

ASSESSMENT NEEDS

GROUNDWATER

A comprehensive assessment of Piedmont Basin groundwater quality is not currently available. However, numerous wells exist and could be networked similar to those in southern New Castle County by the Delaware Geological Survey. Such a network need not equally cover all areas of the Piedmont Basin, and areas such as the northeastern Naamans and Shellpot watersheds where groundwater resources are less available may be deferred until adequate resources warrant inclusion in the network. Financial and programmatic resources and priorities could dictate the identification of areas requiring groundwater monitoring, followed by the compilation of existing data sources for those areas.

Identification of Areas Requiring Groundwater Quality Monitoring

The single most important role of groundwater in the Piedmont Basin is for drinking water. Priority areas based on drinking water use would include the following:

Piedmont Province Areas:

- ◆ Cockeyville Aquifer (Hockessin Valley)
- ◆ Cockeyville Aquifer (Pike Creek)
- ◆ Laird Tract Wellfield

Potomac/Columbia Aquifers (Coastal Plain):

- ◆ Newark South Wellfields
- ◆ Eastern Estates
- ◆ Glendale Wellfield
- ◆ Artesian Airport Wellfields

Piedmont Basin groundwater also serves as the source of base flow to streams that are used as drinking water sources. Since these watersheds encompass large land areas extending into Pennsylvania, interstate coordination is necessary. These watersheds include the following:

- ◆ Brandywine Creek
- ◆ Red Clay Creek
- ◆ Hoopes Reservoir
- ◆ White Clay Creek
- ◆ Mill Creek
- ◆ Christina River
- ◆ Smalley's Dam

The groundwater-quality monitoring regimes would differ between the two purposes — direct drinking-water supply versus stream base flow — yet both would initially

include existing sources and existing well points, supplemented by new monitoring wells as needed. As discussed previously, a very similar approach was taken for southern New Castle County. The agencies involved in developing a network would be DNREC; Delaware Geological Survey; the Water Resources Agency for New Castle County; and the Department of Public Health's Office of Drinking Water.

Identification of Existing Sources of Groundwater Quality Information

There are numerous possible sources of information and available well sampling points. However, each program collects different types of information at various frequencies and stores the information largely on hard-copy files. Integration and electronic data storage are needed to allow an ambient network to be fashioned from these diverse sources. Possible sources include the following:

- ◆ Office of Drinking Water — public water supply sampling
- ◆ DNREC — regulated point sources
- ◆ Water Resources Agency for New Castle County — WRPA-monitored facilities
- ◆ Delaware Geological Survey and U.S. Geological Survey — special studies

Once existing sources have been evaluated as to their quality and adequacy in representing overall groundwater quality, gaps would be identified where sampling should be augmented, quality improved, and new sampling points added.

SURFACE WATER

DNREC, in cooperation with the Pennsylvania Department of Environmental Protection (PADEP), the EPA, the Delaware River Basin Commission (DRBC), and other federal, state, and local agencies, has initiated the development of a comprehensive water-quality management plan for the Christina River watershed. The plan will cover the entire 564 square miles of the watershed in Delaware and Pennsylvania and includes Brandywine Creek, White Clay Creek, and Red Clay Creek. Specific tasks that are part of this five-year study include intensive water-quality and water-quantity monitoring; comprehensive assessment of water-quality conditions; development of water-quality models for the watershed and for the receiving streams; establishment of total maximum daily loads (TMDL) for the point and nonpoint sources of pollution; and public education and participation. TMDLs establish the maximum amount of a pollutant (or pollutants) that a water body can

assimilate and still meet water-quality standards and support designated uses.

Currently, DNREC is actively involved in the second year of the five-year project. Efforts are under way to finalize the water-quality assessment of the watershed; conduct intensive water-quality and quantity monitoring; build an inventory of Geographical Information System (GIS) data layers regarding land use for the watershed — such as land coverage, geology, soil, and topography; and develop hydrodynamic and water-quality models for the watershed and for the receiving streams.

Intensive data collection within the Delaware portion of the Christina River watershed (Christina Sub-basin) is expected to continue with some modifications and additions. Monitoring activities planned by the Division of Water Resources for the state fiscal year (July 1997 – June 1998) are summarized below.

Intensive (Bi-Monthly) Monitoring

The objective of this element of the Christina Sub-basin Monitoring Plan is to collect appropriate water-quality data that will be used for development and calibration of a hydrodynamic and water-quality model of the Christina River and its major tributaries. The collected data will provide the basis for calibration of the model to ensure that it accurately predicts water-quality and quantity conditions. Monitoring stations were selected based on one or more of the following factors: proximity to state line; proximity (or collocation) with U.S. Geological Survey stream gauging stations; proximity to surface-water intakes; confluence of major tributaries; above/below urban areas; above/below point-source discharges; availability of historic data; and ability to serve as a clean reference site.

Stormwater Monitoring

The objective of stormwater monitoring in the Christina River Sub-basin is to collect stormwater related water-quality and quantity data. This information will be used to characterize stormwater runoff based on various land-use activities in the watershed and will be used to calibrate the watershed model. This monitoring activity is part of the Interstate Christina Sub-basin Nonpoint Source Management Strategy and is based on a comprehensive plan developed by the U.S. Geological Survey.

Special Surveys

The purpose of this element of the Christina Sub-basin monitoring activity is to collect additional data that are not covered under other monitoring activities in the sub-basin. Data collected during this activity will be used to satisfy modeling needs. The special surveys may include continuous monitor deployments and/or hydrologic and hydro-

dynamic surveys of the streams. Hydrodynamic surveys of the tidal portion of the Christina River will be conducted using an acoustic doppler current profiler. During these surveys, tidal currents at several locations will be monitored for a full tidal cycle. The information collected will be used to calibrate the hydrodynamic model of the Christina River.

Fish Consumption Advisories

DNREC and the Department of Health and Social Services issued a public health advisory on the consumption of fish taken from the Christina River Sub-basin in April 1996. The advisory was the result of an intensive study of contaminants in fish tissue and is being issued due to the detection of elevated levels of polychlorinated biphenyls (PCBs) in the fish. The immediate goal of the advisory is to reduce the level of human exposure to PCBs.

Along with the study of contaminants in fish and drinking water, DNREC has also conducted sediment sampling throughout the lower Christina Sub-basin to determine the magnitude and extent of contamination. Initial results of the study indicate higher levels of PCBs in the sediments in the areas of the Christina where fish with the highest levels of PCBs were found.

DNREC has been working actively to investigate land-based activities in these areas to determine potential sources and to clean up sites that may be contributing to the contamination. Another tool DNREC is using to clean up contaminated sites is the Brownfields initiative, which is designed to promote voluntary cleanup and reuse of abandoned industrial sites. The longer-term goal of DNREC is to be able to lift the advisory once contaminant levels in the fish are reduced to a safe level. As cleanups continue, improvements to water quality will be assessed.

Biological Assessment

In fall 1993, DNREC collected macroinvertebrate samples and conducted habitat assessment in 39 nontidal streams within the Piedmont Basin. Sites were randomly selected to provide unbiased estimates of the proportion (percent) of stream miles in the region with three classes of quality: “good,” “fair” (moderately degraded), and “poor” (severely degraded). This framework provided the basis for an overall assessment of the biological condition of nontidal streams to complement the more detailed assessments that have been completed on specific streams or stream reaches.

Aquatic organisms were found to be severely impacted throughout the region. Urbanization appears to be a major nonpoint source of pollution and habitat degradation, affecting almost all (90%) of the stream miles in the region. Likely stressors include changes in hydrology, water quality, sediment quality, and physical habitat. Further study is

needed to define the relative contributions of the various stressors impacting the biota.

A small proportion of stream miles (10%) in the region were found to be comparable to reference conditions for either biological or physical habitat quality. Therefore, approximately 30 miles of nontidal streams in the region still remain in “good” condition after 200 years of European settlement and development. The vast majority of stream miles are impacted by a variety of human activities, with urbanization the most widespread. The protection of rare high-quality stream segments and the restoration of numerous impacted segments are management priorities in the region.

Recommendations

- ◆ Continue to implement stormwater controls for new developments; aggressively implement controls, including land-use controls, in the few remaining undeveloped forested watersheds in the region.
- ◆ Coordinate monitoring and assessment activities with Pennsylvania and Maryland.
- ◆ Conduct additional monitoring to identify specific stressors at “fair” and “poor” sites.
- ◆ Evaluate the effectiveness of National Pollutant Discharge Elimination System (NPDES) and stormwater controls.
- ◆ Repeat the biological assessment using the same approach and methodologies as appropriate.

WATER QUANTITY

Assessment needs consist solely of additional program staff to help administer the water allocation and hydrologic conditions monitoring programs.

- ◆ Integrated water resources planning, with particular emphasis on pricing techniques and demand-side management, should be adopted as a matter of regulatory policy and water utility management by municipally owned suppliers.
- ◆ The water quantity management (allocation) program should be used to help encourage more efficient use, restore potentially useful aquifers, assure against further overdrafting of supplies, reallocate surface supplies, and impose appropriate minimum stream-flow standards to protect designated uses.
- ◆ Investigate ASR technology.
- ◆ Encourage reuse — after treatment — of groundwater contaminated by volatile organic chemicals through the allocation and environmental restoration programs. This would serve to “clean up” and create a benefit (continued incentive) for the remediation.

- ◆ Investigate reuse of wastewater.
- ◆ Enhance water conservation practices entailing increased public education in cooperation with the utilities.
- ◆ Support local government recharge maintenance efforts and water-supply protection efforts.
- ◆ Support investments to maintain basic hydrologic monitoring programs in the state and federal governments.
- ◆ Develop cost-effective, environmentally beneficial water-supply projects in conjunction with demand-side measures.
- ◆ Use the model of the Christina River Basin Drought Management Committee as successful implementation of *Whole Basin Management*.

SOILS

The *Soil Survey of New Castle County* was conducted in the 1960s by the U.S. Department of Agriculture’s Soil Conservation Service and was published in October 1970. The concepts and protocols currently applied in the mapping and classification of soils has changed significantly since that soil survey was published. Little, if any, laboratory work was conducted on the soils during that survey, and most soils information was extrapolated from adjacent areas in Maryland and Pennsylvania. The soil survey was primarily prepared for agricultural purposes, and many of the wooded and urban areas were mapped using a very large scale, which resulted in the loss of now-necessary detail and accuracy. Recently, New Castle County commissioned the Natural Resources Conservation Service (formerly the Soil Conservation Service) to re-map southern New Castle County. The Piedmont Basin similarly should be re-mapped to today’s standards of accuracy.

Such a new soil survey — in conjunction with DNREC’s new statewide wetland mapping project and associated new land-use and land-cover data — should facilitate the identification of areas within the Piedmont Basin where growth could be encouraged and areas where development should be discouraged due to unique and/or rare plant communities or wetlands.

Each site evaluation to replace an existing septic system or construct a new one is identified by a tax-parcel number. This information could be further specified as to the *actual on-site septic approvals granted and the type of system approved*. If the site evaluation data base could be linked with other DNREC Geographical Information System data, such as soils and land use/cover layers, it would enable,

for instance, the estimation of nutrient-loading rates to ground- and surface waters from septic systems. A survey of all dwellings in unsewered areas also needs to be conducted to determine areas of high septic system failure or high cesspool numbers, followed by DNREC's encouraging the government of New Castle County to sewer these areas first.

SEDIMENT

Monitoring

The following efforts are needed in order to accurately assess sediment impacts in the Piedmont Basin:

- ◆ Data on stream channel erosion, sediment transport, and deposition.
- ◆ A monitoring program to assess the degree to which contaminated sediments are a "historic" or ongoing problem.
- ◆ Sampling for total suspended solids in surface runoff (i.e., before reaching receiving waters).
- ◆ Sediment sampling in the Shellpot Creek and Naamans Creek watersheds.
- ◆ Expansion of surface-water quality monitoring programs utilizing the "triad" approach in characterizing sediment contamination at selected sites.
- ◆ Additional stream habitat assessments to verify links with watershed imperviousness.

Information Gathering

GIS coverage of tax-map parcel data for New Castle County, active construction sites, and existing stormwater management facilities should be developed in order to accurately assess sediment impacts in the Piedmont Basin.

Evaluation

The following analyses/evaluations should be conducted in order to accurately assess sediment impacts in the Piedmont Basin:

1. Evaluation of existing U.S. Waterways Parametric data to determine if it is possible to separate wet weather data from dry weather data.
2. If #1 is feasible, conduct a trend analysis for total suspended solids under "wet" and "dry" weather data.
3. Analysis of existing sediment sampling data to assess the possibility of determining the historic rate of deposition and measurement of bed-load flux.
4. Analysis of data collected under the EPA's Environmental Monitoring and Assessment Program.

WETLANDS

Comprehensive Conservation and Management Plan for Nontidal Wetlands

A parallel and requisite component of the Freshwater Wetlands Act was to be the development and implementation of a Comprehensive Conservation and Management Plan for Nontidal Wetlands. Intended to be one component of that comprehensive legislative initiative, the absence of its enabling statute and associated regulations necessitated that this plan become instead a major umbrella under which various *non-regulatory* approaches could be developed and implemented.

The principal objective of the plan is to identify all potential tools, mechanisms, and participants available to achieve freshwater, nontidal wetlands conservation. Main plan components address wetland acquisition strategies, voluntary wetland rehabilitation measures, compensatory mitigation instruments, and means by which to build community support through public outreach and technical assistance. This approach necessarily involves coordination with other state, county, and federal agencies, as well as private non-profit entities. Currently under development by the Division of Water Resources' Watershed Assessment Section, the Comprehensive Conservation and Management Plan is organized into the following focus areas:

- ◆ Inventory of the Resource/Status and Trends
- ◆ Laws and Regulations
- ◆ Land Protection
- ◆ Land-Use Planning
- ◆ Research Initiatives/Status of the Science
- ◆ Restoration/Creation/Enhancement and Compensation Banking
- ◆ Building Support/Education
- ◆ Technical Assistance

The developing Comprehensive Conservation and Management Plan includes parallel projects integral to the overall planning effort, from refinement in the characterization of the wetland plant communities to evaluating methodologies for wetlands restoration siting and for wetlands functional assessment.

Recommendation

- ◆ Complete *Comprehensive Conservation and Management Plan for Nontidal Wetlands — Technical report and Strategy*. Implement the plan and strategy, where feasible, in conjunction with the Whole Basin Management approach.

Statewide Wetlands Mapping Project

The Statewide Wetlands Mapping Project will provide recent statewide estimates of wetland acreage by wetland type. Based on the previous mapping project conducted by the National Wetlands Inventory discussed above, the Statewide Wetlands Mapping Project employs a state-modified classification scheme (Cowardin et al., 1979) to further characterize wetland resources. Larger-scale, rectified aerial photography, smaller minimum mapping units, and the depiction of identifiable Category I wetlands will more accurately detail the location, extent, and character of Delaware's wetland resources in both hard copy (mylar) and computerized formats. Geographical Information System analysis of the digital wetlands data will allow for wetland type and acreage analysis for the Piedmont Basin and for each watershed contained therein. Further, completion of the Statewide Wetlands Mapping Project will advance both the recent trends study and the wetlands aerial mapping/tracking methodology, described below.

Recent Wetlands Trends Study

A wetlands trends study is being undertaken through a Memorandum of Understanding with the U.S. Fish and Wildlife Service. Using maps generated through the Statewide Wetlands Mapping Project (see above), the recent trends study will determine the type, location, and cause of lost wetland acreage *by basin* from 1982 to 1992.

Recommendation

- ◆ Use results from Trends Study as input in formulating a Comprehensive Conservation Management Strategy for Nontidal Wetlands.

Wetlands Aerial Mapping / Tracking Methodology

A future Watershed Assessment Section project will develop a wetlands aerial mapping/tracking method for determining future wetlands trends over regular time intervals. This method will be designed on a whole-basin basis, using the 1992 Statewide Wetlands Mapping Project as a recent baseline from which to monitor future changes. This information will be important for (1) determining basin and watershed wetland loss rates; (2) justifying to the public the need to enhance and expand public and private protection programs; and (3) identifying wetland restoration sites and mitigation banking needs by basin and watershed.

Reference Wetlands and Hydrogeomorphic Classification

A national research initiative is seeking to classify wetlands based on principles of hydrogeology (Brinson, 1993). A classification system based on the position of wetlands

in the landscape will provide information on the source, direction, and hydrodynamics of water movement within a hydrogeomorphic class. The Hydrogeomorphic Approach to Functional Assessment identifies five wetland classes: riverine, depressional, slope, fringe, and flats. Functional assessment models have been developed for each wetland class and for specific wetland functions. Theoretically, each hydrogeomorphic class and set of functional models must be modified to meet regional conditions. This is achieved through case studies to identify hydrogeomorphic subclasses and differences in regional functional variables. The models are then scaled to regional hydrogeomorphic conditions through the use of reference wetlands. A case study has been developed by an interagency federal/state work group for the riverine wetland class in the Coastal Plain province of the Mid-Atlantic region. Delaware is participating in this study to identify riverine hydrogeomorphic subclasses and to select appropriate reference wetland sites within the state.

The DNREC Division of Water Resources, Watershed Assessment Section, is undertaking a study to provide baseline data on the ecological integrity of nontidal wetland functions. To coordinate with other restoration initiatives, the St. Jones watershed has been selected as the particular watershed in which reference wetlands would be chosen using a hydrogeomorphic approach. Knowledge gleaned from this pilot Coastal Plain study should be useful in the design of wetlands monitoring studies for the Piedmont Basin.

Recommendation

- ◆ Improve the understanding of wetland hydrogeomorphic classification and wetland functions through monitoring in reference wetlands.

Wetlands Compensatory Mitigation and Mitigation Banking

Compensatory mitigation banking remains a relatively new regulatory concept that has gained increased attention by federal, state, and local governments as a wetland management strategy due, in part, to evidence that individual wetland restoration, creation, and enhancement projects may not adequately compensate for permitted wetlands impacts. Caution is still warranted in the use of mitigation banking as a conservation measure due to the lack of quantitatively and qualitatively identifiable successes among the relatively few existing mitigation banks. However, the current difficulty in predictably establishing, monitoring, and evaluating mitigation banks should be weighed in consideration of the same difficulties associated with individual (non-banking) compensatory mitigation projects.

To date, mitigation banking program design and implementation have generally necessitated the investment of

substantial expertise, financial resources, time, and property. An objective of a recent Division of Water Resources effort has been to identify the situations where mitigation banking — employing wetlands restoration, creation, enhancement, and preservation — can be used to effectuate nontidal wetlands conservation in Delaware. DNREC recognizes that efficiency and expediency in the development and implementation of effective resource and compensatory mitigation programs will benefit both the regulated community and the natural resource. To the greatest extent possible, compensation banking should be undertaken to meet multiple environmental objectives and should consider local, statewide, and regional goals.

Recommendation

- ◆ Establish and encourage the use of public and private sector mitigation banks through the developing Delaware Compensation Banking Program.

Establishment of Interagency Mitigation Banking Agreement

A draft interagency mitigation banking agreement — “The Wetlands Compensatory Mitigation Banking Agreement for the State of Delaware” — has been developed by the Division of Water Resources for the purposes of enabling wetlands banking in Delaware. The agreement endeavors to effectively and efficiently expedite and encourage wetlands banking as a compensatory mitigation instrument for unavoidable impacts to waters of the United States, including wetlands, resulting from projects occurring within Delaware. The wetland banking agreement is a means of insuring that the wetland banking program in Delaware will be consistent with existing federal and state regulatory programs. The agreement will also facilitate comprehensive natural resource management by integrating wetlands compensation into other watershed protection and management programs, such as *Whole Basin Management* (DNREC Draft Agreement, 1996).

Wetlands Restoration in the Silver Lake Watershed

A pilot project to use wetlands as a component of overall watershed management is under way in the Silver Lake sub-watershed of the St. Jones watershed. This watershed was selected based on restoration site suitability (such as the existence of former wetlands which have been drained for farming), the recent deterioration of water quality due to urbanization, and the opportunity to coordinate with other environmental, technical, and educational initiatives within the watershed. The development of a detailed wetlands/watershed restoration plan will provide information that may serve as a prototype for use in the Piedmont Basin.

Wetlands Restoration in Critical Watersheds

Another facet of wetlands restoration is the identification of watersheds or basins in which wetlands restoration is needed. The Watershed Assessment Section will undertake a study (1997–1998) to identify critical basins and watersheds based on past and current federal permit activity in nontidal wetlands. The goal of this study is to locate critical watersheds in which wetlands restoration is needed and for which compensatory mitigation is (or will likely be) required. Thus, compensatory wetlands banks may be sited to improve the ecological health of a watershed while facilitating the compensation process. Additional information on the identification of critical watersheds for wetlands restoration also may be gained through the 1996–1997 trends study.

LIVING RESOURCES

Recommendations

- ◆ Upland forests have experienced severe declines. They continue to decline because of encroaching development and the ensuing invasion of exotic species. A survey of the Piedmont Basin should be conducted as soon as possible to identify remaining upland forests and to evaluate the quality of these areas by such factors as biodiversity, size, age, and exotic infestation. Appropriate actions should then follow, such as natural area designation for qualifying tracts, legal protection, and/or restoration.
- ◆ Some rare habitat types may be in danger of disappearing completely from the Delaware portion of the Piedmont Basin. A survey of such habitats should be conducted and summarized. Appropriate actions should be taken to protect these areas, including natural area designation for qualifying tracts, legal protection, and/or restoration.
- ◆ Guidelines for natural resource protection exist in the New Castle County Comprehensive Plan. The New Castle County Comprehensive Plan has already incorporated some of the ideas put forward in this document. A dedicated effort to enforce the plan must be made in the future to prevent further degradation of the natural resources of the county.
- ◆ County ordinances restricting development in the floodplain have been helpful, but do not sufficiently protect this critical habitat. Sewer lines or sewer line improvements should be prohibited within the floodplain.
- ◆ The majority of our most critical living resources depend on good-quality aquatic habitats and a natural

flooding regime. Activities that eliminate unnaturally high sedimentation and erosion rates and unnaturally high nutrient inputs should be promoted. Water conservation to minimize water withdrawals, especially from White Clay Creek, should be encouraged.

- ◆ One of the most significant impacts on our environment comes from the direct and indirect effects of new construction in areas more and more peripheral to existing urban areas, schools, and employment centers. When and where construction is needed, we should encourage infill to existing developed areas rather than development of “green” spaces.
- ◆ With their population increasing annually, resident geese are becoming a nuisance species in the Piedmont Basin. These birds are most problematic in grassy, mowed areas especially those adjacent to ponds, lakes, and streams, where their feces and feather residues contribute to eutrophication. Even without the geese, these areas often suffer negative effects from the lack of or insufficient buffer along pond and stream edges. Efforts to relocate or hunt the geese are ineffective and impractical. Stream and pond management that incorporates wide buffers of natural vegetation, including stands of woody species, should be encouraged when possible.
- ◆ Loss of forests and shade trees is an issue throughout the Piedmont Basin. In addition to their role in providing habitat, trees provide diverse ecological functions including stabilizing soil, filtering air-borne particulate matter, providing visual and sound barriers, and cooling the environment. As population increases place additional demands on the environment, these free environmental services provided by trees will become more critical. Reforestation in appropriate natural areas and tree planting in urban and suburban areas, especially along roads and stream corridors, should be encouraged.
- ◆ DNREC maintains multiple data bases regarding the state of the environment, many of which are geographically based. All divisions and many sections or programs within those divisions maintain GIS data bases and employ GIS specialists, yet there is no formal coordination of those efforts. A DNREC-wide GIS working group needs to be formalized and supported. The purpose of this group will be to ensure data and equipment compatibility and to facilitate data exchange where appropriate. Make data available to local governments and planning agencies to help these entities make more informed decisions.
- ◆ We need to recognize the threat of invasive exotic plant and animal species in the Piedmont Basin. The situation

is far worse in this basin than elsewhere in the state. We need to discourage the planting of invasive exotic plants, and encourage the use of native and non-aggressive exotic plant species. Management personnel need to be trained to recognize exotic invasives and to develop management strategies. This information needs to be made available to local citizens.

AIR

Monitoring Pollutants with Air-Quality Standards

Sulfur Dioxide, Nitrogen Dioxide, Carbon Monoxide, Lead, and Ozone

The existing monitoring network is sufficient to provide adequate information on ambient concentrations. At this time, no expansion of the monitoring network is needed.

Particulate Matter (PM₁₀)

The existing monitoring network is sufficient to provide adequate information on ambient concentrations. However, when the EPA promulgates new standards for particulate matter, the network will be re-evaluated. No expansion of the monitoring network is presently needed; re-evaluation will occur after promulgation of new particulate matter standards.

Monitoring Pollutants without Air-Quality Standards

Deposition

Nitrogen deposition to the Piedmont Basin has not been quantified. However, monitoring is resource intensive, and resources are limited. Acid precipitation monitoring at Lums Pond is probably representative of precipitation across the Piedmont Basin. Required resources should be assessed to do actual monitoring of wet and/or dry nitrogen deposition in the basin. Acid precipitation monitoring should continue; no expansion is recommended at this time.

Air Toxics

Monitoring for air toxics can include either ambient air or deposition monitoring. Ambient monitoring data in the Piedmont Basin are limited; deposition has not been monitored. Monitoring methodology for both ambient concentrations and deposition varies and is largely still under development; existing methods are resource intensive. Recommendations include continuing current ambient monitoring and continuing to work with the Division of Public Health on a monitoring plan as part of a larger effort to assess environmental pollutant impacts on human health.

Information Gathering — Pollutants with Air-Quality Standards

Sulfur Dioxide, Nitrogen Dioxide, Carbon Monoxide, and Lead

Adequate information currently exists to evaluate the status and trends of these pollutants. No further action is presently required; continue current data collection and evaluation process.

Ozone

The regional nature of the ozone problem makes it essential that we continue to participate with other states and regional agencies in data-sharing efforts. Delaware currently works with other states, regional agencies, and the EPA to communicate ozone data among various states and agencies. This data-sharing effort should continue.

Particulate Matter (PM₁₀)

Adequate information exists to evaluate the status and trends of particulate matter. When new particulate standards are promulgated, information needs will be assessed. No further action is presently required; continue current data collection and evaluation.

Information Gathering — Pollutants without Air-Quality Standards

Deposition

There has been a significant increase in research relating to atmospheric deposition in recent years, some of it resulting from requirements in the 1990 Clean Air Act Amendments. Since actual monitoring is resource intensive, it is important to avoid “reinventing the wheel” by duplicating work already done that is relevant to the Piedmont Basin. Recommendations for nitrogen and acid precipitation include the following: review published research on this subject (particularly work associated with Chesapeake Bay); coordinate with nonpoint pollution and watershed assessment programs; and review recently received data on ion concentrations in the historical data base.

Air Toxics

Deposition of toxic compounds to watersheds has not been the subject of as much research as nitrogen and acid rain. There is a larger body of work relating to measurement of ambient concentrations although there is less data on health or ecosystem impacts. Reviewing published research (particularly work associated with the Chesapeake Bay and the Clean Air Act Amendment’s Great Waters Section) in these areas is recommended.

Emissions Inventories

The periodic ozone precursor emission inventories for volatile organic compounds, nitrogen oxides, and carbon

monoxide are compiled every three years; they are comprehensive and cover all emission source categories. Emission inventories for sulfur dioxide, particulate matter, total suspended particulates, lead, and toxics are performed annually, but only for point sources. Comprehensive inventories of these pollutants are recommended in order to gain additional information on impacts to the Piedmont and other basins. Compiling more comprehensive inventories, however, is resource intensive and cannot be accomplished with current resources. Impacts of emissions on the Piedmont and other basins could also be improved by developing methods to enable area, mobile, and biogenic emissions to be illustrated in graphical form, such as on a GIS map.

Recommendations

- ◆ Explore options for acquiring the needed support to produce comprehensive, periodic inventories of sulfur dioxide, particulate matter, total suspended particulates, lead, and toxics.
- ◆ Develop a method to allocate and graphically portray area, mobile, and biogenic emissions to river basins.

Evaluation of Pollutants with Air-Quality Standards

Sulfur Dioxide, Nitrogen Dioxide, Carbon Monoxide, and Lead

Analysis of current data and trends indicates that ambient air-quality standards are being met; average ambient concentrations are stable or declining. No further action is required; continue current data collection and evaluation.

Ozone

Delaware is participating with the EPA and other regional agencies in data analysis, control strategy development and evaluation, and modeling efforts. While ozone remains a problem, significant progress is being made.

Particulate Matter (PM₁₀)

Analysis of current data and trends indicates that ambient air-quality standards are being met; average ambient concentrations do not show an increase at this time. When new particulate matter standards are promulgated, the data will be reviewed.

Evaluation of Pollutants without Air-Quality Standards

Deposition

The literature and data reviews described previously must be completed before the evaluation phase.

Recommendations

- ◆ *Nitrogen* — Evaluate published research for its applicability to the Piedmont Basin; determine

costs/benefits of monitoring in the Piedmont Basin versus using data generated in other regions.

- ◆ *Acid Rain* — Evaluate as above; determine if there should be any changes to existing monitoring program.

Air Toxics

As stated earlier, the literature and data reviews must be completed before an evaluation can be made. In doing so, one should continue the following:

- ◆ Literature and data reviews for applicability to the Piedmont Basin.
- ◆ Coordination with the Division of Public Health, as stated earlier.
- ◆ Existing monitoring with emphasis on detection of trends.
- ◆ Enhanced review of Toxics Release Inventory data for accuracy.
- ◆ Review of emissions and Toxics Release Inventory data to determine need for expansion/changes in monitoring.

CONTAMINANT SOURCES

Solid Waste

Groundwater and surface water in Shellpot Creek in the Cherry Island area (the Delaware River floodplain between the mouth of the Christina River and Fox Point State Park) are both contaminated. A number of groundwater samples collected from this area have detected anomalous levels of arsenic, iron, zinc, ammonia, and COD (chemical oxygen demand). Surface-water samples from near the mouth of Shellpot Creek have detected anomalous iron, lead, manganese, nickel, zinc, and pH levels. This area needs further assessment to determine the source of this contamination. Possible sources in the area include one municipal, one industrial, and three coal-ash landfills; one resource recovery facility; the City of Wilmington sewage treatment plant; past and ongoing dredge spoil operations; several chemical plants; several Superfund sites; and several National Pollutant Discharge Elimination System (NPDES) outfalls.

Septic Recommendations

- ◆ From the new soil survey, freshwater wetland maps, and 1992 land-use maps and data, determine areas where growth could be encouraged and areas where development should be discouraged due to unique and/or rare plant communities or wetlands.
- ◆ Conduct a survey of all dwellings in unsewered areas to determine areas of high septic system failure or high cesspool numbers. Encourage New Castle County to sewer these areas first.

Hazardous Materials

DNREC needs to determine if all contributing contaminant sources in regions with polluted air, soil, groundwater, surface water, and/or sediment have been identified. If DNREC has not yet identified all contributing sources, the Hazardous Waste Management Branch can conduct Resource Conservation and Recovery Act (RCRA) compliance assessments at hazardous waste generators located in these regions to assess whether the generators may be a contributing source. The Site Investigation and Restoration Branch will continue to perform investigations to determine sources of contamination.

DNREC also needs to identify hazardous materials management facilities and other sites that may release hazardous substances located in environmentally sensitive areas such as locales with species of concern, riparian zones, Water Resource Protection Areas, floodplains, and near wetlands. DNREC can work with facilities located in these areas to help them reduce the amount of hazardous materials on-site and to educate them about proper management of these materials to prevent releases to the environment. The Pollution Prevention Program can also target these facilities for pollution prevention assistance.

Improving coordination and information sharing with publicly owned treatment works is another assessment need. Such coordination can help DNREC identify non-reporting hazardous waste generators and areas where releases of contaminants to the environment may be occurring. The publicly owned treatment works can also assist in encouraging facilities to adopt pollution prevention practices.

LAND USE

Planning

Identifying Technical Problems, Issues, and Opportunities

The Comprehensive Development Plan Update approaches an array of technical matters in a straightforward and easy-to-comprehend manner. The following stand out as areas that are well presented or identified as to their importance in the comprehensive planning process. In some cases, new concepts or ideas have become woven into the essence of the plan. This clearly demonstrates that the New Castle County Department of Planning is responsive to and supportive of a variety of concepts and techniques to improve the county's planning capability. Special note should be made of the following:

- ◆ Reiteration of an "environmental planning ethic" from the 1988 plan to "build an environmental consciousness" that emphasizes preservation and mitigation.

- ◆ Recognition of the *Whole Basin Management* approach as a valuable multidisciplinary effort to evaluate and address environmental issues on a basin-wide level. This is one area where the technical capability of both the state and county can work hand-in-hand to understand environmental problems and develop technical solutions and public policy directions that can improve overall quality of life.
- ◆ Acknowledgment of the *DNREC/EPA Performance Partnership Agreement* and the county's desire to join in this effort.
- ◆ Preparation of a "Conservation Plan" to serve as an inventory as well as to "send a clear message" that natural resources must be protected.
- ◆ Discussion of strategies to link transportation and land use that begin to realistically look at the symbiotic relationship between these two components of growth.
- ◆ Creation of "scenic transportation corridors" that would promote leaving certain country roads as they are by not increasing capacity and only making improvements for safety reasons.
- ◆ Presentation of the "village pattern" as a viable land-use alternative to suburban sprawl and as a reinforcement to maintain the social, cultural, and economic vitality of existing villages in the county. This approach is unique and has great potential.
- ◆ *Transit Overlay District*. This concept is proposed to allow for a "transit friendly neighborhood within walking distance of public transportation in order to increase the efficiency of the transit system." The concept, while not radical, fits comfortably with the initiatives of WILMAPCO and the state to provide for alternative uses within the transportation system. It should receive top priority for detailed analysis by DNREC working with WILMAPCO and DelDOT.
- ◆ *Neighborhood Mixed-Use Zoning*. This is a Department of Planning proposal that would pave the way for implementation of the village zoning district and the transit overlay zone. This somewhat intimate zoning concept would be the base to make the other two zoning districts feasible. It seems obvious because of the focused intent of this zoning approach that areas throughout the county could be selected immediately as candidates for implementing the neighborhood mixed-use zoning.

Growth Management and the Plan

The area that requires a serious evaluation is how the county proposes to manage change, which underscores the transition from policy recommendations to implementation measures. The plan devotes an entire chapter to a "growth management program" and adequately addresses a host of elements that need to be incorporated into the ongoing planning process. There are several "implementation initiatives," as summarized below, that have special merit in effectuating the county plan:

- ◆ *Village Zoning Districts*. Using the justification that the village land-use pattern "should not be subject to the same regulations that are applied to the county's suburban areas," it is recommended that special zoning regulations be adopted to account for the unique qualities that existing (and perhaps even future) villages possess. The Department of Planning proposes a further study to inventory existing villages and evaluate what other communities have done. This seems to be unnecessary considering the information base that already exists and the amount of involvement that DNREC has committed to analyzing its village resources. What needs to be done at this point is to fashion the village zoning concept into a zoning code amendment for enactment.

The Breakdown Between Planning and Implementation

To argue that there has been a failure in the comprehensive planning approach would not be completely fair. The prescription to create and sustain a community based on the interrelationship of protecting environmental integrity, advancing social needs, and allowing for monitored development is at the core of all our plans. At the very least, the concepts, ideas, and proposals have been well established.

Unfortunately, much of our planning has not lived up to expectations to insure orderly growth, which is the basis to achieve a quality of life. Succinctly stated, the problem has not been because of a lack of planning. Rather, what we have witnessed for too long is that there has been a breakdown between the plan-development function and the implementation of approved plans through the regulatory mechanism of zoning.

Where we have gone astray is that the political decision-making process at the local level has not fully embraced planning as a viable approach to guiding future growth. This has resulted in a haphazard pattern of rezonings, which at the time of approval might have had merit on an individual basis, but have demonstrated with time, to be incongruous with long-range goals and policies.

"Shaping Delaware's Future" hopefully will rectify this disparity and re-establish a legitimate context for comprehensive planning at the local level. A positive state role will be to create a new acceptance of insuring that there is a conscientious process to make plans that will be implemented in accordance with agreed-upon goals and visions for the future.

The main critique of the county's *Comprehensive Development Plan Update* (1996) is the ability of the county to make the commitment to implement the various recommendations and proposals it contains. The commitment must start with the Department of Planning itself, which should not become sidetracked in performing more detailed studies. Rather, the department should proceed to develop new regulations or amendments to existing regulations in order to best manage growth. We keep hearing about the "window of opportunity" that we have to address the planning and zoning process and make it fully responsive to the overwhelming consequences of seemingly uncontrolled growth, or sprawl. The county needs to act before the window closes.

Whole Basin Management: Connecting Planning with Environmental Quality

The *Whole Basin Management* approach to assess and manage the state's resources offers an important methodology to evaluate environmental conditions and improvements in a geographical unit. With the designation of the Piedmont Basin and its six watersheds, DNREC will, for the first time, concentrate on a broad analysis of biological, chemical, and physical factors as these determine environmental quality.

There is a cause-and-effect relationship between land use and environmental quality. If the *Whole Basin Management* approach will measure environmental conditions, could we also determine a method to evaluate land-use impact on the environment? More specifically, could we, through the *Whole Basin Management* program, develop a land-use monitoring technique to measure the effectiveness of comprehensive planning in guiding land-use change?

This challenge, if addressed through the Piedmont Basin study, would offer a new basis to understand the connection between land-use development and its impact on the environment, as well as its relationship to comprehensive planning.

Land-Use Monitoring

As noted by James R. Bernard in a workshop at DNREC on April 9, 1996, environmental indicators "describe, analyze, and present scientifically based information on environmental conditions, trends, and their significance. Environmental indicators look at the effects of human activities on the environment as well as the implications of those actions for human health, quality of life, and the integrity of ecosystems."

Through the Piedmont Basin study, the opportunity exists to prepare an information base of "land-use monitoring indicators," modeled after these "environmental indicators." This approach could serve as a "monitoring" of the effectiveness and viability of the comprehensive planning process. With baseline data in hand, we could monitor the changes in land use as they are consistent or inconsistent with the local plan, and how these land-use changes impact the environment.

With time, it should be possible to subscribe some short- and long-range projections for sustaining or improving the quality of life in the watershed predicated on land-use changes and their relationship to the environment.

If this approach can be proven to be both methodologically sound and practical in its application, it might even be suggested that land-use monitoring indicators could become part of the comprehensive planning process. The success of this proposal will be how effective the monitoring indicators are in judging the ability of comprehensive planning to guide future land use. Time will tell.

Land-Use Information Needs

The following discussion suggests that certain additional information will be needed to develop the next two phases of the Piedmont Basin Study: the monitoring phase and the management phase. In addition, this information will be useful in developing the land-use monitoring indicators.

- ◆ A more thorough and complete analysis of the 1982 – 1992 Changes in Land Use/Land Cover should be undertaken, which goes back to the original photography and corrects the classifications of the various polygons and overcomes the problems associated with comparisons of the 10-acre minimum mapping units used in the 1982 project and the 4-acre minimum mapping units used in the 1992 project. Such a project will produce a product with a higher confidence level with respect to accuracy. The product produced in this report is still useful, however, for indicating that sprawled residential and other urban uses are rapidly filling in the Piedmont Basin and that natural areas are rapidly being lost.
- ◆ The Water Resources Agency for New Castle County (WRA) and the Chester County Water Resources Agency (CCWRA) are conducting a "Christina River Basin Nonpoint Source Management Strategy" study, which will provide useful land-use data. The study has field verified the 1992 Land Use/Land Cover mapping of the Christina Basin in order to bring it up to date and placed it in GIS format. The goal is to provide data in acres per watershed for uses of land. These data should provide us with a higher-quality assessment of the Christina River Basin than the DNREC data because it has been field verified and can be used for an up-to-date, build-out analysis on the watershed level. The build-out will compare approved but unbuilt subdivisions and zoning maps with the updated 1992 land-use maps to project what development can be expected using population projections. The build-out can be used to project future infrastructure investment needs and future environmental impacts with respect to different development

policy scenarios, which could yield objective arguments for legislative and policy actions.

- ◆ The WRA is maintaining data layers for maps for this project and others. An updated and detailed list of the data is provided in the July 1996 quarterly report to the Division of Soil and Water. The available information section contains a summary table of the data.
- ◆ Estimates for the sewer capacity expansions, including areas affected, could be very useful indicators of future growth. Wherever central wastewater service is provided, there is an almost irresistible incentive for additional growth. Designation of future growth areas should precede sewer capacity expansion in order to avoid inappropriate growth however that is defined.
- ◆ New aerial photography is needed every five years to map features and changes to the landscape for creating models for pollution management, highway planning, permit writing, zoning analysis, drainage planning, infrastructure planning, and other needs. Land-use and land-cover data used in this analysis were obtained from a multi-agency project involving the Delaware Department of Transportation and DNREC. These data benefited the U.S. Geological Survey, the three county public works agencies, county planning agencies, Delaware Department of Transportation, DNREC, and other agencies. By employing this approach in the future, we can develop maps that meet the needs of many agencies and programs from a single set of aerial photographs at a much lower cost than the customary practice where each agency contracted on its own for photography and maps.
- ◆ On a sub-watershed level, there may still be some streams in New Castle County where impervious land cover has not exceeded the threshold to cause stream habitat decline. These areas for conservation land use should be mapped and tabulated on a sub-watershed level to identify those areas likely to be less than 10% – 15% impervious land cover.
- ◆ Any critical natural areas that are undeveloped and not included in State Resource Areas should be identified as part of the monitoring plan. If these are lands zoned for development, they could be used in a conservation plan that identifies protection mechanisms.

Summary of Land-Use Assessment Needs

Recommendations

- ◆ Use the “Shaping Delaware’s Future Goals” to formulate and implement the monitoring and management plans.
- ◆ Focus efforts on improving information provided to the county to improve zoning.

- ◆ Develop a definition and a “vision” of sustainable development for the Piedmont Basin.
- ◆ Assess state subsidies for their effects on land use in the Piedmont Basin.
- ◆ Use the build-out study from the WRA/CCWRA Christina River Basin Study to project development trends and model impacts.
- ◆ Program infrastructure building to facilitate environmentally sensitive settlement and development patterns.
- ◆ Fortify and improve the accuracy of the Delaware GIS (DEGIS) to overcome limitations of the present map.
- ◆ Use the bi-state Christina River Basin Study to implement monitoring and cleanup/management through existing and planned environmental programs that are already endorsed by Pennsylvania local governments.
- ◆ Address surface-water issues in the Smalley’s Pond watershed caused by rapid land-use changes that may threaten public water supply.
- ◆ Address stormwater management and other high priority issues in the Shellpot and Naamans watersheds.
- ◆ Perform a more detailed analysis of land use/land cover changes similar to what was done in the Nanticoke River to monitor environmental impacts and to program land acquisition.
- ◆ Focus efforts to preserve any unique or important natural areas in the areas of greatest development pressure and remaining open lands.

Land-Use Monitoring Indicators. The following recommendations concern land use and comprehensive planning:

1. Develop a set of “land-use monitoring indicators” that would identify baseline information concerning the land-use settlement pattern.
2. Determine a method to utilize the monitoring indicators to evaluate land-use impact on the environment.
3. Evaluate the possibility of having land-use monitoring indicators incorporated in the comprehensive planning process at the local level.

RECREATION

Parks and Greenways

The assessment of recreational opportunities indicates that the recreational needs of the citizens of the Piedmont Basin are adequately served when evaluated by national standards. Although the basin ranks as *average*, this is not

to say that improvements need not be made. As mentioned earlier, as population density increases in the basin, so will the demand for recreation. Also, as demographics change in the basin, so will desired recreational activities and facilities. Due to these demographic trends, it is obvious that in order to maintain the current level of recreation in the Piedmont Basin, strategies to maximize recreational opportunities in an urban environment must be identified.

In order to improve the current range of recreational opportunities and expand needed open space and provide additional recreational facilities, the following initiatives and programs must be instituted and expanded.

- ◆ Continue a concerted cooperative effort among all recreation providers to provide quality recreational opportunities and facilities in line with recommendations established in the State Comprehensive Outdoor Recreation Plan.
- ◆ Continue the active acquisition of additional and strategically located open space by local governments and the state. Additional lands should be actively acquired/protected in the rapidly developing Christina River and White Clay Creek watersheds. Available lands suitable for recreation/resource protection adjacent to existing facilities should also be a high priority for acquisition.
- ◆ Increase funding to local governments for open space acquisition and greenway and park development through the Delaware Land and Water Conservation Trust Fund. Encourage participation by the private sector in providing funding and assistance for recreational improvements.
- ◆ Maximize the benefit of existing recreational facilities by connecting them to population centers through a statewide system of greenways.

Fish and Wildlife Recreation

The assessment of fish and wildlife recreation opportunities within the Piedmont Basin indicate that, although limited by continued high human population levels, the opportunities that are available receive tremendous participation and provide some of the most unique sporting opportunities within the state. Unfortunately, ever-increasing suburban sprawl within the region has raised moral and safety concerns about hunting and fishing and further restricted public access, while development, industry, and poor agricultural practices continue to degrade the fish and wildlife habitats on which these activities depend. Therefore, in order to continue to meet the region's recreational needs, programs and initiatives that address these detriments to fish and wildlife recreation must be implemented, supported, and expanded.

These efforts should include the following:

- ◆ Continued support and expansion of aquatic habitat protection and improvement initiatives, specifically those addressing stormwater management, fish habitat improvement, and nonpoint source pollution and sediment control.
- ◆ Continuing research to determine sources of, remediation of, and extent of contaminants within finfish of the Christina, Brandywine, and Red Clay watersheds.
- ◆ Continuing support of the assessment of impacts and alternatives to proposed water supply solutions within northern New Castle County.
- ◆ Continued support and expansion of recreational hunting programs specifically designed to reduce nuisance wildlife populations to within social carrying capacities.
- ◆ Continued support and expansion of the Northern Delaware Wetlands Rehabilitation Program's efforts to restore tidal exchange to tributaries of the Christina River, thereby improving wetland functions and values to these highly degraded wetland complexes.