1st each year on the progress and success in achieving the Visions and Actions. The Executive Order creating the Council should be reissued to broaden the membership and purpose of the Council.

Direct the Department of Natural Resources with assistance from the Departments of the Environment, State Planning, and Agriculture and in cooperation with local governments to define and map sensitive areas by January 1990.

Appoint by March 1, 1989 a private/public Resource Protection Work Group to coordinate, establish priorities, target, and share information about the various private and public programs to acquire and protect sensitive areas. The group should make its recommendations for improvements to the Governor within six months of its creation.

Direct the Department of State Planning in cooperation with local governments to prepare by September 1, 1989 a model resource protection program. Provide assistance to local governments in establishing resource protection programs to include buffers, performance standards, easements, etc.

Request Secretaries of the Departments of Budget and Fiscal Planning and State Planning to explore creation of Development and Conservation Trust Funds including sources of funds, and use and allocation of funds. Results are to be reported to the Governor by April 1, 1989.

Establish a Forest Protection Task Force to include the Departments of Natural Resources, Agriculture, and State Planning, local government officials and private sector participants to prepare local and State legislative and administrative proposals for the protection and re-establishment of forest land and wildlife habitat. If possible, proposals will be drafted for consideration during the 1989 and definitely prior to the 1990 General Assembly session.

Virginia Action Agenda

Virginia should consider the following actions.

Charge and appropriately fund an agency to collect, develop, and distribute 1) current and projected population figures, and 2) environmental, land use, and economic data in support of the needs of state agencies, regional planning commissions, and local governments.

Create a Virginia Commission for the Year 2020 to evaluate and recommend a statewide planning process in support of the Panel's recommendations. This Commission should be inclusive of state, local, and private interests. Briefings of the Panel's findings to local government officials, state boards, the

development community, and the general public should be an integral part of the Commission's activities.

Commission an economic analysis to explore the best combination of actions to fund the Panel's recommended Development and Conservation Funds.

Direct that state funds be expended on infrastructure (e.g., water, sewer, roads) only in locations that support the Panel's suggested development patterns.

Request a detailed assessment of legal barriers to the use of creative, innovative, and cooperative land management techniques, and develop a strategy for eliminating them.

Initiate legislation or regulatory actions, as needed, and a program of incentives and disincentives in support of resource conservation. The program should include waste minimization and recycling -- especially a beverage container deposit and return program -- the reduction of automobile use and increased support for mass transportation, and reduced water and power usage.

Initiate a program to define and map sensitive areas consistent with other Chesapeake Bay wetlands and living resources commitments.

District of Columbia Action Agenda

The District of Columbia should consider the following actions.

Assign to the Interagency Planning Council the responsibility to evaluated and recommend a District-wide strategy to implement the Panel's recommendations.

Continue to implement the Environmental Protection Policies in the District's Comprehensive Plan.

Implement erosion control measures along streams within the city such as stream bank cleaning and stabilization programs.

Consider constructing a boat ramp at an appropriate location along the Anacostia River to improve boating access.

Increase enforcement of soil erosion controls and construction activities through appropriate permitting processes.

Aggressively implement provisions of D.C. Law 7-33, which outlines several resource recovery initiatives, including yard waste and composting programs, multi-material recycling centers and the identification of environmentally sound methods of sludge disposal.

Fully implement the wetlands conservation plan developed by the city and the National Park Service under the 1986 Emergency Wetlands Protection Act.

Federal Action Agenda

Control of land use is a state responsibility, but the Federal government must become a strong supporter of their programs. To this end, Federal environmental programs and policies should be specifically directed at preserving environmental quality through research, technical assistance, and, where necessary, regulation.

EPA should examine the available methods useful in quantifying the impacts of growth and the technologies for further controlling emissions and reducing waste generation.

Federal agencies owning and occupying real estate in the watershed should ensure Federal facility conformance with State Comprehensive Development and Infrastructure Plans.

The U.S. Environmental Protection Agency and the U.S. Department of Agriculture should establish a task force to examine ways to integrate programs to protect water quality into Federal agricultural laws and programs. These should have the flexibility to be specifically adopted to the needs of the Chesapeake Bay watershed.

The U.S. Environmental Protection Agency should specifically examine ways to integrate Federal incentives for the protection of environmentally sensitive areas with evolving State efforts.

Chapter One

Introduction And Background

Introduction

Population growth and development are issues facing the Chesapeake Bay watershed. This report examines the relation of projected growth to the living resources and water quality of the Chesapeake Bay system and to the quality of life in communities throughout the region.

The ideas presented here form the basis of what must become a regional agenda for action, for change. The way land is developed needs to be examined critically, with the intention of doing a better job from now on. The vitality of the region -- both economically and environmentally -- will be closely tied to the degree of success achieved in dealing with problems associated with growth.

Clear boundaries between land use, environmental quality, and economics do not exist. An act or decision in one area affects the others. How the land is used is a basic factor in the ecological health of the Chesapeake Bay. Land use and the health of the Bay, in turn, affect the economic vitality of the region.

A growing population requires land for homes, transportation, shops, jobs, and recreation. This development and use of land and the manner in which people conduct their daily lives can create pollutants that enter the environment. While the connection between human activities on land and Bay degradation is inevitable, the flow of pollutants can and must be managed or there will be a steady erosion of the gains already made or planned in Bay improvement.

"How the land is used is a basic factor in the ecological health of the Chesapeake Bay."

A good deal is known about the relationships between land use and other human activities, and their effects on the environment and people.

Some practices are harmful, and benefits are derived from following one course of action over another. A course of action that fosters sound development practices, land use patterns, and land management is fundamental to preserving ecosystems such as the Chesapeake Bay as growth continues.

There are solutions to the problems, but their implementation requires foresight and persistence.

Vested Interest In Success

Each person has a vested interest in solving environmental and social problems. Failure costs dearly. Taxes increase, services decline, and an already degraded environment continues to slip. This vested interest in successful problem solving is often ignored. Time and distance frequently separate an act from its consequences elsewhere, fooling people into disregarding the connection. The connections are increasingly being demonstrated: the quality of the Bay is deteriorating, roads are clogged, and there is a widespread unease about society's impact on the environment generally.

"Today, unmanaged new growth has the potential to erase any progress made in Bay improvements..."

Unfortunately, people also have a vested interest in keeping things they way they are. The familiar is more comfortable and easier to deal with than the unfamiliar and new. Political, social, and economic institutions are most comfortable perpetuating themselves. To tinker with a problem here, tighten up on a regulation there is the customary way of doing business. But, to change the trend, to give a new direction to society, requires a tremendous amount of time, energy, and money. Above all it requires persistence.

Today, unmanaged new growth has the potential to erase any progress made in Bay improvements, overwhelming past and current efforts. Extensive programs underway to remedy and clean up existing problems hold promise of success. However, success in dealing with existing problems will be temporary, if new growth generates additional quantities of pollutants.

The Panel finds that this need not be the case. Changes in the way land is used and managed are achievable.

Change begins with ideas. Ideas become actions. The actions proposed in this report, if supported, will preserve these gains so they become a legacy of those who acted during this century.

The 1987 Chesapeake Bay Agreement

The 1987 Chesapeake Bay Agreement ushered in a new level of inter-government commitment to restoring the Bay. The Governors of Virginia, Maryland, and Pennsylvania, the Mayor of the District of Columbia, the Chairman of the Chesapeake Bay Commission, and the Administrator of the U.S. Environmental Protection Agency are signatories to this pact, committing each to undertake substantial and meaningful actions to restore the Bay's environmental and economic health. These officials constitute the Chesapeake Executive Council, and are responsible for implementing the Agreement.

The 1987 Agreement included goals and commitments for seven areas of concern, including Population Growth and Development -- the subject of this report.

The population growth and development, goal is clear and straightforward. It is to:

"Plan for and manage the adverse environmental effects of human population growth and land development in the Chesapeake Bay watershed."

In support of this goal, the Agreement lists six objectives to be achieved. These are to:

"Designate a state-level office responsible for ensuring consistency with this Agreement among the agencies responsible for comprehensive oversight of development activity, including infrastructure planning, capital budgets, land preservation and waste management activities.

Provide local governments with financial and technical assistance to continue and expand their management efforts.

Consult with local government representatives in the development of Chesapeake Bay restoration and protection plans and programs.

Identify and give public recognition to innovative and otherwise noteworthy examples of local government restoration and protection-related programs.

Assure that government development projects meet all environmental requirements.

Promote, among local, state and federal governments, and the private sector, the use of innovative techniques to avoid and, where necessary, mitigate the adverse impacts of growth."

The Agreement finds *"a clear correlation between population growth and associated development and environmental degradation in the Chesapeake Bay system."*

The Agreement also states: *"The States and the Federal government will assert the full measure of their authority to mitigate the potential adverse effects of continued growth."* States are to forge an active and cooperative partnership with local governments to establish policies, guidelines, and practices that will manage growth and development throughout the Chesapeake Bay watershed.

The 2020 Panel

In partial fulfillment of the goal and objectives of the Population Growth and Development Commitment, a 12-member panel was commissioned to report by December 1988, on anticipated growth and related issues through the year 2020. Based on its time horizon, the group soon became known simply as the 2020 Panel.

The specific charge to the 2020 Panel, outlined in the 1987 Bay Agreement, is to report to the Executive Council on:

"Anticipated population growth and land development patterns in the Bay region through the year 2020.

Infrastructure requirements necessary to serve growth and development.

Environmental programs needed to improve Bay resources while accommodating growth.

Alternative means of managing and directing growth.

Alternative mechanisms for financing governmental services and environmental controls".

The 2020 Panel, support staff, and interested observers met regularly throughout 1988 to discuss and debate various aspects of growth -- its impacts, its management, appropriate levels of government involvement, the wisdom of various techniques and approaches, technical and educational needs of professional and elected officials, and ways to effectively accommodate growth while improving Bay quality and the quality of life throughout the region.

"This report . . . calls for a focused and ambitious agenda of cooperative and coordinated planning..."

Four public meetings were held, one in each jurisdiction, to receive comments and recommendations from the public. Dozens of citizens, representing themselves or groups to which they belong, offered perceptive and thoughtful comments on growth and development and the Bay's future. These comments reflected a broad-based consensus throughout the Bay watershed for effective land use management that will restore and protect the Bay and maintain and improve the quality of life.

This report distills that process of meeting, listening, and debating. It calls for a focused and ambitious agenda of cooperative and coordinated planning and management to improve the quality of the Bay and human life, accommodate new residents and businesses, preserve the sensitive and valued environmental resources of the Bay region, and be a model of interjurisdictional cooperation for the nation.

Experience Across the Nation

The Panel devoted considerable attention to the activities of other states with regard to planning for and managing population growth and development and protecting of environmental resources. Understanding the direction of other states throughout the nation aided the Panel in forming its recommendations.

The programs of ten states were examined. These states have several characteristics in common with the Chesapeake Bay watershed: considerable water-related resources, considerable past and anticipated growth, and considerable tourism and recreation. Thus, the experience of these states is particularly relevant to the Chesapeake Bay area. Through review of these programs, the Panel found common traits and factors important to their success. A summary of those characteristics necessary to establish a strong and acceptable program follows:

A new State agency or commission is created to perform the new duties and responsibilities.

The State is required to prepare a plan. State agencies and local government policies, plans, and projects must be consistent with the State plan. In some cases, agency budgets must be consistent with the State plan. State and local plans must be coordinated.

The focus of the State and local plans is to define and delineate growth and resource protection areas.

The State agency prepares guidelines, criteria, or standards to guide preparation of local plans and

programs. The local plans and programs and amendments thereto are approved by the State agency.

In some cases, the State agency authorizes permits, issues orders, hears appeals, resolves conflicts.

Strong, pervasive and sustained citizen participation is an important ingredient.

Initial and continuing bipartisan support is needed to make these State efforts successful.

Provision of substantial and sustained technical assistance and funds to local governments to enable them to comply with the new program is necessary.

Precise specification of the duties and responsibilities of each involved party and clear definition of each element of any program are necessary.

Enforcement, monitoring, and serious long term commitment and follow through are required if these programs are to reach their potential.

Several incentive and penalty devices are used to gain compliance with the State plan, for example:

- Denial or veto of permits,
- Compliance prerequisite to qualification for funding,
- Higher priority is given to consistent projects,
- Local governments are enable to institute specific measures when they adhere to they State plan, for instance, impact fees, transferable development rights programs, purchase of development easements.

Role of State legislature and regional planning agencies varies considerably among the different State programs.

The more recent programs cover entire States; earlier programs were tailored to address specific resource areas. The earlier programs were more environmentally oriented; recent programs are more development and infrastructure related.

"Understanding the direction of other states throughout the nation aided the Panel in forming its recommendations."

State programs reviewed by the Panel included:

California	Maine
Oregon	New Jersey
Florida	Hawaii
North Carolina	Maryland
Vermont	Virginia

Assumptions in the Panel's Work

The Panel chose to operate with some basic assumptions. First, this report is addressed to the Chesapeake Executive Council, whose members are responsible for implementing the Bay Agreement Commitments.

Second, we accepted that growth will happen, but that it should not happen in the unplanned and unregulated way that it has in the past. At issue were where, in what form, and how much growth might occur and what could be done to minimize impacts and maximize its contribution to the region.

Third, the focus was on the future. A vision was sought of what environmentally and socially responsible growth could be. The im-

aginations of developers, planners, and officials need to stretch to find better ways to put new development on the landscape -- ways that take into account the on-site and off-site consequences of a development decision, both immediately and over time.

The last major assumption was that identifying the appropriate roles of state and local governments in land use management, growth policy, and intergovernmental relations was a priority.

"If we continue to rely on highways and automobiles; and if we continue with the same patterns of growth, it is virtually impossible that the quality of life in the region will get anything but worse."

Effectively dealing with growth rests with the Chief Executives, legislators, officials, and citizens of each jurisdiction. The degree of success the Bay programs have will depend in large measure on daily, individual decisions about how to develop land, conduct lives, dispose of wastes, and invest time and energy. The Bay was not crippled by a few gross acts of wanton polluting. A great many decisions by individuals over decades created incremental changes, imperceptible in their effect as isolated acts, but devastating in sum. The solution to the Bay's problems, and to other regional environmental problems, will come about in the same way, as the aggregate of thousands of daily decisions.

The Bay's Problems

The Bay's problems are not simply the Bay's problems -- they are problems of living on the land. The region's officials and citizens are beginning to acknowledge this and do something about them.

Effects of Development

If growth and development are given free rein, it is reasonable to expect that for some counties the rate of growth will be staggering, as a wave of development reaches them. If we continue to rely on highways and automobiles; and if we continue with the same pattern of growth, it is virtually impossible that the quality of life in the region will get anything but worse.

The effects of growth and development experienced in the Chesapeake Bay region -- both in the water and on land -- are not unique. American society has been transformed; both the pattern and consequences of development are different from earlier generations. Americans produce, and put into the environment, vast quantities of exotic chemicals and nutrients. Wealth has freed people to pursue individual ways of living that were only dreams a generation ago.

Scattered development is a fact, and new development continues to follow this trend. Outside urban centers, this pattern is characteristically low density. Low density subdivisions and mini-estates necessarily rely on disbursed shopping centers to provide food, clothing, and luxury items. Pedestrian traffic

between home and other destinations is virtually impossible due to distances or the difficulty of negotiating roads and parking lots. Even in areas of higher density, easily accessible commercial and transportation services are often inadequate.

Effective mass transportation systems to serve scattered development are extraordinarily expensive to develop. The residential density is too low for collection, and individual destinations are too numerous for efficient service because jobs and shops are scattered throughout the region. The car is the preferred means of locomotion in any case.

Scattered development is wasteful of land. The wise use of land is not an idle daydream; it has important consequences. With scattered development, large areas effectively become "vaccinated" against any use except low density residential development. Farming, gravel mining, or timber production are impractical when houses are peppered throughout the landscape, and homeowners are generally opposed to these activities nearby.

Accessibility of areas via highways fosters the scattered pattern. Lack of central water supplies and sewage systems in many areas opened by highways result in on-site utilities: septic systems and private or local wells. These reinforce the trend to low density and land consumption. Public policies further this trend: if congestion and pollution are issues, local governments simply require development to be spread even more thinly, under the mistaken notion that this will be a solution.

Higher density, alone, is not a panacea. Increased density -- with its wiser use of resources and more logical mix of land uses -- must also have a greater emphasis on controlling and managing environmental impacts.

How Growth Goes Unmanaged

Until a high rate of growth is experienced locally, most citizens and officials do not spend a good deal of time and energy on land use planning. In areas where there is no tradition of planning, and where growth has been at a slow pace, the need for zoning, comprehensive planning, and site development review is not widely accepted. In many places these land management tools are in place, but are perfunctory or only weakly guide development.

"The imaginations of developers, planners, and officials need to stretch to find better ways to put new development on the landscape..."

Often, factors external to the public planning and decision process control the pace and location of development in the area.

Community leaders, public officials, and professional planners react to development. The potential for local communities to foster specific patterns of development, enhance the quality of life, and increase the efficiency of public services often goes unrealized. It has become the habit to let the market drive the

planning and land management process. Development is initiated in response to real or expected demand for housing, offices, or retail shops. If it fits with the often broadly drawn zoning requirements of a community, the community has little choice but to accept whatever is proposed. The developer responds to the demand and initiates the physical development process.

"...the need for zoning, comprehensive planning, and site development review is not widely accepted."

The Tragedy of the Commons

The problems we see around us today have come about because decisions that from an individual point of view are sensible can lead to an overall bad result. This is the tyranny of small decisions. Individual decisions -- one-by-one -- become a torrent of decisions throughout the region. The results of those decisions eventually wash to the Bay.

Local governments in the region are acting out the tragedy of the commons. In pre-industrial England each villager had a right to graze livestock on the common area of the village. Initially, the commons was large enough to support the livestock of everyone in the village. Population growth and increased wealth resulted in more cattle being grazed. Overgrazing followed, with the commons suffering from erosion and loss of vegetation. From the individual's perspective it made sense to add one more cow since the benefit (in milk, hides, and meat) from the added cow accrued to the individual, while the damage was spread to everyone equally. Reduced use of the commons by everyone would sustain it in good condition, but this would require the self-restraint of everyone. Although the more thoughtful villagers could foresee the end -- a commons useless to all -- the day-to-day decision of whether to add a cow overrode the need to protect everyone's collective long-term interest in having a sound and productive commons. Collective action was required to achieve a level of mutually agreed restraint with its long-term benefits.

Manifestations of the Problems

Current land use practices in most areas parallel those of the commons. When the country was younger, citizens could subscribe to the view that a property owner should be able to use land as he or she chose, with minimal regard to the general welfare. As the nation becomes more densely settled, the poverty of that philosophy if applied to its logical end is recognized.

Suburban growth around cities, creating congestion and pollution and requiring extensive resource consumption, is a manifestation of the problem. Day-to-day decisions that may seem sound in the short-term, only compound problems in the long-term. Institutional arrangements, decision processes, and traditional ways of viewing the world that have served well historically are not proving effective in dealing with the suburbanization process and its results. Self-restraint will not

work if everyone is not participating. Lacking any assurance of universal restraint, individual (or local) decisions are made the best they can be under the circumstances. The problem is the circumstances. They need to be changed. Actions among affected parties need to be coordinated and planned.

The decline of the Bay's water quality and resources resulting from the individual choices of landowners and consumers is well documented.

Changes at the most basic levels of the ecosystem have had a disruptive effect throughout the Bay. The floor of the Bay is a major sink for metals and organic compounds. Studies have shown that Bay sediments are toxic to aquatic organisms, probably due to a combination of high metal content and high loads of organic compounds.

Although the input of metals to the Bay comes from both human and natural sources, some metals have been found to occur in sediments in the northernmost part of the Bay floor at levels up to eight times higher than would occur from natural processes alone. In the Patapsco and Elizabeth Rivers where industry has located, metal concentrations up to 100 times greater than natural background levels have been found. High levels of metal contamination have been also found in the upper Potomac, upper James, small sections of the Rappahannock and York Rivers, and the upper mid-Bay.

Excessive levels of nutrients are also a major problem in the Bay. As nutrient levels increase, algal growth is encouraged. High levels of algae are a harbinger of oxygen depletion, especially during summer months. When algae die, the natural decaying process consumes oxygen. When oxygen is depleted, water can become anoxic and devoid of most forms of life except anaerobic bacteria.

" ...traditional ways of viewing the world . . . are not proving effective in dealing with the suburbanization process and its results."

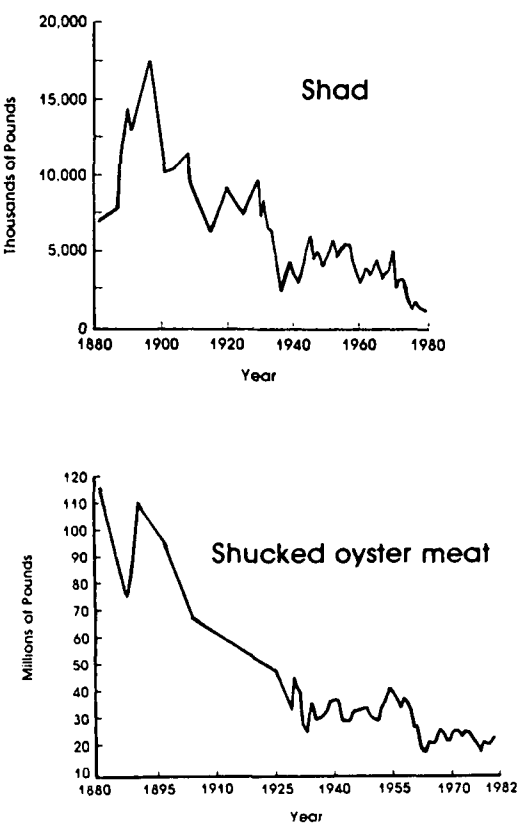
In July 1950, there were no anoxic waters and only limited areas of low dissolved oxygen in the main stem of the Bay. In July 1980, a very large area of the main stem of the Bay experienced anoxic conditions. The duration of oxygen depletion has also increased. This spatial and temporal increase in the extent of low dissolved oxygen levels reduces the area of the Bay that can support normal finfish and shellfish populations.

Submerged aquatic vegetation (SAV) was once abundant throughout the Chesapeake Bay. In recent years, there has been a decline in all species of SAV in all sections of the Bay, with 1965 to 1980 representing a period of unprecedented decline. Annual surveys of SAV have shown that the number of vegetated survey stations in Maryland dropped from 28.5% in 1971 to 4.5% in 1982. Changes in the distribution and abundance of Bay waterfowl, which feed on SAV, have paralleled these vegetation changes.

Areas of greatest SAV loss correspond with areas of greatest nutrient enrichment.

Reports show that on a worldwide basis, SAV communities are becoming increasingly affected by man-induced changes, and have declined in areas where there is extensive industrial or urban development.

Impacts to fishing harvests have also occurred. Between 1930 and 1960, annual harvests of 30 million pounds of shucked oyster meat were sustained. Between 1960 and 1980, annual yields dropped to about 20 million pounds. Annual harvests of freshwater spawning finfish declined from a maximum of 20.44 pounds per acre (between 1901 and 1910) to 5.64 pounds per acre (1971 to 1980). Declines have occurred in harvests of alewife (herring), shad, yellow perch, striped bass, and white perch. A variety of factors impact finfish, and natural variables have major influences on the populations. However, evidence suggests that human-caused stresses, especially nutrient enrichment and toxicity in low-salinity spawning and nursery areas, may be related to recent declines in anadromous species.



Fishery Harvests

The Role of Growth and Development

Not all these problems result from the development process and the pattern of development. All, however, result from an increase in the number of people living in the watershed, creating increased per capita demand for electricity, water, sewage, roads, trash disposal, recreation areas, and other goods and services. Growth dictates the need for public strategies to reduce per capita impacts if we are to merely maintain the status quo.

Low density residential growth requires extensive use of the private automobile, which dictates the need for extensive paved areas for roads and parking. These surfaces shed excess, contaminated runoff to waterways. Increased fuel use puts more pollutants into the atmosphere, from where they fall or are washed out to the land and the Bay. Combustion of hydrocarbon fuels adds carbon

dioxide to the atmosphere, contributing to the "greenhouse" effect and the warming of the earth. Greater car use requires greater use of motor oil. Nationwide, motor oil accounts for nearly 40% of the hydrocarbon pollution found in waterways. Nearly 80% of the oil purchased for do-it-yourself oil changes is not recycled. Quart by quart it finds its way into stormdrains, landfills, and holes dug in the backyard. It also finds its way to the Bay.

Removal of trees and native vegetation near waterways takes away a natural buffer and filter. Stream quality drops due to both the loss of vegetation and the added pollutants and runoff. Large grassed areas are generally maintained by the application of fertilizers and pesticides. Both are feedstock for water pollution. The degree of pollution depends on how much is used, the proximity of surface or groundwater, the timing of the use, and the characteristics of the chemicals, the soils, and the vegetation. Non-native vegetation used in gardens and parks often is not well matched to the soils and rainfall of the region and will require extensive use of water and chemicals to survive.

Public sewage treatment facilities can be effective at removing nutrients from the waste stream. Low density growth makes the development of a community sewer very expensive. Private septic systems are the norm in low density residential areas, but these systems can be ineffective in some soil and groundwater conditions. Also, over time the systems require upkeep, which is the responsibility of the homeowner. If there is no obvious problem on the ground surface, malfunctioning systems go untended, adding their pollutants to groundwater and nearby surface water.

Global Connections

The Bay is affected by global problems as well. It has been estimated that as much as 25% of the nitrogen introduced into the Bay is from air pollution. Automobile and power plant emissions are deposited directly on the Bay or within the watershed, whence they wash to the Bay.

Likewise, the long-term integrity of the Bay's wetlands will be challenged by sea level rise brought about by global warming. For the last two or three thousand years, sea level rise along the Northeast coast has been about .3 feet per century. Since 1940, the rate has risen to about 1 foot per century, and is projected to increase to a rate of 3 to 6 feet in the next century. Existing wetlands will disappear as they are submerged by the sea, and new ones will grow in areas newly inundated by the sea's rise. Unimpeded, wetlands will generally migrate landward, occupying land that was once upland but which has become tidally influenced. In some instances, accumulating sediment within a wetland will keep pace with the sea's rise and build new wetlands atop the old. To continue to exist, wetlands will also need to migrate landward of their present locations. Bulkheads, retaining walls, and fill destroy this process. Serious loss of wetlands in the Bay can be expected unless communities are farsighted enough to ensure that development does not interfere with the migration of wetlands.

Clearly, problems in the Bay link directly back to how people conduct themselves on land: the style of life, the pattern of development, and the investment policies followed with regard to roads, sewers, water systems, and trash disposal. These linkages were acknowledged in the 1987 Chesapeake Bay Agreement.

Chapter Two

Development Patterns In The Chesapeake Bay Region

Population Growth and Distribution Until Now

The entire Chesapeake Bay watershed encompasses portions of Maryland, Virginia, Pennsylvania, and the District of Columbia, as well as portions of Delaware, New York and West Virginia. The Population Growth and Development Commitment of the 1987 Bay Agreement deals only with the Maryland, Virginia, Pennsylvania and District of Columbia portion of the watershed. This somewhat smaller area was the focus of the 2020 Panel's concern. The 1990 population for the study area is estimated at 13,590,900 individuals, which is 83 percent of the total watershed population.

Although more than 1/3 of the Chesapeake Bay basin and 1/4 of the basin's population lie within Pennsylvania, most of the recent growth in the basin has taken place in Maryland and Virginia, near the Bay and its major tributaries. For example, between 1973-1981 in Maryland, 17% of all new development in the counties around the Bay occurred within 1000 feet of the Bay and its tributaries. This strip accounted for only 9% of the land in these counties. In Queen Anne's County, one of the Maryland Bay Counties, the disparity in development between shoreline and interior land was extreme. Seventy four percent of all development occurred in the 1000-foot zone, which represents only 11% of the county's land.

" ...the Bay and rivers of the region have acted as powerful magnets to growth . . . The pattern of growth ignores political boundaries..."

It is not simply the number of people that affect a region. For example, one evidence of growth -- traffic congestion -- became a substantial issue in the last decade. The number of cars on roads has increased at a greater rate than the population. Likewise, the number of houses has increased at a greater rate

than the increase in population. How we conduct our daily lives has a profound effect.

Wealth and the Automobile

Since World War II, the number of cars and houses in this country has grown dramatically. Congestion on two-lane highways gave rise to the $108 billion dollar interstate highway system and to the upgrading of other federal, state and local highways. The social and cultural changes that have swept our

" ...the Baltimore-Washington-Annapolis area . . . of the Bay watershed has 5.8 million people, ranking 4th in the Nation behind New York, Los Angeles, and Chicago."

Nation (and the world) have manifested themselves in many ways. One is that many more women are in the workforce, and many households have two or even three cars -- cars that are likely to be on the road as parents go to separate job destinations and teenaged children drive to school. Having a car has shifted from a luxury to a necessity, fostered by the development patterns we have sought. Fueled by relatively cheap gasoline and a subsidized road network, we have spread out in the low density pattern of living we have come to label "sprawl".

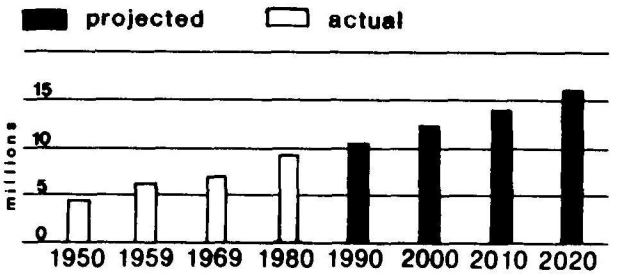
The impact of this is readily seen in growing areas. In Fairfax County, Virginia, for example, the population since 1975 has risen 31%, as people and jobs have come to the county. Washington, D.C. is still the job center for many people, but just as many people now spread out across the region, driving to new employment centers around highway interchanges throughout the greater Washington area. In Fairfax, the 31% population increase was accompanied by an 84% increase in autos. Not only are there a tremendous number of cars, they are being driven more. In 1976, 466,000 vehicles a day used the Capital Beltway; now 735,000 vehicles a day make use of this road. The average speed on the Beltway in 1981 was 47 miles per hour; now this has been halved to 23 miles per hour.

Population Patterns

The population of the region is not spread uniformly. Growth has been most dramatic in the suburban counties around the region's cities. The parts of these counties nearest the cities are now largely urbanized, albeit at a lower density than the core cities. Now growth is moving into the far reaches of these counties and into the once more remote counties. Many counties in the hinterland, most notably in the upper reaches of the Susquehanna River have remained static or even lost population, as have central cities. In all cases, the Bay and rivers of the region have acted as powerful magnets to growth. Living in proximity to water remains a high priority of many people. People are moving toward the shore and to surburban areas around the cities. The pattern of growth ignores political boundaries, and once distinct areas are now merging where their spheres of

influence overlap. It is not unusual for people to live in one city and commute to another. Couples often select intermediate points of residence. This merging is clearly evident in the Baltimore-Washington-Annapolis area. If viewed as a metropolitan region, this area of the Bay watershed has 5.8 million people, ranking 4th in the Nation behind New York, Los Angeles, and Chicago.

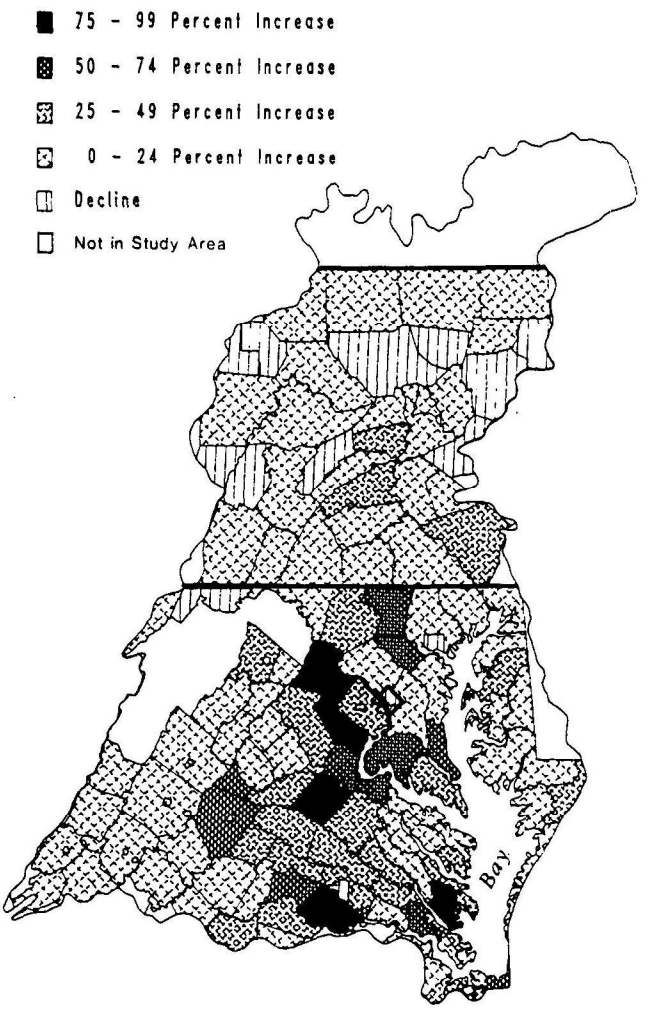
Chesapeake Bay Watershed Population



Future Population Growth and Distribution

Looking across the next three decades, it is possible to anticipate not only how many people there will be but how other aspects of life may change. No doubt, technology and social habits will change some things radically, while other aspects of life will remain virtually the same as they are today. As for the make-up of the region's population, we expect smaller families, an older average population, and a population with more wealth, leisure time, and education.

Percent Population Increase: 1990 - 2020



Where New Residents Will Go

In the next 30 years the Pennsylvania, Maryland, and Virginia portion of the watershed is projected to grow by 2.6 million people (nearly 20%), from 13.6 million in 1990 to 16.2 million in 2020. This projected growth, which is less than the increase of the last three decades, will still add considerably to the stress potentially applied to the Bay and to the region's environment generally. As with prior growth, the projected growth is not expected to be uniformly distributed.

Near-shore areas and the metropolitan ring counties will see much of the growth.

Population projections for the portion of each jurisdiction within the Chesapeake Bay watershed indicate the following percentage increases between 1990 and 2020. Pennsylvania's population will grow 8%, Maryland 18%, and Virginia 32%. Washington will remain static.

" ...conversion of agricultural and forest land to low density residential use is the form that most of this growth will take."

Currently undeveloped land near the major urban centers of Washington, Baltimore, Northern Virginia, Richmond, and Norfolk, as well as Harrisburg and York, is likely to be converted for residential use as this growth occurs. If recent trends are an indication, conversion of agricultural and forest land to low density residential use is the form that most of this growth will take.

The Washington Council of Governments has forecast population, household, and job growth in its region, and predicts a return to the rapid growth of the late '50s to early '70s. Over the next 25 years, local population is projected to increase 32%, with an increase of 47% in the number of households (reflecting the trend to smaller household size), and a 66% increase in jobs. About one-third of these jobs, but little population growth, is forecast for the central metro area of the District, Arlington, and Alexandria. The inner suburban counties -- Montgomery, Prince Georges, and Fairfax -- are expected to see about half of both the population growth and the jobs. The outer suburban counties -- Loudoun, Prince William, Charles, and Frederick -- will see 40% of the population growth while jobs grow by only 13%. This continues the trend of commuting from bedroom communities to central city and beltway work places.

In contrast, the Richmond Regional Planning District projects that future land development in the Richmond region would occur at slightly higher densities than existing development because of such factors as increased costs for energy, construction, and land, and decreased household size. If these assumptions are correct, land consumption will grow at a slower rate than will population in that region.

Consumption of Land

Undeveloped land has been converted to developed land at a rate that exceeds the rate of population growth. Between 1970 and 1980 in Maryland, for example, population increased 7.5 percent, but developed acreage increased 16.5 percent. In other words, the land used for development is more than doubling on a per capita basis. This is the result of development on large lots (e.g., 1 acre or more per house). The use of land was not uniform, however. Although only 8% of all developed parcels were sized 2-20 acres, these parcels accounted for 52% of developed residential land. It has been projected that by the year 2000 in Maryland, 80 percent of new housing will occupy one

third of the land being converted for new housing. This 80% will be in sewer service areas. The remaining 20 percent of the housing demand will consume 2/3 of new residential land, and will be located outside sewer service areas.

The entire Chesapeake basin population grew almost 50% between 1950 and 1980 (from about 8.3 million to 12.4 million). In the same period, the amount of land used for residential and commercial purposes increased 180% (from 1.5 million acres to 4.2 million acres). This corresponds to a land consumption rate of .65 acres per new resident.

Looking at just the three state area, population will increase 31% between 1980 and 2020. If land consumption continues at the same pace as before, 59% more land will be developed than was developed in 1980. In 1978 (the only year for which basin-wide data are available), developed land made up 10% of the Bay watershed within Maryland, Virginia, Pennsylvania, and the District. In 2020, this would increase to 16% of the watershed. By jurisdiction, the amount of developed land in Maryland will increase from 19% to 33%, in Virginia from 10% to 18%, in Pennsylvania from 7% to 8%, and in the District of Columbia there will be no change.

Although the accuracy of projections is always debatable, it is clear from experience that per capita land consumption is now taking place at a greater rate than was once the case. For example, in 1950, each resident in the region accounted for .18 acres of developed land. During the three decades from 1950 to 1980, each new resident accounted for .65 acres of new development. The result is that the regional average of developed land per person has nearly doubled to .33 acres.

Effects of Growth on Key Resources

Loss of Sensitive Areas

Between 80 and 90 percent of the total Bay seafood harvest depends at some stage on wetlands. Wetlands provide a food source for finfish larvae, and serve as a buffer against excessive nutrients, sediment, and pollutants.

"Undeveloped land has been converted to developed land at a rate that exceeds the rate of population growth."

Nearly 1.2 million acres of wetland, 75% of which are inland wetlands, are found in the Chesapeake Drainage Basin. Between the mid-1950s and the late 1970s, more than 2,800 acres of wetlands were lost annually, principally to development and agriculture. Between 1955 and 1978, Maryland lost about 24,000 acres, (5%) of its 440,000 acres of wetlands. Virginia, with slightly more than one million acres of wetlands, lost 63,000 acres (6%) of its wetlands between 1956 and 1977. Of nearly 500,000 acres of wetlands in Pennsylvania, 28,000 acres (6%) were lost between 1956 and 1979. Overall, inland wet-

lands are disappearing at a faster rate than coastal wetlands. No doubt, this is due to protective federal and state laws now being applied to coastal wetlands.

Other sensitive areas are at risk from growth and development. These include watersheds of water supply reservoirs, areas over groundwater wells, aquifer recharge areas,

"Between the mid-1950s and the late 1970s, more than 2,800 acres of wetlands were lost annually..."

and large undisturbed forests that act as important wildlife habitat. The natural fragility of these resources makes them especially vulnerable to impacts from development on or near them.

Waste Generation

The demand for additional waste management services or facilities will be significant as population in the watershed continues to grow. Each resident generates about 1,300 pounds of municipal solid waste a year. For the basin, this translates to a need to manage 3.4 billion pounds of additional solid waste per year by 2020.

By 2020, 260 million gallons of additional wastewater will be generated each day in the watershed (assuming 100 gallons per person per day). While some will be disposed of in septic systems, most will require municipal treatment. Assuming 80% of new development is in sewer service areas, an additional 208 million gallons of wastewater per day will require municipal treatment.

The design capacity of sewage treatment plants in the coastal plain (i.e., where most of the growth and therefore demand will be) is estimated to be 1,269 million gallons per day (mgd), with 321 mgd of that available to treat additional waste flows.

Capacity of Sewage Treatment Plants in the Coastal Plain

	1985 Flow	Design Capacity	Available Capacity
Metro*DC	301 mgd	370 mgd	69 mgd
MD	291	423	132
VA	356	537	181
Total	948	1330	382

*includes VA and MD suburbs

In the aggregate, current or planned capacity appears adequate to treat expected flow increases, or even larger volumes. Some of the currently available capacity is likely to be used to extend service to currently developed areas, and will therefore be unavailable to serve future growth. The location of new growth in relation to existing treatment capacity will be an important factor is whether additional capacity is needed.

In addition to readily quantifiable waste streams, increased development in the Bay watershed is likely to be accompanied by increased loadings from nonpoint sources. For example, it has been estimated that 2,300 tons of sediment per year erode from one square mile of land during development, and 700 tons of sediment per year erode from one

square mile of developed land. The latter rate of sediment loss is six times higher than the rate of sediment loss from wooded areas. (Some reports estimate that as much as 25,000 - 50,000 tons per square mile of sediment comes from land stripped for construction.)

If land development continues at a faster rate than population growth, as has occurred over the past 30 years, as much as 1.5 million additional acres (2,300 square miles) of land could be developed. This development will generate an estimated 5.3 million tons of sediment during construction, and 1.6 million tons per year at build-out. Not all of the built-out sediment load will be in addition to the current load, as the farmland and undeveloped land being replaced also contribute sediment.

Water Use

In 1970, 76% of Bay area residents and many industries relied on central water supplies (872 mgd). By 2020, the demand for fresh water is expected to increase greatly. The Corps of Engineers estimates that the demand may increase by 170% to 2,320 mgd, and that 2/3 of the water systems will have average demands that exceed supplies.

Even if we assume no growth in demand from existing development, new residents alone, at 100 gallons per day, will require approximately 260 mgd for domestic use.

Water supply is a particular problem in the rapidly growing Hampton Roads section of Virginia. The community-by-community approach to water supply planning, with the Commonwealth taking a minor role, led the Administrator of EPA Region III to conclude that ..."the technical, legal and institutional tools essential for a regional solution to water resource development are not adequate at this time." Local solutions for water planning often put other resources at risk. For example, counties searching for suitable locations for impoundments seek to be allowed to dredge wetlands and streams.

"Local solutions for water planning often put other resources at risk."

Increased diversions from streams and rivers, groundwater withdrawals, and creation of impoundments in wetlands and across watercourses are current issues that will require regional and state-level solutions. A 20% population growth in the region (and a 32% growth in Virginia in particular) will only exacerbate this problem.

Infrastructure Costs

A report by the National Association of Home Builders, based on "typical" development and infrastructure, indicated that as housing densities increase, unit costs decrease. About 80% of the on-site cost variation is accounted for by density factors (on-site development costs include: grading and land preparation, stormwater drainage and management facilities, water and sewer

lines or septic tanks and wells, street construction plus curbs and gutters, landscaping and site amenities). Increasing density requires fewer linear feet of water and sewer pipes, fewer square feet of paving, and fewer cubic yards of grading per dwelling unit.

"It is unlikely that the roads, sewers, and other public facilities needed to fully support growth could be built if growth continues in present patterns and densities."

A study by the Maryland Department of State Planning concluded that, although initial costs per unit for constructing very low density housing may in some cases be lower (for example, a septic tank may cost less than a sewerage hook-up), in fact the costs are usually higher over the long term. Long term costs are usually incurred by the public, often through federal and state grants, for the following reasons:

In rural areas, pupils and cars are added slowly, giving the appearance of low cost until schools and roads must be expanded or replaced (in Maryland, school construction costs are paid for by the state). Per capita costs for operating rural schools are high due to long and scattered bus routes, and operating costs due to small school size.

Other community facilities (e.g., fire, police, library, health care) seem unnecessary during early phases of low density residential expansion, but are eventually added, with costs borne by residents and government.

Septic tanks often require replacement within a 20 or 30 year period, or septic or well failures necessitate hooking up to public water/sewer systems (in Maryland, over 85% of water and sewer facility construction outlays are paid for with state and federal money).

At densities of one unit per 1-5 acres, approximately $3,500 in site development costs can be saved for each one unit increase in density. In the range of 2-5 units/acre, approximately $1,800 in site development costs can be saved for each one unit increase in density. For multifamily construction, approximately $400 can be saved for each one unit increase.

Traffic on Virginia roads has increased from 34.6 billion vehicle miles traveled in 1975 to 49.7 billion vehicle miles in 1985, an increase of 44 percent. Conversely, State transportation construction funding dropped from $230 million in 1975 to $130 million in 1987 (a decrease of 43 percent). This has recently reversed and a massive new investment in transportation in Virginia is underway. In 1988 alone, the state approved $915 million for highway construction and other transportation-related projects. Virginia plans to spend about $10 billion over the next dozen years.

Other costs of traffic congestion are increased accident rates, operating costs, air pollution, and shipping costs. Decreased productivity due to all of these factors, and

barriers to economic development result from traffic congestion.

It is unlikely that the roads, sewers, and other public facilities needed to fully support growth could be built if growth continues in present patterns and densities. The trend is otherwise: 92% of the roads in the U.S. were built prior to 1960 and keeping them repaired, let alone expanded, is a costly battle. In 1950, 19.1% of government expenditures were on public works; in 1985, only 6.8% of government spending was invested in public works. Even if the money to build new roads was available, most experts agree that no one would be unable to build enough to ever satisfy the demand. The illusion of ease of travel brings forth more of us in our cars.

The Panel's evaluation (See Appendix A) reveals that roads will be a substantial expense. By 2020, growth is projected to require between $6.6 billion and $17.4 billion in new road construction, depending on the density of development. A policy favoring high density growth patterns rather than low density patterns could translate into as much as a $10.8 billion (present value) cost savings. This savings effectively becomes available to use in other programs, such as sensitive land acquisition.

Chapter Three

Envisioning An Alternative Future

It is not difficult to make a case that development and growth over the past three decades has created some severe problems. Likewise, not much disagreement is found when we say we need to do things better in future. Better can be interpreted a number of ways, of course. Better can be doing the same things more efficiently and effectively, or better can be doing things differently.

In working to establish an agenda for how future growth and development should take place, the 2020 Panel had to get beyond describing what was wrong currently to describing what alternatives were available in the future. The future was taken to be not just the year 2020. The future is tomorrow and everyday thereafter. Envisioning an achievable alternative future -- that could begin to be put into place immediately -- became the focus of the Panel in its final deliberations.

We determined that alternative futures for population growth and development are most usefully expressed as alternatives in either the location or density of growth, or both. When we change the location of populations, we change the ease with which pollutants generated by those populations can reach aquatic systems. Pathways and opportunities for pollution migration are changed. Sensitive areas and buffers are preserved. When population density changes within the landscape, the actual quantities of pollutants generated change. Land occupancy and activities that generate pollution are altered. A part of "density" is the mix of mutually supportive land uses available within the vicinity.

" ...we need to do things better in future . . . Better can be doing the same things more efficiently and effectively, or better can be doing things differently."

Basic planning and hydrologic principles can be applied to determine where populations should locate. However, a comparative method is needed to evaluate the relative advantages of varying population densities.

While it is very difficult to quantify all of the impacts from land use, key features can be examined and the relative costs quantified under different densities. Some of the features to consider are automotive emissions,

sediment in runoff, energy use, driving time, and road construction costs.

Location Alternatives

The choice of location for development is largely controlled by land availability, access, and infrastructure. Public policies have directed development away from some areas (e.g., wetlands), but this accounts for relatively little of the land in the region. Common practice is for communities to zone large areas for various land uses. In more rural areas there is either no zoning or zoning which is readily changed to accommodate development proposals.

"Sprawl is an ineffective use of the land, difficult to service with infrastructure and transportation, requiring extensive use of automobiles, and consuming large land areas."

More than any single development factor, we were concerned with low density sprawl. Sprawl is an ineffective use of the land, difficult to service with infrastructure and transportation, requiring extensive use of automobiles, and consuming large land areas. Location of development should be more tightly controlled. For instance, distance to job centers, urban or village centers, cultural amenities, and recreation could be used to define an outer limit to development -- effectively an urban boundary.

Within such a boundary, certain natural resource areas should be avoided. Wetlands, large wooded tracts, stream corridors, steep slopes, and shorelines are examples of resources that are sensitive to development impacts. Thus, it is possible to create a "map" of the region which would show the geographic limits to significant development (i.e., located within reasonable boundaries and supported by infrastructure) and the constraints on development within this boundary. Capital improvements need to be planned and scheduled as an integral part of planning for growth in such areas. Growth would be actively discouraged in areas not designated to be developed, while incentives are offered for growth in appropriate areas. This effectively creates a template of where development is most suitable, based on infrastructure, distance to urban and job centers, and environmental constraints.

Density Alternatives

Once alternative location patterns are determined, the question of density of development within these patterns arises. Greater density requires less paving, landscaping, and automobile use, which results is less pollution, runoff, and sediment per person. A drawback, of course, is that concentrating people will result in a parallel concentration of problems. Greater use of public transportation is feasible, with greater use creating a demand for better and more frequent service. Higher density also provides opportunities to mix supporting commercial, institutional, and employment uses with residential uses.

Three residential land use patterns were examined: Low Density, Medium Density, and High Density. Each pattern is made up of five possible dwelling types: Single Family Conventional, Single Family Clustered, Townhouses, Walk-up Apartments and Highrise Apartments. (See the Appendix A for details on the analysis.)

For purposes of this analysis, the Low Density land use pattern consists of 75% Single Family Conventional homes and 25% Single Family Clustered homes. In the Low Density alternative, there are no Townhouses, Walk-up Apartments or Highrise Apartments.

The Medium Density land use pattern has an equal distribution of the five dwelling types. Thus, Single Family Conventional homes constitute 20% of all new homes, Single Family Clustered homes comprise 20% of all new homes, Townhouses account for 20% of all new dwellings, and Walk-up Apartments and Highrise Apartments are each 20% of the new dwellings.

The High Density land use pattern contains no Single Family Conventional homes, but would contain 10% Single Family Clustered, 20% Townhouses, 30% Walk-up Apartments and 40% Highrise Apartments.

For illustrative purposes, we used the forecasted population change for the region along with development variables from the book: The Cost of Sprawl, and considered these values in terms of the three development scenarios (Low, Medium and High Density).

Aside from the obvious costs associated with development, such as land acquisition and construction costs, cost implications come from the physical effects of alternative land use patterns. For example, if one land use pattern produces more air pollution than does an alternative, we can be reasonably sure that the social costs of that land use pattern also will be greater. The higher the air pollution, the greater the institutional costs to reduce these levels of pollution. With the addition of more stringent regulations comes greater costs of changing the emission producing or controlling technology.

Comparison of High, Medium, and Low Density

We found that the cost of roads to serve Low Density housing is highest: about 1.7 times the cost of roads serving Medium Density housing and about 2.6 times higher than that associated with High Density housing.

The energy required for Low Density housing is about 1.4 times the amount required by Medium Density living, and about 1.8 times the amount required by High Density housing. The overall driving time for Low Density housing is about 70% greater than for Medium Density, and about 90% greater than for High Density housing.

Potential air pollution from auto emissions in a Low Density land use alternative is about 1.6 times as high as the Medium Density case, and about 2 times as high as the High Density situation. Commuting is the major reason for this difference. Also, at lower densities fewer destinations can be

reached without using an automobile. Thus, the Low Density alternative would be the most expensive per capita air pollution problem to remedy and High Density emissions would be the least expensive.

" ...the Low Density alternative produces environmental effects and infrastructure demands that are more expensive to remedy..."

Potential air pollution (sulfur oxides) from residences using natural gas in a Low Density land use alternative is about 1.3 times the Medium Density alternative and about 1.7 times the High Density alternative.

Sediment due to erosion is highest for the Low Density alternative. Low Density erosion is about 1.5 times the Medium Density alternative and about 1.75 times the High Density alternative.

Not unexpectedly, the Low Density alternative produces environmental effects and infrastructure demands that are more expensive to remedy than the effects associated with Medium and High Densities. The cost differences are likely to be significant.

Effect of Delay

In the analysis of population growth impacts, we examined the question of how delay in implementing new management strategies might affect pollution loads. To study this question, we assigned to the year of its establishment all of the pollution expected from a new household by the year 2020. Thus, a household arriving or being set up in 1990 would be credited with 30 years of impact, while a household coming in 2018 would be credited with only 2 years of impact. Although population growth is projected to be fairly steady, those who establish households earliest will have many more years in the region than later arrivals. The evaluation revealed that households established in the 1990s have a forecasted 16.6 million household-years in the region, while those arriving the the last decade (the 2010s) have a total of only 2.8 million household-years in the region by 2020.

If there is no change in our approaches to growth and development management over the next decade, then new households will develop in a similar fashion to those of, say, the past decade. These new households would contribute pollution and other impacts at the same level as existing households.

About 38% of the new households projected for the next three decades will be set up by 1999. But, based on their longevity in the region, by the year 2020 these early households will have accounted for nearly 59% of the pollution attributable to all new households. Thus, the benefit of acting soon to introduce changes in development patterns is clear.

Directing Growth

For the purpose of discussing alternative land use patterns, the Panel focused on the new increment of population and the spaces created to accommodate growth. In assessing household development, it was recognized that even if there were no growth in population, additional households would be developed as average household size grew smaller. Changing household size for both the existing and new population means that the rate of household development will outpace the population growth rate.

The panel did not discuss in depth policy alternatives that might apply to existing structures or land use patterns. The discussion was focused principally on land use practices and policies that apply to yet-to-be-created development.

One basic approach to directing population growth is "no change". This alternative presumes that the market will create the best land use patterns (or that government is powerless to affect them) and that whatever government intervention already takes place is adequate. The Panel determined that this was not a valid growth directing mechanism for the region, and we needed a better alternative. Thus, attention was focused on three approaches that are within the power of government and have been used in various forms for many years. These three techniques either build on existing practices or require new or additional government actions to implement.

Land Management and Regulation

Land management and regulation through the use of the police power is the most frequently used technique. Zoning-based land management is the principal strategy employed by most localities. Zoning has

" ...the benefit of acting soon to introduce changes in development patterns is clear."

wide variations in how it is applied. Incentive Zoning, for example, allows the acquisition of a social good (such as a park) by giving a private good (such as a tax abatement). Conditional Zoning allows setting conditions for zoning concessions. This is much like incentive zoning but involves individual negotiations. Impact Zoning establishes a framework for negotiation based on likely impacts. Approval is contingent upon proof that development will result in no substantial increase in costs for the community. Performance Zoning encourages development to be consistent with natural features. For example, there would be no floodplain filling. Other management approaches include affecting the amount of developable land. For instance, Transfer of Development Rights allows current property owners to realize the economic value of the development potential of their land and allows the government to specify development and non-development areas.

Infrastructure Investment

A second basic technique is to control the timing, size, and location of public facilities. This approach is based on the simple notion that the government, by investing in roads, sewers, and water systems, creates opportunities for growth to flourish. Planned management of this investment for land use control has not been widespread, but is rapidly being recognized as a key element in the management of growth and development. Managing public facilities requires the government to determine the optimal level and location of public facilities and then allow only the magnitude of growth that is consistent with that capacity. Capital facilities can determine growth patterns. They attract growth that would have otherwise spread throughout the region. By increasing access and reducing costs (e.g., sewer hook-ups are less expensive than septic systems), public infrastructure attracts growth around it. Building infrastructure in designated growth areas and withholding it from other areas reinforces growth management strategies at the local level. Government needs to clearly commit itself to building the necessary infrastructure according to a plan and schedule.

"With 2.6 million new people by the year 2020, the states and their local governments need to adopt a more highly integrated approach to planning and growth direction and management."

Taxes and Incentives

The last growth management technique is to impose or forgive taxes or fees as appropriate. Imposing penalties for development in designated low growth areas discourages their wholesale development. Conversely, growth can be greatly encouraged in designated areas by granting subsidies and other economic incentives. Public infrastructure development, for instance, is one type of subsidy.

While many of these and other techniques to manage growth have been applied from place to place in the region, they have not been applied in an effective and regionally comprehensive way. With 2.6 million new people by the year 2020, the states and their local governments need to adopt a more highly integrated approach to planning and growth direction and management. Coordinated, region-wide efforts need to be based on a common vision of the future. A much better job of managing, investing, and providing incentives is required.

Chapter Four

Visions Of The Future

Background

The face of the land has been altered dramatically. More subtly, human activity has altered the balance of nature. Prior to colonial settlement and even well after, the Bay region consisted of largely wooded uplands. The water's edge was dominated by wetlands. Abundant fish and fowl were to be found, as observed by Captain John Smith in 1606, when he wrote that the Chesapeake was a fair Bay encompassed "with fruitful and delightsome land." Even before effects on the Bay were discernable, as forests were cleared for farms and towns, William Penn warned that his colony's resources were not boundless. Among his conditions for governing the Province, published in 1681, was a requirement "that in clearing the ground, care be taken to leave one acre of trees for every five acres cleared."

Use of the land gives rise to a host of environmental issues. Choices of location for development, the types and densities of land use undertake, construction methods, and the ways day-to-day domestic and business practices are conducted all have significant implications for environmental quality. For every action or choice there seems to be both intended and unintended consequences. The goal always must be to act in ways and at locations where negative effects are avoided

"The goal always must be to act in ways and at locations where negative effects are avoided or made minimal."

or made minimal. The sequence of events between land development decisions and their environmental consequences always must be recognized. Points of influence over the chain of events should be identified and suitable choices made on how to affect the results in a positive way.

The continued attraction of the region as a place to live and work is both a boon and a curse. It brings with it prosperity and diversity, but also puts more people the region, changing the very place they came to. The amenities of the Bay -- its open water, shore, and river networks -- continue to attract people. Natural, visual, and cultural resources abound. The heritage and amenities of the region clearly illustrate the relationship be-

tween a desirable environment and a good economy.

Leadership for the Visions

From its deliberations, the 2020 Panel developed a linked set of visions of the Chesapeake Bay watershed's future. The principal finding was that the states must take a stronger role in managing their growth. Localities struggle daily with the issues, but lack the active participation of the state. Regional planning, technical assistance, resource protection, all need a strong, cooperative presence from the state. Achieving the future visions will require bold leadership at all levels of government. In the public meetings and in discussions with state and local officials, we heard one overriding sentiment repeatedly voiced: current problems and future growth require planning that is effective and coordinates growth management strategies across jurisdictions and levels of government. The only way to achieve the envisioned future is through a fully implemented plan -- one that is supported by effective programs and a leadership prepared to follow the plan. Otherwise, it really is just "business-as-usual," with a continuing enfeebling of the environment and, ultimately, the economy of the region.

"Achieving the future visions will require bold leadership at all levels of government."

Proposing alternative futures for the watershed that address fundamental issues of land use cannot be done in isolation. Alternatives for the region were reviewed and from these a vision of how new growth must fit into the region has been constructed. The visions are not complete in every detail; no vision ever is. Its purpose is to affirm that there is an alternative to following existing trends and continuing current practices. If there are visions to work toward, it is possible to set a purposeful agenda and annually accomplish tasks that, in sum, lead to realization of the visions. To propose change without a clear direction and a program to measure success, leaves the region little better off than if everyone continued their individual ways. The Panel's visions are not a blueprint, rather, they are a guide -- one that calls for the development of specific policies and practices to implement the envisioned future.

Visions of Success

The Panel is dismayed by the lack of growth management and planning, particularily on a state and regional level. It became readily apparent that the lack of comprehensive state and regional planning, uncoordinated public investment strategies, and undirected problem solving contribute greatly to the current problems of the watershed. Unless changed, this lack of clear policy and direction will compound future problems.

To provide a framework for making useful recommendations, the Panel conceived six linked visions of what should come to pass in

the region by the year 2020. All segments of society will benefit from achievement of these visions. Likewise, all must share in the in the cost of their implementation. The visions are clearly and simply stated. They are presented in the present tense to emphasize this is what will have happened if appropriate actions are undertaken today. Accomplishing the visions will produce a watershed with the following characteristics:

Well before the year 2020, state Comprehensive Development and Infrastructure Plans have been developed and implemented. State and federal agencies, counties, and municipalities encourage diverse and efficient land development patterns -- ones that concentrate growth and development in urban, suburban, and already developed rural centers. All growing areas have existing or planned facilities. Densities in most of these areas support mass transportation, van pooling, or other forms of ride sharing to reduce traffic.

These thriving urban centers and suburban areas are supported with funding adequate to maintain or enhance existing services. Cities and towns are vitalized by prudent public and private investment. Developers are offered incentives to provide greater community services and mitigate environmental impacts.

New mixed use growth centers are planned to take advantage of existing or projected infrastructure. Large open space areas are located within walking, bicycling, or short-drive distances of most people. Open space amenities are given the same priority as infrastructure.

Sensitive areas are protected from encroachment and damage. These areas have been defined and mapped by state and local authorities, and effective programs are in place to protect these natural assets. Very sensitive areas are in public ownership or under easement. Wetlands and lakes, rivers, and other waterbodies are protected from upland impacts by undisturbed vegetated buffers. In both urban and rural areas the shoreline of the Bay and its tributaries forms a series of vegetated corridors. These connect to large forested areas and allow for enhanced water quality, ecological balance, and biological diversity. Water supply has become a statewide issue, and safe and adequate supplies are available from protected groundwater and surface water sources.

Areas with resource-based industries such as agriculture, forestry, mining, and seafood harvesting are protected from encroachment of incompatible land uses. These industries remain important parts of the local and state economy. They have brought their environmental problems under control. Protection of these areas through effective land use controls, reasonable incentives, and innovative funding mechanisms insures a lasting, diverse economy and resource use options for the future.

Transfer of development rights from one land parcel to another better suited for development is commonplace and is proving to be an effective growth and resource management tool.

Growth in rural areas takes place in existing centers. Rural towns and highway intersections are defined by service boundaries and development space is provided for an appropriate mix of uses. These centers, with the assistance of state and federal governments, provide adequate sewer and water utilities. Use of on-site waste water treatment is limited so as to protect effectively surface and groundwater from pollution.

Outside these rural centers, residential development is limited so as to retain the economic, ecological, and scenic values of the countryside. Large woodlots and forests are retained and are selectively used for managed forestry, if they are not in preserves or parks. Quarries and other

mining activities occur but are screened from neighboring uses by well developed wooded buffers. Municipal, County, and State roads are planned to allow for adequate capacity for rural traffic.

The volumes of waste produced in the region have been greatly reduced and are being effectively handled. Energy and water use per capita has been reduced as conservation programs have been put in place.

The public and government agencies are sensitive to their responsibilities not to damage the environment and to conserve resources.

Stewardship of the land and Bay is practiced by ordinary citizens who have been made aware of how they affect the land and water. The quality of the Bay is improved, tourism is strong, resource-based industry, manufacturing, and service businesses desire to locate in the basin because of its resource base, amenities, diverse economy, and the quality of life it provides residents.

Those programs that require funds are supported by Development and Conservation Trust Funds that fund infrastructure and purchase land, easements, and development rights in support of the goals of the Comprehensive Development and Infrastructure Plan.

Realizing the Visions - Recommended Actions

Success in realizing these visions hinges on two things: the states must take a much more active and central role in the planning process for both land use and infrastructure, and a Comprehensive Development and Infrastructure Plan must be put in place in each state to guide state investments and policy and to create coordination among local land use plans. Only then can the visions and recommended actions listed below be implemented to change the course of the Chesapeake region.

Vision I: Development is concentrated in suitable areas.

Action 1. States must each develop and keep current a Comprehensive Development and Infrastructure Plan. All planning, funding, and development must be consistent with this Plan.

- The Chief Executive of each jurisdiction should establish a broad-based Task Force or Commission to promote the preparation and implementation of a state-level plan.
- Legislatively create (or designate) and fund a lead state planning agency with responsibility for preparing the state plan, coordinating planning and development activities, and achieving consistency among and with local and other state plans.
- By legislation, require that all agencies conform to the state plan.
- Develop criteria for the content of state and local plans and for determining consistency of local plans with the state plan.
  - require local zoning and planning.
  - require regular updates of state and local plans.
  - establish an interagency task force to report to the Governor or Mayor an-

nually on the plan and its progress and success.

Action 2. States must take the lead to establish and implement policies and programs that result in compact and efficient growth patterns.

- Create incentives
  - for reuse and redevelopment of areas already served by infrastructure (e.g., enterprise zones, creative zoning, density bonuses, and land assembly).
  - for locating housing and employment in designated growth areas served by public transportation.
  - to encourage use of mass transportation, car pools, and van pools.
- Invest in public transportation to support state and local growth policies.
- Develop programs to reduce private automobile use:
  - provide adequate and attractively priced parking at public transportation stations.
  - decrease availability of free or subsidized parking.
  - develop more high occupancy vehicle lanes and bus lanes on highways.

Action 3. States and localities must maximize use of existing infrastructure.

- Adopt programs and policies that concentrate growth at appropriate densities in designated growth areas with existing infrastructure.

Action 4. States should allow local communities maximum flexibility in innovating and adopting procedures for creating public open space and obtaining easements that are of public benefit.

Vision II. Sensitive areas are protected

Action 1. States must define sensitive areas and have appropriate state and local agencies designate such areas on a series of maps that comply with a standard map specification. These are to be used in planning, management, and project review.

- Include wetlands, floodplains, aquifer recharge areas, wellhead protection zones, water supply watersheds, important habitat areas, unique and scenic areas, large forest tracts, and other areas in need of special protection.
- Coordinate all mapping through a single agency that establishes statewide standards.

Action 2. States must make sensitive area protection mandatory.

- Require that the Comprehensive Development and Infrastructure Plan contain criteria for sensitive resource protection, management, and enforcement.
- Provide training for local officials in land use planning, resource management, and development review

- Furnish state or county level technical assistance for sensitive area protection planning and development proposal review.

- Adopt and enforce minimum standards for site development, construction, and maintenance to minimize impacts to the environment.

Action 3. States should coordinate acquisition and protection programs directed at sensitive resources.

- Coordinate public and private land and easement purchases by creating a coordinating group that keeps participating groups and agencies informed of needs, priorities, and progress.

- Provide state funds for purchase of very sensitive areas either in fee simple or through conservation easements.

- Review incentives available to encourage conservation easement donations and provide better incentives.

Action 4. Establish federal, state and local buffer zone programs that require adequate deep-rooted vegetated buffers be left undeveloped around sensitive resources and along all watercourses and water bodies.

- Set criteria for buffer zone widths according to the resource being protected and adjacent conditions. Clearly define the uses permitted within a buffer that will not compromise its effectiveness.

- Reestablish buffers in developed areas.

Vision III.Growth is directed to existing population centers in rural areas and resource areas are protected.

Action 1. Require state and local plans to define and map growth and resource protection areas.

- Indicate all areas where growth is inconsistent with resource protection.

- Provide adequate funding to improve and develop infrastructure in designated growth areas.

- Limit public investment in sewer and water systems to designated service areas. Require any expansion of the service areas to conform with local and state plans.

Action 2. Protect important agricultural and forest lands.

Action 3. State and local governments must protect water supply watersheds from development.

- Protect and where necessary purchase areas within watersheds where development would degrade the water supply. Encourage creation of easements that protect the watershed.

- Develop a specific management plan for each of these watersheds.

- Provide state leadership in planning and developing water supplies to meet the needs of rural areas.

Action 4. In Maryland and Virginia, stop condemnation of shellfish areas for marina and sewage treatment plant development.

Action 5. Each state should expand public park and recreation systems.

- Provide funding for the development of green belts around urbanized areas.
- Expand recreation opportunities near developed and designated growth areas.
- Emphasize low intensity recreational areas in undeveloped areas.
- Provide more public access to waterbodies.

Action 6. States should develop strategies to discourage development in areas devoted to resource-based industries and to reduce the need for localities to compete for property tax revenues.

- Institute a transfer of development rights system to allow local officials to designate areas of high and low growth, and to transfer the development rights from a designated resource protection area to a designated growth area. This will compensate the affected landowner and keep designated land in its current use.
- Offer incentives and other inducements to industrial development when this development is inside designated growth areas.

Vision IV. Stewardship of the Bay and the land is a universal ethic.

Action 1. State agencies should establish written environmental stewardship policies to guide their actions and should review their programs to ensure conformance within these policies.

Action 2. States should develop a required school curriculum unit focused on environmental and growth issues.

Action 3. Each state and the federal government should prohibit dumping of sewage from vessels into the Bay.

Action 4. Develop a broader-based public awareness of stewardship and proper environmental management.

Vision V. Conservation of resources, including a reduction in resource consumption, is practiced throughout the region.

Action 1. Reduce waste generation.

- Impose disincentives on excessive waste generation, including excessive use of consumer packaging that will become waste.
- Promote hazardous waste minimization.
- Create local recycling programs for all materials that are capable of being recycled.
- Require recycling of used motor oil, including do-it-yourself oil changes.

- Establish hazardous household products collection programs at the local level.

Action 2. States should develop programs to reduce automobile use and fuel consumption.

Action 3. States should develop programs to reduce water and power usage.

- Impose a sliding scale levy on water and power use to discourage excessive consumption.
- Set standards and require all new construction and remodeling to be energy and water use efficient.

Action 4. States should make best environmental management practices mandatory for development, agriculture, and forestry.

Action 5. Foster innovative technology and programs that reduce resource consumption and environmental impacts.

- Fund approaches that are practical and can be widely used.

Vision VI. Funding mechanisms are in place to achieve all other visions.

Action 1. Establish state Development and Conservation Trust Funds to provide for infrastructure, development incentives, and the purchase of land, permanent easements, or other rights in the land.

- Potential sources of funds to capitalize the Funds include:
  - higher fuel taxes
  - tax on profits from land sales
  - utility surcharges
  - user fees
  - property transfer tax
  - voluntary income tax check-off

Action 2. Develop revenue sharing or pooling arrangements among municipalities or counties affected by growth.

Action 3. States should encourage development of local taxing districts to allow local governments to recover the operating costs of public facilities unique to that district.

State and Federal Actions

Each jurisdiction has a unique set of concerns and needs, and programs that address the impacts of growth are at various stages of definition and development. Different approaches and priorities to reach the Visions and achieve the Actions will be used by each jurisdiction. In some cases legislative changes will be needed and in others fiscal appropriations will be required. Many actions can be initiated immediately, while others will require longer to implement. In addition to the general recommendations, each State's delegation to the Panel has prepared an agenda for action tailored to its state. The Panel prepared a Federal agenda.

Pennsylvania Action Agenda

Pennsylvania should consider the following actions.

Convene a task force charged with reviewing this report, and present within 90 days a Pennsylvania Action Agenda. The Action Agenda should take the report's respective recommendations and apply them, as appropriate, to the Commonwealth.

Legislation should be prepared and enacted to establish a State Planning Office in the Office of the Governor. The Planning Office should be directly responsible to the Governor, and should be broadly charged with the planning and overview responsibilities set forth in the 2020 Report. The legislation should also provide for a State Planning Board, advisory to the Governor and to the State Planning Office, with membership representative of the interests, economy, and cultural composition of the Commonwealth.

Legislation should be prepared and enacted dealing with regional planning in the Commonwealth, a function whose area-wide perspective warrants statutory expression.

The Municipalities Planning Code should be reviewed in light of the findings in the 2020 Report, and amendments to the Code should be drafted to accomplish the Report's recommendations.

A mechanism should be established for providing technical assistance and funding support to municipalities as they seek to deal with their responsibilities in implementing the recommendations of the 2020 Report.

Convene a panel to review the management policies that apply to all lands owned by the Commonwealth, and to suggest ways in which the various policies can be better coordinated, consistent with the mission of each land-managing agency, to further the aims of the 2020 Report.

Funding should be provided for the development of a model environmental education curriculum for Pennsylvania school districts.

Maryland Action Agenda

Maryland should consider the following actions.

Release the 2020 Report with strong support for the Visions to local governments, environmental and, development, economic, and community interests. Conduct a series of informational meetings and workshops to explain the background and purposes for the Visions and Actions and obtain ideas for how the Visions and Actions can be accomplished.

Request that state agencies indicate how the Visions and Actions can be accomplished with current or new resources and authorities. Each agency should state what issues it must address and what it will have to do differently to help realize the Visions and Actions. State agencies should respond by March 1, 1989.

Charge the Department of State Planning with preparation of the initial Comprehensive

Development and Infrastructure Plan by September 1, 1989, including criteria for determining consistency of State and local Plans. Capital improvements including major facilities; transportation; open space, recreation, and park areas; schools, etc. will be included.

Direct the Governor's Council on the Chesapeake Bay to report to the Governor on July 1st each year on the progress and success in achieving the Visions and Actions. The Executive Order creating the Council should be reissued to broaden the membership and purpose of the Council.

Direct the Department of Natural Resources with assistance from the Departments of the Environment, State Planning, and Agriculture and in cooperation with local governments to define and map sensitive areas by January 1990.

Appoint by March 1, 1989 a private/public Resource Protection Work Group to coordinate, establish priorities, target, and share information about the various private and public programs to acquire and protect sensitive areas.

The group should make its recommendations for improvements to the Governor within six months of its creation.

Direct the Department of State Planning in cooperation with local governments to prepare by September 1, 1989 a model resource protection program. Provide assistance to local governments in establishing resource protection programs to include buffers, performance standards, easements, etc.

Request Secretaries of the Departments of Budget and Fiscal Planning and State Planning to explore creation of Development and Conservation Trust Funds including sources of funds, and use and allocation of funds. Results are to be reported to the Governor by April 1, 1989.

Establish a Forest Protection Task Force to include the Departments of Natural Resources, Agriculture, and State Planning, local government officials and private sector participants to prepare local and State legislative and administrative proposals for the protection and re-establishment of forest land and wildlife habitat. If possible, proposals will be drafted for consideration during the 1989 and definitely prior to the 1990 General Assembly session.

Virginia Action Agenda

Virginia should consider the following actions.

Charge and appropriately fund an agency to collect, develop, and distribute 1) current and projected population figures, and 2) environmental, land use, and economic data in support of the needs of state agencies, regional planning commissions, and local governments.

Create a Virginia Commission for the Year 2020 to evaluate and recommend a statewide planning process in support of the Panel's recommendations. This Commission should

be inclusive of state, local, and private interests. Briefings of the Panel's findings to local government officials, state boards, the development community, and the general public should be an integral part of the Commission's activities.

Commission an economic analysis to explore the best combination of actions to fund the Panel's recommended Development and Conservation Funds.

Direct that state funds be expended on infrastructure (e.g., water, sewer, roads) only in locations that support the Panel's suggested development patterns.

Request a detailed assessment of legal barriers to the use of creative, innovative, and cooperative land management techniques, and develop a strategy for eliminating them.

Initiate legislation or regulatory actions, as needed, and a program of incentives and disincentives in support of resource conservation. The program should include waste minimization and recycling -- especially a beverage container deposit and return program -- the reduction of automobile use and increased support for mass transportation, and reduced water and power usage.

Initiate a program to define and map sensitive areas consistent with other Chesapeake Bay wetlands and living resources commitments.

District of Columbia Action Agenda

The District of Columbia should consider the following actions.

Assign to the Interagency Planning Council the responsibility to evaluated and recommend a District-wide strategy to implement the Panel's recommendations.

Continue to implement the Environmental Protection Policies in the District's Comprehensive Plan.

Implement erosion control measures along streams within the city such as stream bank cleaning and stabilization programs.

Consider constructing a boat ramp at an appropriate location along the Anacostia River to improve boating access.

Increase enforcement of soil erosion controls and construction activities through appropriate permitting processes.

Aggressively implement provisions of D.C. Law 7-33, which outlines several resource recovery initiatives, including yard waste and composting programs, multi-material recycling centers and the identification of environmentally sound methods of sludge disposal.

Fully implement the wetlands conservation plan developed by the city and the National Park Service under the 1986 Emergency Wetlands Protection Act.

Federal Action Agenda

Control of land use in a state responsibility, but the Federal government must become a strong supporter of these programs if hard won gains in environmental quality are to be preserved in areas of high growth.

To this end, Federal environmental programs and policies should evolve to be specifically directed at preserving environmental quality through research, technical assistance, and, where necessary regulation.

EPA should examine the array of available methods useful in quantifying the imports of growth and the technologies for further controlling emissions and for reducing generation of wastes.

Federal agencies owning and occupying real estate in the watershed should implement processes that ensure Federal facility conformous with State Comprehensive Development and Infrastructure Plan.

The U.S. Environmental Protection Agency and the U.S. Department of Agriculture establish a task force to examine ways to integrate programs to protect water quality into Federal agricultural lows and programs with the flexibility to be specifically adopted to the needs of the Chesapeake Bay watershed.

The U.S. Environmental Protection Agency should specifically examine ways to integrate Federal incentives for the protection of environmentally sensitive areas with involving State efforts.

Appendix A

Introduction

Population forecasts were provided by each jurisdiction and compiled by the Maryland Department of State Planning. It was assumed that the population forecasts apply to the beginning of the referenced year. Thus, referring to Table 1.1, as of 1990, Pennsylvania's watershed population is forecasted to be 3,570,719 and by 2000 the population is forecasted to be 3,657,049.

The Panel assumed that any proposed land use policy or management program will leave existing structures and infrastructures intact. That is, new land use policy will not affect existing structures. Rather, land use policy will be taken to mean policy applying to the new uses of land due to population growth. Hence, all calculations use population change because of the interest in the land use management of population growth.

Population

As we can see in Table 1.1, the total population (the total watershed population of the Chesapeake Bay Agreement signatories) is forecasted to increase over the next 30 years to 16.2 million people.

Table 1.2 shows the forecasted total number of households, based on the forecasted size of households (Table 1.3) and the change in population (Table 1.4).

Table 1.4 contains population change values. These values are calculated by taking the differences in the population forecasts of Table 1.1. For example, between 1990 and 2000, the population in Virginia is expected to increase by 500,550. Table 1.4 also shows that the rate of population growth is not explosive in most cases. For example, Maryland is forecasted to accrue 339,350 additional people during the 1990s, however Maryland forecasts fewer additional people, 243,300, during the first decade of the new century and about 247,750 additional people during the second decade of the 21st century. Population is forecasted to grow at an approximately constant rate. The additional people identified in Table 1.4 are those to whom we are referring when we talk about "population growth" (in the District of Columbia population will decline in some years).

Table 1.5 calculates changes in the number of households. This is equal to the number of additional housing units that will service the additional households, assuming that each residence will house only one household. Even in central cities, where population may dip, the number of households and housing units is expected to increase owing to the decreasing size of the average household. For the watershed as a

Tables 1.1 - 1.5 State and Total Population Values

Table 1.1 Forecasted Total Populations

	1990	2000	2010	2020
Pennsylvania (Watershed)	3,570,719	3,657,049	3,767,125	3,854,450
Maryland (includes Garrett)	4,666,200	5,005,550	5,248,850	5,496,600
Virginia (Watershed)	4,725,950	5,226,500	5,731,300	6,228,700
District of Columbia	628,300	634,000	627,700	627,700
Total	13,591,169	14,523,099	15,374,975	16,207,450

Table 1.2 Forecasted Total Households

	1990	2000	2010	2020
Pennsylvania (Watershed)	1,368,674	1,477,687	1,573,670	1,651,146
Maryland (includes Garrett)	1,752,325	1,981,575	2,148,200	2,306,875
Virginia (Watershed)	1,792,837	2,090,115	2,369,540	2,640,753
District of Columbia	270,187	287,405	294,177	301,667
Total	5,184,023	5836,7829	6,385,587	6,900,441

Table 1.3 Forecasted Population per Household

	1990	2000	2010	2020
Pennsylvania (Watershed)	2.61	2.47	2.39	2.33
Maryland (includes Garrett)	2.66	2.53	2.44	2.38
Virginia (Watershed)	2.64	2.50	2.42	2.36
District of Columbia	2.33	2.21	2.13	2.08
Total	2.62	2.49	2.41	2.35

Table 1.4 Forecasted Population Change

		Change by Decade			Total Change
	1990	1990 to 2000	2000 to 2010	2010 to 2020	1990 to 2020
Pennsylvania (Watershed)	3,570,719	86,330	110,076	87,325	283,731
Maryland (includes Garrett)	4,666,200	339,350	243,300	247,750	830,400
Virginia (Watershed)	4,725,950	500,550	504,800	497,400	1,502,750
District of Columbia	628,300	5,700	(6,300)	0	(600)
Total	13,591,169	931,930	851,876	832,475	2,616,281

Table 1.5 Forecasted Changes in Number of Households

		Change by Decade			Total Change
	1990	1990 to 2000	2000 to 2010	2010 to 2020	1990 to 2020
Pennsylvania (Watershed)	1,368,674	109,013	95,983	77,476	282,472
Maryland (includes Garrett)	1,752,325	229,250	166,625	158,675	554,550
Virginia (Watershed)	1,792,837	297,277	279,426	271,213	847,916
District of Columbia	270,187	17,218	6,772	7,490	31,480
Total	5,184,023	652,758	548,806	514,854	1,716,418

whole, the number of new homes decreases slightly over each of the three decades.

Alternative Land Use Policies

Alternative land use policies with regard to population growth were taken to mean principally residential land use policies. Maryland has found that land development due to growth is predominantly residential construction. Thus, land use alternatives are defined to be alternative housing patterns for the additional households.

Three land use patterns were used: Low Density, Medium Density and High Density residential living. As Table 2 shows, the densities are defined in terms of five types of housing units: Single Family Conventional (SFConv), Single Family Clustered (SFClust), Townhouse (TwnH), Walk Up Apartment (WUApt), and High Rise Apartments (HiRise). The Low Density housing pattern (or the Low Density land use) implies that households are not living very closely to one another. Thus, in the Low Density option, most of the new construction would be Single Family Conventional homes and no new construction would be High Rise Apartments. In the Low Density option each home may occupy quite a significant amount of acreage. In contrast, the High Density land use implies that households are living much closer together. Thus, as Table 2 shows, a high percentage of new construction would be dedicated to apartments.

Table 3 presents the number of residences in each housing unit type for each state and for each of the three land use alternatives (Low, Medium and High Density). The number of units in Table 3 are those which are forecasted to accrue in the next 30 years. The values in Table 3 come from the total number of additional housing units required (Table 1.5) for each state multiplied by the percent distributions of residential types (Table 2).

Acreage: Acreage is required for both the residential site itself and for roads. Table 4 first presents a site acreage requirement for each type of residence. Using this requirement and the number of new units for each type of residence (Table 3), the site acreage that might be needed for the next 30 years is forecasted and presented in Table 4.

Every new housing unit must be connected to the rest of the community. Roads have been, and are likely to remain the most important connection. In general, units that are more spread out over an area will require longer road lengths than units that are closer together. Table 5 presents a road acreage requirement for each type of residence and presents total road acreage use for the 30-year horizon.

Table 6 adds the site acreage of Table 4 to the road acreage of Table 5 to present the total development acreage related to housing required for the next 30 years. This is acreage which must come from an existing use such as forest or agriculture.

Road Costs

Tables 7.1 and 7.2 are used to present road costs. Table 7.1 presents road acreage in a

Table 2. Land Use Alternatives: Residential Development Percent Distribution of Residential Types for Each Land Use Alternative

	Residential Types				
	SFConv	SFClust	TwnH	WUApt	HiRise
Low Density	75%	25%	0	0	0
Medium Density	20%	20%	20%	20%	20%
High Density	0	10%	20%	30%	40%

Data Source: Real Estate Research Corporation, "The Costs of Sprawl," prepared for the Council on Environmental Quality, U.S. Government Printing Office, April 1974, page 90.

Table 3. Total Additional Housing Units by Residential Types for Each State and Each Land Use Alternative, 1990 - 2020

	Residential Types				
	SFConv	SFClust	TwnH	WUApt	HiRise
Pennsylvania (Watershed)					
Total New Housing Units = 282,472					
Low Density	211,854	70,618	0	0	0
Medium Density	56,494	56,494	56,494	56,494	56,494
High Density	0	28,247	56,494	84,741	112,988
Maryland (includes Garrett)					
Total New Housing Units = 554,550		2000			
Low Density	415,912	138,637	0	0	0
Medium Density	110,910	110,910	110,910	110,910	110,910
High Density	0	55,455	110,910	166,365	221,820
Virginia (Watershed)					
Total New Housing Units = 847,916					
Low Density	635,937	211,979	0	0	0
Medium Density	169,583	169,583	169,583	169,583	169,583
High Density	0	84,791	169,583	254,374	339,166
District of Columbia					
Total New Housing Units = 31,480					
Low Density	23,610	7,870	0	0	0
Medium Density	6,296	6,296	6,296	6,296	6,296
High Density	0	3,148	6,296	9,444	12,592
Total New Housing Units = 1,716,418					
Low Density	1,287,313	429,104	0	0	0
Medium Density	343,283	343,283	343,283	343,283	343,283
High Density	0	171,641	343,283	514,925	686,567

Table 4. Acreage Developed for Additional Housing, 1990 - to 2020

	Residential Types				
	SFConv	SFClust	TwnH	WUApt	HiRise
Site Acres Required Per Unit (1)	0.33	0.2	0.1	0.07	0.06

	Residential Types					
Pennsylvania (Watershed)	SFConv Acres	SFClust Acres	TwnH Acres	WUApt Acres	HiRise Acres	Total Acres
Total New Housing Units = 282,472						
Low Density	69,911	14,123	0	0	0	84,034
Medium Density	18,643	11,298	5,649	3,954	3,389	42,933
High Density	0	5,649	5,649	5,931	6,779	24,008
Maryland (includes Garrett)						
Total New Housing Units = 554,550						
Low Density	137,250	27,727	0	0	0	164,977
Medium Density	36,600	22,182	11,091	7,763	6,654	84,290
High Density	0	11,091	11,091	11,645	13,309	47,136
Virginia (Watershed)						
Total New Housing Units = 847,916						
Low Density	209,859	42,395	0	0	0	252,254
Medium Density	55,962	33,916	16,958	11,870	10,174	128,880
High Density	0	16,958	16,958	17,806	20,349	72,071
District of Columbia						
Total New Housing Units = 31,480						
Low Density	7,791	1,574	0	0	0	9,365
Medium Density	2,077	1,259	629	440	377	4,782
High Density	0	629	629	661	755	2,674
Total New Housing Units = 1,716,418						
Low Density	424,813	85,820	0	0	0	510,633
Medium Density	113,283	68,656	34,328	24,029	20,596	260,892
High Density	0	34,328	34,328	36,044	41,194	145,894

Note: (1) Source for acres required is: Real Estate Research Corporation, "The Costs of Sprawl," Prepared for the Council on Environmental Quality, U.S. Government Printing Office, April 1974,

Table 5. Acreage Developed for Additional Roads to Serve New Housing, 1990 - 2020

	Residential Types				
	SFConv	SFClust	TwnH	WUApt	HiRise
Road Acres Required Per Unit (1)	0.077	0.062	0.044	0.029	0.016

	Residential Types					
Pennsylvania (Watershed)	SFConv Acres	SFClust Acres	TwnH Acres	WUApt Acres	HiRise Acres	Total Acres
Total New Housing Units = 282,472						
Low Density	16,312	4,378	0	0	0	20,690
Medium Density	4,350	3,502	2,485	1,638	903	495
High Density	0	1,751	2,485	2,457	1,807	8,500
Maryland (includes Garrett)						
Total New Housing Units = 554,550						
Low Density	32,025	8,595	0	0	0	40,620
Medium Density	8,540	6,876	4,880	3,216	1,774	25,286
High Density	0	3,438	4,880	4,824	3,549	16,691
Virginia (Watershed)						
Total New Housing Units = 847,916						
Low Density	48,967	13,142	0	0	0	62,109
Medium Density	13,057	10,514	7,461	4,917	2,713	38,662
High Density	0	5,257	7,461	7,376	5,426	25,520
District of Columbia						
Total New Housing Units = 31,480						
Low Density	1,817	487	0	0	0	2,304
Medium Density	484	390	277	182	100	1,433
High Density	0	195	277	273	201	946
Total New Housing Units = 1,716,418						
Low Density	99,123	26,604	0	0	0	125,727
Medium Density	26,432	21,283	15,104	9,955	5,492	78,266
High Density	0	10,641	15,104	14,932	10,985	51,662

Note: (1) Source for acres required is: Real Estate Research Corporation, "The Costs of Sprawl," prepared for the Council on Environmental Quality, U.S. Government Printing Office, April 1974, Data were transformed from length/width to acres.

Table 6. Total Acreage Developed for Additional Housing and Additional Roads, 1990 - 2020

Pennsylvania (Watershed)	SFConv Acres	SFClust Acres	TwnH Acres	WUApt Acres	HiRise Acres	Total Acres
	>----------Residential Types----------<					
Total New Housing Units = 282,472						
Low Density	86,223	18,501	0	0	0	104,724
Medium Density	22,993	14,800	8,134	5,592	4,292	43,428
High Density	0	7,400	8,134	8,388	8,586	32,508
Maryland (includes Garrett)						
Total New Housing Units = 554,550						
Low Density	169,275	36,322	0	0	0	205,597
Medium Density	45,140	29,058	15,971	10,979	8,428	109,576
High Density	0	14,529	15,971	16,469	16,858	63,827
Virginia (Watershed)						
Total New Housing Units = 847,916						
Low Density	258,826	55,537	0	0	0	314,363
Medium Density	69,019	44,430	24,419	16,787	12,887	167,542
High Density	0	22,215	24,419	25,182	25,775	97,591
District of Columbia						
Total New Housing Units = 31,480						
Low Density	9,608	2,061	0	0	0	11,669
Medium Density	2,561	1,649	906	622	477	6,215
High Density	0	824	906	934	956	3,620
Total New Housing Units = 1,716,418						
Low Density	523,936	112,424	0	0	0	636,360
Medium Density	139,715	89,939	49,432	33,984	26,088	339,158
High Density	0	44,969	49,432	50,976	52,179	197,556

Table 7.1 Additional Road Acreage by Decade

	2000	2010	2020	Total
	Low Density			
Pennsylvania (Watershed)	7,984	7,029	5,674	20,687
Maryland (includes Garrett)	16,792	12,204	11,622	40,618
Virginia (Watershed)	21,774	20,467	19,865	62,106
District of Columbia	1,260	495	548	2,303
Total	47,810	40,195	37,709	125,714
	Medium Density			
Pennsylvania (Watershed)	4,968	4,375	3,530	12,873
Maryland (includes Garrett)	10,451	7,597	7,233	25,281
Virginia (Watershed)	13,555	12,739	12,365	38,659
District of Columbia	783	306	338	1,427
Total	29,757	25,017	23,466	78,240
	High Density			
Pennsylvania (Watershed)	3,279	2,888	2,330	8,497
Maryland (includes Garrett)	6,899	5,014	4,774	16,687
Virginia (Watershed)	8,947	8,408	8,161	25,516
District of Columbia	516	201	223	940
Total	19,641	16,511	15,488	51,640

Table 7.2 Additional Road Costs: Construction and Right-of-Way Costs (1989 dollars)[1]

	1990 to 2000	2000 to 2010	2010 to 2020	1990 to 2020
	Low Density			
Pennsylvania (Watershed)	1,479,353,111	915,140,603	499,035,321	2,893,529,035
Maryland (includes Garrett)	3,111,036,490	1,588,674,936	1,022,045,411	5,721,756,837
Virginia (Watershed)	4,034,199,679	2,664,175,564	1,746,919,917	8,445,295,160
District of Columbia	233,645,021	64,567,569	48,238,233	346,450,823
Total	$8,858,274,201	$5,232,576,602	$3,316,250,995	$17,407,101,798
	Medium Density			
Pennsylvania (Watershed)	890,299,134	550,744,670	300,329,331	1,741,373,135
Maryland (includes Garrett)	1,872,315,169	956,114,094	615,098,505	3,443,527,768
Virginia (Watershed)	2,427,884,371	1,603,373,928	1,051,336,793	5,082,595,092
District of Columbia	140,597,189	38,847,066	29,034,742	208,478,997
Total	$5,331,136,700	$3,149,108,451	$1,995,799,374	$10,476,044,525
	High Density			
Pennsylvania (Watershed)	568,469,663	351,659,156	191,760,160	1,111,888,979
Maryland (includes Garrett)	1,195,496,206	610,484,950	392,744,139	2,198,725,295
Virginia (Watershed)	1,550,230,835	1,023,768,295	671,292,743	3,245,291,873
District of Columbia	89,772,651	24,804,328	18,539,039	133,116,018
Total	$3,403,995,809	$2,010,738,751	$1,274,346,008	$6,689,080,568

Note: (1) Excludes major limited access highways.

format different from that of Table 5. In Table 5, the road acreage is presented as the 30 year totals, broken down into residential types. In Table 7.1, we aggregated density types and present road acreage on a decade basis. Because the two tables come from the same data base, their values are consistent. For example, in Table 5, for Pennsylvania, for the Low Density alternative, the total road acreage equals 20,690. In Table 7.1, for Low Density, for Pennsylvania, the total road acreage is presented as 20,687 (the difference is due to truncation in the intermediate calculations). Consistent with the population change, the change in road acreage over the three decades is somewhat constant.

Each type of residential development requires different types of roads. For evaluation purposes, three types of roads were considered: minor, collector and arterial. Minor roads link the residence with a collector road. Collector roads link a set of minor roads to an arterial road. Arterial roads connect a set of collector roads to an interstate highway. The following road lengths requirements were assumed for each residential type. The road lengths are in feet.

Street	SFConv	SFClust	TwnH	WUApt	HiRise
Minor	47	22.00	10.0	4.50	1.70
Collector	7	17.25	13.5	8.75	4.85
Arterial	6	5.50	5.0	3.75	2.40

Data Source: Real Estate Research Corporation, "The Costs of Sprawl," US Government Printing Office, April 1974, p.58.

In order to calculate total road lengths for each road type, the feet/residential type was multiplied by the number of units in each residential type.

Although road costs are functions of many factors (traffic volumes and types, construction materials, topography, weather), for this study it assumed that road costs are a function of road types. Total costs are the sum of construction costs, right-of-way costs, and maintenance costs.

For planning purposes maintenance costs are not usually considered. For this report, the convention of ignoring maintenance costs is followed. However, there appears to be growing opinion that maintenance costs must be included in any planning analysis especially when the time horizon of the study exceeds the expected life of the capital investment (in this case, roads). Roads are often considered to have a 20-year expected life. And because the study time horizon is 30 years, not only maintenance, but also replacement costs, are relevant. Thus, the absolute values of these cost estimates may be quite understated.

Construction and right-of-way costs are included. Right-of-way costs are those that are incurred in order to procure the property and include both property acquisitions and any relocations (business or residence). These costs can be substantial, sometimes exceeding the construction costs. Right-of-way costs are often expressed as functions of construction costs. It was assumed the right-of-way cost equals 25% of the construction cost (this value was suggested by Mr. Orcutt, Virginia Department of Transportation).

Minor and collector roads were assumed to have substantially the same construction cost, $166/foot. Adding 25% for right-of-way costs, the per foot cost of minor and collector roads equals $208. Arterial roads cost $497/foot for construction. With 25% added for right-of-way, the per foot cost for arterial roads equals $621. In summary,

	Cost/Foot
Minor street	$208
Collector street	$208
Arterial street	$621.

Data Source: Virginia Department of Transportation "Estimated Roadway Construction Costs," September 1988, transformed to dollars per foot.

In Table 7.1, the additional road acreage remains rather constant throughout the time horizon, but the present value costs in Table 7.2 decrease. Roads will not be cheaper in the future. Rather, Table 7.2 presents those present value dollars which (if invested in 1989 and earning a real rate of 4%) would be sufficient to pay future construction and right-of-way costs.

Ecosystem Effects

Housing units not only remove acreage from a current use, but the people who live in these residences produce effects on the environment. Once a unit is built, it is assumed that someone will constantly live in that housing unit from the time it is built until the year 2020. Thus, although each housing unit makes a one-time claim for land, the people who live in the residence have a continual impact on the environment. At this point, it is necessary to introduce the "household-year".

The household-year (hh-y) may be described in two ways. One might say that 2 hh-y either represents 2 households each living in their housing units for 1 year, or 1 household living in a housing unit for 2 years. The hh-y is important for calculating the ongoing effects people produce on the ecosystem when they live in alternative densities (Low, Medium and High). Once a type of residence is built, the associated behavior or activity (lawn care, driving hours, runoff, erosion, use of solvents, etc.) continues for each of the years extending from the time the residence is built until the end of the study period, 2020. Thus, if a housing unit is built in 1990, then that housing unit will contribute 30 hh-y by the year 2020. However, if a unit is built in 2019, then it will contribute, at most, 1 hh-y by 2020.

The hh-y is important because it enables us to use typical pollution data (such as units of pollution per unit time per household) for an extended period of time. The hh-y enables us to calculate the future contributions of pollution that are made by the additional households which move into a particular density pattern in a particular year. Such a calculation shows that the longer government waits to implement an alternative land use policy, the greater are the ecological effects of the existing policies. The suburban sprawl built in 1990 will exist in the year 2020 and will have contributed its effects on the environment for each of the 30 years. However, if in 1990, a new land use policy encouraging more compact living were imple-

mented, then the foregone environmental degradations of that living would also accrue in each of the 30 years to produce a cleaner environment at the end of the 30 years than would have otherwise been the case.

Household-years were calculated in the following way. Household data on a decade basis were divided by 10 to obtain the forecasted number of new households on an annual basis. The number of housing units was also forecasted on an annual basis. The number of new units (for example, 50) in any one year (for example, 1990) was then multiplied by the number of years remaining in the study period (2020 - 1990) in order to calculate the number of hh-y (1500 hh-y). The hh-y contributions, in this example 1500, are assigned to the construction year, 1990, in order to identify the year in which all future, unavoidable environmental impacts start to accrue. Once developed, the only way to avoid impacts is to apply mitigation policies to this land that will be applied to all existing development.

Tables 8.1 and 8.2 present the number of new housing units and their household-years, respectively. Table 8.1 is a restatement of Table 1.5, presented, again, for the reader's convenience. Table 8.2 presents the set of values which resulted from transforming decade data into annual data, calculating household-years on an annual basis and then aggregating annual values of hh-y back up to decade data. These tables show that approximately 650,000 residences are forecasted to be built throughout the watershed in the last decade of this century, these residences will contribute approximately 28 million hh-y to the environment by the year 2020. Although the number of new residences is approximately the same for each of the next three decades (Table 8.1), the number of household-years brought about by the construction in each decade is not at all constant (Table 8.2). The most telling positive results will, come from rapid implementation of new strategies. This will bring more households under management earlier hence more household-year-based pollution will be prevented.

Tables 9.1 and 9.2 present pollution factors. The values in Table 9.1 are data with their original units of measure, pollution units per time per household. Table 9.2 presents the data transformed to pollution units per household-year. The values from Table 9.2, when multiplied by the hh-y in Table 8.2, yield the ecosystem effects presented in Tables 10.1 through 10.5.

Tables 10.1 through 10.5 present the ecosystem effects for each of the four signatory jurisdiction and the total watershed. The values in these tables are growth-related loads on the ecosystem which are forecasted to occur for the next three decades. The pollution loads are not total loads, they are only that part of the loading due to population growth.

Tables 8.1 and 8.2 New Residences and Their Household-Years

Table 8.1 ----------> Forecasted Number of New Housing Units <----------

	1990 to 2000	2000 to 2010	2010 to 2020	Total 1990 to 2020
Pennsylvania (Watershed)	109,013	95,983	77,476	282,472
Maryland (includes Garrett)	229,250	166,625	158,675	554,550
Virginia (Watershed)	297,277	279,426	271,213	847,916
District of Columbia	17,218	6,772	7,490	31,480
Total	652,758	548,806	514,854	1,716,418

Table 8.2 ----------> Forecasted New Household-years <----------

	1990 to 2000	2000 to 2010	2010 to 2020	Total 1990 to 2020
Pennsylvania (Watershed)	2,779,755	1,487,690	426,085	4,693,530
Maryland (includes Garrett)	5,845,875	2,582,610	872,685	9,301,170
Virginia (Watershed)	7,580,385	4,331,010	1,491,655	13,403,050
District of Columbia	438,855	104,935	41,195	584,985
Total	16,644,870	8,506,245	2,831,620	27,982,735

Tables 9.1 and 9.2 Pollution Factors

Table 9.1 Pollution Factors in their Original Form

Pollutants	>------Community Densities-----< Low	Medium	High	Units of Measure
Auto				
Carbon Monoxide	0.404	0.254	0.202	Pounds/Day/Household
Hydrocarbons	0.0487	0.0306	0.0244	Pounds/Day/Household
Nitrous Oxides	0.0475	0.0299	0.0238	Pounds/Day/Household
Residential				
Sulfur Oxides	0.0005	0.0004	0.0003	Pounds/Day/Household
Carbon Monoxide	0.0003	0.0002	0.0002	Pounds/Day/Household
Hydrocarbons	0.0317	0.0231	0.0181	Pounds/Day/Household
Nitrous Oxides	0.0951	0.0693	0.0542	Pounds/Day/Household
Particulates	0.0143	0.0104	0.0082	Pounds/Day/Household
Sediment (erosion)	0.617	0.443	0.37	Tons/Year/Household
Water Use	0.0117	0.0091	0.0076	Million Gallons/Year/Household
Energy Use	0.406	0.2822	0.2274	Billion BTU/Year/Household
Driving Time	3.2	1.86	1.66	Hours/Day/Household

Data Source: Real Estate Research Corporation, "The Costs of Sprawl," prepared for the Council on Environmental Quality, U.S. Government Printing Office, April 1974, pages 12 & 13.

Table 9.2 Pollution Factors in Terms of Household-years

Pollutants	>------Community Densities-----< Low	Medium	High	Units of Measure
Auto				
Carbon Monoxide	147.46	92.71	73.73	Pounds/Householdyear
Hydrocarbons	17.7755	11.169	8.906	Pounds/Householdyear
Nitrous Oxides	17.3375	10.9135	8.687	Pounds/Householdyear
Residential				
Sulfur Oxides	0.1825	0.146	0.1095	Pounds/Householdyear
Carbon Monoxide	0.1095	0.073	0.073	Pounds/Householdyear
Hydrocarbons	11.5705	8.4315	6.6065	Pounds/Householdyear
Nitrous Oxides	34.7115	25.2945	19.783	Pounds/Householdyear
Particulates	5.2195	3.796	2.993	Pounds/Householdyear
Sediment (erosion)	0.617	0.443	0.37	Tons/Householdyear
Water Use	0.0117	0.0091	0.0076	Million Gallons/Householdyear
Energy Use	0.406	0.2822	0.2274	Billion BTU/Householdyear
Driving Time	1168	678.9	605.9	Hours/Householdyear

Table 10.1 Ecosystem Effects due to Population Growth under Three Residential Land Use Scenarios

Pennsylvania (Watershed)

Low Density Development

Pollutants	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	409,902,672	219,374,767	62,830,494	692,107,933	Pounds
Hydrocarbons	49,411,535	26,444,433	7,573,873	83,429,841	Pounds
Nitrous Oxides	48,194,002	25,792,825	7,387,248	81,374,075	Pounds Residential
Sulfur Oxides	507,305	271,503	77,760	856,568	Pounds
Carbon Monoxide	304,383	162,902	46,656	513,941	Pounds
Hydrocarbons	32,163,155	17,213,317	4,930,016	54,306,488	Pounds
Nitrous Oxides	96,489,465	51,639,951	14,790,049	162,919,465	Pounds
Particulates	14,508,931	7,764,997	2,223,950	24,497,878	Pounds
Sediment (erosion)	1,715,108	917,904	262,894	2,895,906	Tons
Water Use	32,523	17,405	4,985	54,913	Million Gallons
Energy Use	1,128,580	604,002	172,990	1,905,572	Billion BTU
Driving Time	3,246,753,840	1,737,621,920	497,667,280	5,482,043,040	Hours
Land Use, Houses	10,700	13,644	10,824	35,168	Acres
Land Use, Roads	2,634	3,358	2,664	8,656	Acres

Medium Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	257,711,086	137,923,739	39,502,340	435,137,165	Pounds
Hydrocarbons	31,047,083	16,616,009	4,758,943	52,422,035	Pounds
Nitrous Oxides	30,336,856	16,235,904	4,650,078	51,222,838	Pounds
Residential					
Sulfur Oxides	405,844	217,202	62,208	685,254	Pounds
Carbon Monoxide	202,922	108,601	31,104	342,627	Pounds
Hydrocarbons	23,437,504	12,543,458	3,592,535	39,573,497	Pounds
Nitrous Oxides	70,312,512	37,630,374	10,777,607	118,720,493	Pounds
Particulates	10,551,949	5,647,271	1,617,418	17,816,638	Pounds
Sediment (erosion)	1,231,431	659,046	188,755	2,079,232	Tons
Water Use	25,295	13,537	3,877	42,709	Million Gallons
Energy Use	784,446	419,826	120,241	1,324,513	Billion BTU
Driving Time	1,887,175,669	1,009,992,741	289,269,106	3,186,437,516	Hours
Land Use, Houses	5,465	6,970	5,528	17,963	Acres
Land Use, Roads	1,638	2,089	1,658	5,385	Acres

High Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	204,951,336	109,687,383	31,415,247	346,053,966	Pounds
Hydrocarbons	24,756,498	13,249,367	3,794,713	41,800,578	Pounds
Nitrous Oxides	24,147,731	12,923,563	3,701,400	40,772,694	Pounds
Residential					
Sulfur Oxides	304,383	162,902	46,656	513,941	Pounds
Carbon Monoxide	202,922	108,601	31,104	342,627	Pounds
Hydrocarbons	18,364,451	9,828,423	2,814,930	31,007,804	Pounds
Nitrous Oxides	54,991,893	29,430,971	8,429,239	92,852,103	Pounds
Particulates	8,319,806	4,452,656	1,275,272	14,047,734	Pounds
Sediment (erosion)	1,028,509	550,445	157,651	1,736,605	Tons
Water Use	21,126	11,306	3,238	35,670	Million Gallons
Energy Use	632,116	338,300	96,891	1,067,307	Billion BTU
Driving Time	1,684,253,554	901,391,371	258,164,901	2,843,809,826	Hours
Land Use, Houses	3,056	3,897	3,091	10,044	Acres
Land Use, Roads	1,081	1,379	1,093	3,553	Acres

Table 10.2 Ecosystem Effects due to Population Growth under Three Residential Land Use Scenarios

Maryland (includes Garrett)

Low Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	862,032,727	380,831,670	128,686,130	1,371,550,527	Pounds
Hydrocarbons	103,913,351	45,907,184	15,512,412	165,332,947	Pounds
Nitrous Oxides	101,352,857	44,776,000	15,130,176	161,259,033	Pounds
Residential					
Sulfur Oxides	1,066,872	471,326	159,265	1,697,463	Pounds
Carbon Monoxide	640,123	282,795	95,559	1,018,477	Pounds
Hydrocarbons	67,639,696	29,882,089	10,097,401	107,619,186	Pounds
Nitrous Oxides	202,919,090	89,646,267	30,292,205	322,857,562	Pounds
Particulates	30,512,544	13,479,932	4,554,979	48,547,455	Pounds
Sediment (erosion)	3,606,904	1,593,470	538,446	5,738,820	Tons
Water Use	68,396	30,216	10,210	108,822	Million Gallons
Energy Use	2,373,425	1,048,539	354,310	3,776,274	Billion BTU
Driving Time	6,827,982,000	3,016,488,480	1,019,296,080	10,863,766,560	Hours
Land Use, Houses	42,064	30,158	30,709	102,931	Acres
Land Use, Roads	10,356	7,425	7,561	25,342	Acres

Medium Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	541,971,071	239,433,773	80,906,626	862,311,470	Pounds
Hydrocarbons	65,292,577	28,845,171	9,747,018	103,884,766	Pounds
Nitrous Oxides	63,798,956	28,185,314	9,524,047	101,508,317	Pounds
Residential					
Sulfur Oxides	853,497	377,061	127,412	1,357,970	Pounds
Carbon Monoxide	426,748	188,530	63,706	678,984	Pounds
Hydrocarbons	49,289,495	21,775,276	7,358,043	78,422,814	Pounds
Nitrous Oxides	147,868,485	65,325,828	22,074,130	235,268,443	Pounds
Particulates	22,190,941	9,803,587	3,312,712	35,307,240	Pounds
Sediment (erosion)	2,589,722	1,144,096	386,599	4,120,417	Tons
Water Use	53,197	23,501	7,941	84,639	Million Gallons
Energy Use	1,649,705	728,812	246,271	2,624,788	Billion BTU
Driving Time	3,968,764,537	1,753,333,929	592,465,846	6,314,564,312	Hours
Land Use, Houses	21,489	15,407	15,688	52,584	Acres
Land Use, Roads	6,446	4,621	4,704	15,771	Acres

High Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	431,016,363	190,415,835	64,343,065	685,775,263	Pounds
Hydrocarbons	52,063,362	23,000,724	7,772,132	82,836,218	Pounds
Nitrous Oxides	50,783,116	22,435,133	7,581,014	80,799,263	Pounds
Residential					
Sulfur Oxides	640,123	282,795	95,559	1,018,477	Pounds
Carbon Monoxide	426,748	188,530	63,706	678,984	Pounds
Hydrocarbons	38,620,773	17,062,012	5,765,393	61,448,178	Pounds
Nitrous Oxides	115,648,945	51,091,773	17,264,327	184,005,045	Pounds
Particulates	17,496,703	7,729,751	2,611,946	27,838,400	Pounds
Sediment (erosion)	2,162,973	955,565	322,893	3,441,431	Tons
Water Use	44,428	19,627	6,632	70,687	Million Gallons
Energy Use	1,329,351	587,285	198,448	2,115,084	Billion BTU
Driving Time	3,542,015,662	1,564,803,399	528,759,841	5,635,578,902	Hours
Land Use, Houses	12,016	8,615	8,772	29,403	Acres
Land Use, Roads	4,254	3,049	3,105	10,408	Acres

Table 10.3 Ecosystem Effects due to Population Growth under Three Residential Land Use Scenarios

Virginia (Watershed)

Low Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	1,117,803,572	638,650,734	219,959,446	1,976,413,752	Pounds
Hydrocarbons	134,745,133	76,985,868	26,514,913	238,245,914	Pounds
Nitrous Oxides	131,424,924	75,088,885	25,861,568	232,375,377	Pounds
Residential					
Sulfur Oxides	1,383,420	790,409	272,227	2,446,056	Pounds
Carbon Monoxide	830,052	474,245	163,336	1,467,633	Pounds
Hydrocarbons	87,708,844	50,111,951	17,259,194	155,079,989	Pounds
Nitrous Oxides	263,126,533	150,335,853	51,777,582	465,239,968	Pounds
Particulates	39,565,819	22,605,706	7,785,693	69,957,218	Pounds
Sediment (erosion)	4,677,097	2,672,233	920,351	8,269,681	Tons
Water Use	88,690	50,672	17,452	156,814	Million Gallons
Energy Use	3,077,636	1,758,390	605,611	5,441,637	Billion BTU
Driving Time	8,853,889,680	5,058,619,680	1,742,253,040	15,654,762,400	Hours
Land Use, Houses	62,046	62,573	61,656	186,275	Acres
Land Use, Roads	15,276	15,406	15,180	45,862	Acres

Medium Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	702,777,493	401,527,937	138,291,335	1,242,596,765	Pounds
Hydrocarbons	84,665,320	48,373,050	16,660,294	149,698,664	Pounds
Nitrous Oxides	82,728,531	47,266,477	16,279,176	146,274,184	Pounds
Residential					
Sulfur Oxides	1,106,736	632,327	217,781	1,956,844	Pounds
Carbon Monoxide	553,368	316,163	108,890	978,421	Pounds
Hydrocarbons	63,914,016	36,516,910	12,576,889	113,007,815	Pounds
Nitrous Oxides	191,742,048	109,550,732	37,730,667	339,023,447	Pounds
Particulates	28,775,141	16,440,513	5,662,322	50,877,976	Pounds
Sediment (erosion)	3,358,110	1,918,637	660,803	5,937,550	Tons
Water Use	68,981	39,412	13,574	121,967	Million Gallons
Energy Use	2,139,184	1,222,211	420,945	3,782,340	Billion BTU
Driving Time	5,146,323,376	2,940,322,689	1,012,684,579	9,099,330,644	Hours
Land Use, Houses	31,698	31,967	31,501	95,166	Acres
Land Use, Roads	9,508	9,589	9,448	28,545	Acres

High Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	558,901,786	319,325,367	109,979,723	988,206,876	Pounds
Hydrocarbons	67,510,908	38,571,975	13,284,679	119,367,562	Pounds
Nitrous Oxides	65,850,804	37,623,483	12,958,006	116,432,293	Pounds
Residential					
Sulfur Oxides	830,052	474,245	163,336	1,467,633	Pounds
Carbon Monoxide	553,368	316,163	108,890	978,421	Pounds
Hydrocarbons	50,079,813	28,612,817	9,854,618	88,547,248	Pounds
Nitrous Oxides	149,962,756	85,680,370	29,509,410	265,152,536	Pounds
Particulates	22,688,092	12,962,712	4,464,523	40,115,327	Pounds
Sediment (erosion)	2,804,742	1,602,473	551,912	4,959,127	Tons
Water Use	57,610	32,915	11,336	101,861	Million Gallons
Energy Use	1,723,779	984,871	339,202	3,047,852	Billion BTU
Driving Time	4,592,955,271	2,624,158,959	903,793,764	8,120,907,994	Hours
Land Use, Houses	17,726	17,875	17,616	53,217	Acres
Land Use, Roads	6,276	6,329	6,236	18,841	Acres

Table 10.4 Ecosystem Effects due to Population Growth under Three Residential Land Use Scenarios

District of Columbia

Low Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	64,713,558	15,473,715	6,074,614	86,261,887	Pounds
Hydrocarbons	7,800,867	1,865,272	732,261	10,398,400	Pounds
Nitrous Oxides	7,608,648	1,819,310	714,218	10,142,176	Pounds
Residential					
Sulfur Oxides	80,091	19,150	7,518	106,759	Pounds
Carbon Monoxide	48,054	11,490	4,510	64,054	Pounds
Hydrocarbons	5,077,771	1,214,150	476,646	6,768,567	Pounds
Nitrous Oxides	15,233,315	3,642,451	1,429,940	20,305,706	Pounds
Particulates	2,290,603	547,708	215,017	3,053,328	Pounds
Sediment (erosion)	270,773	64,744	25,417	360,934	Tons
Water Use	5,134	1,227	481	6,842	Million Gallons
Energy Use	178,175	42,603	16,725	237,503	Billion BTU
Driving Time	512,582,640	122,564,080	48,115,760	683,262,480	Hours
Land Use, Houses	705	0	0	705	Acres
Land Use, Roads	173	0	0	173	Acres

Medium Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	40,686,247	9,728,523	3,819,188	54,233,958	Pounds
Hydrocarbons	4,901,571	1,172,019	460,106	6,533,696	Pounds
Nitrous Oxides	4,789,444	1,145,208	449,581	6,384,233	Pounds
Residential					
Sulfur Oxides	64,072	15,320	6,014	85,406	Pounds
Carbon Monoxide	32,036	7,660	3,007	42,703	Pounds
Hydrocarbons	3,700,205	884,759	347,335	4,932,299	Pounds
Nitrous Oxides	11,100,617	2,654,278	1,042,006	14,796,901	Pounds
Particulates	1,665,893	398,333	156,376	2,220,602	Pounds
Sediment (erosion)	194,412	46,486	18,249	259,147	Tons
Water Use	3,993	954	374	5,321	Million Gallons
Energy Use	123,844	29,612	11,625	165,081	Billion BTU
Driving Time	297,938,659	71,240,371	27,967,285	397,146,315	Hours
Land Use, Houses	359	0	0	359	Acres
Land Use, Roads	105	0	0	105	Acres

High Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	32,356,779	7,736,857	3,037,307	43,130,943	Pounds
Hydrocarbons	3,908,442	934,551	366,882	5,209,875	Pounds
Nitrous Oxides	3,812,333	911,570	357,860	5,081,763	Pounds
Residential					
Sulfur Oxides	48,054	11,490	4,510	64,054	Pounds
Carbon Monoxide	32,036	7,660	3,007	42,703	Pounds
Hydrocarbons	2,899,295	693,253	272,154	3,864,702	Pounds
Nitrous Oxides	8,681,868	2,075,929	814,960	11,572,757	Pounds
Particulates	1,313,493	314,070	123,296	1,750,859	Pounds
Sediment (erosion)	162,376	38,825	15,242	216,443	Tons
Water Use	3,335	797	313	4,445	Million Gallons
Energy Use	99,795	23,862	9,367	133,024	Billion BTU
Driving Time	265,902,244	63,580,116	24,960,050	354,442,410	Hours
Land Use, Houses	200	0	0	200	Acres
Land Use, Roads	69	0	0	69	Acres

Table 10.5 Ecosystem Effects due to Population Growth under Three Residential Land Use Scenarios

Total

Low Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	2,454,452,530	1,254,330,887	417,550,685	4,126,334,102	Pounds
Hydrocarbons	295,870,886	151,202,757	50,333,461	497,407,104	Pounds
Nitrous Oxides	288,580,433	147,477,022	49,093,211	485,150,666	Pounds
Residential					
Sulfur Oxides	3,037,688	1,552,389	516,770	5,106,847	Pounds
Carbon Monoxide	1,822,613	931,433	310,062	3,064,108	Pounds
Hydrocarbons	192,589,468	98,421,507	32,763,259	323,774,234	Pounds
Nitrous Oxides	577,768,405	295,264,523	98,289,777	971,322,705	Pounds
Particulates	86,877,898	44,398,345	14,779,640	146,055,883	Pounds
Sediment (erosion)	10,269,884	5,248,353	1,747,109	17,265,346	Tons
Water Use	194,744	99,523	33,129	327,396	Million Gallons
Energy Use	6,757,817	3,453,535	1,149,637	11,360,989	Billion BTU
Driving Time	19,441,208,160	9,935,294,160	3,307,332,160	32,683,834,480	Hours
Land Use, Houses	115,515	106,375	103,189	325,079	Acres
Land Use, Roads	28,439	26,189	25,405	80,033	Acres

Medium Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	1,543,145,897	788,613,973	262,519,490	2,594,279,360	Pounds
Hydrocarbons	185,906,553	95,006,250	31,626,363	312,539,166	Pounds
Nitrous Oxides	181,653,788	92,832,904	30,902,884	305,389,576	Pounds
Residential					
Sulfur Oxides	2,430,151	1,241,911	413,416	4,085,478	Pounds
Carbon Monoxide	1,215,075	620,955	206,708	2,042,738	Pounds
Hydrocarbons	140,341,221	71,720,404	23,874,804	235,936,429	Pounds
Nitrous Oxides	421,023,664	215,161,214	71,624,412	707,809,290	Pounds
Particulates	63,183,926	32,289,706	10,748,829	106,222,461	Pounds
Sediment (erosion)	7,373,677	3,768,266	1,254,407	12,396,350	Tons
Water Use	151,468	77,406	25,767	254,641	Million Gallons
Energy Use	4,697,182	2,400,462	799,083	7,896,727	Billion BTU
Driving Time	11,300,202,243	5,774,889,730	1,922,386,818	18,997,478,791	Hours
Land Use, Houses	59,011	54,344	52,717	166,072	Acres
Land Use, Roads	17,697	16,299	15,810	49,806	Acres

High Density Development

	1990 to 2000	2000 to 2010	2010 to 2020	Total Change 1990 to 2020	Units of Measure
Auto					
Carbon Monoxide	1,227,226,265	627,165,443	208,775,342	2,063,167,050	Pounds
Hydrocarbons	148,239,212	75,756,617	25,218,407	249,214,236	Pounds
Nitrous Oxides	144,593,985	73,893,750	24,598,282	243,086,017	Pounds
Residential					
Sulfur Oxides	1,822,613	931,433	310,062	3,064,108	Pounds
Carbon Monoxide	1,215,075	620,955	206,708	2,042,738	Pounds
Hydrocarbons	109,964,333	56,196,507	18,707,097	184,867,937	Pounds
Nitrous Oxides	329,285,463	168,279,044	56,017,938	553,582,445	Pounds
Particulates	49,818,095	25,459,191	8,475,038	83,752,324	Pounds
Sediment (erosion)	6,158,601	3,147,310	1,047,699	10,353,610	Tons
Water Use	126,501	64,647	21,520	212,668	Million Gallons
Energy Use	3,785,043	1,934,320	643,910	6,363,273	Billion BTU
Driving Time	10,085,126,733	5,153,933,845	1,715,678,558	16,954,739,136	Hours
Land Use, Houses	32,998	30,387	29,479	92,864	Acres
Land Use, Roads	11,680	10,757	10,434	32,871	Acres

Appendix B

Other Topics

In the course of its meetings and discussions, Panel members and others brought to the group many topics that were briefly discussed but were not fully explored. A number of these topics may warrant further study and are listed here. Most relate to fiscal issues.

1. Expand environmental trust funds to pay for such diverse growth-related topics as:
   - private and public transportation systems
   - research in technology to reduce resource consumption
   - extensive land acquisition (sensitive land, state parks)
2. Increase user fees to reduce consumption
   - gasoline taxes
   - credits for developers and employers who promote ridesharing and other group transportation modes
   - increase use of toll roads
   - tax second homes substantially
   - increase transfer tax on houses adjoining the shore
   - credits for environmental retrofits to property
   - increased boating fees
3. Fund projects to deal with combined sewers.
4. Review road standards for subdivisions with the intention of reducing stormwater runoff.
5. Require water saving and energy saving devices in new construction.

For Additional Information:

Virginia

Council on the Environment
903 Ninth Street Office Building
Richmond, VA 23219
(804) 786-4500

Maryland

Governor's Chesapeake Bay Coordinator
Governor's Office
State House
Annapolis, MD 21401
(301) 974-3004

or

Department of State Planning
301 W. Preston Street
Baltimore, MD 21201
(301) 225-4500

Pennsylvania

Governor's Office of Policy Development
506 Finance Building
P.O. Box 1323
Harrisburg, PA 17120
(717) 787-1954

District of Columbia

D.C. Office of Planning
Strategic Planning and Development Review Division
415 12th Street NW
Washington, DC 20005
(202) 727-6500

U.S. Environmental Protection Agency

Chesapeake Bay Liaison Office
410 Severn Avenue
Annapolis, MD 21403
(301) 266-6873

Chesapeake Bay Commission

Chesapeake Bay Commission
60 West Street, Suite 200
Annapolis, MD 21401
(301) 263-3420

Fritts Golden and John Rogers, of the firm of Rogers, Golden & Halpern, acted as technical staff for the Year 2020 Panel. In this role, they and their staff organized meetings, facilitated discussions, conducted research, and produced the final report for the 2020 Panel. The Report was developed based on Panel discussions and went through four drafts. Substantial changes were made by the Panel at each stage, until a consensus was reached.